

**ENERGY EFFICIENCY  
IN BUILDINGS:**

untapped reserves  
for Uzbekistan  
sustainable  
development

SUMMARY



## ABBREVIATIONS

ADEME	French Environment and Energy Management Agency
AIM	Asian Integrated Model
BP	British Petroleum
CSE	Cost of Saving Energy
IEA	International Energy Agency
PV	Photovoltaic
RES-UZ	Residential energy consumption model
TACIS	Technical Assistance for the Commonwealth of Independent States
ADB	Asian Development Bank
GDP	Gross Domestic Product
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
GEF	Global Environmental Facility
EBRD	European Bank for Reconstruction and Development
EU	European Union
IFEB	Integrated Fuel and Energy Balance
EEC	European Economic Community
WHO	World Health Organization
OJSC	Open Joint Stock Company
OECD	Organization for Economic Cooperation and Development
GHG	Greenhouse gases
UNDP	United Nations Development Programme
RF	The Russian Federation
CIS	Commonwealth of Independent States
GAK	Federal joint stock company
U.S.	United States of America
HOA	Home Owners Association
CHP	Combined heat and power plant
TPP	Thermal power plant
CENEf	Center for Energy Efficiency
KMK	Building code

Developed by the Center for Energy Efficiency under supervision of the Nobel Peace Prize holder Mr. Bashmakov Igor.

## FROM THE AUTHOR

The objective of this study was to assess the perspectives for energy efficiency improvement in the Uzbekistani residential sector, as well as the energy saving potential and relevant social and economic benefits that may be obtained before 2050. Such time horizon allows it to go beyond the persistence of thinking, to avoid a primitive extrapolation of the current situation for the future, and to see and assess the perspectives that today may seem unrealistic. The goal was not formulated so as to “shift” the past and the present into the future; rather it was to estimate the future possibilities and to verify the current policies accordingly in order to early enough lay the basis for a bright future which is seen as an innovative “green” economy, and to turn future “maths” into current practices.

The major findings and results of the study are summarized in the Summary for Decision Makers. This version shows condition and evolution of the housing and municipal utility stocks, barriers to energy efficiency improvement in the buildings sector, development of energy efficiency regulatory framework in the Republic of Uzbekistan, as well as outputs of assessment of energy efficiency improvement perspectives in the Uzbekistani buildings for three scenarios: “Baseline”, “Step into the XXI century”, and “Soft way”.

Development of projections until 2050 required a set of mathematical models for long-term projections that are described in full version of the report.

This study was accomplished for the UNDP office in Uzbekistan by CENEF staff: Igor Bashmakov, Vladimir Bashmakov, Konstantin Borisov, Maxim Dzedzichek, Oleg Lebedev, Alexey Lunin, and Anna Myshak. Editing and layout by Tatiana Shishkina and Oksana Ganzhyuk. Translated into English by Tatiana Shishkina.

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Igor Bashmakov

Executive Director, CENEF

## SUMMARY

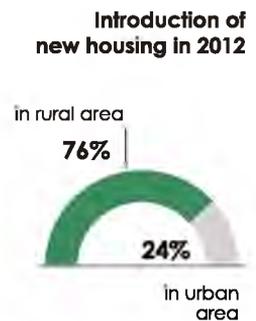
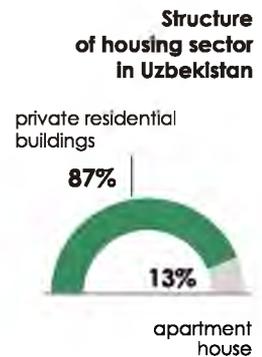
### Major findings and recommendations related to energy efficiency policies in the building sector in Uzbekistan

#### Housing and public building stock: 560 million m<sup>2</sup> in 2011

By 2012, Uzbekistan's housing stock was 450 million m<sup>2</sup>, 98.9% of which was private housing. As individual construction grew, multifamily housing construction decreased, dropping from 0.9% to 0.8% between 2000-2012. During the same period, the floor area for multifamily housing also decreased from 17% to 13% and by 1 July 2013, there were 31,671 multifamily houses, comprising 965,801 flats, with a floor area amounting to 58.3 million m<sup>2</sup>. Just over 30% (9,596) of these houses (floor area of 25.7 million m<sup>2</sup>) are located in Tashkent. Approximately 30-40 multifamily houses are built per year.

By 1 January, 2013, the population of Uzbekistan had reached approximately 30 million people. Housing per capita had grown from 13.8 m<sup>2</sup> in 2000 to 15.2 m<sup>2</sup> in 2012. The commissioning of new buildings had also increased from 8 million m<sup>2</sup> in 2000 to 10.4 million m<sup>2</sup> in 2012, i.e., the average commissioning rate was 0.35 m<sup>2</sup>/person/year. However, only 24% of the newly constructed floor area was commissioned in urban regions in 2012, with the remaining 76% being commissioned in rural regions. However, the total commissioned floor area for individual housing increased from 97% in 2000 to 99% in 2012.

According to available data, between 2002 and 2010 a total of 22,585 multifamily buildings, i.e., 73% of the overall number of multifamily buildings, were capitally refurbished. This refurbishment primarily targeted the renovation of in-house heat and water supply networks, doors and windows in entrance halls, and the installation of hot and cold water meters.



**If the quality of housing and municipal utility services is to be improved, substantial improvements will need to be made to housing amenities, primarily by providing access to tap water supply.** In 2010, only 66% of Uzbekistan's housing stock had access to a tap water supply, 31% to a sewage system, 43% to district heating, 80% to a natural gas supply, 24% to a DHW supply, and only 25% had bath tubs (fig. 1).

Around 95% of residential gas consumers are equipped with meters, while 74% of the total number of flats and individual buildings with access to DHW have meters, and only 4% of residential buildings have building-level heat meters.

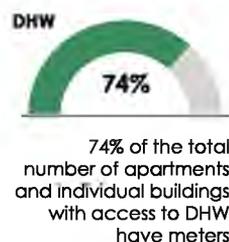
**CENEF estimates indicate that costs for housing and municipal utility services exceed 10% of residential incomes and are therefore beyond the affordability threshold.** And this is with a 3.5 year housing affordability ratio, which means a very affordable housing by international standards.

**The floor area of public and commercial buildings in Uzbekistan is approximately 110 million m<sup>2</sup> and more than half these buildings are educational institutions.**

Uzbekistan's statistics only account for some of the parameters of commercial and public floor area, therefore the missing data must be estimated.

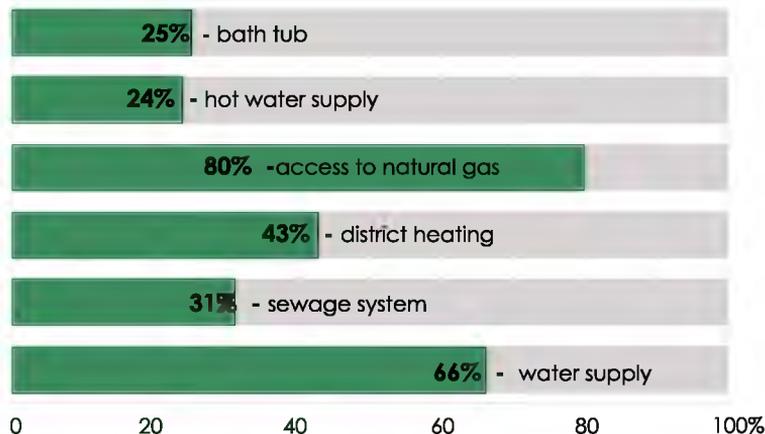
No information is available on public and commercial sector amenities, however they should correlate with housing stock amenities.

**Equipping with meters in housing sector**



**3,5 year -**  
housing affordability ratio

Fig.1 Provision of housing fund of Uzbekistan with municipal services in 2010



Source: The graph was prepared by UNDP project «Supporting Uzbekistan in transition to a low-emission development path» based on CENEF data

## More than 50% of primary energy is consumed by the building sector

In 2011, the building sector accounted for 55% of end-use energy consumption (or 50% of primary energy consumption, if fuel and energy complex process needs, electricity, heat generation and transmission losses are included). Buildings are responsible for 75% of final heat consumption; 26% of final electricity consumption; 64% of final natural gas consumption; Together with electricity and heat generation for the building sector, they are responsible for 56% of natural gas consumption. By improving the efficiency of natural gas, electricity, and heat use, consumption by this sector could be halved and the amount of natural gas consequently available for export could more than 10 billion cubic meters.

