Energy efficiency assessment of household electrical appliances in Central Asia and policies for energy performance standards and labeling

Kazakhstan

Kyrgyzstan

Tajikistan

Turkmenistan

Uzbekistan

2015

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Summary

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The report was prepared by Atabek Umirbekov and Almaz Akhmetov (CAREC), who collected and analyzed all necessary data and information. Country level data was gathered by Darkhan Kurmanbayev (Kazakhstan), Tatyana Vedeneva (Kyrgyzstan), Furguzod Usmonov (Tajikistan), and Rakhimzhan Babakhodzhayev (Uzbekistan). Maria Semenova of UNEP coordinated implementation effort and provided technical assistance in development of the regional assessment. The project was managed by Mozaharul Alam, Regional Climate Change Coordinator for UNEP's Regional Office for Asia and the Pacific.

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Acronyms and abbreviations

BAT	Best Available Technology
CA	Central Asia
CAREC	Regional Environmental Centre for Central Asia
CIS	Commonwealth of Independent States
EE	Energy Efficiency
EES&L	Energy Efficiency Standards and Labeling
UNEP	United Nations Environment Programme
EEU	Eurasian Economic Union
EU	European Union
FES	Fuel and Energy Sector
GDP	Gross Domestic Product
HEA	Home Electric Appliance
KR	Kyrgyz Republic
RE	Renewable Energy
RK	Republic of Kazakhstan
RU	Republic of Uzbekistan
USSR	Union of Soviet Socialist Republics
UN	United Nations
WTO	World Trade Organization

Introduction

Globally, household electrical appliances (HEA) represent one of the fastest growing segments of energy use, with increasing share of electricity consumption by households (Worldwide Trends of Energy Use and Efficiency, IEA, 2008). This trend manifests in multiple countries and is generally predetermined by gradually expanding national economies and improving public welfare. Other underlying factor sinclude falling technology costs due to technical progress and decreasing production costs for the most common types of household appliances.

Consequently, the rapid increase of electricity consumption by households contributes to augmenting power consumption by national economies. In developing countries where electricity output depends on fossil fuels, growing electricity consumption inflates GDP carbon intensity and environmental pollution. Whether energy-resource rich or deficient, the overall context suggests the need to amplify generating capacity. Broad use of energy-consuming appliances in the residential sector entails increased power grid base and peak loads, and exacerbates risk of power supply emergency shutdowns. These demand additional technical servicing of residences, and consequently require either increasing electricity supply-related costs for households, or in cases of subsidized tariffs, increasing state expenditure.

However, the world is already witnessing enhanced energy efficiency of electrical equipment due to scientific and technical progress, and implementation of national energy-efficiency (EE) policies. Expansion of international trade promotes dissemination of power-efficient goods in various countries, including those lacking clear target policies (i.e., legal energy consumption requirements for types of devices and/or energy-performance class labeling). Their absence leaves domestic markets vulnerable to importation of inefficient equipment, and prevents quality regulation related to domestically manufactured electrical appliances. Lack of energy consumption labeling curbs use of consumer choice as a viable market tool. In combination, these factors lead to use of low energy-efficient equipment.

In recent years, understanding of the importance of energy saving and efficiency in Central Asian (CA) countries has improved considerably. Countries in the region endorse laws and regulations – technical regulations, programs to replace inefficient lamps, and energy management systems at industrial enterprises – to increase EE of various segments of the economy. The electrical appliances sector is not disregarded either; the states formulate national programs to increase EE of electric devices.

The objectives of UNEP/CAREC regional assessment included (i) analyzing electricity consumption dynamics by households and assessing corresponding factors, (ii) identifying the most common household appliances in Central Asian countries, and application of EES&L to those that have the greatest impact in terms of saved energy, and (iii) reviewing development of EE legal frameworks generally and on EES&L specifically, and identifying paths to enhancement of legal, technical, and institutional schemes.

The study covered nearly all Central Asian countries. For Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan, analysis was conducted using data collected by national project experts and those available in open sources, including national statistics. For Turkmenistan, analysis was limited to data available through open analytical sources.

Section 1 of the report reviews energy profiles of countries in Central Asia (CA), and their respective electricity generation and consumption dynamics by sector. Current shares and trends of electricity use by the residential sector, and the volume of household electricity consumption in the countries, were investigated separately. The section concludes with decomposition analysis to evaluate the degree and direction of influence imposed on electricity consumption by households by individual factors during the last two decades.

Section 2 analyzes the most popular types of household appliances in CA states, household ownership rates for types of equipment, and data on sources and short-term dynamics of electrical appliances supply in Central Asian states. The section also incorporates information on primary technical characteristics of the most typical household appliances, and assesses approximate duration of their operation in on, off, and standby modes per year. This analysis allowed detection of several types of appliance regulations of power consumption in relation to those that yield the best results. For these devices, an estimated calculation of potential reduction of electricity consumption was conducted in cases of using more energy-efficient models, followed by calculation of reduced household spending on electricity supply and decreased CO_2 emissions.

Section 3 assesses the status and direction of developing EES&L policies in CA countries, emphasizing policy papers that promote increased energy efficiency of various HEAs. The section reviews several initiatives on introducing energy performance class labeling in some countries in the region, opportunities to expand domestic capacities to compliance verification, and gradual replacement of power-inefficient devices. Economic integration occurring in the region, and its influence on national EE policies, receive special attention.

Section 4 summarizes proposals and recommendations regarding further development and implementation of EES&L policies formulated at the Regional Seminar "Energy efficiency assessment of household electrical appliances in Central Asia and policies for energy performance standards and labeling" held from June 18 to 19, 2015 in Almaty (Kazakhstan). The workshop gathered power, energy-efficiency and standardization experts from the region, and a number of international experts, and was devoted to discussing preliminary assessment findings and current EES&L policies in Central Asian countries.

Overview

Enhancing energy efficiency is a pressing issue in Central Asia, where broken economic ties and change store source and production bases have affected the volume and structure of energy consumption. Not with standing a considerable decline of production in the region after the breakdown of the Soviet Union, fuel and energy consumption in the region has increased progressively during the last decade. In 2013, it returned to 1990 levels in Turkmenistan and Uzbekistan.

Similar tendencies were observed for electricity generation and consumption. In some Central Asian states, the post-1990 recession ceased only by the mid-2000s. Today the level of electricity consumption returned, and is comparable to that of 1990. However, the consumption structure underwent considerable changes, and one of the most significant was the increased share of population and residential/municipal sectors regarding overall electricity use. The last 20 years saw steady growth of electricity consumption by the population, against falling consumption by industry, agriculture, and transportation.

The growing number of households is one underlying cause. Analysis also suggests several additional factors such as increasing average power consumption per household due to growing GDP, rising public incomes, and thus the possibility of allocating a growing share of family budgets to acquisition of various types of household, energy-consuming appliances.

Average annual electricity consumption in the residential sector per household is lower than in industrially developed countries, but above the average of other Asian countries. Nearly all countries in the region demonstrate gradual growth of power consumption by households. A number of the countries, particularly Kyrgyzstan, already demonstrate electricity consumption comparable to that of developed European states. According to forecasts, electricity demand will continue its accelerated growth.

Steadily increasing household power consumption might also link with the expanding variety and quantity of household appliances and electric devices used by major electricity consumers. According to available data, the region is characterized by a high degree of household ownership of TVs and refrigerators. Ownership rates for washing machines are also high. Average household ownership of other types of appliances differs among countries due to country-specific circumstances.

In Kyrgyzstan and Tajikistan, the share of electric heating devices and kitchen stoves is high, due possibly to insufficient supplies of natural gas and use of electricity as a prevailing source of power for heating (water and houses) and cooking. Kyrgyzstan also has a large number of incandescent lamps, which might be explained by the country hosting the only full-cycle incandescent lamp factory in the region. Unlike Kyrgyzstan, households in Kazakhstan and Tajikistan use few incandescent lamps, perhaps because of restrictions on their production and importation. Generally, Kazakhstan demonstrates a higher degree of ownership for all types of HEAs, which might be due to robust economic development and higher public incomes. In Tajikistan this indicator is lowest in the region.

The majority of household appliances used in Central Asia are imported. Data available from 2012 show that the net import value of electrical appliances per household was highest in Turkmenistan and Kazakhstan and the lowest in Tajikistan. In comparison to the previous year, Turkmenistan and Uzbekistan demonstrated growth of HEA imports. The greatest share of household devices was imported to CA from China, and a significant portion of imports to Kazakhstan came from Russia, and to Turkmenistan from Turkey.

Domestic production of household appliances and electric devices in the region satisfies a substantial share of internal demand. Manufacturers based in Kazakhstan and Uzbekistan cover only 10% to 20% of the total supply in the region. Nevertheless, their production demonstrates steady growth, and governments are setting new production targets that reflect significant expansion regarding the variety and volume of domestically manufactured HEAs.

Among other topics, the study assessed energy-saving potential in the case of introducing stricter energy-efficiency requirements regarding HEAs in the region. Particularly, based on ownership/supply data and operating characteristics of household electrical appliances in Central Asia, the assessment team calculated the energy-saving effect due to introducing best available technologies (BAT) concerning TVs and refrigerators. Thus, the annual energy-saving potential by family was estimated at 100 to 110 kWh for TVs and 130 to 170 kWh for refrigerators. The total BAT potential for these two types of household appliances was highest in Uzbekistan and Kazakhstan, at about 1,000 and 1,500 GWh/year, respectively. This was due to large national populations and high ownership rates among households for these types of devices.

Gradual growth of electricity consumption by HEAs, and their expanding variety and quantity used by families in Central Asia, evidence the need to develop and deploy target regulations and tools. Analyses from government initiatives in Central Asia suggest gradual mainstreaming of energy consumption issues and indicators related to household appliances into national energy-saving agendas. Unfortunately, only a small portion of these plans has been implemented so far. For example, Tajikistan and Kazakhstan recently introduced restrictions on production and importation of incandescent lamps.

Nevertheless, national policies and programs in a number of target countries encourage active advancement of HEA energy efficiency. Uzbekistan is introducing mandatory labeling of appliance energy-performance classes, and drafting technical standards and regulations. Starting in 2016, the country banned importation and sale of household electrical appliances that lack energy-efficiency information in their technical documentation and/or markings/labels. Uzbekistan also planned phased introduction of minimum energy-performance standards; a corresponding timeframe of target actions related to banning importation and sale of low energy-efficient appliances is already in place.

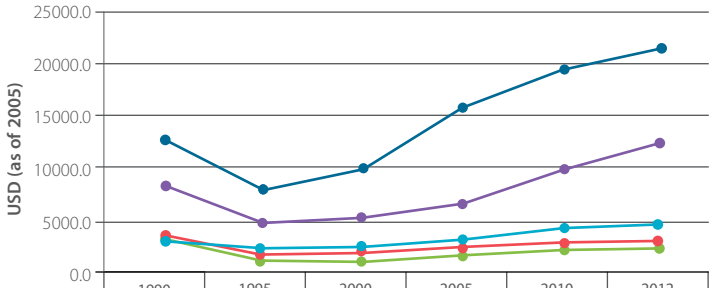
As for Kazakhstan and Kyrgyzstan, regional economic integration plays an increasing role regarding promoting HEA energy-efficiency. Both countries are members of the Eurasian Economic Union (EEU), which supports uniform regulation of commodity markets and foreign trade. The EEU Technical Committee already drafted guidelines on mandatory energy labeling of household appliances. The document is under interstate review, and is expected to be enacted in EEU member-states in 2016 and 2017.

Electric power sector and electric energy consumption by households in Central Asian countries

1.1 Economic and demographic trends, and power sector featuress

Central Asian countries differ from each other by size, population, reserves of natural resources, and economic and human development. The break up of the Soviet Union led to disruption of economic ties among former USSR republics, which in turn provoked deep regional economic recession. Economic reform, attraction of investment, and encouraging exportation potential gradually brought about the countries' economic rehabilitation and economic growth. The region's economic growth relies largely on natural resources and raw materials and their prices on the global market.
(Fig.1, Fig. 2)

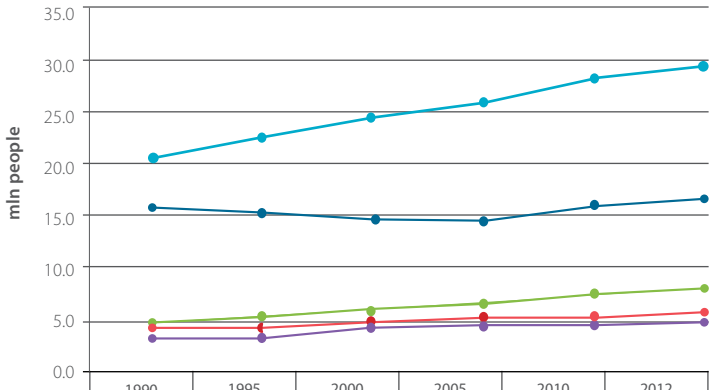
Figure 1 GDP per capita recalculated based on purchasing power parity in Central Asia



	1990	1995	2000	2005	2010	2012
Kazakhstan	12728.5	8078.6	9706.0	15619.2	19601.1	21505.7
Kyrgyzstan	3474.7	1696.4	2074.5	2370.2	2790.2	2869.8
Tajikistan	3635.3	1265.6	1185.6	1719.0	2110.3	2320.3
Turkmenistan	8353.2	4622.9	5350.7	6504.9	10031.6	12460.1
Uzbekistan	3043.2	2221.7	2480.9	3041.3	4185.1	4704.5

Source: World Bank

Figure 2 Population of Central Asian countries



	1990	1995	2000	2005	2010	2012
Kazakhstan	16.3	15.8	14.9	15.1	16.3	16.8
Kyrgyzstan	4.4	4.6	4.9	5.2	5.4	5.6
Tajikistan	5.3	5.8	6.2	6.8	7.6	8.0
Turkmenistan	3.7	4.2	4.5	4.7	5.0	5.2
Uzbekistan	20.5	22.8	24.7	26.2	28.6	29.8

Source: World Bank

Kazakhstan, Turkmenistan, and Uzbekistan possess considerable hydrocarbon reserves, whereas the energy sectors of Kyrgyzstan and Tajikistan rely primarily on hydropower.

