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Scaling-up Energy Efficiency in Rural Buildings of Uzbekistan

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The views expressed in this publication are those of the working group and do not necessarily reflect the official opinion of the CER and UNDP.

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Introduction

Integrating "green" principles in construction of buildings has been the mainstream of policy measures directed to facilitate the transition to the green economy. Sustainable buildings use energy, water and land resources more efficiently and create more productive and healthier jobs and living environment. Green buildings have lower operations and maintenance costs and pay lower utility bills. The cost-benefit analysis of sustainable buildings indicates that green investment is paid off and the return to green investment is ten times more than the initial investments required to design and construct a green building. It is noteworthy to mention that energy savings alone exceed the average increased costs associated with green construction.

Residential buildings have the largest potential to save energy and generate financial, social and environmental benefits

Residential buildings have the largest potential to save energy and generate financial, social and environmental benefits (energy consumption in residential buildings in Uzbekistan is twice as large as in OECD countries). At the same time, the largest number of residential buildings in Uzbekistan are being constructed in rural areas. In fact, rural buildings accounted for more than 63% of housing being constructed in Uzbekistan in 2010-2014. This is explained by the fact that the Government of Uzbekistan is making significant investments in new rural and peri-urban settlements through its State Programme on Housing for Sustainable Rural Development (referred to here as the Rural Housing Programme, or RHP). Under the RHP, the Government has invested over US$ 2.5 billion between 2009 and 2014 in the construction of over 1,000 new rural settlements, including a total of 33,557 houses from 2009 to 2013 and 11,000 houses in 2014.

Taking into account the large number of buildings being constructed in rural areas, integrating "green" principles in rural building construction in Uzbekistan could produce large savings and benefits for the economy, society and environment and generate high rates of return to "green" investment.

In order to fully employ the potential and benefits of rural green construction this study aims to assess the benefits to be generated by the implementation of green principles in rural housing construction and suggest efficient mechanisms to facilitate transformation towards sustainable rural housing.

[1] The costs and financial benefits of green buildings, a report to California's Sustainable building taskforce
[2] "Green Buildings in Uzbekistan: Technologies, Legal Framework and Incentives", CER, 2012
[3] Additional information on the Rural Housing Programme is available at ADB (2015), Housing for Integrated Rural Development Investment Program, http://www.adb.org/projects/documents/housing-integrated-rural-development-investment-program-uzbekistan-rrp
[4] Government of Uzbekistan (2013) "Government Approves the Rural Housing Programme for 2014." http://www.uzbekembassypakistan.org/?q=nod; and Qishloq Qurilish Bank (2014) "Financing Support of Housing Construction in Rural Areas and Development of Mortgage Crediting System in Uzbekistan." http://www.unece.org/fileadmin/DAM/hlm/wpla/workshops/Tashkent2014/Djabbarov_Eng.pdf

Chapter 1. Energy efficiency in existing and newly built rural buildings

In Uzbekistan, buildings are the largest consumer of final energy - 24.5 mtoe

In Uzbekistan, buildings are the largest consumer of final energy - 24.5 mtoe in 2011 which represents nearly half of all energy produced in the country . Average energy use indicators in homes, commercial and public buildings exceed the average world indicators by at least 2 times due to the prevalence of design and construction practices using energy intensive technologies , insufficient insulation, insufficient energy efficiency of heating and air conditioning systems, engineering and communication systems. Increasing energy efficiency of buildings by introducing "green" principles in the construction and reconstruction of buildings will allow to save more than 12 million tons of oil equivalent energy per year . It means that the major consumer of energy with the largest energy saving potential must be the priority of policy measures directed to build "green" economy and to satisfy the energy demand of economy.