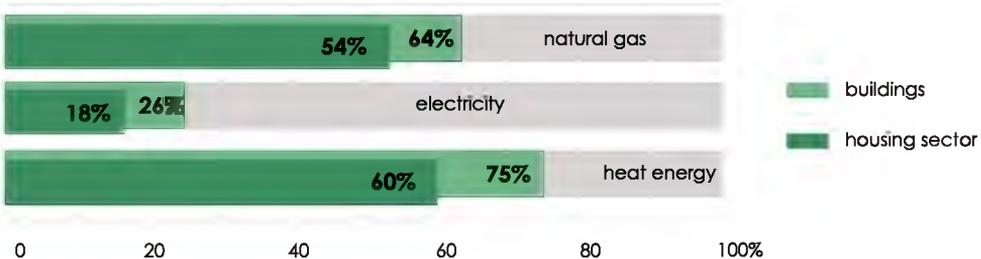
**Residential buildings are the largest energy consumer in Uzbekistan:** Residential buildings consume 33% of primary energy and 46% of final energy. They are responsible for 60% of final heat consumption, 18% of final electricity consumption, and 54% of final natural gas consumption. (fig.2) In 2011, the combined electricity and heat consumption of residential buildings and the energy requirements and losses associated with energy generation, amounted to 41% of primary energy consumption. According to CENEf estimates overall residential energy consumption, following a slight reduction, had relatively stabilised by 2003 at 15-16 mln. t.o.e. (22-23 mln. t.c.e.), with the consumption of natural gas dominating (84%) the consumption structure. The consumption rate also varied depending on the weather.

15-16 mln. t.o.e. - overall residential energy consumption

### Energy consumption structure in housing sector



Fig.2 Final energy consumption of all buildings and housing sector in Uzbekistan



Source: The graph was prepared by UNDP project «Supporting Uzbekistan in transition to a low-emission development path» based on CENEf data

**Specific energy consumption per 1 m<sup>2</sup> of household living space relates closely to figures in the Russia and the United States, i.e. countries substantially differing in climate and levels of development and housing amenities.** Specific energy consumption per 1 m<sup>2</sup> in 2011 was 52 kgce/m<sup>2</sup>/year (423 kWh/m<sup>2</sup>/year) and exceeded that of Russia (49 kgce/m<sup>2</sup>/year), where the average number of degree-days is twice that of Uzbekistan. In the EU, average specific energy consumption in the residential sector varies between 150 kWh/m<sup>2</sup>/year in Spain (a climate similar to Uzbekistan's) to 320 kWh/m<sup>2</sup>/year in Finland (fig.3). Global indicators show consumption figures of 450 kWh/m<sup>2</sup>/year in the U.S., 300 kWh/m<sup>2</sup>/year in Japan, and around 175 kWh/m<sup>2</sup>/year for the Chinese urban population. The higher value of specific energy consumption is to some extent determined by the larger share of individual low-rise residential buildings. Another factor, which is seldom considered in cross-country comparisons, is that the average household in Uzbekistan tends to be larger than that of other countries (double that of Russian households).

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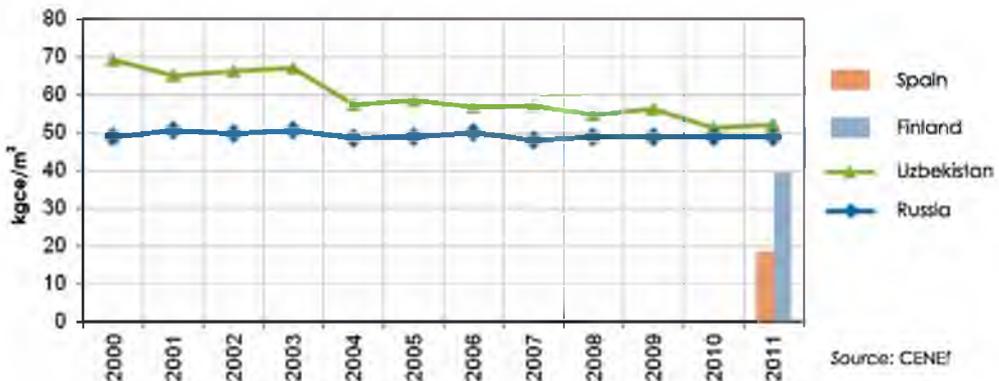
**52 kgce/m<sup>2</sup>/year**  
or  
**423 kWh/m<sup>2</sup>/year**

energy consumption  
per 1 m<sup>2</sup> of living area  
in Uzbekistan

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**The average EU residential energy consumption for space heating is 2-3 times below that of Uzbekistan.** In 2011, EU energy consumption for space heating was slightly less than 16 mln. T.c.e. The average total energy consumption for space heating for buildings was 0.121 Wh/m<sup>2</sup>/degree-days; for multifamily buildings 0.035-0.065 Wh/m<sup>2</sup>/degree-days, and for single-family houses 0.136 Wh/m<sup>2</sup>/degree-days. The average values for EU countries are 0.035-0.06 Wh/m<sup>2</sup>/degree-days.

Fig.3 Evolution of specific residential energy consumption in Uzbekistan in 2000-2011



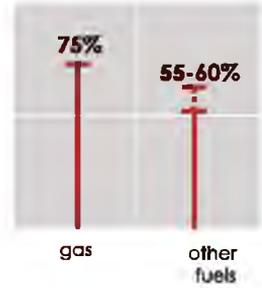
**Two thirds of residential energy consumption is related to space heating.** Heat for this purpose is primarily generated from natural gas, a large percentage of which is also used for domestic hot water supply and cooking. However, the share of energy consumed by lighting and appliances is relatively small (around 4%), while energy consumption by DHW, cooking and appliances is on the increase (fig.4).

**The share of residential buildings with access to district heat is relatively low** (13% of the overall floor space), therefore specific energy consumption to a large degree depends on the efficiency of the space heating equipment used. In Uzbekistan, the efficiency rate for gas-fired systems is 75% and 55-60% for space heating using other fuels, while the average efficiency rate of district heating boilers is only 68%.

As distribution losses account for 15% or more, **it does not make sense to continue district heating in zones with low heat load densities.** Even if gas-fired district heat boilers are replaced with more efficient models, and individual consumers are equipped with condensing boilers, the same conclusion applies.

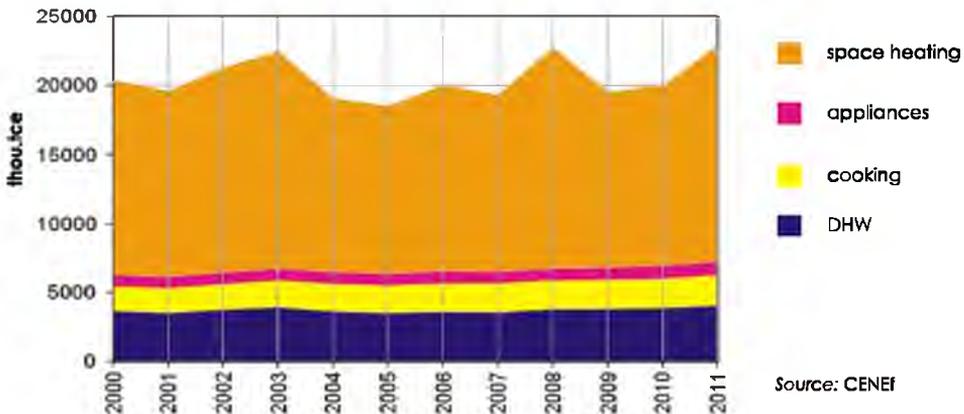
**A cross-country analysis and an analysis of random energy audits data indicated that the energy saving potential of residential space heating is 8-13 mln. t.c.e. (51-83% of the 2011 energy consumption).** Thus a substantial energy saving potential is possible in space heating and in DHW. It is the single-family individual houses that are responsible for the major gap in space heating efficiency.

**Equipment efficiency of district heating systems**



**68%** - average efficiency of centralized boilers

Fig.4 Residential energy consumption dynamics in Uzbekistan in 2000-2011 broken down by major uses



Source: CENEF

\*Estimate based on the assumed correlation of heat supply with the temperature curve and lack of any substantial undersupply.