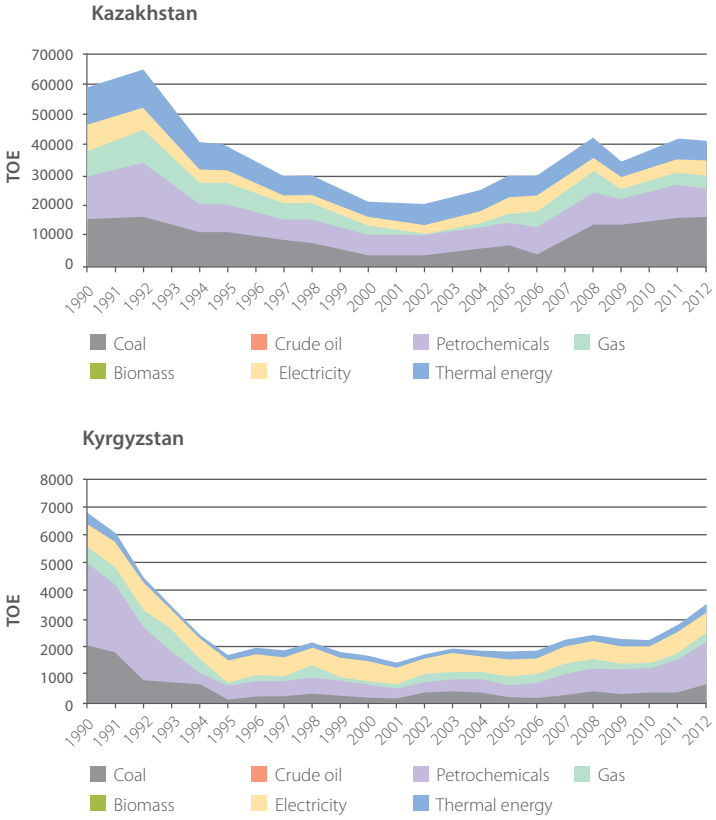
Table 1 Energy reserves in Central Asian countries

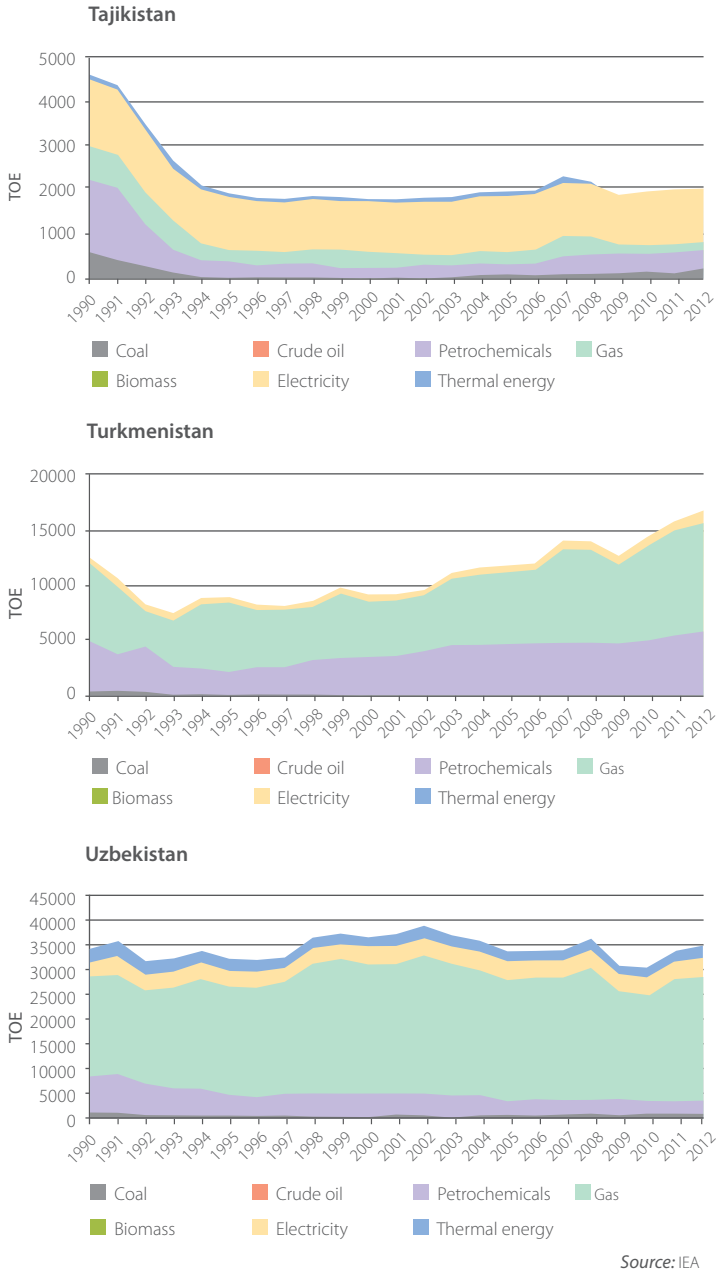
Country	Crude oil, bln barrels	Natural gas, trl m^3	Coal, bln tons	Hydro energy, bln kWh/year
Kazakhstan	30,0	1,5	33,6	40,2
Kyrgyzstan	<0,1	<0,1	3,5	142,5
Tajikistan	<0,1	<0,1	4,5	527
Turkmenistan	0,6	17,5	<0,1	<0,1
Uzbekistan	0,6	1,1	2,4	88,5
Total	**31,2**	**20,1**	**44,1**	**798,3**

Source: British Petroleum, CIS Interstate Statistics Committee

Fuel consumption in Central Asia varies across countries, depending on domestic energy assets, population, size of industrial and processing sectors and a number of other factors (**Fig. 3**).

Figure 3 **Total consumption of energy resources in Central Asian countries**





Source: IEA

After the break up of the Soviet Union, Kazakhstan experienced a sharp fall in energy resources use due to contraction of domestic industrial production; starting in 1990, its total fuel consumption reduced by 43%, and in 2012 it amounted to 41,728 kilotons of oil equivalent (kTOE). Today, consumption of coal – the primary energy source in the country – is higher than it was in 1990. During the same period, electricity consumption fell by 40%, due primarily to changes to the structure of industrial production. Nonetheless, the share of electricity of total energy resources consumption did not fall below 10%, and in 2012, it was 12%.

In Kyrgyzstan, total fuel use dropped nearly by half to 1990, and in 2012, it was 3,530 kTOE. The structure of fuel consumption also underwent major changes. Consumption of all types of fuels except electricity reduced, caused by a reduction of resource and production capacity as the result of the USSR's collapse. Consumption of electricity increased two-fold in comparison to 1990.

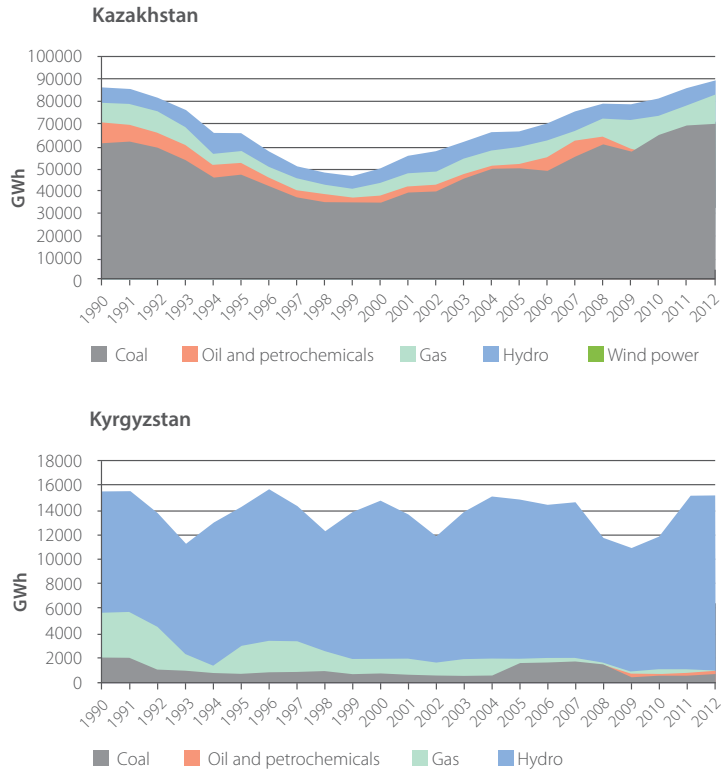
In Tajikistan, total fuel consumption fell more than two-fold in comparison to 1990, and in 2012, it amounted to 2,051 kTOE. With electricity the primary source of domestic energy, its total consumption remained nearly unchanged, while use of other fuels dropped significantly. The share of electricity in gross energy consumption is 60%.

Total fuel consumption in Turkmenistan increased since the Soviet times, and in 2012 was 16,774 kTOE. Turkmenistan is the largest producer of natural gas not only in the region, but also the world, which explains the prevalence of gas over other energy sources. Since 1990 domestic electricity consumption increased by 15%.

Uzbekistan's overall consumption of energy resources has not changed much since the Soviet era, and in 2012, it was 35,458 kTOE. In the same year, the share of natural gas in general energy consumption comprised nearly 75% or 26,007 kTOE. The volume of electricity consumption has changed little since 1990.

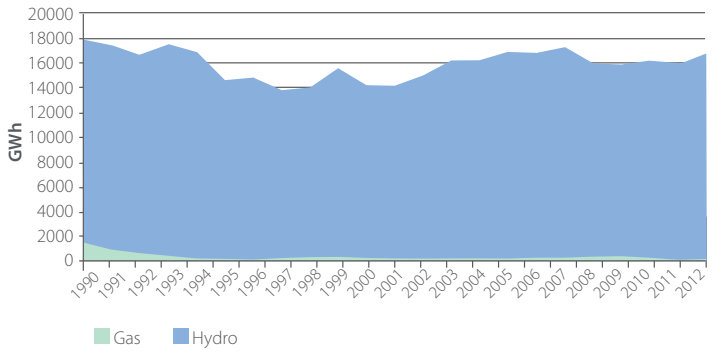
The structure of energy sources used to generate electricity also varies depending on the country. Kyrgyzstan and Tajikistan rely largely on large-scale hydropower. In Turkmenistan and Uzbekistan, natural gas dominates the electricity output balance. Kazakhstan is the only country in the region in which electricity generation demonstrates significant reliance on coal **(Fig. 4).**

Figure 4 **Structure of electricity generation in Central Asian countries by energy sources**

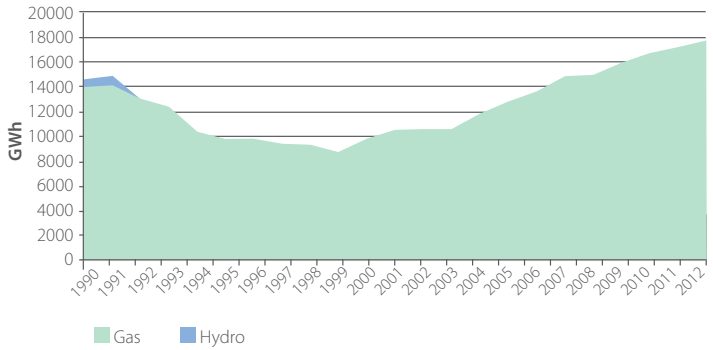


Source: IEA

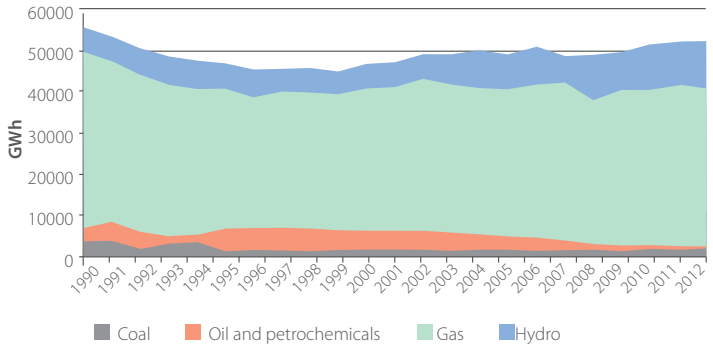
Tajikistan



Turkmenistan



Uzbekistan



Source: IEA

By 2012, electric power output in Kazakhstan exceeded that during the Soviet period, reaching 91,207 GWh. Historically, domestic electricity is generated by coal-fired power plants that were built during USSR times (i.e., nearly 80% of total electricity output). Net importation of electricity into the country fell by 92%, from 17,338 GWh in 1990 to 1,319 GWh in 2012.

In 2012, Kyrgyzstan generated 15,168 GWh of electricity. The national power industry relies on hydropower, the share of which increased from 63% (or 9,986 GWh) in 1990 to 93% (or 14,179 GWh) in 2012. Consequently, electricity generation is vulnerable to annual fluctuations of river run off and global climate change.

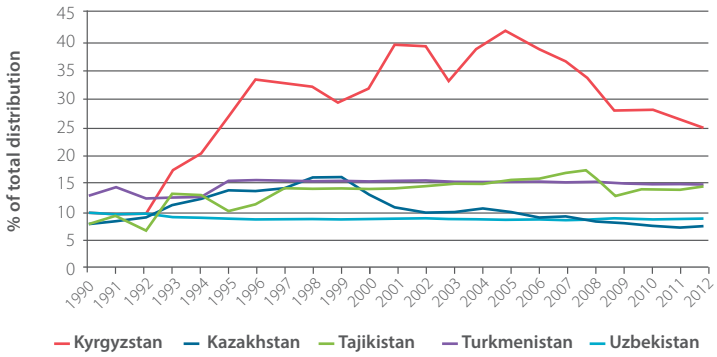
Electricity output in Tajikistan was 16,974 GWh in 2012, below Soviet time values. Nearly all domestic electricity is produced by hydropower plants, which causes winter interruptions in electricity generation. Thus, the energy sector relies on seasonal water runoff variations and anticipated climate change consequences.

In Turkmenistan, electricity is generated historically by gas-fired power plants. In 2012, its output exceeded that of the Soviet period, amounting to 17,750 GWh and making the country the largest regional exporter of electric power.

In 2012, electricity generation in Uzbekistan nearly reached Soviet time levels (52,500 GWh), with gas as the primary fuel used for this purpose. Electricity generation at hydropower plants increased by 70% in comparison to 1990 due to upgrades to and construction of small-scale facilities.

Power generating and distribution infrastructure in the region is obsolete and worn-out, causing considerable losses. **Fig. 5** reflects excessive losses of electricity in Tajikistan, Turkmenistan and Kyrgyzstan. Data for Kyrgyzstan point to considerable unaccounted for power consumption.

Figure 5 Losses in power grids in Central Asian countries

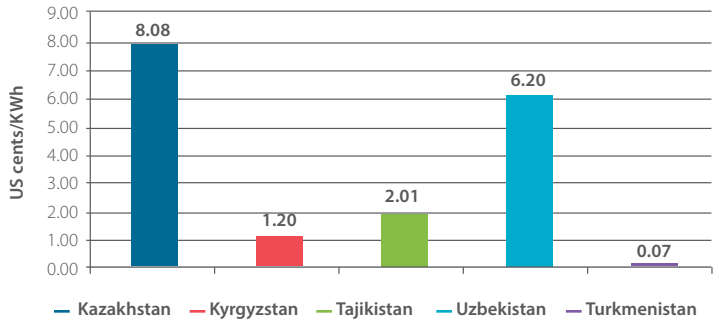


Source: IEA

Electricity tariffs in the region influence the dynamics of energy use by populations. Their low level (due possibly to subsidies) is regarded by national governments as a tool for maintaining social stability, while they simultaneously result in decreased motivation to save energy. People often use electricity not for household purposes, but for private welding and construction. The highest electricity tariffs for residents exist in Kazakhstan, with the lowest in Turkmenistan. The latter even offers limited free electricity to the population **(Fig. 6)**.

Power consumption varies across the Central Asian countries, with Kazakhstan being the largest electricity consumer; its domestic consumption is 7 times more than Kyrgyzstan and Turkmenistan. Industry is the primary consumer of electric power across four Central Asian countries, except Kyrgyzstan, in which the population consumes the greatest share.