Residential buildings have the largest potential to save energy and generate financial, social and environmental benefits. At the same time, the largest number of residential buildings in Uzbekistan are being constructed in rural areas. In fact, rural buildings accounted for more than 63% of housing being constructed in Uzbekistan in 2010-2014. This could be explained by the fact, that the Government of Uzbekistan is making significant investments in new rural and peri-urban settlements through its State Programme on Housing for Sustainable Rural Development (referred to here as the Rural Housing Programme, or RHP). Launched in 2009, the RHP was accompanied by a Presidential Decree, "On Additional Measures for Scaling-Up Housing Construction in Rural Areas." Under the RHP, the Government has invested over US$ 2.5 billion between 2009 and 2014 in the construction of over 1,000 new rural settlements, including a total of 33,557 houses from 2009 to 2013 and 11,000 houses in 2014. The RHP grew exponentially from US$ 25.4 million in 2009 to

[5] Source: International Energy Agency

[6] This is due to the fact that up to date the main focus in construction is traditionally concentrated on minimizing one-time expenses, and the upcoming high maintenance expenses on heating and conditioning of buildings are almost not taken into account

[7] According to IEA data, buildings in Uzbekistan consume 320-690 kWh per m2 a year which is 2-2.5 times higher than the energy consumption in developed countries

[8] CER Report (2015) "Green buildings in Uzbekistan: Technologies, Legal framework, Incentives"

[9] Additional information on the Rural Housing Programme is available at ADB (2015), Housing for Integrated Rural Development Investment Program, http://www.adb.org/projects/documents/housing-integrated-rural-development-investment-program-uzbekistan-rrp

[10] Government of Uzbekistan (2013) "Government Approves the Rural Housing Programme for 2014." http://www.uzbekembassypakistan.org/?q=nod; and Quishloq Qurilish Bank (2014) "Financing Support of Housing Construction in Rural Areas and Development of Mortgage Crediting System in Uzbekistan." http://www.unece.org/fileadmin/DAM/hlm/wpla/workshops/Tashkent2014/Djabbarov_Eng.pdf

US$ 886.3 million in 2014. In this period, more than 6.5 million m2 of housing space was constructed and sold in rural areas across Uzbekistan.

Taking into account the large number of buildings being constructed in rural areas, integrating "green" principles in rural building construction in Uzbekistan could produce large savings and benefits for the economy, society and environment and generate high rates of return to "green" investment.

To estimate the potential benefits from transition to green economy in the sector of buildings, the current state of both existing and new buildings in rural areas needs to be assessed.

1. Energy efficiency potential of existing rural housings.

The potential for improving the energy efficiency can be explained with the following characteristics of rural housings:

a) Construction attributes of buildings

The average monthly consumption of natural gas per household is 8.3 m3/m2 which is 33% higher than the energy use of energy efficiency homes

The age of more than 70% of rural housings is more than 15 years. Due to the low energy prices at those times, most of these buildings were constructed not taking into account energy efficiency measures (such as plastic windows, thermal insulation materials, roof insulation). 68% of buildings have single pane wooden windows and replacing these wooden windows with double-glazed plastic windows can substantially reduce the energy consumption of a building. More than 95% of buildings were constructed without roof insulation and without weatherization measures. As a result of insufficient weatherization, roof insulation, large share of wooden windows and homemade boilers in rural housings, the average monthly consumption of natural gas per household is 8.3 m3/m2 which is 33% higher than the energy use of energy efficiency homes (5.5 m3/m2).

b) Heaing and hot water system

There is also a large potential to improve effectiveness of space heating boilers in rural buildings. In fact, 55% of boilers are home made with efficiencies of about 50%, 99% of boilers don't have an automatic thermostat . At the same time, the respondents are fine with the quality of boilers, generally enjoy acceptable indoor temperatures and are unwilling to invest in upgrades, which means that additional incentives are needed to make people invest in energy efficient equipment.

[11] CER Report (2015) "Energy efficiency of buildings in Uzbekistan: potential of energy efficiency, directions of reform and expected effects"