**The technical energy saving potential in the residential sector** is estimated at 13.8 mln. t.c.e. (61% of the 2011 consumption). However, this can only be achieved if all housing complies with the KMK 2.01.18-00\* “Pre-determined levels of energy consumption for space heating, ventilation, and air conditioning in buildings and facilities”. Additionally, the energy savings potential from houses complying with the passive houses requirements is estimated at 17.6 mln. t.c.e. (77% of the 2011 consumption).

*The economic* energy saving potential was estimated based on the incremental costs (related to passive house energy saving measures) and using natural gas export prices as an opportunity cost, which equals 13.8 and 14.9 mln. t.c.e. respectively.

*The market* energy saving potential was estimated based on the incremental costs and a 12% discount rate at 0.3 and 4.1 mln. t.c.e. With more stringent requirements in household construction and from Home Owners Associations regarding the energy efficiency investment paybacks and 33% discount rate the saving potential does not exceed 0.5 mln. t.c.e.

**Uzbekistan has a relatively low market energy saving potential primarily because of cheap energy resources.** It is very difficult to raise energy prices without going beyond residential energy affordability thresholds. Since the economic energy saving potential is quite substantial, **the introduction of subsidies for energy efficiency improvements in buildings** is an important tool for realising this potential until 2020, and would result in significant additional natural gas export revenues.

**Since 2000, compliance regulations, such as the “Pre-determined levels of energy consumption for space heating, ventilation, and air conditioning in buildings and facilities” KMK 2.01.18-00\* have been developed, adopted, and enacted in Uzbekistan. In 2011, under the UNDP/GEF project, 10 key building codes were revised.**

Following the revision of these building codes, energy consumption for space heating declined by 30-40% from previous levels. Even in the developed countries the building codes requirements are not always met.

The extent to which these requirements are met in individual housing construction is not clear, however, average energy consumption for space heating in single-family houses dropped by 17% in 2000-2011 (fewer degree-days of the heating season).

Although this decrease was partially determined by the weather, the leading factor was the introduction of energy efficiency

### Estimated technical potential of energy saving in heating of residential buildings

Comparative analysis

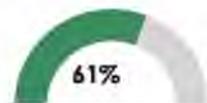
**8-13 mln. t.c.e.**



of energy consumption in 2011

Bringing of all buildings to KMK 2.01.18-00\* requirements will allow saving up

**13,8 mln. t.c.e.**



of energy consumption in 2011

Bringing of all buildings to “passive house” parameters will allow saving up

**17,6 mln. t.c.e.**



of energy consumption in 2011

improvements mandated by the building codes enforced in 2000 and by weatherisation measures undertaken by households (installation of glass units). These two latter factors contributed to around 14% of the decrease in space heating energy consumption.

**Audits of rural, single-family houses built using standard construction show a high rate of specific energy consumption.** This is due to the sub-standard installation of both heating systems and windows and to the lack of thermal performance requirements in the building design.

If all single-family buildings were replaced with passive houses, energy savings would amount to 12.7 mln. t.c.e., or 55% of the overall residential energy consumption and 18.6% of primary energy consumption in 2011.

**Public and commercial buildings are responsible for around 10% of final energy consumption.** These include one- and two-storey buildings with 204-450 kWh/m<sup>2</sup>/year specific energy consumption for space heating.

Preliminary estimates from the UNDP/GEF pilot project on energy efficiency improvement in public buildings, show that the measures currently in place may result in savings of 50-65%.

The technical energy saving potential in public and commercial buildings may be estimated at 2.4-2.9 mln. t.c.e. (70-84% of the 2011 consumption), and the potential of fuel substitution with renewable energy is nearly 0.5 mln. t.c.e.

**Estimated technical potential of energy saving in heating of residential buildings**

Bringing of all buildings to "passive house" parameters will allow saving up

**12,7 mln. t.c.e.**



of energy consumption in 2011

Promoting energy efficiency in public buildings will allow saving up

**2,4-2,9 mln. t.c.e.**



of energy consumption in 2011

## Uzbekistan's heat supply systems are in disrepair and inefficient

Uzbekistan does not produce data on heat balances, which makes it difficult to assess the condition of heat supply systems. Natural gas is the major fuel used by thermal power plants and boiler-houses. Approximately 70% of Uzbekistan's boiler-house energy equipment is in disrepair, therefore, the efficiency of most boilers is only 68-75% on average.

Around 31% of the country's heating networks are dilapidated and, since 1997, the overall size of the heating networks has been decreasing.

Nearly 30% of the network pipes have no insulation due to poor maintenance, while the poor condition of in-house networks contributes to the extent of water leakages in the larger network as a whole.

Heat losses are estimated at 27.6% of total heat generation. The current frequency of accidents and emergencies in the heating networks exceeds that of large Russian cities by 5-10 times.

## A set of mathematical models was used for energy consumption projections in the building sector

Two mathematical models were used to assess the effects of implementing an energy efficiency policy in the Uzbekistan's building sector. The first model (RES-UZ) relates to residential energy consumption and includes energy consumption for residential space heating; energy consumption for DHW supply; energy consumption for cooking; energy consumption by appliances.

Since long-term projections until 2050 or even 2020 are unavailable in Uzbekistan, another model was used to forecast GDP growth, investments, investments in the housing construction, and new housing commissioning.

A comparison model was also developed to compare potential development options and to assess the costs and benefits of various scenarios.

### Estimated technical condition of heating system in Uzbekistan



Physical depreciation of the power equipment of boilers



Depreciation level of the thermal networks



Share of pipelines without thermal insulation



Heat losses of the total amount of heat generated

## **Energy efficiency barriers must be addressed before implementing energy saving policies**

There are four main barriers to energy efficiency:

- lack of incentives;
- lack of information;
- lack of financial resources and “long-term money”;
- lack of organisation and coordination.

These barriers relate to prices and financing; to the economic and market structure and organisation; and to institutional, social, cultural, and behavioural barriers. Nearly all can be addressed through the introduction of energy efficiency policy measures.

Technological barriers include a lack of design skills, of materials and technologies, and of experience in the operation of energy efficient buildings. Another technological barrier is caused by a lack of monitoring and assessing during construction or renovation. Another important barrier to energy efficiency is the different motivation that drives both principal and agent during construction. Thus finding consensus on whether a building should adhere to energy efficiency regulations is also a barrier that must be overcome.

Other, equally important barriers include

- the initial cost of equipment and construction;
- a large share of poor families;
- small project size;
- low and subsidized energy prices for residential consumers;
- low payment discipline;
- risk perception;
- poor statistics on residential buildings;
- a lack of awareness and trust by municipal utility consumers;
- a lack of energy efficiency policies and relevant funds;
- a lack of qualified personnel.

## **Energy efficiency activities in Uzbekistan's building sector have increased in recent years, however further action is required**

**An energy efficiency and renewable energy regulatory framework is being developed.** Under the UNDP/GEF project “Promoting Energy Efficiency in Public Buildings in Uzbekistan” and in cooperation with three national design institutions 10 building codes have been revised and are expected to produce a 25% reduction of specific energy consumption, both in renovated and new buildings.

**The experiences of other countries in the implementation of energy efficiency policies in buildings can be applied in Uzbekistan.** The most important include:

- energy efficiency requirements in building codes; mandatory standards for the energy efficiency of appliances;
- buildings and equipment certification and labelling;
- federal procurement of only efficient buildings and equipment;
- energy service contracts;
- energy efficiency improvements by utility companies through integrated resource planning, demand management, white certificates and energy efficiency resource standards;
- energy service financing;
- preferential loan programmes, including preferential mortgage schemes for energy efficient buildings and “green” buildings;
- federal subsidies;
- tax benefits;
- public-private partnerships in the development and market penetration of new technologies;
- housing stock inventory and improvement of statistics;
- energy audits;
- information campaigns.

## Baseline scenario

By 2050, Uzbekistan's housing stock will have increased to 949-987 million m<sup>2</sup>, while housing per capita will have grown to approximately 26 m<sup>2</sup> per person. The assumption is that between 2014-2050 the share of commissioned multifamily buildings will be 2% and that housing stock amenities will have improved substantially by 2050. It is also assumed that the requirements of KMK2.01.18-2000\* "Pre-determined energy consumption for space heating, ventilation, and air conditioning of buildings and facilities" established in 2011 will not be revised until 2050, and the requirements of KMK 2.01.18-2000\* will only pertain to new construction.