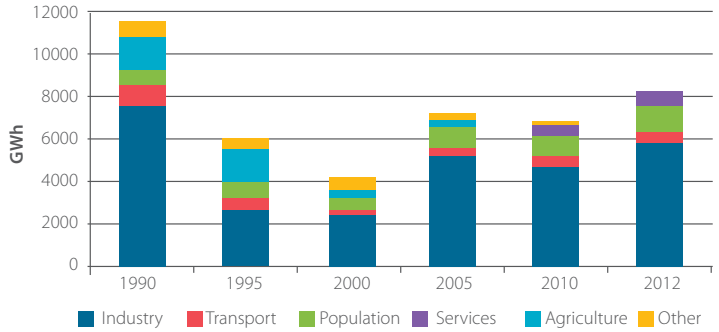
Figure 6 Electricity tariffs for natural persons in Central Asian countries



Source: IEA

By 2012, electricity consumption in Kazakhstan fell by 40% in comparison to 1990, amounting to 64 GWh. Domestic industry was the primary energy consumer, followed by the population. Since 2000, the growing public welfare has been the reason behind a 7% annual increase in power consumption. Current consumption of electric energy by citizens exceeds that of the Soviet period. The "2030 Electric Power Industry Master-Plan of the RK" recommends increasing power output to 14,400 GWh (or by 50% to 60% above the 2012 level) to cover domestic energy demand **(Fig. 7)**.

Figure 7 Electricity consumption by sectors in Kazakhstan

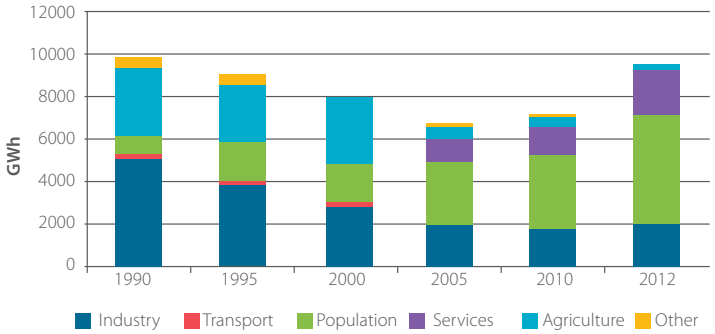


Source: IEA

In Kyrgyzstan, total electricity consumption in 2012 was approximately 9,500 GWh. Its overall structure has under gone significant changes since 1990, and thus electricity consumption by industry fell nearly three-fold, whereas public consumption increased more than 5 times during the same period. Kyrgyzstan's residential sector is the largest electricity consumer (more than 50% of total consumption). According to a forecast from the CIS Interstate Statistics Committee, by 2020, demand for electric power in Kyrgyzstan will rise to 14,000 GWh. There are plans to foster extraction and production of domestically available hydrocarbons to satisfy some of the demand **(Fig. 8).**

By 2012, total electricity consumption in Tajikistan fell by 28% against the 1990 volume. Electricity consumption by industry decreased nearly two-fold in comparison to the Soviet period, but the sector remains a primary consumer of electric energy. Public electricity consumption in absolute values increased twice since 1990, but has been falling by around 1% per year since 2000. After the launch of a new electricity-generating infrastructure, power use in Tajikistan is expected to reach 20,000 GWh in 2020 (CIS Interstate Statistics Committee). Like Kyrgyzstan, Tajikistan is considering ways to expand domestic extraction and production of hydrocarbons to respond to growing internal demand **(Fig. 9)**.

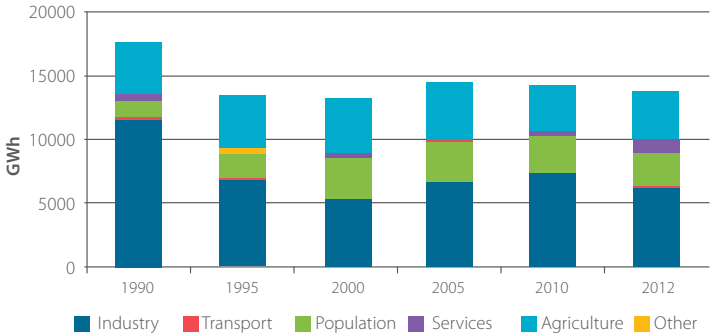
Figure 8 **Electricity consumption by sectors in Kyrgyzstan**



Source: IEA

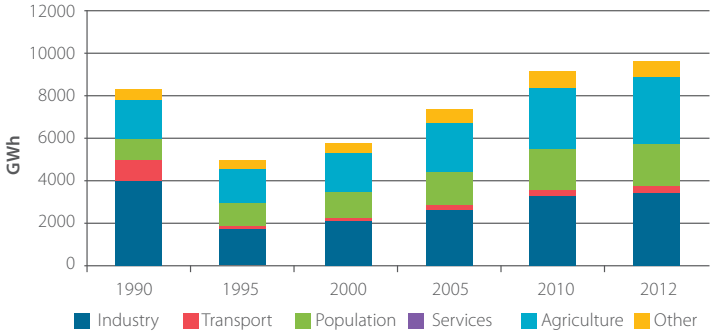
Since the fall of the USSR, total electricity consumption in Turkmenistan increased by 15%, with industry and agriculture constituting its major consumers (about 70% of total consumed electric power). Electricity use by the population increased two-fold since the Soviet time, and according to forecasts from the CIS Interstate Statistics Committee, it will reach 21,000 GWh by 2020 **(Fig. 10)**.

Figure 9 **Electricity consumption by sectors in Tajikistan**



Source: IEA

Figure 10 **Electricity consumption by sectors in Turkmenistan**



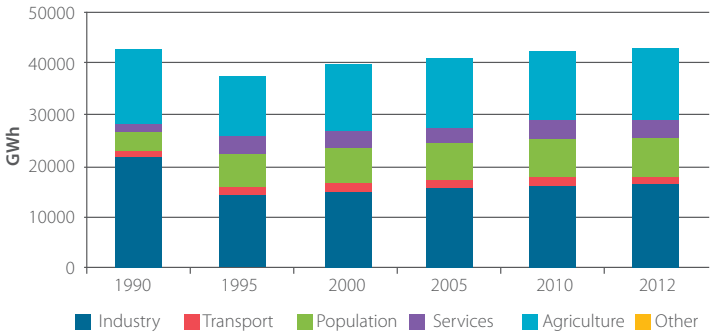
Source: IEA

Uzbekistan experienced no sharp fall in electricity use after the breakdown of the Soviet Union. Combined electricity consumption by industrial and agricultural sectors accounts for more than 70% of overall domestic electricity consumption. Since 1990, public electricity use grew by 122%. As per national development strategies, by 2020, increased electricity output of up to 68,700 GWh, or 30% versus 2012 levels, is planned to satisfy growing internal demand for power **(Fig. 11)**.

Electricity consumption by the residential sector of Central Asia has been increasing. During the last two decades, the total volume of electric power used by this sector in the countries experienced significant growth. It is remarkable that this occurred against the backdrop of a considerable fall in electricity consumption in other economic sectors such as industry, agriculture, and transportation **(Fig.12).**

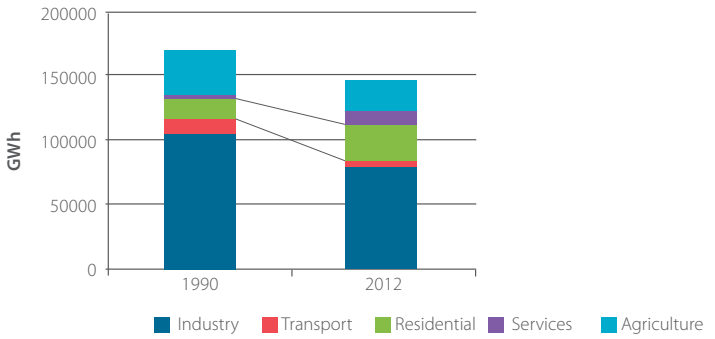
Calculation of indirect CO_2 emissions due to public electricity use was based on IEA and OECD data, with the highest levels observed in Kazakhstan and Uzbekistan, and the lowest in Tajikistan. **(Fig. 13)**.

Figure 11 **Electricity consumption by sectors in Uzbekistan**



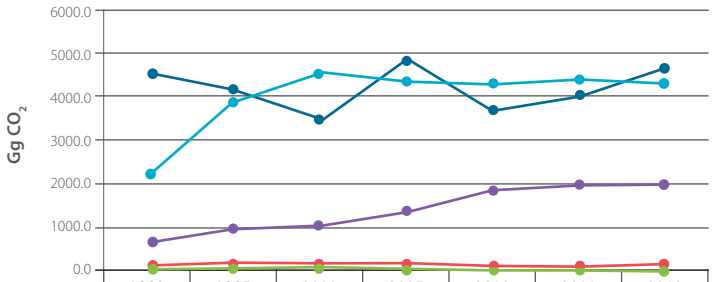
Source: IEA

Figure 12 **Total shares of primary industries in electricity consumption in Central Asia**



Source: IEA

Figure 13 **Indirect CO_2 emissions due to public electricity consumption in Central Asia**



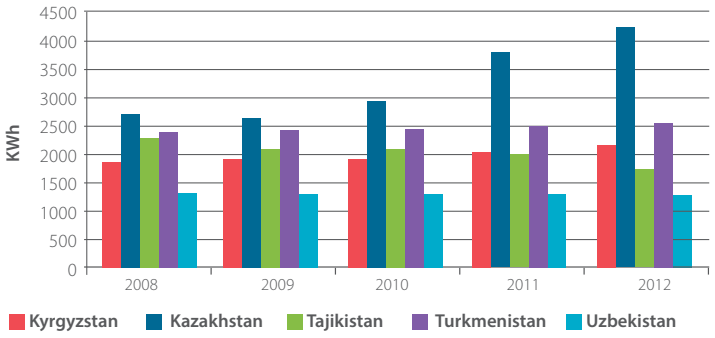
	1990	1995	2000	2005	2010	2011	2012
Kazakhstan	4478.6	4212.2	3478.5	4800.5	3631.9	4058.3	4674.5
Kyrgyzstan	162.7	189.1	153.3	158.9	128.4	140.9	182.7
Tajikistan	88.4	50.4	84.5	66.4	2.9	3.0	2.7
Turkmenistan	699.7	978.5	1069.1	1362.9	1843.1	1955.2	2011.5
Uzbekistan	2210.2	3862.7	4542.0	4329.4	4252.1	4371.9	4285.6

Source: calculations based on IEA and OECD data

1.2 Dynamics and factors of electricity consumption by households

Electricity consumption per household in the residential sector has increased since 2008 in Kazakhstan, Kyrgyzstan, and Turkmenistan. During the same period, it fell in Tajikistan and Uzbekistan. Since 2008, power consumption per household by the population grew by 57% in Kyrgyzstan, and fell by 25% in Tajikistan. Data on energy use do not reflect public demand in some countries since not all households have uninterrupted and reliable access to electricity, and since electricity deficit countries restrict volumes of available electric power, especially in rural areas (**Fig. 14**).

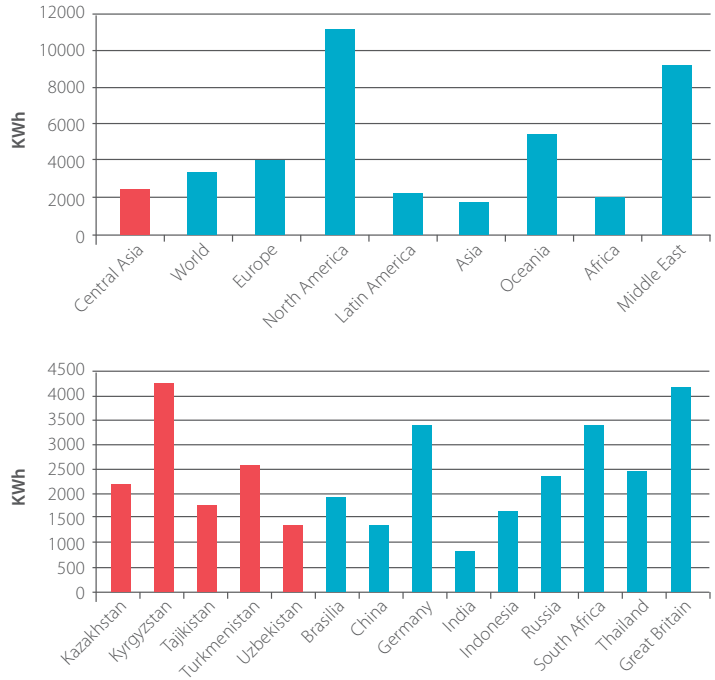
Figure 14 **Average annual energy consumption per household in the residential sector in Central Asia**



Source: calculations based on IEA and Helgi Library data

In Central Asia, average annual electricity consumption per household in the residential sector is 40% lower than that worldwide; it is 64% lower than in the EU, but 41% higher than in other Asian countries. However, in some Central Asian countries, this indicator is high. For example, in Kyrgyzstan, average annual electricity use per household in the residential sector exceeds that in Germany and the UK. This indicator is also high in Turkmenistan (**Fig.15**).

Figure 15 **Average annual energy consumption per household in the residential sector in Central Asia and other regions and countries of the world in 2012**



Source: World Energy Council and calculations based on IEA and Helgi Library data

To examine factors that influence energy use in the residential sector, assessment included decomposition analysis (Index Decomposition Analysis (IDA)) of data for 2008 through 2012, allowing estimates of the degree and direction of influence of individual factors on changing electricity consumption by households. The following factors were investigated for Central Asian countries:

- Changes to the number of households in a country;
- Changes to economic activity and welfare based on GDP dynamics;
- Dynamics of the share of final consumption by households in GDP as a factor that influences energy consumption due to changing family spending (without linking it to economic activity);
- Changes to energy intensity of final consumption by households (kWh per 1 USD of household consumer spending). This indicator usually characterizes the change in energy efficiency used by households. However, alteration of this parameter does not always point to increasing energy efficiency. Thus, a correction parameter that reflects changes to electricity consumption by households due to other reasons was used.

Analysis (Appendix 1) suggests that from 2008 to 2012, total energy consumption in the residential sector in Kazakhstan increased by 1,820 GWh, or 22%. Corresponding factors included growing economic activity, improving living standards, and increasing consumer spending per household.

The total increase in electricity use in the residential sector in Kyrgyzstan from 2008 to 2012 was 2,106 GWh, or 68%. The growth of energy intensity of final consumption by households led to a 1,833 GWh increase in power use, which might link to increases in hydropower used for domestic and non-domestic needs of families in deficient environments, and high costs of other fuels. The growing number of households and level of economic activity in the country resulted in increased power consumption in the residential sector (276 GWh and 52 GWh, respectively). At the same time, a reduction of the share of final consumption (i.e., spending) by households in the national GDP led to a 56 GWh, or 2%, fall in energy consumption in the sector.

Tajikistan was the only country in the region in which energy consumption in the residential sector fell by 438 GWh, or 14%, from 2008 to 2014. The reduction of energy intensity of final consumption by households in 2012 led to a 1,970 GWh reduction of power use by the sector, or 63%, in comparison to 2008. This might have been caused by deficient electricity generation and limited availability of other energy sources. At the same time, increased share of household final consumption (i.e., spending) within the national GDP, growing numbers of households, and enhanced economic activity led to increased power consumption by 958 GWh, 382 GWh, and 192 GWh, respectively.