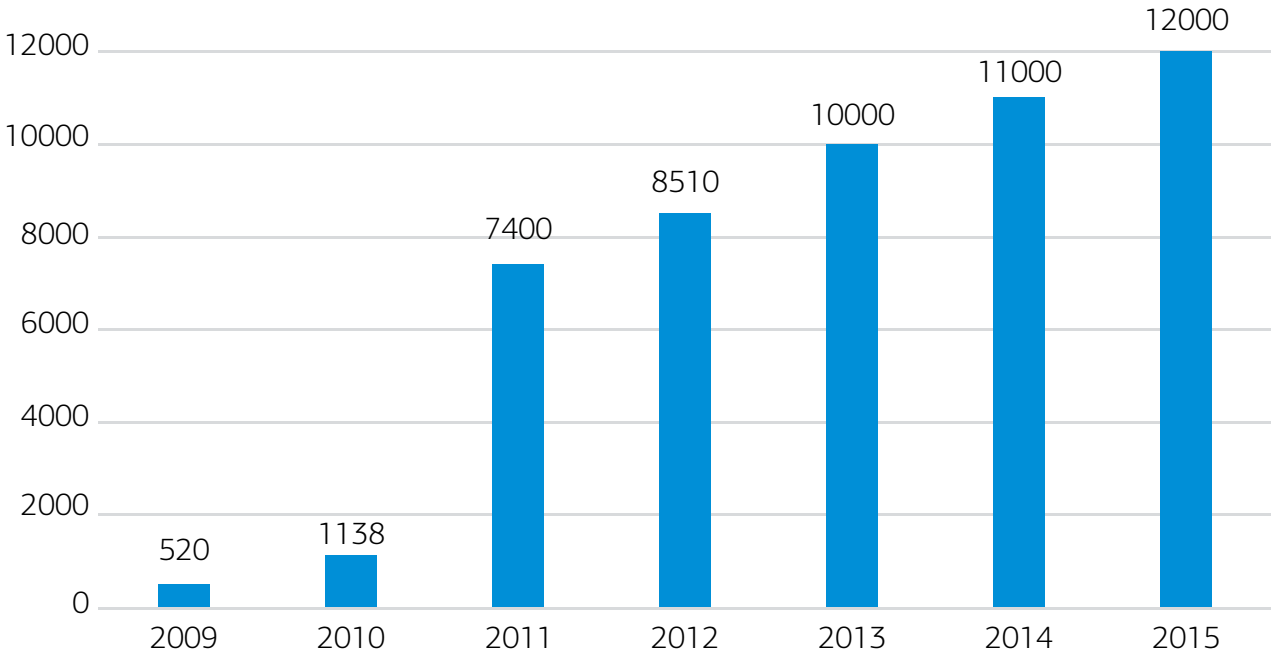
[12] CER Report (2015) "Energy efficiency of buildings in Uzbekistan: potential of energy efficiency, directions of reform and expected effects"

2. Energy efficiency potential of newly built rural houses

Characteristics of standard house design still fall short of the existing potential for energy savings and GHG emissions reduction

The new 'typical' rural houses have been built since 2009 under the National Rural Housing Program. The houses have 3, 4, 5 rooms with an average space of 150 m2. The figure 1 shows the dynamics of increasing the volume of individual housing construction on model projects with 3, 4 and 5 bedrooms. As seen from the chart below, 520 houses were built in the first year (2009) of the implementation of state program during the solution of technical, financial and organizational issues of starting the construction of rural dwellings in the early years. The number of houses doubled in 2010. In 2011, 2012 and 2013, a sharp increase in construction is observed (by 6.5, 7.4 times and 8.7 times, respectively, in relation to the volumes of 2010). Starting in 2013, the increase in construction volumes has leveled off and reached 1000 of individual dwellings per year, annually. So, 11000 houses were built in 2014 with total area of 1.7 million m2, and 12000 houses in 2015 of 1.8 million m2.

Figure 1. The dynamics of increasing volume of rural individual housing construction



Although energy use in newly built individual rural houses is much lower than in the existing rural houses, the characteristics of standard house design still fall short of the existing potential for energy savings and GHG emissions reduction. For example, rural houses do not have sufficient insulation of the walls, ceiling or floor, they are usually not located with regards to the north-south,

[13] Inna Rudenko, 2015. Observational study of rural household energy use.

only windows in some houses are covered with plastic during the winter season to reduce heat loss. The important and most efficient way to raise energy use efficiency in typical newly built rural houses is to conduct insulation measures. As boilers are located outside the house, more energy required to convey water into the house and additional insulation for pipes outside the house is required. Moreover, there are no regulators on radiators, some pipes are hidden over the ceiling thus losing the heat in the cold under-roof space, boilers have low energy efficiency and there is also a lack of alternative heating sources besides gas boilers.