Income growth leads to a substantial increase in the number of appliances per residential household, while the efficiency of appliances will remain for the most part unchanged.

It is assumed that the quality of energy supply will improve. In the baseline scenario the assumption is made that the share of renewable energy used for DHW production will not exceed 6.5% until 2050.

In the baseline scenario, the growing demand for natural gas reduces the gas export potential by two thirds. Despite the fact that by 2050 specific energy consumption in the residential sector would be nearly halved, and that specific energy consumption by new houses would have dropped below 20 kgce/m<sup>2</sup> (163 kWh/m<sup>2</sup>), the scenario does not envisage a halt in residential energy consumption growth (fig. 5).

### Key assumptions of the baseline scenario

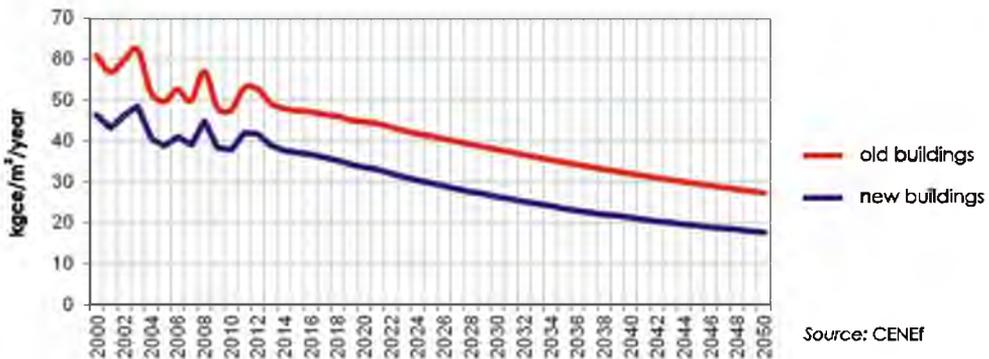
#### Growth of housing



Energy consumption keeps growing, despite the fact that by 2050 specific energy consumption would reduce almost twice

Share of RES < 6.5%  
in DHW production until 2050

Fig. 5 Specific residential energy consumption by groups of buildings in the baseline scenario



Source: CENEF

The increased demand for residential energy is primarily caused by the requirements for space heating resulting from the growth in housing stock.

Energy consumption for DHW and cooking first increases, then levels off and then begins to decline.

Appliances and lighting show the most dynamic growth. (fig.6)

The increase in the consumption of electricity is nearly 10 bln. kWh, or around 20% of the 2011 electricity consumption.

In 2010-2050, energy consumption by public and commercial buildings will have increased by 37%. (fig.7)

Fig.6 Residential energy consumption by processes in the baseline scenario

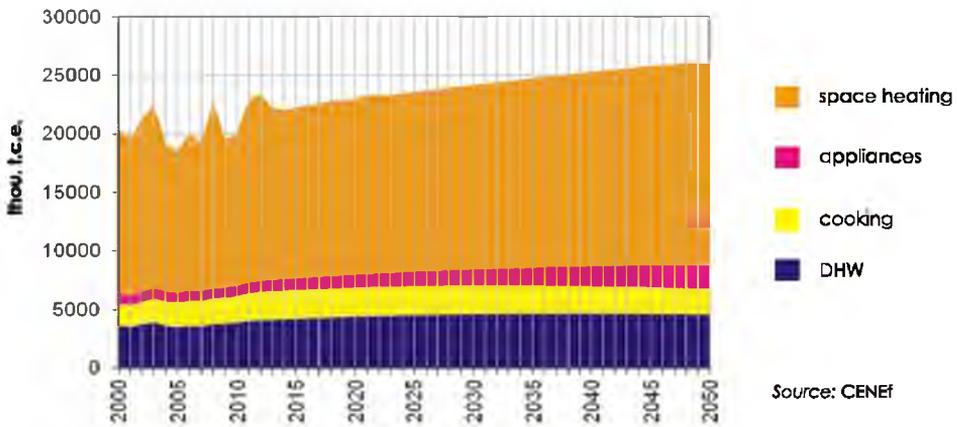
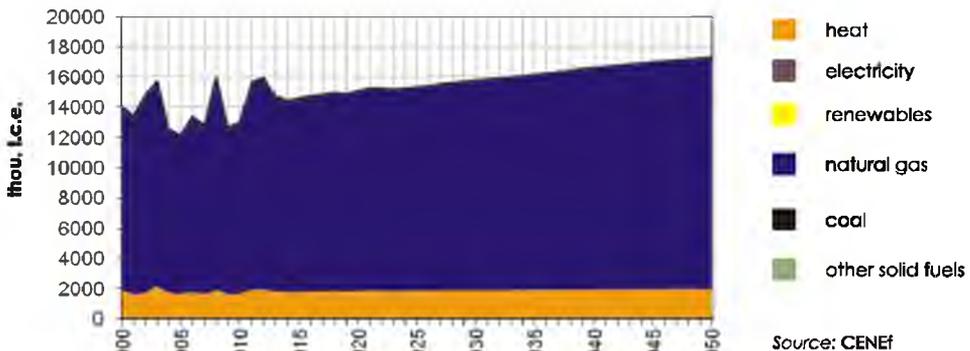


Fig.7 Structure of energy resource use for residential space heating in the baseline scenario



## "Step Into the XXI century" scenario

The "Step into the XXI century" scenario suggests an expansion of the KMK regulations by integrating energy efficiency requirements into comprehensive capital retrofits of existing buildings. For new buildings it suggests integrating sufficiency (buildings orientation, roof colour, and other bio-climate parameters of projects aimed at energy demand reduction), efficiency (requirements for the thermal performance of buildings and equipment efficiency), and renewable energy supplies (energy generation from renewable energy sources in buildings). New building codes in Europe now stipulate a transition to zero energy buildings and plus-energy buildings (fig. 8).

The "Step into the XXI century" scenario specifies a schedule for enforcing stringent requirements related to specific heat consumption for space heating and ventilation:

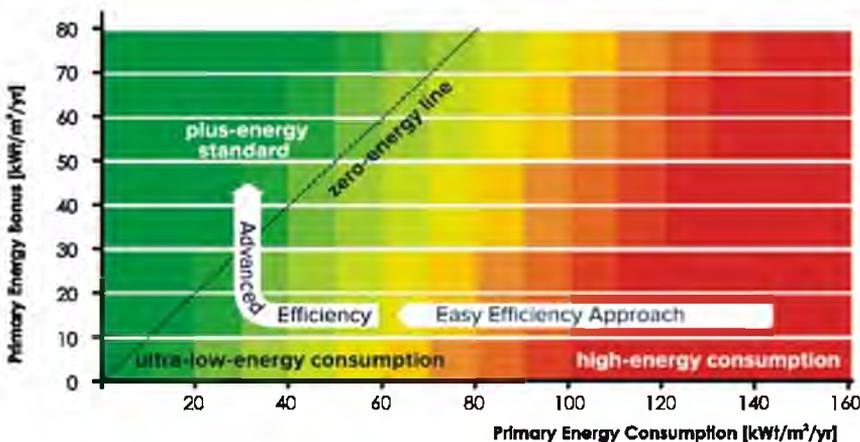
- by 2021: 30% reduction of specific heat consumption from 2011 levels to 100 kWh/m<sup>2</sup>/year (for a 1-storey building);
- by 2031: 64% reduction of specific heat consumption from 2011 levels to the current parameters of low energy houses (50kWh/m<sup>2</sup>/year for a 1-storey building);
- by 2041: 90% reduction of specific heat consumption from

**Key assumptions of the "Step Into the XXI Century" scenario**

**Building codes for existing buildings**  
Include requirements of energy efficiency for comprehensive capital retrofit projects

**Building codes for new buildings**  
Integrate requirements for transfer to "zero" energy consumption and for plus-energy buildings

Fig.8 Strategic direction of transformation of existing buildings into low-energy or plus-energy buildings



Source: P. Hennicke. Wrap up policy packages how to make energy efficiency policies work? Wuppertal Institut für Klima, Umwelt, Energie. 14th CII Workshop. 26 September. Berlin 2013.