Since 2008, power use by households in Turkmenistan increased by 206 GWh, or 11%, with factors being increased energy intensity of family consumption (due to low tariffs against a background of high supply of domestic energy sources), growing GDP, and increasing numbers of households. Simultaneously, the reduction of the share of consumption by households within the GDP led to a 1,751 GWh fall of energy consumption.

In Uzbekistan, economic growth, increased share of household final consumption (i.e., spending) within the national GDP, and growing numbers of families led to higher electricity use (2333 GWh, 802 GWh, and 606 GWh, respectively). The reduction of electricity intensity per 1 USD of the final consumption by households created reduced power use in the sector by 3,282 GWh by 2012.

Overview of the most common household electrical appliances in Central Asian countries and assessment of their energy efficiency

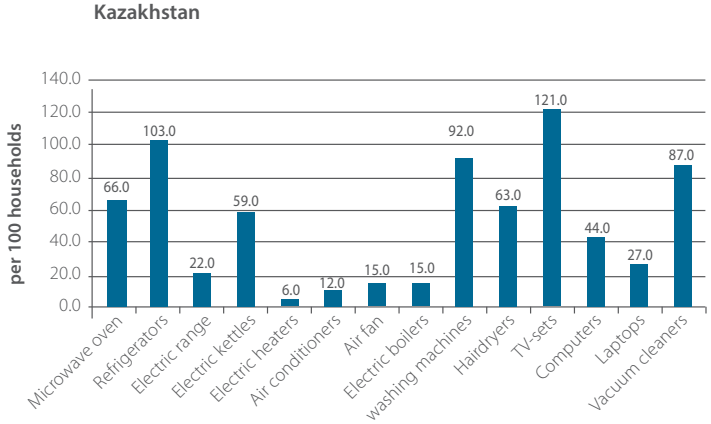
2.1 Ownership of the most common household electrical appliances

The policy on standardization and labeling of energy-efficiency classes regulates the level of energy efficiency of only newly bought electrical household appliances since it is impossible to change technical characteristics of electric devices that families already use. Therefore, while assessing the prospects of introducing EES&L for target equipment, it is necessary to analyze various features of the household electrical appliances market that combined reflect current and future demand and influences on electricity consumption. Data available for countries in Central Asia allowed investigation of the following significant indicators:

- household ownership rates for types of electric devices (i.e., units per 100 households). This indicator reflects the degree of importance or popularity of HEAs for families, and allows estimation of potential demand for types of household appliances (depending on dimensions and purpose);
- dynamics of household appliances supply(i.e., imports and/or own production);
- prevailing technical characteristics of the most common HEAs (including electricity consumption) and their purpose in determining mode and frequency of use.

Fig. 16 reflects ownership rates for the most common types of household appliances in the region, based on official data and expert estimations. Data for Kazakhstan are extensive since national statistics agencies conduct regular, targeted surveys. Information on appliance ownership rates for Kyrgyzstan and Tajikistan was sourced from statistical reports published by the CIS Interstate Statistics Committee, and covers only select, major types of equipment. Corresponding indicators for Uzbekistan were sourced from reports of the National Electrotechnical Company. Such data for Turkmenistan were unavailable. The estimated ownership rates presented below are national averages, and do not reflect disparities between urban and rural population.

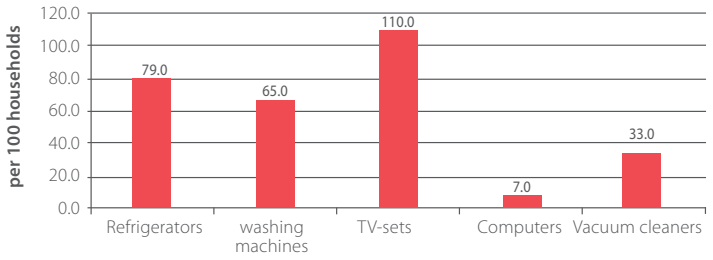
Figure 16 **Ownership rates for household electrical appliances in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan (units per 100 households)[1]**



Source: Statistics Committee of the Republic of Kazakhstan

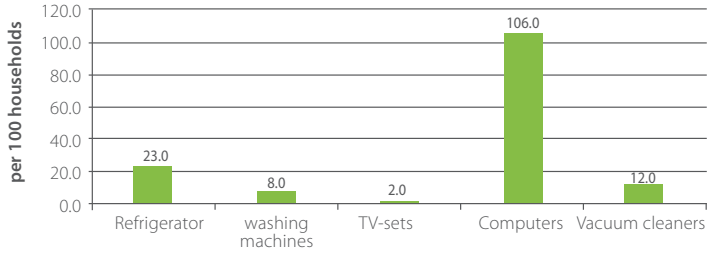
[1] Author's note.Data on ownership rates for lighting appliances is not included.

Kyrgyzstan



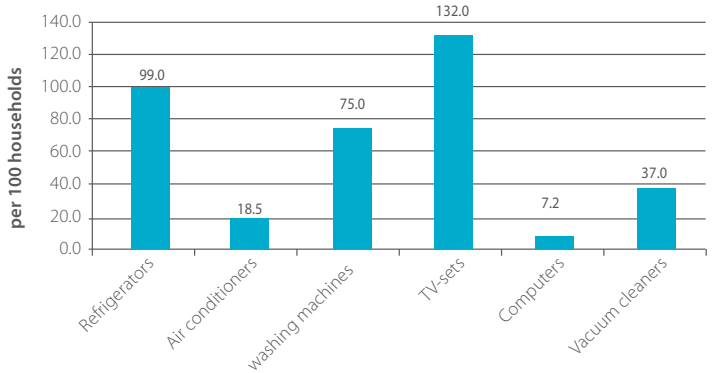
Source: CIS Interstate Statistics Committee

Tajikistan



Source: CIS Interstate Statistics Committee

Uzbekistan



Source: UZELTECHSANOAT JSC

According to available data, all countries in Central Asia have high ownership rates for TVs and refrigerators (nearly 100% of all households). Only in Tajikistan the ownership of refrigerators lower than in other countries in the region (23 units per 100 families). Kazakhstan, Kyrgyzstan, and Uzbekistan have high ownership rates for washing machines (99, 65, and 75 units per 100 households, respectively). The same indicator for Tajikistan is several times lower – about 8 units per 100 families.

Kazakhstan has higher ownership rates for all common types of HEAs, which might link with its greater economic development and public incomes. Values for Uzbekistan and Kyrgyzstan are comparable, whereas Tajikistan has the lowest appliance ownership rates in the region.

In Kazakhstan and Kyrgyzstan, household ownership rates for various types of lamps (e.g., incandescent, halogen, luminescent, and LED) are very high. As per official statistics, in Kazakhstan, each 100 households use 770 incandescent, 250 halogen, 29 LED, and 15 luminescent lamps, and in Kyrgyzstan, it is 915 incandescent and 353 luminescent lamps per 100 households. The large number of incandescent lamps used in Kyrgyzstan is explained by a domestic company – *Mayluhu-Suhu* Lamp Factory – the only such manufacturer of lamps in Central Asia. Corresponding data for Tajikistan and Uzbekistan are unavailable.

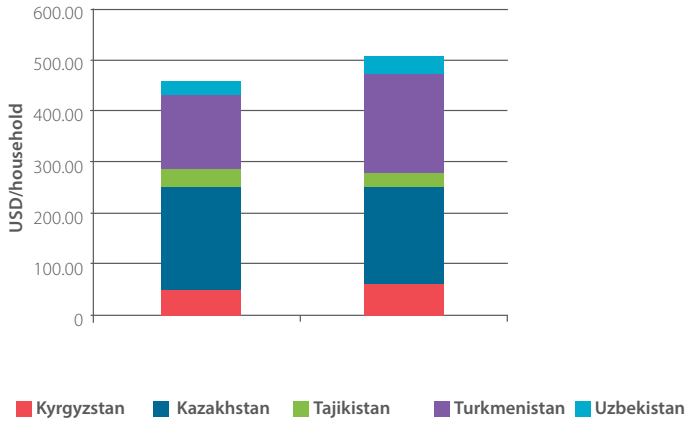
Central Asian states have been implementing national programs to phase out inefficient lamps and replace them with more energy-efficient options. Several supporting projects in this area are being implemented by international agencies. In contrast, development of national EE policies that focus on household electrical appliances is still in an early stage. Therefore, assessment focused on identification of the most energy-consuming HEAs, and excluded lighting equipment from analysis.

2.2 Supply of household electrical appliances in Central Asia: imports

The overwhelming share of demand for household appliances in the countries is satisfied by imports, and domestic production covers an insignificant portion. According to available data, in 2012, net monetary imports of HEAs per family were highest in Turkmenistan and Kazakhstan, and lowest in Tajikistan. Kyrgyzstan, Turkmenistan, and Uzbekistan experienced growth of household electrical appliances imports versus the previous year (**Fig. 17**).

Corresponding data for countries presented below are segregated by types of household appliances. Despite the absence of quantitative data, import shares by types of HEAs in monetary equivalency provide some indication regarding the most popular types of devices during 2011 and 2012. During this period, TVs represented the greatest share of imports of household appliances in Kazakhstan. In Kyrgyzstan and Tajikistan, a large import share associated with refrigerators and electric space heaters, and with air conditioners in Turkmenistan and Uzbekistan.

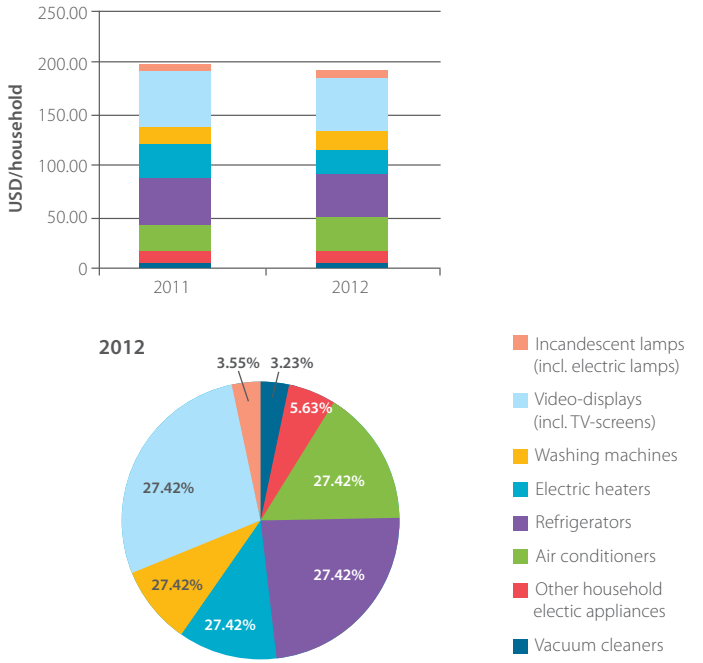
Figure 17 **Net imports of household electrical appliances per household in Central Asian countries (zero inflation)**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

In 2012, the total value of HEA imports to Kazakhstan fell slightly (3%) in comparison to 2011, amounting to 192.81 USD/household. This trend affected importation of all types of household equipment, except air conditioners and vacuum cleaners, which experienced growth of 25% and 20%, respectively. TVs and refrigerators had the largest share in the overall monetary importation structure, with vacuum cleaners the lowest (**Fig. 18**).

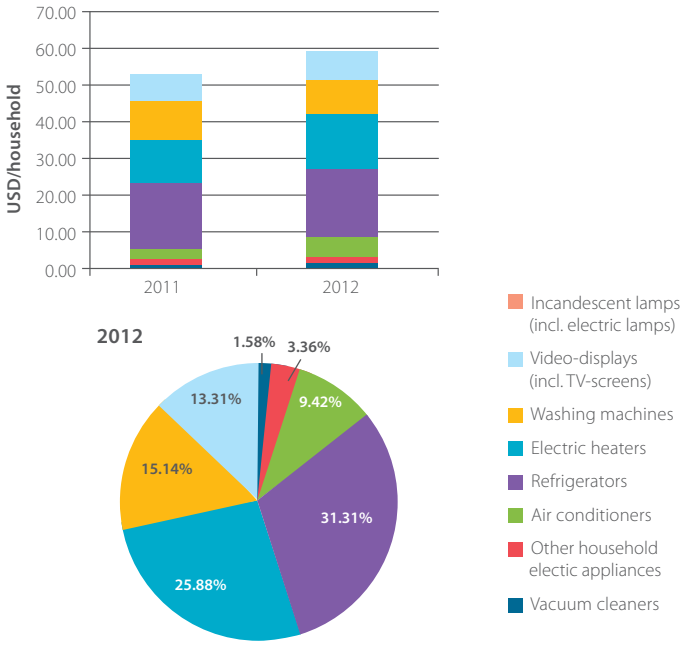
Figure 18 **Dynamics and structure of household electrical appliances import per household in Kazakhstan**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

In comparison to 2011, in 2012, Kyrgyzstan experienced a 12% increase in HEA imports, amounting to 58.88 USD/household. Air conditioners and vacuum cleaners had the strongest upward dynamics; the monetary volume of their importation jumped 140% and 80%, respectively. Importation of electric space heaters and TVs during the same period also experienced growth. Refrigerators and electric space heaters accounted for the largest share within the importation structure, followed by washing machines and TVs. Kyrgyzstan was the only net exporter of household electric lamps in the region **(Fig. 19)**.

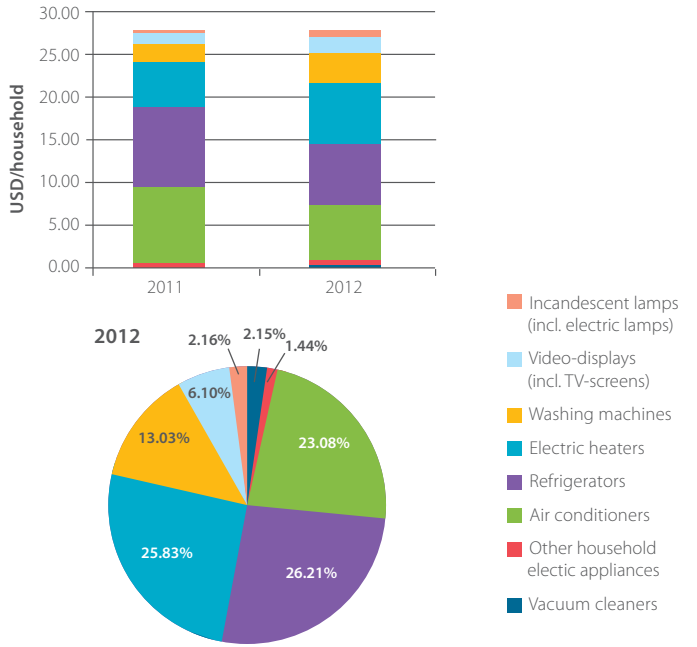
Figure 19 **Dynamics and structure of household electrical appliances import per household in Kyrgyzstan**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

In 2012, total importation of HEAs to Tajikistan remained nearly unchanged in comparison to 2011, amounting to 27.56 USD per household. Importation of electric space heaters and washing machines increased, but fell for refrigerators and air conditioners. However, refrigerators and air conditioners still represent the largest share in the overall import structure, along with electric space heaters and washing machines **(Fig. 20)**.