There is also a large potential to improve energy efficiency due to better zoning and settlement planning. Land-use plans could take the low-carbon considerations into account, thus expanding efficiency gains from applying passive solar design techniques and village-level energy solutions.

Insulating walls and floors and treatment of radiators with regulators could decrease the monthly consumption of natural gas by 24.7%

Insulating walls and floors and treatment of radiators with regulators could decrease the monthly consumption of natural gas by 24.7% on average. In addition, using renewable sources of energy along with abovementioned measures can increase the energy efficiency potential up to 25.1%.

Chapter 2. Opportunities for transition to green rural housing construction: Life cycle cost estimates of green investment

Integrating green principles in the construction of new typical rural housings under the National Rural Housing Program is the efficient way of realizing the potential of energy efficiency in rural areas. Two types of prototype rural houses with significantly improved energy performance in comparison to newly built 'typical' rural houses are proposed (Table 1):

• Energy-efficient (EE) houses will feature an array of cost-effective EE solutions that may include better insulation for external walls and foundation walls; more efficient window placement; and the use of thermostatic valves and heat reflectors for radiators. These EE houses are approximately 2.9% more expensive than standard RHP houses, but they will reduce annual energy use by an estimated 24.5%.

• Low-carbon houses will include all of the EE home features, but they will also include a solar PV system to meet lighting needs. These low-carbon houses are approximately 6.2% more expensive than current standard RHP houses, but they will reduce energy consumption by 25.1% and offer a reliable supply of power that is independent from the electricity grid.

Energy efficient houses are 2.9% more expensive than standard RHP houses, but will reduce annual energy use by 24.5%

Table 1.
Performance of new rural houses in Uzbekistan

Type of Housing	Annual Energy Consumption (kWh /yr)	Energy Savings Compared to Standard (%)	Cost of Home (USD)	Cost Differential Compared to Standard (%)
Standard Home (existing design)	38,557	--	$61,108	--
Energy-Efficient Home (extra insulation)	29,124	24.5%	$62,898	2.9%
Low-Carbon (EE +RE) Home	28,884	25.1%	$64,888	6.2%

Although the proposed new rural houses offer a significant energy efficiency potential, the cost of such investment is more than the standard RHP houses (Table 1). Incremental cost of converting standard home to EE home ('green premium') is $1790 and $ 3780 for LC home respectively. However, the cost-benefit analysis using life cycle cost methodology shows that benefits generated as a result of less use of energy substantially exceed upfront costs or green premium (Table 2).

Table 2.
Life cycle cost estimates resulting from green investments in EE and LC homes

Type of Housing	During 25 years
EE Home Present value of savings from the less use of energy Green premium Savings/green premium	 $3,971.86 $1,790 222%
LC Home Present value of savings from the less use of energy Green premium Savings/green premium	 $4,477.20 3780 118%

Incremental cost of converting standard home to EE home ('green premium') is $1790 and $ 3780 for LC home

'EE home' green investment option produces $2.22 return to each $1 of green investment during the lifetime of a house (25 years), while 'LC Home' green investment option produces $1.2 return to each $1 of green investment during the same time horizon. It is noteworthy to mention that energy savings alone exceed the average increased cost associated with building green. Moreover, if we included financial benefits of green buildings in terms of reduced emissions, waste and water value, decreased operating and maintenance cost value and improved productivity and health value during lifetime of a house, then net present value of these benefits would dramatically exceed any upfront green costs.

Chapter 3. Green mortgage market mechanism to scale-up demand for energy saving

Introduction of green mortgage scheme will offer affordable financing mechanism to invest in new rural houses with energy saving or renewables features. This is important to make rural mortgages under the RHP encourage the purchase of energy efficient or low carbon homes.