2011 levels to the current parameters of passive houses (15 kWh/m<sup>2</sup>/year).

**As the growth rate for the commissioning of new housing begins to slow down, it will become increasingly important to improve the efficiency of existing buildings through comprehensive capital retrofits that include energy efficiency measures. Under the “Step into the XXI century” scenario, the schedule for enforcing stringent requirements to specific energy consumption for space heating and ventilation during capital retrofits is as follows:**

- **2016** - a requirement integrated into the building codes that comprehensive capital retrofits effect a 30% specific energy consumption reduction from the baseline level;
- **from 2016** - 2% of residential buildings undergo capital retrofits per year, of which 50% are multifamily residential buildings;
- **2031** - a requirement integrated into the building codes that comprehensive capital retrofits effect a 50% specific energy consumption reduction from the baseline level;
- **2041** - 90% reduction of specific energy consumption from the 2011 baseline year to the current parameters of a passive house (15 kWh/m<sup>2</sup>/year).

**Energy efficiency requirements of appliances also become substantially more stringent (fig.9).**

#### Key assumptions of the “Step into the XXI Century” scenario

The graph on increased requirements to the specific heat consumption for heating and ventilation

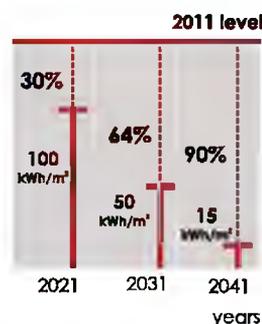
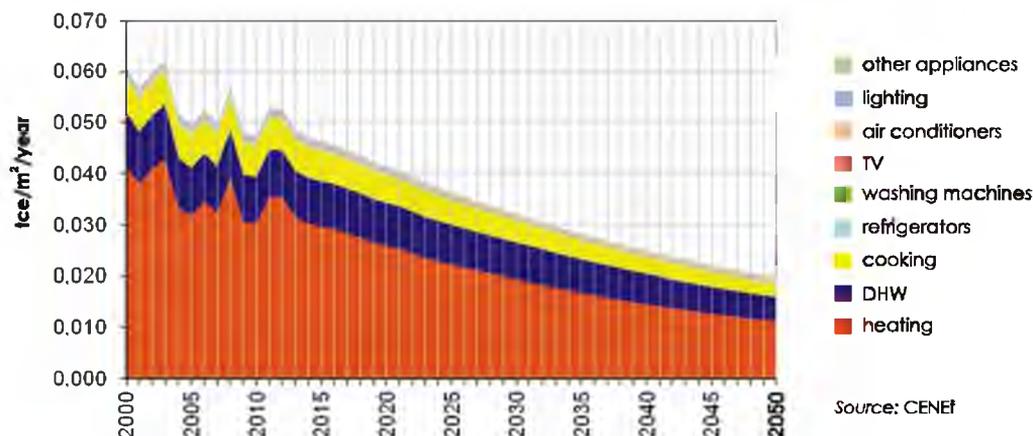


Fig.9 Specific residential energy consumption in the “Step into the XXI century” scenario



Source: CENEF

It is assumed that 5% of gas-fired boilers will be withdrawn from service every year, and only boilers with at least 92% efficiency will be installed in any new construction, capital retrofits or replacement of dated boilers.

It is further assumed that, as CFLs improve and the use of LED lighting increases, the average voltage required to provide lighting equivalent to a standard 60W incandescent bulb, will be reduced by 1% per year. The use of efficient lighting will increase from 19% to 50% in 2020, and from 29% to 100% by 2030.

Information campaigns and programmes that provide incentives for purchasing more efficient appliances will help to speed up the annual reduction of average specific energy consumption by major appliance stock by 0.1%. For computers and other small appliances and information equipment, specific energy consumption per unit will decrease by 3% per year and all households will have computers by 2050.

After some growth in 2010-2020, residential energy consumption will begin to decline as a result of the measures implemented under the “Step into the XXI century” scenario, despite the substantial increase in housing stock.

Additionally, the potential for gas exports will not be affected, as the growth demand for natural gas will be slower. The growth in residential energy consumption will cease, and by 2050 will have been reduced by 6% from 2010 levels and by 12% from 2020 levels (fig. 10).

**Key assumptions of the “Step into the XXI Century” scenario**

Increase in energy efficiency of heating boilers and water heating boilers

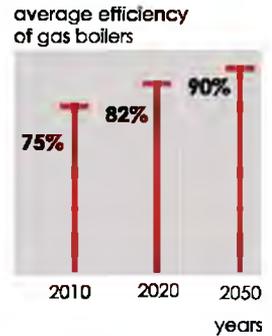
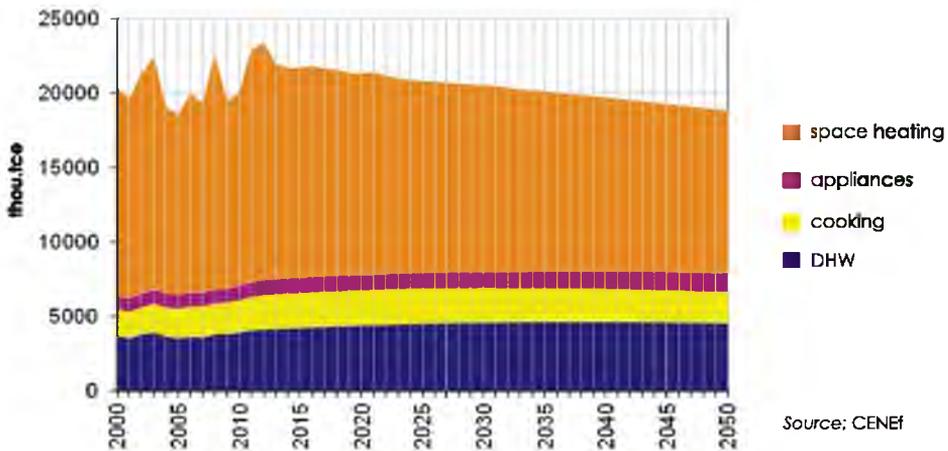


Fig.10 Residential energy consumption by processes in the “Step into the XXI century” scenario



Source: CENEF

Specific residential energy consumption will have been reduced by 2.7-fold, and the specific energy consumption of new buildings will decrease to 12.5 kgce/m<sup>2</sup> (102 kWh/m<sup>2</sup>) by 2050.

The electricity consumption of appliances and lighting systems compared to the baseline scenario will grow much more slowly: 33% growth in 2010-2050 (fig.11).

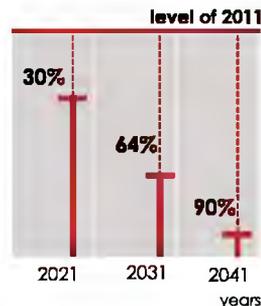
The increase in electricity consumption will drop nearly 4-fold to 2.6 bln. kWh from 10 bln. kWh. This reduction amounts to 14% of the 2011 electricity consumption.

Although the demand is still highest for natural gas in the residential fuel balance throughout the whole period, gas consumption does decline both in relation to the baseline scenario (by 1.6 bln. m<sup>3</sup> in 2020, by 3.8 bln. m<sup>3</sup> in 2030, and by 7.8 bln. m<sup>3</sup> in 2050) and in absolute terms.

In the “Step into the XXI century” scenario, energy savings in public and commercial buildings will amount to 0.7 mln. t.c.e. by 2030 and to 1.5 mln. t.c.e. by 2050 when compared to the baseline scenario. Natural gas savings in public and commercial buildings will amount to 0.5 bln. m<sup>3</sup> in 2020, 1 bln. m<sup>3</sup> in 2030, 1.5 bln. m<sup>3</sup> in 2040, and 2.1 bln. m<sup>3</sup> in 2050.

The total amount of energy savings in residential and public buildings will be 4.2 mln. t.c.e. in 2030 and 8.8 mln. t.c.e. in 2050.