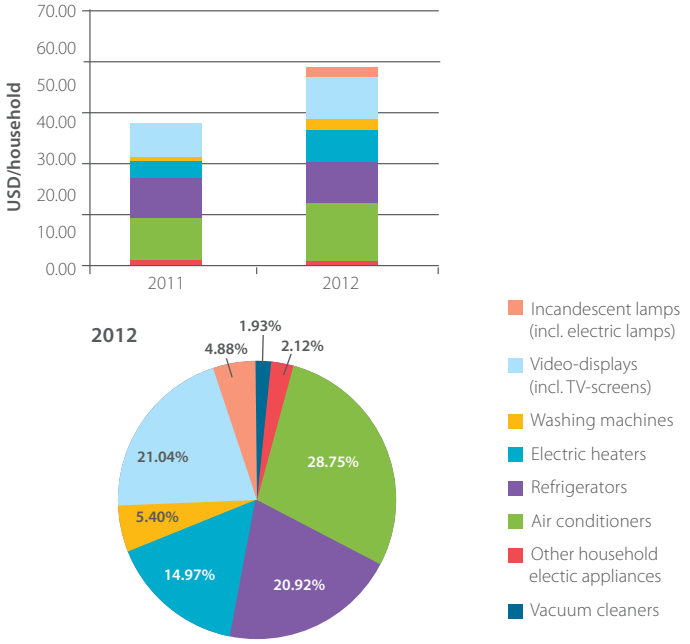
Figure 20 **Dynamics and structure of household electrical appliances import per household in Tajikistan**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

In 2012, total importation of HEAs to Turkmenistan increased by 27% in comparison to 2011, amounting to 193.96 USD per household, with air conditioners, TVs, refrigerators, and electric space heaters representing the largest, and vacuum cleaners and other electrical household appliances the smallest, share within the import structure. The volume of imported air conditioners, refrigerators, electric heaters, TVs, and washing machines experienced significant growth **(Fig. 21).**

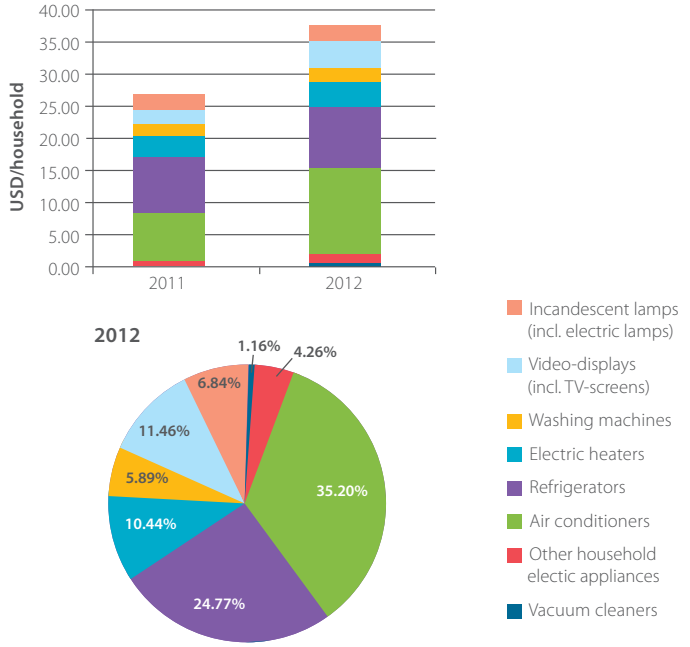
Figure 21 **Dynamics and structure of household electrical appliances import per household in Turkmenistan**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

In 2012, Uzbekistan had the highest rise (41%) of HEA imports in comparison to 2011 for all target equipment categories, with total importation amounting to 37.88 USD per household. The highest increase in monetary terms associated with air conditioners, TVs, and electric space heaters. Regarding import structure, air conditioners, refrigerators, TVs, and electric space heaters accounted for its largest share, and vacuum cleaners the smallest **(Fig. 22)**.

Figure 22 **Dynamics and structure of household electrical appliances import per household in Uzbekistan**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

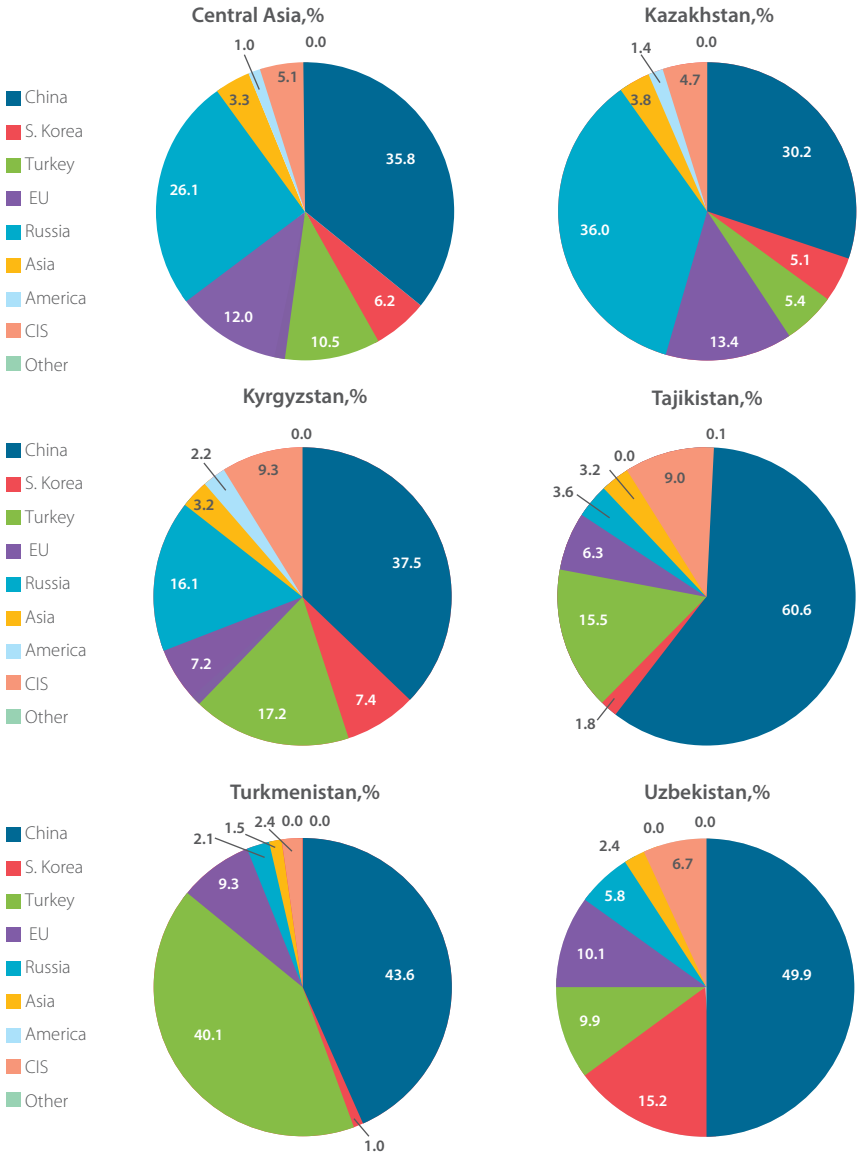
Mentioned above, the largest share of household equipment imports to Central Asia comes from China. HEA imports from Russia to Kazakhstan, comparable to those coming from China, are the only exception. There is also a high share of household appliances imports to Turkmenistan from Turkey, which is only slightly below the import volume from China (**Fig. 23**).

It is possible to link the predominance of the aforementioned countries of origin to low prices, customs fees, and transportation costs. However, in the short-term, it might also be useful to consider the influence of entry of some Central Asian countries into regional and international trade agreements. Thus, Kyrgyzstan's recent joining of the Eurasian Economic Union is expected to boost imports from Russia, Kazakhstan, and Belarus. Kazakhstan's accession to the WTO might also lead to modifications to the structure of its household appliance imports.

2.3 Supply of household electrical appliances in Central Asia: domestic production

Stated above, domestic production of HEAs in Central Asia is insignificant. According to some estimates, capacities in Kazakhstan and Uzbekistan cover about 10% to 20% of their internal demand in target equipment. Both countries are involved primarily in licensed assembly of household appliances of Russian, Korean, European, and Chinese manufacturers. Other countries in the region still lack large-scale production or assembly of household devices.

Figure 23 **Household electrical appliances imports by country of origin**



Source: calculations based on Hausmann etal, Simoes & Hidalgo, and Helgi Library data

According to statistics, by 2013, HEA production in Kazakhstan had risen seven-fold in comparison to 1990, and two-fold in comparison to 2000. About 70% of domestically produced equipment are TVs **(Fig. 24)**.

Uzbekistan experienced significant growth of household appliances production. In 2013 alone, it was more than 25% in comparison to 2012. UZELTEKHSANOAT National Holding Company is the largest domestic manufacturer of household electrical equipment. By 2019, it plans to increase its output of TVs to 635,000 units (400,000 currently), refrigerators to 600,000 and mobile phones to 1 million **(Fig. 25)**.

2.4 Electricity consumption by most common types of household electrical appliances and energy-saving potential

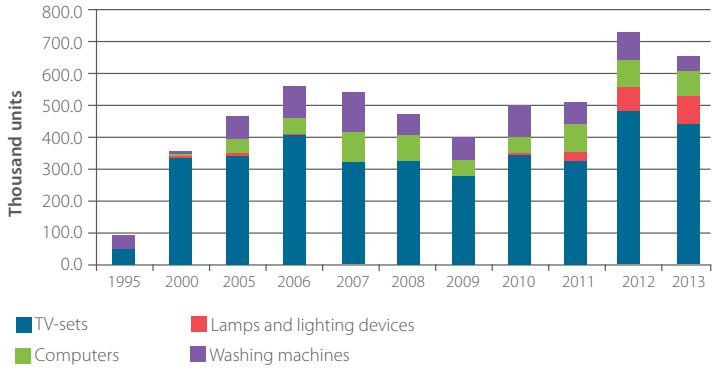
The assessment incorporated an approximate calculation of average electricity consumption by types of HEAs, and evaluation of corresponding energy-saving potentials from introducing technologies with better energy performance. To approximate the volume of electricity used by each type of household appliance, both quantitative data and qualitative parameters were used. The former included average ownership rates by types of appliances, and was based on statistics and assessments presented in Section 2.1 "Ownership rates for the most common household electrical appliances".

The latter included prevailing technical characteristics of appliances and typical patterns of use such as typical power consumption in various operation modes and typical duration of operation in various modes in one year. Information on appliance operation patterns was based on expert opinions and information collected by national assessment consultants. Annual volume of consumed electric power (E_i) for each type of appliance was calculated as:

$$E_i = N_i \, x \, (AW_i \, xA_i + PW_i \, xP_i),$$

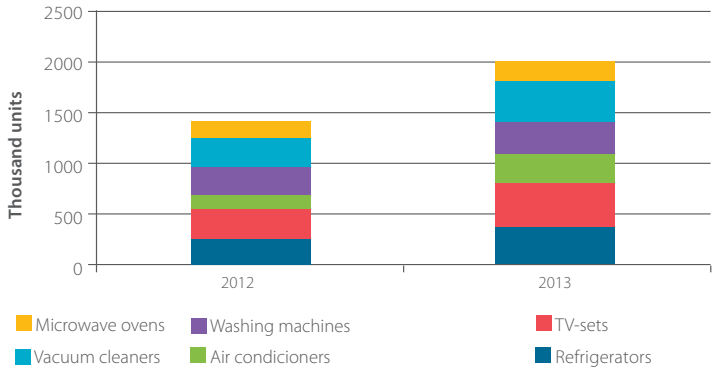
where N_i represents average ownership rate per household for a given appliance and in a given country (calculated using available data on the quantity of owned units per 100 families), AW_i is the estimated power consumption of a given appliance in "on" mode (in watts), A_i is the duration of a given appliance operation in "on" mode (number of hours in one year), PW_i is the estimated power consumption of a given appliance in "standby" mode (in watts), and P_i is the duration of a given appliance's operation in "standby" mode (number of hours in one year).

Figure 24 **Production of household electrical appliances in Kazakhstan**



Source: Statistics Committee of the Republic of Kazakhstan

Figure 25 **Production of household electrical appliances in Uzbekistan**



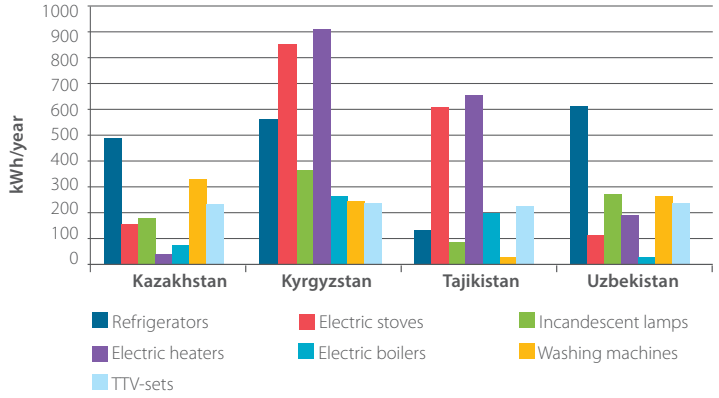
Source: Uzeltechsanoat JSC

Tables summarizing basic operating characteristics of HEAs, their typical operating patterns, and estimated annual power use in "on" and "standby" modes appear in Appendix 2.The estimates and calculations were based on data collected by national assessment consultants.These calculations, and data on appliance ownership rates, allowed drawing a short list of the most common household appliances with the highest levels of electricity consumption (**Fig. 26).**

Based on the calculations, the most power-intensive household appliances (i.e., annual power consumption per household) included refrigerators, lighting equipment and incandescent lamps, electric space heaters, TVs, and washing machines. Whereas annual power use by TVs is similar among the countries, annual energy consumption by other types of HEAs showed disparities across the region.

In Kyrgyzstan and Tajikistan, high levels of electricity use were observed for electric space heaters and stoves. This might link to likely high ownership rates for these appliances in these two countries due to lack of centralized heating and extremely limited supplies of natural gas to the population. Kyrgyz and Tajik families must rely on electricity for water heating, space heating, and cooking to a much greater extent than people living in other Central Asian countries.

Figure 26 Household appliances devices with the highest estimated energy consumption (per household in KWh/year)



Power consumption by lighting equipment is low in Tajikistan due to limited use of incandescent lamps, production and imports of which were banned by the national government in 2011.Power use by lighting equipment is also low in Kazakhstan, also due to a ban against incandescent lamps.

Under the condition of excluding electric space heaters, and accounting for the largest share of power consumption in Kyrgyzstan and Tajikistan, the most power-consuming household appliances common to Central Asian countries include refrigerators (on average, 450 to 600 kWh/year per household), washing machines (200 to 300 kWh/year per household), and TVs (200 to 250 kWh/year per household).Annual power consumption per family by these HEAs is lower in Tajikistan due to respective low ownership rates.

2.5 Review of household electrical appliances with the highest energy-saving potential

For the purpose of this assessment, selection of appliances that are likely to produce the highest energy-saving effect with the introduction of EES&L was conducted with due account of all data and factors described in previous sections. A summary of main points presented in sections above is presented below.

Kazakhstan has high ownership rates for all types of HEAs. Refrigerators, washing machines, and TVs are the most widely owned, and the most power-intensive, among them. TVs, refrigerators, air conditioners, and electric space heaters represent the largest shares in the appliances import structure, with the share of air conditioners showing an upward trend. TVs associate with the largest and still growing segment in domestic HEA production.

Kyrgyzstan also shows high ownership rates for the most power-intensive household appliances such as TVs, refrigerators, and washing machines. There exist no data on ownership rates for electric space heaters and electric kitchen stoves. However, other indirect data (e.g., import volumes, high level of electricity use for household needs, and limited supply of other energy sources) suggest high ownership rates. Refrigerators, electric space heaters, washing machines, and TVs represent the largest shares in the appliances import structure. All, apart from washing machines, also demonstrate an upward import volume trend. The share of air conditioners in the import structure is also increasingly.

Ownership rates for all types of HEAs are lower in Tajikistan. TVs and refrigerators have the highest value in the country. Similar to Kyrgyzstan, it is possible to suggest high ownership rates for electrical space heaters and electrical stoves for Tajikistan. Refrigerators, electric space heaters, air conditioners, and washing machines comprise the largest shares in appliances imports. During the reviewed period, importation of washing machines and electric space heaters increased, and importation of refrigerators and air conditioners contracted.

The assessment team was unable to obtain information on ownership rates for household appliances in Turkmenistan. Available data on appliance imports revealed that the largest import shares belonged to air conditioners, refrigerators, TVs, and electric space heaters. Importation of such HEAs over the reviewed period also demonstrated a strong upward trend.

Uzbekistan has high ownership rates for the most power-intensive types of appliances such as TVs, refrigerators, and washing machines. The largest shares in the appliances import structure belong to air conditioners, refrigerators, TVs, and electric space heaters. Their importation and domestic production volumes also show upward movement.

Based on the assessment in the previous sections, the most widespread and power-intensive household appliances in the region are refrigerators, TVs, incandescent lamps, and washing machines. Kyrgyzstan and Tajikistan have high ownership rates, and large and increasing importations, of electrical space heaters. Strong upward trends were observed for importation of air conditioners and washing machines. In some Central Asian countries, air conditioners are also acquiring an increasing share in the import structure.

It is important to note that in space heaters, electricity is converted directly into thermal energy (90%+ efficiency), and therefore the potential for increasing their energy performance is in significant. As for washing machines and air conditioners, based on the analysis above, they represent a good target for introducing EES&L. However, an accurate assessment of the energy-saving potential of these two appliances requires a much more detailed review of technologies and operation patterns typical for concerned countries. Thus, the assessment of potential benefits by introducing EES&L was conducted for TVs and refrigerators, which are characterized by very high ownership rates and the highest levels of power consumption in the region.

The regional assessment of the energy-saving potential as a result of transition to the best available technologies (BATs) for TVs and refrigerators was based on data on ownership rates and operating characteristics and patterns.

Table 2 describes technical characteristics of the best available technologies for these two appliances.

Table 2 Best available technologies

BAT	Energy-saving potential	Source
Energy Star 5.0 for LCD TV-sets	76% of annual energy consumption	Howard et al., 2012
Vacuum-insulated panel (VIP) in FZR and FF models	27% of annual energy consumption	McNeil&Bojda, 2012

Source: Howard et al., 2012 and McNail and Bojda, 2012

The largest energy-saving potential (per family) of introducing BAT for refrigerators was observed in Uzbekistan due to very high ownership rates. Energy-saving potential (per family) of introducing BAT for TVs was similar for all countries in the region because of similar ownership.

The annual energy-saving potential per household for TVs in all the countries amounted to approximately 100 to 110 kWh/year. The indicator for refrigerators in all countries falls within the 130 to 170 kWh/year range. An exception is Tajikistan, where ownership of refrigerators is lower. The total estimated energy-saving potential for these two types of HEAs was highest in Uzbekistan and Kazakhstan, with large populations and hence large numbers of households. The total energy-saving potential for refrigerators and TVs in Kazakhstan and Uzbekistan was estimated at 1,000 GWh/year and over 1,500 GWh/year, respectively **(Fig. 27).**

Besides estimation of energy-saving potential, assessment also included calculation of family financial savings and CO_2 emissions reductions that might result by introducing the BATs. The highest potential of financial savings by households was identified in Uzbekistan and Kazakhstan, which might be due to their large populations and high numbers of households, higher electricity tariffs, and higher HEA ownership rates. These two countries also have the highest potential for CO_2 emissions reductions **(Fig. 28).**

Estimated financial savings do not reflect the full extent of potential economic benefits, but rather possible financial benefits for the population under electricity tariffs. Electricity prices in Kyrgyzstan and Tajikistan are substantially below the cost of its generation and transmission. Thus, the economic benefits of energy efficiency measures in these countries might exceed these estimates.

Figure 27 Energy-saving potential with BAT introduction in Central Asian countries

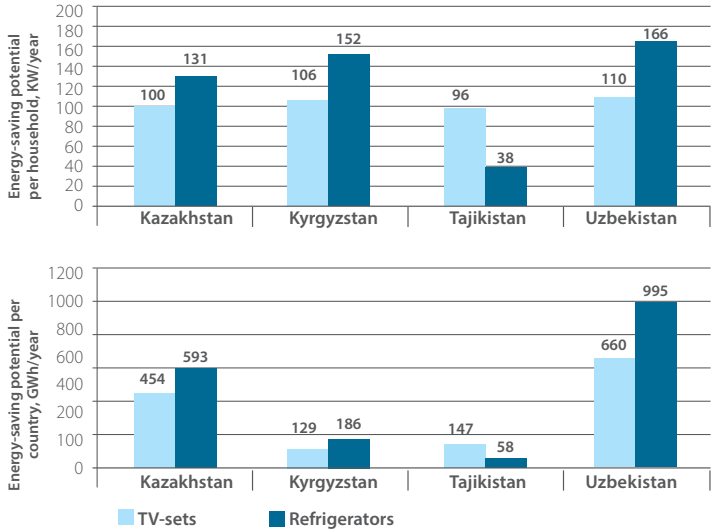
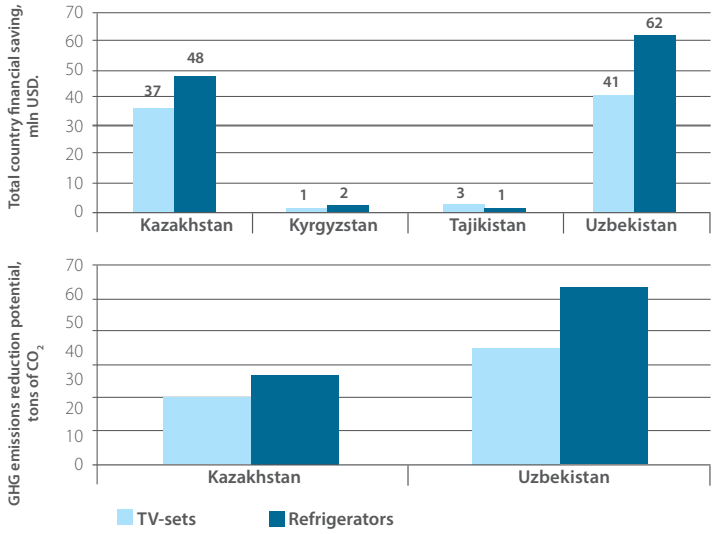


Figure 28 **Financial savings and CO_2 emissions reduction potential with BAT introduction in Central Asian countries**



Policy and regulatory frameworks relevant to energy efficiency standards and labeling in Central Asia: status and trends

3.1 Kazakhstan

In December 1997, Kazakhstan enacted the Law of the Republic of Kazakhstan "On Energy Saving" to establish economic and institutional conditions for effective use of fuel and national energy resources, and environmental protection. However, the law had many shortcomings; a number of its provisions on power-efficiency inspection procedures for enterprises, encouragement of energy savings, legal liabilities for violating energy-saving legislation, etc. were ineffective. Among other reasons, these drawbacks were caused by lack of supporting legal and regulatory frameworks.

At the same time, the issues of rational use of energy resources gained increasing significance within state agendas. For example, the "*2010-2014 State Program on Accelerated Industrial and Innovative Development of the Republic of Kazakhstan*" set the task of decreasing GDP power intensity by not less than 10% by 2015, and 25% by 2020. Another target objective to ensure saving of electric energy by annual 10% slashing of the economy's energy intensity from 2013 to 2015 was formulated. To fulfill these tasks, the national government drafted and approved the "*2012-2015 Integrated Plan of Increasing Energy Efficiency of the RK*". In 2012, a new Law of the RK "*On Energy Saving and Increasing Energy Efficiency*" was passed.

The Ministry of Industry and New Technologies of the Republic of Kazakhstan was the designated authority to develop and implement state policies on energy savings and efficiencies. However, after reorganization of the government in 2014, these functions were transferred to the Committee of Industrial Development and Industrial Safety of the Ministry of Investments and Development of the RK.

After adoption of the new law "*On Energy Saving and Increasing Energy Efficiency*" in 2012, a number of bylaws regulating the mechanisms and relationships in the field of energy saving and increasing energy efficiency were enacted. They particularly stipulated:

- phased banning of incandescent lamps;
- introduction of energy consumption standards for all types of manufactured goods and services.

The aforementioned legal and technical regulations do not contain direct energy-efficiency requirements for HEAs. Nevertheless, a drafted technical regulations of the Eurasian Customs Union[2] "*On Informing Consumers on Power Efficiency of Electric Power Consuming Devices*" is under interstate review. The Customs Union will enforce unified technical regulations (i.e., protocols, technical requirements, and standards) for goods and services manufactured in and/or imported to the territory of EEU member-states. It is planned to apply this Technical Regulations for the following long-term use goods:

- electric cooling devices;
- washing and combined washing-drying household electric machines (250W, 50Hz);
- household dishwashing machines (250W, 50Hz);
- electric cabinet ovens (i.e., household electric ovens);
- household air conditioners;
- household electric lamps.

The Technical Regulations will establish energy-efficiency classes and characteristics in relation to the household appliances mentioned above to ensure energy savings and notification of consumers regarding their energy performance. In parallel, the EEU Technical Committee is working on the Technical Regulations "*On Energy Efficiency Requirements for Household and Other Energy-Consuming Devices and their Labeling*". The Committee of Technical Regulation and Metrology of the Ministry of Investments and Development of the RK oversees development of corresponding standards in Kazakhstan.

[2] The EEU Customs Union is a trade and economic framework that integrates Belarus, Kazakhstan, Russia, Armenia, and Kyrgyzstan. The Union forms a single customs territory, in which no customs duties and/or economic restrictions, except special protection, anti-dumping, and compensation measures, can be applied for mutual trade in goods. The Customs Union member-states use unified customs tariffs and other trade regulation measures in relation to third countries. In 2015, the Customs Union transformed into the Eurasian Economic Union.

3.2 Kyrgyzstan

Adoption of the Laws of the Kyrgyz Republic "*On Energy*" (1996) and "*On Energy Saving*" (1998) might represent the beginning of establishing a national energy saving and efficiency policy. The former spells out the basic principles of organizing and regulating economic activities in the fuel and energy complex (FEC), with the purpose of enhancing its economic efficiency and reliability, protecting consumer and manufacturer interests.

The latter establishes a legal framework for implementation of a state energy-efficiency policy, and legal procedures of creating and operating institutional, economic, and information mechanisms under the policy. The law stipulates a need to include energy-efficiency indicators prescribed by legislation of the Kyrgyz Republic regarding state energy-efficiency standards for energy-consuming goods.

Article 16 of the Law requires mandatory certification of energy-consuming goods of any purpose, and energy resources. Compliance of household equipment to requirements established by state standards is confirmed by mandatory labeling; information on a correlation between energy efficiency of a device and energy-efficiency standards should be marked either on the device or in its technical documentation.

The "*2008-2010 National Power Program of the Kyrgyz Republic*" and the "*2025 Strategy of FEC Development*" (adopted April 24, 2008) state the purpose, priorities, and objectives of developing the national energy sector. According to the Program, standardization of equipment and electric technical devices constitutes a priority of scientific technical and economic research. Measures under the Program include drafting an energy efficiency and saving program per Kyrgyzstan's obligations in the CIS agreements.

In 2012, the Government of the KR approved the *2012-2017 Mid-Term Development Strategy for the Energy Sector of the Kyrgyz Republic*", highlighting development of an energy-saving policy. The measures will be aimed at establishing energy-saving standards and mandatory requirements for various economic sectors and non-industrial sphere. Monetary incentive programs to stimulate electricity saving will be developed also. Significant attention will be rendered to awareness-raising efforts among the population and businessmen focusing on the energy-saving policy.

The most recent step in relation to developing an energy-saving policy by the Government of Kyrgyzstan within the framework of the "*2013-2017 Transition Program of the Kyrgyz Republic to Sustainable Development*" was drafting of the "*2015-2017 Energy Saving and Efficiency Policy Planning Program in the Kyrgyz Republic*". After its approval, the national Ministry of Energy and Industry will implement it. At the time as executing the report, the Program underwent public hearings and approval by all concerned state agencies, and was undergoing governmental review. The Program stresses the importance of creating a system of standards and certification of energy-consuming and power-generating equipment and labeling household appliances, and establishes a special educational-analytical and forecast center under the Ministry of Energy and Industry of the KR to manage demand for energy carriers, ensure energy saving and efficiency, and encourage mainstream renewable energy.

However, the laws and programs are legal acts of indirect action, requiring enforcement of a number of secondary regulations. Analysis indicates the absence of:

- Operating economic mechanisms that stimulate development of energy saving and efficiency, including energy-performance certification and labeling of equipment;
- Energy-consumption categories and a range of energy-consuming equipment regulated by corresponding energy-efficiency standards and regulations;
- Economic sanctions and legal liabilities for violating energy-consumption standards.

Kyrgyzstan's accession to the EEU in 2015 should become a decisive factor for its transition from legal declarations to actions in the field of energy efficiency of electricity-consuming equipment. Thus, it is anticipated that after the country's entry into the Union, the EEU Technical Regulations "*On Informing Consumers on Power Efficiency of Electric Power Consuming Devices*" and "*On Energy Efficiency Requirements for Household and Other Energy-Consuming Devices and their Labeling*" will be enacted. As per the Agreement "*On Uniform Principles and Rules of Technical Regulation in the Republic of Belarus, the Republic of Kazakhstan and the Russian Federation*", after enforcement of these regulations, relevant mandatory requirements established by the legislation of member-states shall become ineffective within their respective territories.

3.3 Tajikistan

In 2009, the President issued the Decree "*On Additional Measures on Economical Use of Energy and Energy Saving*". To ensure its execution, in 2013, the Government adopted the Law "*On Energy Efficiency and Energy Saving*", stipulating legal and organizational frameworks pertaining to energy efficiency and introduction of energy-efficient materials, equipment, and technologies. The Law also contains recommendations on drafting energy-efficiency criteria and requirements regarding effective energy use for buildings and households.

In 2009, as per the presidential decree, the Government of Tajikistan banned production, importation and sale of incandescent lamps to promote energy-efficient devices such as compact luminescent and LED lamps. Since then, all public and industrial buildings, and more than 90% of the population, transitioned to energy-saving lamps. The government also funded procurement of such lamps for 241,000 low-income families.