Graph of increasing requirements to specific energy consumption for heating and ventilation



Graph of gas economy in fuel balance relative to baseline scenario

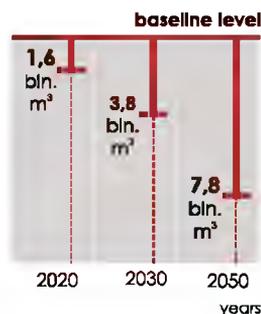
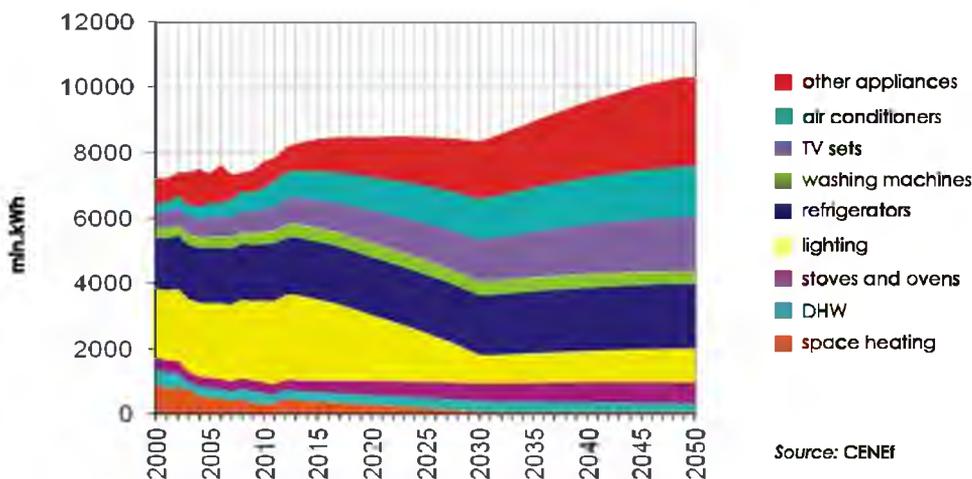


Fig.11 Residential electricity consumption by processes in the “Step into the XXI century” scenario



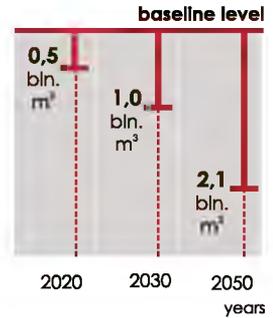
Source: CENEF

Direct and indirect savings of natural gas will amount to nearly 10 bln.m<sup>3</sup> by 2050 compared to the baseline scenario, which is close to the total figure for 2011 gas exports.

**Many energy efficiency policies will need to be launched in the building sector to enable the practical implementation of the “Step into the XXI century” scenario.** These include:

- a) by 2041 - building code requirements that are substantially more stringent with regard to specific heat consumption for space heating and ventilation in new buildings, thus making them comparable to passive houses (15kWh/m<sup>2</sup>/year);
- (b) increasing to 2% the share of buildings that annually undergo comprehensive capital retrofits and concurrently enforcing the requirement for, firstly, a 30% and then a 50% reduction of specific energy consumption for space heating and ventilation resulting from these capital retrofits;
- (c) providing incentives for the replacement of space heating equipment (primarily gas-fired boilers and water heaters) with efficient models;
- (d) increasing the share of efficient lighting fixtures to 50% in 2020 and to 100% by 2030;
- (e) replacing appliances with more efficient models and developing local production of such models.

Graph of gas saving in fuel balance of public buildings comparing to baseline scenario




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Natural gas saving will be  
**10 bln.m<sup>3</sup> - by 2050**  
 comparing to baseline scenario

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## "Soft way" scenario

The climate in Uzbekistan provides numerous opportunities for utilising renewable energy. However, the rural construction programme currently under implementation in the country (fig. 12-a) does not include the use of renewable energy. At the same time, evidence has shown that it is possible to build energy-plus buildings in climate conditions similar to those of Uzbekistan.

The "Soft way" scenario builds on the assumption that incentives will be provided for the construction of "passive" buildings and for renewable energy use.

This scenario suggests that once the system for monitoring the compliance of residential building construction with the KMK requirements has been fine-tuned, in 2021 a programme to provide incentives for the construction of low energy ( $50\text{kWh/m}^2$  for space heating and cooling) and passive houses ( $15\text{kWh/m}^2$ ) will be launched.

The assumption is also that the share of new low energy and passive houses will thereafter increase by 1% annually, and there will be 30% of each house type in 2050. The share of housing stock equipped with heat pumps will increase to 5% in 2030 and to 17% in 2050.

It is assumed that the share of houses equipped with solar water heaters will increase to 11% in 2020, 18% in 2030, and 32% in 2050.

### Advantages of "plus-energy" building

It consumes in average

**44.4 kWh/m<sup>2</sup>/year**  
for heating ,

**11.2 kWh/m<sup>2</sup>/year**  
for air conditioning

**Water consumption is 70% lower** due to the use of rain and 'grey' water for watering and installation of efficient sanitary ware.

**The lighting system uses 10 Wt capacity** light-emitting diodes.

**Heat energy for heating is generated by heat pumps**  
**Heat energy for DHW is generated by solar water heater.**

**Solar photovoltaic module** allows generation of energy **that is 2.5 times higher** than the building requires.

Fig.12 Typical houses built under the standard rural housing construction programme (a) and an energy generating plus-energy house in Istanbul (b)



a)



b)

Source: <http://www.rehva.eu/index.php?id=495>

It is further assumed that specific water consumption per person in houses with solar water heaters will decline by 1% per year due to the use of more efficient taps and sanitary ware.

It is also surmised that as solar photovoltaic (PV) modules become cheaper, they will become a cost-effective option for residential electricity supply. The PV experimental phase, including the accumulation of experience and training of personnel, will last until 2021, and a large-scale programme to provide incentives for the use of PV panels will be launched thereafter.

It is assumed that 1% of single-family houses will have PV panels by 2030, 3% by 2040, and 5% by 2050 (fig.13).

In the “Soft way” scenario, renewables will meet nearly 15% of the overall energy demand by 2050. Residential energy consumption will decrease by 7% in 2050 compared to 2010 levels.

Consumption of electricity supplied from the grid will only increase by 14% in 2010-2050, while overall electricity consumption will increase by 70%.

The difference amounts to 4.3 bln. kWh in 2050 and is covered through individual electricity generation.

Although natural gas usage will continue to dominate in the fuel balance of the residential sector throughout the whole period, its share substantially decreases (fig.14).

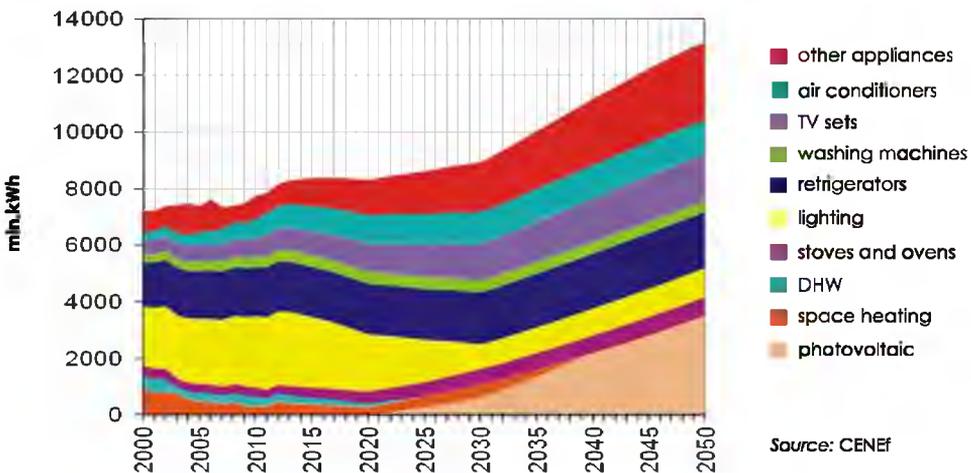
**Key assumptions of the “Soft way” scenario**

The monitoring system of residential building construction will be fully adjusted according to building codes by 2021

Since 2021 a program will be launched to promote construction of buildings with low energy consumption  
**(50 kWh/m<sup>2</sup>/year)** for heating and cooling and “passive” buildings  
**(15 kWh/m<sup>2</sup>/year)**

Promoted use of heat pumps, solar water heaters, photovoltaic modules is expected

Fig.13 Residential electricity consumption by processes in the “Soft way” scenario



Source: CENEF

The direct and indirect savings in natural gas usage, resulting solely from the measures of the “Soft way” scenario, will increase to 2.7 bln. m<sup>3</sup> by 2050, If combined with the measures of the “Step into the XXI century” scenario, these savings (compared to the baseline scenario) increase from 1.8 bln. m<sup>3</sup> in 2020 to 4.7 bln. m<sup>3</sup> in 2030, to 7.6 bln. m<sup>3</sup> in 2040, and to 10.6 bln. m<sup>3</sup> in 2050.