The national government also set the task of a 20% reduction in energy consumption by 2020 based on energy-efficiency measures. In October 2014, an Interagency Working Group responsible for execution of initiatives concerning RE and EE, and implementing corresponding regulations, was established. The Group drafted the Provisions "*On Renewables, Energy Saving and Efficiency Fund*" under the Ministry of Energy and Water Resources of the RT, and submitted it for governmental review. The Group includes a subgroup tasked with development of regulations necessary due to the Law of the RT "*On Energy Saving and Energy Efficiency*". The Group is also working on the "*National Strategy of Energy-Efficient Technologies*".

To enforce provisions of the Law of the RT "*On Energy Saving and Energy Efficiency",* the national government adopted the Standard "*Methods of Confirming Compliance of Energy-Efficiency Indicators of Energy-Consuming Goods to their Standard Values*". The Standard sets general requirements related to energy-consuming technical and household goods during all stages of their life cycles, and regarding methods of confirming energy-efficiency indicators' compliance with established values. Corresponding indicator values are stipulated by various statutory documents such as national regulations, industry standards, technical regulations, standards of scientific and technical societies and associations, and enterprise-specific standards.

The Government of Tajikistan expressed interest in joining the Eurasian Economic Union as a successor of the Customs Union, and is reviewing potential avenues. Thus, in case Tajikistan enters the EEU, it is possible that the country will also enforce the EEU Technical Regulation "*On Informing Consumers on Power Efficiency of Electric Power Consuming Devices*".

3.4 Uzbekistan

The Government of the Republic of Uzbekistan appointed the State Electric Industry Inspectorate (or *Uzgosenergonadzor*) as aprimary regulator in the domestic electric power industry. Companies included in the *Uzbekenergo* SJSC and *Uzbekneftegaz* National Holding Company are tasked with introducing energy efficiency and saving technologies in relevant sectors. As per national legislation, *Uzgosenergonadzor* is also assigned several functions:

- supervision of observance by legal entities of current legislation and by laws on energy, and supervision of rational and effective development, transportation, and consumption of electric and thermal energy and use of coal;

- development of legal acts and rules related to production, transportation, and consumption of electric and thermal energy, and use of coal.

In 2012, the Government of Uzbekistan adopted the Resolution "*On Additional Measures to Reduce Production and Industrial Goods Costs*", stipulating an 11.2% reduction of manufacturing costs, including energy components, by industrial enterprises by 2013. The Resolution covered only industrial facilities, but a subsequent resolution adopted at the beginning of 2015," *On Additional Measures to Reduce Production and Industrial Goods Costs*", provided for measures to increase energy efficiency of household devices gradually. The document particularly stipulated drafting of a proposal of step-by-step introduction of mandatory energy-performance labeling and certification for all HEAs within national borders and based on best international practices.

The Resolution served as a starting point for drafting the Resolution of the Cabinet of Ministers of the RU "*On Measures to Introduce the System of Mandatory Power Labeling and Certification of Sold Electrical Household Appliances, Newly Built Buildings and Installations in the Republic*". It established requirements regarding mandatory presentation of information on corresponding energy-efficiency classes in technical documentation, and labeling and/or label(s) of HEAs imported and sold in the country and within its territory, and identified corresponding energy-efficiency classes (A, B, C, D, E, and G). The requirements cover the following 10 types of electrical household appliances:

- air conditioning installations (air conditioners);
- refrigerators and freezers;
- household dishwashing machines;
- household washing machines;
- electric water-heating installations;
- electric space-and soil-heating installations;
- microwave ovens;
- other furnaces, electric stoves, hot plates, electric boilers, monitors, and color and monochrome television communication output equipment (TVs);
- electric incandescent and gas-discharge lamps.

Starting January 1, 2016, the importation, and starting July 1, 2016, the sale, of HEAs that lacked information on energy-efficiency classes in their technical documentation, labeling, and/or label(s) are banned in the country, except for household electric devices already in use.

The Resolution also provides for phased introduction of energy-efficient requirements. For example, the importation and sale of "G" class household electrical appliances will be prohibited as of January 1, 2017, "F" class as of January 1, 2018, and "E" class as of January 1, 2019.

The *Uzstandart* Agency was tasked with accreditation of testing labs and certification organizations, which will assess electric technical goods and validate compliance of domestically and foreign manufactured household electrical appliances with established energy-efficiency classes.

Outcomes of the Regional Workshop "Energy efficiency assessment of household electrical appliances in CA and policies for energy performance standards and labeling"

On June 18-19, 2015 in Almaty, UNEP and CAREC jointly organized a regional workshop to discuss preliminary findings from regional assessment and review policies and legislation on energy efficiency, standardization, and labeling in Central Asian countries. The event's target audience included representatives from state agencies, experts, and practitioners who deal with energy efficiency, standardization, metrology, and certification in Central Asia. Experts from countries outside the region also attended the meeting to share experiences from their countries regarding development and implementation of national EES&L strategies. The following ideas and suggestions concerning further steps to developing and implementing EES&L policies for household electrical appliances were voiced by participants.

1 Revisit prioritization of household appliances at the country level by analyzing the influence of appliance use patterns on electricity consumption and load profiles (e.g., peak loads, and daily and seasonal variations)

As demonstrated by assessment and workshop experts, Central Asia countries have already established basic legal frameworks for energy efficiency promotion, and are expanding them to regulate energy use by HEAs. They have already identified priority appliances, and are considering types of standards and labels, and appropriate EE levels. Such priority appliances and policy options are largely informed by relevant EU policies and practices. However, it would be beneficial for countries to revisit prioritization of appliances and reconsider cut-off efficiency levels to customize EES&L policy development to national contexts better, including by analyzing electricity load profiles (to identify which appliances contribute to base loads, and daily and seasonal variations in electricity consumption, and to what extent).

2 Incorporate development of compliance and enforcement frameworks already in the early stage of EES&L policy planning

As demonstrated during the workshop, countries are already formulating policies and legislation on EES&L for household appliances. However, a concern was voiced that during this stage, insufficient importance is given to development of compliance and enforcement frameworks. Failure to have in place an operational and effective compliance and enforcement framework at the point of EES&L policy deployment is likely to undermine effectiveness and trustworthiness of the entire policy, with ramifications even for further revisions of such policies. Therefore, it is crucial to incorporate development of compliance and enforcement frameworks early during EES&L policy planning.

3 Consider regional options of compliance monitoring and control, with a view to optimize the cost of EES&L policy implementation

Testing labs are an important element of a compliance and enforcement framework. However, setting up a fully equipped, accredited domestic testing facility is too costly to justify such spending during an early stage of policy planning and deployment. In-country institutional and human capacities might be insufficient to service such laboratories early during the process. It might be feasible to consider regional cooperation to adopt regulations on recognizing testing reports from accredited labs in other countries. The potential of such a path is likely to be reinforced by ongoing expansion of the EEU. This regional, economic integration organization, with a supranational mandate, is developing technical regulations, including those on energy performance and compliance testing and enforcement, which will take precedence over national regulations. Involvement of its member-states in shaping such technical regulations might yield good results.

4 Consider benefits of regional harmonization of standards and/or testing procedures

There exist many arguments in favor of regional harmonization of standards, and there are examples from other regions in the world of such a path being successful. However, identification of an energy efficiency level at which to apply a regional standard might be problematic during early stages of policy development. This is especially the case for regions in which countries differ significantly in their markets and overall economic development. An EE level appropriate in one country might not be viable at this stage in another. A recommendation offered during the workshop suggests that in such contexts, it might be both efficient and cost-effective to first focus on regional harmonization of testing procedures. This recommendation synergizes with the one above since EEU expansion can play a facilitating role. As mentioned during the workshop, anticipation of technical regulations adoption by the EEU hinders independent development of such regulations in some countries.

5 Consider an optimum pattern for EES&L policy deployment: Voluntary labeling, Mandatory labeling and MEPS

Voluntary labeling is a softer, more cost-effective approach to introduce energy performance regulations by allowing sufficient time for the appliance market (both suppliers and consumers) to adjust and to accommodate introduction of stricter regulations during a later stage. It is important however not to drag transition to mandatory regulations too long to avoid losing momentum.

6 Createa national analytical foundation for EES&L policy planning and development, including:

- Conducting a detailed household appliance market analysis (status and trends);
- Conducting a cost-benefit analysis for EES&L policy options (including analysis of influences of policies on suppliers and consumers);
- Conducting an institutional capacity and technical needs assessment, including mapping of existing domestic testing facilities and their degree of technical and human capacities, assessing technical and human capacity needs and identifying necessary interventions, assessing gaps in enabling institutional and legal frameworks (including supporting policy compliance and enforcement, accreditation, and certification).

7 Create an enabling environment for the business sector (i.e., manufacturers, importers, distributors, etc.) to become a driving force for EES&L implementation

As mentioned during the workshop, there are examples in which energy efficiency labels were developed, promoted, and implemented by an industry (e.g., Russian Federation). Involvement of business is necessary to guarantee energy performance regulations taking root (e.g., knowledge of existing cost-effective technologies and understanding the market). However, the business sector possesses better resources (including financial) to support development and implementation of standards and labels. Involvement by the business sector is viable only in an environment in which HEA energy efficiency offers a competitive edge in comparison to similar products on the market. Such an environment might be enabled through government policies (including adjusting energy tariffs to reflect energy generation costs, elimination of energy subsidies, fiscal and other incentives for business entities, subsidizing the cost of efficient appliances [e.g., Thailand]).

8 Enable public consumer protection organizations to monitor EES&L compliance

An idea was shared that one source of insight could be public consumer protection organizations that have extensive experience with supporting general product safety and quality control.

9 Involve retail industries in promoting energy efficient appliances by providing guidelines on creating POS presentations of appliances and training sales personnel

Participants mentioned examples of retail personnel failing to explain the meaning of an energy performance label on an appliance after a customer inquiry. This represents a lost opportunity to inform consumers and influence consumer choices by explaining the benefits of an HEA versus alternatives. Clear and effective presentation of information on energy efficient appliances at POS, the ability of sales personnel to explain differences in technical characteristics, and highlighting potential direct benefits to consumers contribute to positive consumer choices.

10 Involve the education system from preschool through high school and universities in developing a new consumer culture and influencing consumer preferences

During the workshop, it was emphasized that consumer preferences are the primary factor behind a successful EES&L policy. It is important to involve education systems in molding new consumer habits and influencing consumer culture.

11 Other recommendations

- awareness campaigns from government, non-government organizations, and media;
- enhance inter-country sharing of information on experiences with EES&L policy formulation and implementation;
- importation regulation and restriction of inefficient appliances from entering the market;
- special cases of quality control for appliances that underwent repairs;
- creating and accreditation of testing facilities;
- training and licensing of staff members in testing facilities.

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Appendix 1
Decomposition analyses

Among various decomposition analysis methods, LMDI (Logarithmic Mean Divisia Index) methodology is the most appropriate due to its theoretical robustness, adaptability and the possibility of providing complete decomposition (Ang, 2004). Public consumption of electric energy may be decomposed into the following four factors:

$$E_i = \frac{HC_i}{GDP_i}\frac{E_i}{HC_i}\frac{GDP_i}{NH_i}NH_i = H_i\, I_i\, A\ {}_iNH_i \qquad (1)$$

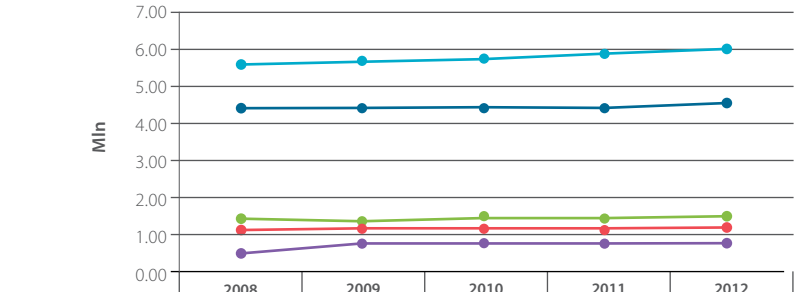
where E_i represents total electricity consumption by the population (GWh), HC_i – final consumption (spending) by households (2005, US dollars), GDP_i – GDP in 2005 in US dollars calculated through expenditure method, NH_i – total number of households in a given country, H_i – share of final consumption (spending) by families within GDP, I_i – specific electric energy intensity per 1 US dollar (2005) of the final consumption (spending) by households, and A_i – economic activity factor.

In 2012, the **total quantity of households** in the region amounted to more than 14 mln, with the largest share falling on Uzbekistan and the smallest – on Turkmenistan. The highest annual growth of the number of households in 2008-2012 was observed in Tajikistan (3.4%), and the lowest– in Kazakhstan (0.9%). In 2008-2012, the number of households in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan grew by 4%, 7%, 14%, 4% and 8%, respectively (Fig. 29).

The factor of economic activity and changing living standards. According to the World Bank's classification of world economies based on gross national income, Kazakhstan and Turkmenistan belong to upper-middle income, whereas Kyrgyzstan, Tajikistan and Uzbekistan – to lower-middle income countries. The GDP calculated through expenditure method totals final consumption by economic sectors, investment, government spending and net exports of goods and services. In its turn, the final consumption totals consumption by households, public sector and the sector of non-for-profit organizations that are servicing households. The GDP for Kazakhstan was the highest in the region, whereas the lowest GDP's were observed in Tajikistan and Kyrgyzstan. Over the period of 2008-2012, the highest GDP growth was observed in Turkmenistan and Uzbekistan – the increase amounted to about 47% in both countries over that entire period. The lowest GDP growth during the same period was observed in Kyrgyzstan (8%). In 2008-2012, the average annual GDP growth in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan amounted to 5%, 2%, 5%, 10% and 10%, respectively (Fig. 30).

The dynamics of final consumption (spending) by households within GDP. The levels of final consumption by families in the region demonstrate significant differences. Thus, the final household spending in Kazakhstan is 16 times higher than in Kyrgyzstan. During 2008-2012, the indicator increased in all Central Asian countries except Turkmenistan, where the corresponding expenses fell by 41%. In 2008-2012, the final consumption by households grew in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan by 35%, 7%, 70% and 63%, respectively (Fig. 31).