This not only fully compensates the natural gas consumption increase in the baseline scenario, but also cuts gas consumption in absolute terms.

Until 2030, natural gas savings will be obtained primarily through energy consumption reduction measures.

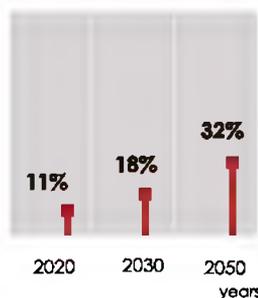
Beyond 2030, the contribution of renewable energy substantially increases.

Overall natural gas savings in 2013-2050 equal 196 bln.m<sup>3</sup>, which is more than three years of gas production or 17-year volume of net gas export.

According to British Petroleum, the proven reserves of natural gas in Uzbekistan were 1.1 trillion m<sup>3</sup> in 2012. Between 2013-2050 the demand for residential buildings fuel alone will amount to 660 bln. m<sup>3</sup> of natural gas, or to 770 bln. m<sup>3</sup>, if combined with the fuel demand for the public and commercial buildings. Another 310 bln. m<sup>3</sup> of natural gas will be needed during this period for electricity and heat generation for the building sector, while at least 300 bln. m<sup>3</sup> reserves will be needed to ensure that the level of gas production can meet the gas consumption of

**Key assumptions of the “Soft way” scenario**

Share of residential buildings equipped with solar water heaters



Share of residential buildings equipped with heat pumps

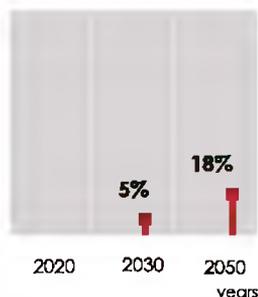
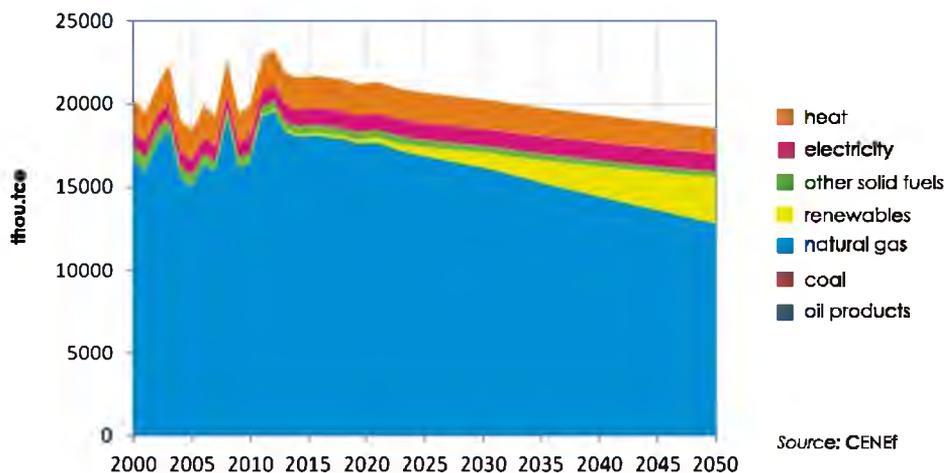


Fig. 14 Residential energy consumption breakdown in the “Soft way” scenario



buildings for at least another 10 years after 2050. The energy demand of buildings between 2013-2050 will amount to 1.1 trillion m<sup>3</sup>, and will be even greater beyond 2050.

**The measures implemented under the “Soft way” scenario will not bring any noticeable additional energy savings in commercial buildings, but will bring additional natural gas savings.** By 2050, nearly 17% of the total commercial energy demand will be met through distributed renewable energy.

Direct natural gas consumption will show a decline of 60% in 2050 compared to the baseline scenario. In all, natural gas savings in 2013-2050 compared to the baseline scenario will be 50.6 bln.m<sup>3</sup>.

Grid electricity consumption will only increase by 14% while heat consumption will decrease by 15%.

**Policies which provide incentives for renewable energy development will need to be launched in 2021, at the latest, to promote the implementation of the “Soft way” scenario.** These would include

- incentives which target increasing the share of single-family houses equipped with heat pumps (to 5% in 2030 and to 17% in 2050),
- solar water heaters (to 11% in 2020, to 18% in 2030, and to 32% in 2050),
- PV panels (to 1% in 2030, 3% in 2040, and 5% in 2050).

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**1,1 trillion m<sup>3</sup>-**  
proven reserves  
of natural gas  
in Uzbekistan in 2012

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**1,1 trillion m<sup>3</sup>-**  
the amount of natural  
gas required for energy  
supply buildings in  
2013-2050

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Natural gas savings  
in 2013-2050  
according to  
“Soft way” scenario

**50,6 bln. m<sup>3</sup>**



of natural gas  
consumption in 2050  
according  
to the baseline scenario

## Costs and social and economic benefits

Implementation of the “Step into the XXI century” scenario in 2014-2050 would cost USD 27 bln., and the “Soft way” scenario another USD 11 bln., thus a total additional cost of USD 38 bln. would be incurred.

Housing construction, retrofits and equipment costs will show a 20% growth by 2020, 37% growth by 2030, and 53% growth by 2050.

The measures required under the “Step into the XXI century” scenario will add 18% to these costs by 2020, 27% by 2030, and 35% by 2050.

However, revenues obtained through the export of resultant gas savings (in the residential sector alone) will amount to USD 57 bln. in 2014-2050 (or USD 95 bln., with gas export prices growing at a rate of 2% above the inflation rate).

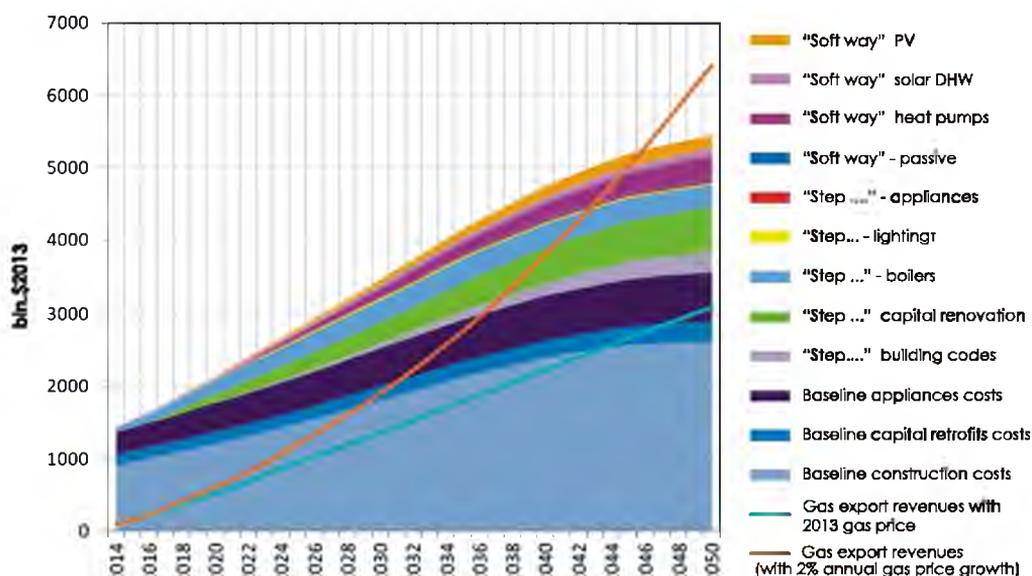
These revenues outweigh the additional costs throughout 2014-2050 (fig. 15).

Moreover, monetisation of the additional effects will substantially (by 30-70%) increase the estimated economic effect.