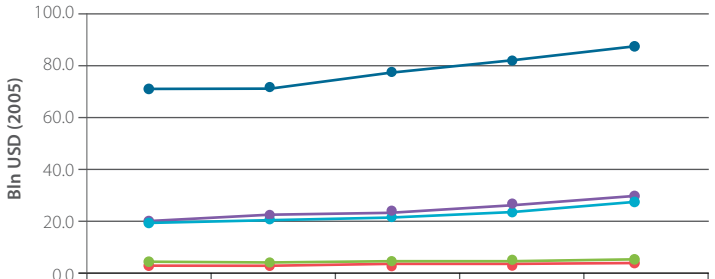
Figure 29 Dynamics of the number of households in Central Asian countries (2008-2012)



	2008	2009	2010	2011	2012
Kazakhstan	4.37	4.39	4.44	4.48	4.53
Kyrgyzstan	1.14	1.15	1.17	1.19	1.22
Tajikistan	1.34	1.38	1.41	1.47	1.53
Turkmenistan	0.76	0.77	0.78	0.78	0.79
Uzbekistan	5.55	5.68	5.80	5.89	6.01

Source: Expert assessments 2015

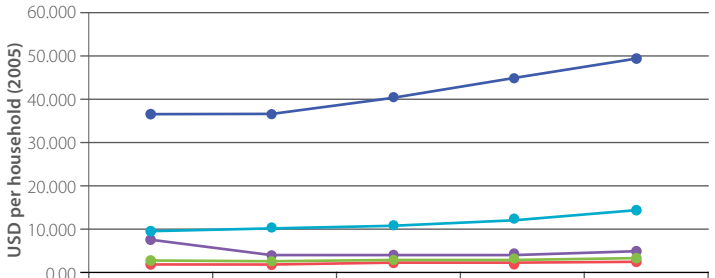
Figure 30 GDP dynamics in 2005 US dollars in countries in Central Asia (expenditure method, 2008-2012)



	2008	2009	2010	2011	2012
Kazakhstan	71.2	72.0	77.3	83.1	87.2
Kyrgyzstan	3.0	3.1	3.1	3.2	3.2
Tajikistan	2.9	3.0	3.2	3.2	3.5
Turkmenistan	20.0	21.3	23.2	26.5	29.4
Uzbekistan	18.4	19.9	21.6	23.4	27.1

Source: Expert assessments 2015

Figure 31 Dynamics of final consumption (spending) by households in Central Asian countries

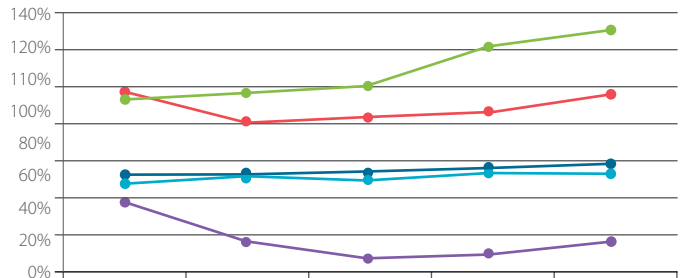


	2008	2009	2010	2011	2012
Kazakhstan	36.314	36.232	40.534	44.752	49.151
Kyrgyzstan	2.874	2.460	2.527	2.764	3.073
Tajikistan	2.651	2.859	3.158	3.922	4.512
Turkmenistan	7.477	3.031	1.195	2.065	4.439
Uzbekistan	8.585	10.029	10.373	12.163	14.031

Source: Expert assessments 2015

Besides the difference in economy sizes, the countries of Central Asia differ greatly in terms of their GDP structures. For example, the combined share of government spending, investment and net exports in the overall GDP structure (expenditure method) is much greater in Kazakhstan, Turkmenistan and Uzbekistan (countries with abundant mineral assets), than in Kyrgyzstan and Tajikistan. In addition, Tajikistan and Kyrgyzstan receive large amounts of remittances from abroad: based on some estimations, their volume may reach 50% of total GDP. In this regard, the shares of final consumption by families within the GDP's of Kyrgyzstan and Tajikistan are higher than in other countries in the region. Since 2008, the share of final consumption in Tajikistan grew substantially and in 2012 equaled 129%. In Kazakhstan, Kyrgyzstan and Uzbekistan the indicator changed only slightly and in 2012 reached 56%, 95% and 52%, respectively. In Turkmenistan, the share of final household consumption fell more than two fold since 2008 and in 2012 amounted to 15%. Remittances appear as the most probable reason for the growing shares of final consumption by households in Kyrgyzstan, Tajikistan and Uzbekistan **(Fig. 32).**

Figure 32 Shares of final consumption (spending) by households within GDP in Central Asian countries



	2008	2009	2010	2011	2012
Kazakhstan	51%	50%	52%	54%	56%
Kyrgyzstan	96%	80%	83%	85%	95%
Tajikistan	93%	96%	100%	121%	129%
Turkmenistan	37%	14%	5%	8%	15%
Uzbekistan	47%	50%	48%	52%	52%

Source: Expert assessments 2015

Change in specific electric energy intensity per 1 US dollar (2005) of the final consumption (spending) by households. Specific energy intensity[3] of the final consumption by households considerably varies between countries in Central Asia. In Kyrgyzstan, it is the highest and amounts to 1.7kWh/USD (2005) of the final consumption by families; it is the lowest in Kazakhstan at 0.21kWh/USD (2005) of the final household consumption. During 2008-2012, specific energy intensity of the final consumption by families in Kazakhstan, Tajikistan and Uzbekistan fell by 10%, 50% and 35%, respectively. In 2008-2012, the corresponding indicator grew by 57% in Kyrgyzstan and amounted to 1.70kWh/USD (2005) in 2012. In Turkmenistan, it demonstrated an upward trend in the course of 2008-2010, and then was falling during 2011-2012. The total growth of specific energy intensity during 2008-2012 in Turkmenistan amounted to 87%. The recent 30% increase of electricity tariffs may constitute a potential reason **(Fig. 33)**.

The overall consumption of electricity by the population in 2008-2012 may be calculated using the following formula:

$$\Delta E = E^{2012} - E^{2008} = \Delta E_{HC} + \Delta E_{EI} + \Delta E_{A} + \Delta E_{NH} \quad (2)$$

where ΔE_{HC} represents the change of electricity consumption due to the dynamics of the share of final consumption (expenses) by households within GDP, ΔE_{EI} – change in electricity consumption due to the dynamics of specific energy intensity of electricity consumption, ΔE_{A} – change in electricity consumption due to changes in economic activity and welfare, and ΔE_{NH} – change in electricity consumption due to changes in the quantity of households. The explanatory factors are calculated based on the following formulas:

$$\Delta E_{HC} = w_i \ln((H_i^{2012})/(H_i^{2008})) \quad (3)$$
$$\Delta E_{EI} = w_i \ln((I_i^{2012})/(I_i^{2008})) \quad (4)$$
$$\Delta E_{A} = w_i \ln((A_i^{2012})/(A_i^{2008})) \quad (5)$$
$$\Delta E_{NH} = w_i \ln((NH_i^{2012})/(NH_i^{2008})) \quad (6)$$

where w_i represents the logarithmic mean of public electricity consumption in 2012 and 2008:

$$w_i = (E_i^{2012} - E_i^{2008})/(\ln E_i^{2012} - \ln E_i^{2008}) \quad (7)$$

[3] Hereinafter, specific energy intensity corresponds to specific electricity consumption per one 2005 US dollar of final consumption (spending) by households.

For the purpose of this decomposition analysis, the following data sets were used: data on electricity consumption by population sourced from the International Energy Agency, data on final consumption (spending) by households and GDP sourced from the UN Data, and data on the total number of households in each country sourced from the Helgi Library. The results of the decomposition analysis of the data for 2008-2012 are presented in **Table 3** below.

Figure 33 **Dynamics of energy intensity of final consumption by households in Central Asian countries**

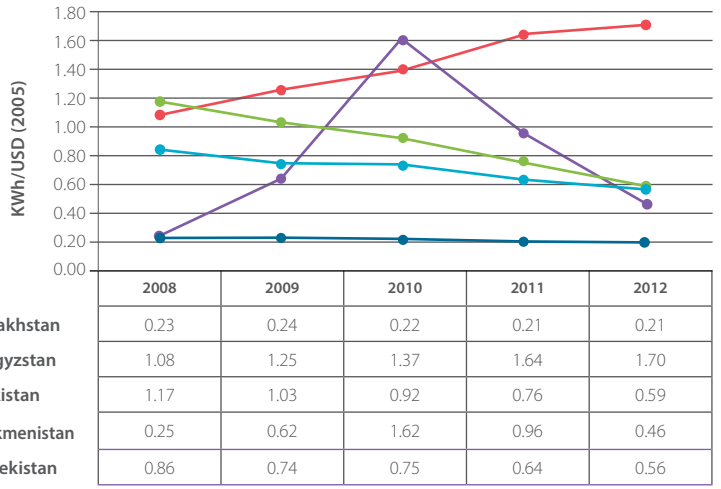


Table 3 **Outcomes of decomposition analysis of the factors influencing power consumption by household in Central Asian countries in 2008-2012**

Country	ΔE	ΔE_{HC}	ΔE_{EI}	ΔE_{A}	ΔE_{NH}	ΔE	ΔE_{HC}	ΔE_{EI}	ΔE_{A}	ΔE_{NH}
	GWh									
Kazakhstan	1820	914	-965	1540	331	22	11	-12	19	4
Kyrgyzstan	2106	-56	1833	52	276	68	-2	59	2	9
Tajikistan	-438	958	-1970	192	382	-14	31	-63	6	12
Turkmenistan	206	-1751	1214	668	75	11	-96	66	36	4
Uzbekistan	460	802	-3282	2333	606	6	11	-44	32	8

Appendix 2

Operating characteristics of the most common types of household electrical appliances in Central Asia countries

Table 4 **Operating characteristics of the most common types of household electrical appliances in Kazakhstan**

Electric Appliance	Average capacity (W)		Annual use (hours/year)			Electricity consumption (KWh/year)		
	On	Stand-by	On	Stand-by	Off	On.	Stand-by	Total
Microwave oven	1050	4	60	8406	294	63	34	97
Refrigerator	120	3	3800	4960	0	456	15	471
Electric stove	2250	6	300	8440	20	675	51	726
Electric kettle	1600	5,5	75	289	8396	120	2	122
Incandescent lamps	75	0,3	1225	1330	6205	92	0	92
Halogen lamps	55	3	1825	2555	4380	100	8	108
Fluorescent lamps	25	0,3	1225	0	7665	31	0	31
LED	7,5	0,3	1225		7879	9	0	9
Electric heater	1000	8,5	725	1283	6753	725	11	736
Air-conditioner	2100	1	300	8460	0	630	8	638
Ventilator	1100	3	90	1370	7300	99	4	103
Electric boiler	1750	10	300	430	8030	525	4	529
Washer	2250	5	156	1596	7008	351	8	359
Hair-dryer	750	3,9	142	0	8644	107	0	107
Analog TV-set	201	5	913	7227	621	183	36	220
LCD TV-set	180	5	913	1444	6404	164	7	171
Computer	200	0,5	2298	0	6765	460	0	460
Laptop	55	0,4	1868	1053	5840	103	0	103
Vacuum cleaner	1750	4	12	0	7462	21	0	21
Press iron	2200	0	30	8730	0	66	0	66
Stereo system	1500	0,1	271	94	8395	407	0	407

Table 5 **Operating characteristics of the most common types of household electrical appliances in Kyrgyzstan**

Electric Appliance	Average capacity (W)		Annual use (hours/year)			Electricity consumption (KWh/year)		
	On	Stand-by	On	Stand-by	Off	On	Stand-by	Total
Microwave oven	1187	4	60	8406	294	71	34	105
Refrigerator	150	10	4500	3800	0	675	38	713
Electric stove	1894	6	616	8124	20	1167	49	1216
Electric kettle	1539	5,5	75	289	8396	115	2	117
Incandescent lamps	75	0,3	1225	730	6205	92	0	92
Halogen lamps	55		1825	2555	4380	100	0	100
Fluorescent lamps	25	0,3	1225	0	7665	31	0	31
LED	7,5		1225	0	7879	9	0	9
Electric heater	1807	5	725	1283	6753	1309	6	1316
Air-conditioner	2422	3	300	8460	0	727	25	752
Ventilator	1100		90	1460	7300	99	0	99
Electric boiler	1667	9	300	84	8030	500	1	501
Washer	2250	5	156	1502	7008	351	8	359
Hair-dryer	1534	3,9	142	0	8644	218	0	218
Analog TV-set	201	11	913	6315	621	183	69	253
LCD TV-set	180	6	913	531	6404	164	3	167
Computer	348	21	2298	0	6765	800	0	800
Laptop	125	16	1868	1053	5840	233	17	249
Vacuum cleaner	1635	0	12	0	7462	20	0	20
Press iron	2200	0	30	8730	0	66	0	66
Stereo system	1500	8	271	94	8395	407	1	407

Table 6 **Operating characteristics of the most common types of household electrical appliances in Tajikistan**

Electric Appliance	Average capacity (W)		Annual use (hours/year)			Electricity consumption (KWh/year)		
	On	Stand-by	On	Stand-by	Off	On	Stand-by	Total
Microwave oven	1187	4	60	8406	294	71	34	105
Refrigerator	150	10	3800	4260	0	570	43	613
Electric stove	1894	6	616	8124	20	1167	49	1216
Electric kettle	1539	5,5	75	289	8396	115	2	117
Incandescent lamps	75	0,3	1225	730	6205	92	0	92
Halogen lamps	55	3	1825	2555	4380	100	8	108
Fluorescent lamps	25	0,3	1225	0	7665	31	0	31
LED	7,5	0,3	1225	0	7879	9	0	9
Electric heater	1807	5	725	1283	6753	1309	6	1316
Air-conditioner	2422	3	300	8460	0	727	25	752
Ventilator	1100	3	90	1460	7300	99	4	103
Electric boiler	1677	9	300	84	8030	500	1	501
Washer	2250	5	156	1502	7008	351	8	359
Hair-dryer	1534	3,9	142	0	8644	218	0	218
Analog TV-set	201	11	913	3615	621	183	69	253
LCD TV-set	180	6	913	531	6404	164	3	167
Computer	348	21	2298	0	6765	800	0	800
Laptop	125	16	1868	1053	5840	233	17	249
Vacuum cleaner	1635	0	12	0	7462	20	0	20
Press iron	2200	0	30	8730	0	66	0	66
Stereo system	1500	8	271	94	8395	407	1	407

Table 7 **Operating characteristics of the most common types of household electrical appliances in Uzbekistan**

Electric Appliance	Average capacity (W)		Annual use (hours/year)			Electricity consumption (KWh/year)		
	On	Stand-by	On	Stand-by	Off	On	Stand-by	Total
Microwave oven	1187	4	60	8406	294	71	34	105
Refrigerator	150	10	3800	4960	0	570	50	620
Electric stove	1894	6	616	8124	20	1167	49	1216
Electric kettle	1539	5,5	75	289	8396	115	2	117
Incandescent lamps	75	0,3	1225	1330	6205	92	0	92
Halogen lamps	55	3	1825	2555	4380	100	8	108
Fluorescent lamps	25	0,3	1225	0	7665	31	0	31
LED	7,5	0,3	1225	0	7535	9	0	9
Electric heater	1807	5	725	1283	6753	1309	6	1316
Air-conditioner	2422	3	300	8460	0	727	25	752
Ventilator	1100	3	90	0	7300	99	0	9
Electric boiler	1677	9	300	430	8030	500	4	504
Washer	2250	5	156	1596	7008	351	8	359
Hair-dryer	1534	3,9	142	0	8644	218	0	218
Analog TV-set	201	11	913	7227	621	183	79	263
LCD TV-set	180	6	913	7227	621	164	43	208
Computer	341	5	2298	6765	6765	800	34	834
Laptop	125	5	1868	1053	5840	233	5	238
Vacuum cleaner	1635	55	12	0	7462	20	0	20
Press iron	2200	0	30	0	8730	66	0	66
Stereo system	1500	0,1	271	94	8395	407	0	407