Basic steps  
in assessment  
of costs and benefits

- 1 Assessment of **basic costs** for construction of new residential buildings, capital retrofit of the existing housing stock and equipment of building with home appliances
- 2 Assessment of **additional costs** for implementation of projects within scenarios
- 3 Assessment of **benefit**, but only from **saving of natural gas**, which can be exported

Fig.15 Assessment of costs and benefits of the “Step into the XXI century” and “Soft way” scenarios



Source: CENEF

**The reduction of natural gas consumption through improved gas efficiency in buildings becomes an important means of maintaining Uzbekistan's natural gas export potential.**

In all, natural gas savings in the residential sector will amount to 246 bln.m<sup>3</sup> in 2013-2050, which equals four years of gas production or a 21-year volume of net gas export by Uzbekistan.

If the measures of both the “Step into the XXI century” and “Soft way” scenarios are implemented the amount of natural gas consequently saved and available for export will amount to 2.1 bln.m<sup>3</sup> (2020), 4.9 bln.m<sup>3</sup> (2030), 7.4 bln. m<sup>3</sup> (2040), and 10 bln.m<sup>3</sup> (2050).

Until 2030, natural gas savings will be primarily obtained through energy consumption reduction measures. After 2030, the contribution of renewable energy increases substantially.

With gas export prices close to USD 250/1,000 m<sup>3</sup>, the revenue from the export of gas obtained through the energy efficiency improvements made in buildings and the development of renewable energy sources under the “Soft way” scenario will bring USD 72 bln. over 2013-2050, which is equal to five years of export revenues or six years of import expenditures<sup>\*)</sup>.

---

**246 bln. m<sup>3</sup>-**  
potential of natural gas export due to improved efficiency of its use in buildings in 2013-2050

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**\$ 72 bln.-**  
Income from the additional export of natural gas in 2013-2050 according to "Soft Way" scenario

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Fig.16 Fifteen positive impacts of energy efficiency improvements in buildings



Source: P. Hennicke  
Wrap up policy packages - how to make energy efficiency policies work?  
Wuppertal Institut für Klima, Umwelt, Energie.  
14th CTI Workshop.  
26 September. Berlin 2013

\*) Uzbekistani export in 2012 equaled USD 14,258.8 mln., and import was USD 12,027.7 mln.

By 2024, the savings will already exceed USD 1 bln. per year. With 1% annual growth of the real gas export price, this figure will increase to USD 93 bln., and with 2% annual growth of the real export price, will reach USD 120 bln.

**Improving the energy efficiency of buildings can contribute to the attainment of many of the Millennium Development Goals.** Additionally, numerous positive economic and social benefits can be realised through the implementation of energy efficiency programmes in buildings, including improved health, combating poverty, incentives for economic growth, job creation and investment growth, improved living conditions, etc.

**Investing in gas savings is ,3-5 times more cost-effective, per unit of capital investment, than investing in gas production.** Additional gas volumes obtained by improving the energy efficiency of buildings and by substituting gas with distributed renewable energy sources ensures less capital-intensive economic growth, and so with a pre-determined accumulation ratio allows for higher economic growth rates. Provided that relevant incentives are available, the construction of energy efficient residential buildings can become an important driver of economic growth. A reliable energy supply and an improved working environment will increase productivity in the commercial sector by 5-10%.

**An additional annual investment of approx. USD 1 bln. could create up to 100,000 jobs.** Additionally, the development of “green” construction would provide a new job market for the application and maintenance of innovative construction technologies, materials and equipment. Manufacturing these products domestically would help reduce import expenditures and encourage industrial and commercial development.

**Implementing projects that integrate the “Step into the XXI century” and “Soft way” scenarios will increase the amount of individual income spent on house purchase but will reduce the amount spent on housing energy bills.**

The additional costs for constructing passive houses are around 10-30% more than normal construction costs but reduce energy consumption by 70-80%.

**The cost of supplying residential energy, compared to the baseline scenario, shows a decrease of 12% by 2020, 28% by 2030, 40% by 2040, and 50% by 2050.**

The associated savings in 2013-2050 will amount to USD 24 bln.

---

**\$1 mnl.**

Invested  
In energy efficiency  
In the building sector  
will create

**40-100  
new jobs**

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**10-30% -**  
additional costs in  
construction of  
“passive” buildings

**70-80% -**  
reduction in energy  
consumption in their  
exploitation

---

Furthermore, the proposed measures will allow residential consumers to keep within the energy affordability threshold.

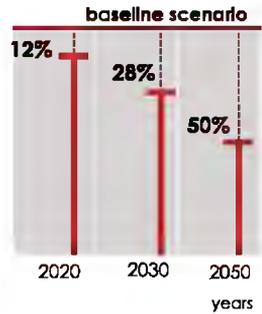
Assistance provided by the State to low-income families in obtaining low-energy or plus-energy housing will completely eliminate the need for the subsidies currently required to eradicate “energy poverty”.

A reduction in the number of 'sick' days resulting from substandard working conditions will consequentially lead to a reduction in sickness-related income loss and medical expenses, which is a crucially important factor for low-income families.

Finally, the measures proposed in the “Step into XXI century” and “Soft way” scenarios not only eliminate emissions growth in this sector, but also ensure a noticeable emissions reduction (fig. 17). The residential sector is responsible for at least 27% of overall energy-related GHG emissions. Compared to the baseline scenario, the reduction in emissions will amount to 3.9 mln. t CO<sub>2</sub>eq. in 2020, 10 mln. t in 2030, 16.3 mln. t in 2040, 22.6 mln. t in 2050. The latter figure equals 22% of the 2010 emissions.

In all, GHG emissions decline by 421 mln. t CO<sub>2</sub>-eq between 2013-2050, which is four times less than the 2010 emissions volume. If this is combined with the reduction of emissions from the commercial sector, the overall reduction in GHG emissions throughout the building sector will be 528 mln. t CO<sub>2</sub>-eq., five times less than the 2010 energy-related GHG emissions.

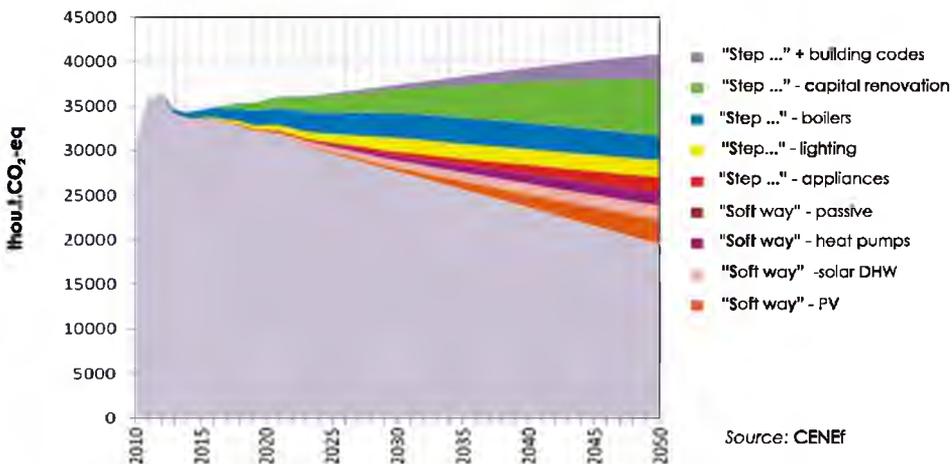
Graph of reduced costs for energy supply of residential buildings comparing to the baseline scenario



**\$ 24 bln. -**

cost saving of energy supply of residential houses in 2013-2050

Fig. 17 Contribution of individual integrated measures to the evolution of GHG emissions in the residential sector



Source: CENEF

**The proposed measures will improve living conditions, promote better health, reduce indoor emissions and improve air quality, all of which will help to reduce sickness and death rates.**

The beneficial effects on health resulting from improved amenities or thermal comfort are estimated to be 8-22% of the energy saving costs.

Total reduction  
of GHG emissions  
from all buildings  
In 2013-2050

**528 mln.t CO<sub>2</sub>-eq.**

**OR**

**5\*V<sub>2010</sub>**

5-fold reduction  
of the GHG emissions  
from the energy sector  
in 2010

Summary table of the main comparative indicators of different scenarios

Scenario	Additional cost (2014-2050) \$ bln/2013	Savings of natural gas by 2050 bln. m <sup>3</sup> /year	Savings of natural gas during 2014-2050 period bln. m <sup>3</sup>	Electricity consumption increase by 2050 bln. kWh
Baseline	0	0	0	10
“Soft way”	11	2,7	50,6	4,3
“Step into the XXI century”	27	7,9	145,4	2,6