Introduction of green mortgage scheme will offer affordable financing mechanism to invest in new rural houses with energy saving

The term "green mortgage" is defined as financing that allows homebuyers to borrow extra money for items that save energy and/or reduce GHG emissions. Green mortgage initiatives typically create a consortium between a bank, the investor/developer, the homebuyer and a competent authority or expert organization to certify green residential projects that are environmentally responsible and energy efficient relative to the standard offer. Financial institutions – through the issuance of "green mortgages" tied to certified homes with improved energy and environment performance – can significantly reduce their mortgage default risk. In turn, these conditions allow them to offer a lower cost of financing. Lower finance costs provide the homebuyer with greater purchasing power to invest in improved construction quality, as the green mortgages internalize the value of significant reductions in energy, repair and health costs for buyers purchasing certified homes. Green mortgages will also help the residential marketplace to better appreciate the positive value of sensible borrowing to invest properly at the beginning of the building process .

The introduction of such a financial product enables significant progress toward energy-efficient buildings, improved uptake of green energy, reduced greenhouse gas emissions, reduced construction waste, and reduced toxicity of building materials compulsory for all new and existing residential buildings. Growing energy security concerns and rising energy costs reward residential projects that require less costly and scarce natural resources to build and operate. By contributing to the creation of homes eligible for green mortgages, residential investors and developers can facilitate a rapid and profitable transformation of the construction and real estate industry toward a low-carbon/ green economy.

Offering green mortgage products with favorable terms for houses that meet a higher standard of energy performance through commercial banks participating in the Rural Housing Programme provides efficient way of financing EE and LC homes. The purpose of the scheme will be to make mortgage conditions for EE and low-carbon houses as attractive to the borrowers as the

[14] Steven Bornkamp, http://www.usgbc.org/education/sessions/greenbuild-euromed/green-homes-mortgages-quality-health-financial-returns-all-728

ones currently in place for standard houses. Table 3 provides the details of financing mechanism of standard homes offered by Rural Housing Programme and compares it with proposed green mortgage schemes. The green mortgage mechanism will subsidize the interest payments to bring them to the same level as those for a standard RHP mortgage.

Table 3.
Standard mortgage vs. green mortgage

		Standard mortgage	EE home mortgage	LC home mortgage
Cost of Home	(USD)	$59,783	$61,573	$63,563
Percentage Loan to Value	(%)	77.1%	77.1%	77.1%
Percentage Downpayment	(%)	22.9%	22.9%	22.9%
Mortgage Size	(USD)	$46,079 1,000	$47,458 1,030	$48,992 1,063
Ratio of Minimum Wage	(x)	x	x	x
Total Downpayment Size (Upfront and at Commissioning)	(USD)	$13,705	$14,115	$14,571
Years 1-5 - Interest Rate	(%)	7.000%	6.750%	6.750%
Years 1-3 - Monthly Payment (Interest)	(USD)	$269	$267	$276
Years 4-5 - Monthly Payment (Principal & Interest)	(USD)	$474	$482	$497
Years 6-15 - Interest Rate	(%)	8.100%	8.100%	8.100%
Years 6-15 - Monthly Payment (Principal & Interest)	(USD)	$497	$511	$528
Total Interest Payments for 15 Year Mortgage - All 3 Phases	(USD)	$35,706	$36,074	$37,240
Years 1-3 (Grace Period)	(USD)	$10,733	$10,620	$10,963
Years 4-5 (Low Interest Rate)	(USD)	$6,106	$6,059	$6,255
Years 6-15 (Central Bank Linked Interest Rate)	(USD)	$18,867	$19,395	$20,022

[15] In different green mortgage programs, financing is made more attractive either by lowering the interest rate (taking into account improved creditworthiness due to lower utility payments), which lowers the total cost of the loan, or by expanding the size of the mortgage that a homebuyer with a certain income would normally be allowed to assume; this mechanism resembles the latter. In all cases, the green mortgage is rolled into the primary home mortgage, resulting in a single monthly payment for the homebuyer.

Chapter 4. Life cycle cost performance of EE and LC homes financed through green mortgage

This report uses a life cycle costing (LCC) approach to evaluate and integrate the benefits and costs associated with sustainable buildings. Green buildings cost more to build than conventional buildings, especially when incorporating more advanced technologies and higher levels of sustainability. However, they also offer significant cost savings over time. Quantifying costs and benefits of green investment and comparing them allow to answer the following question: Does it make financial and economic sense to build a green building?

The tariff policy plays an important stimulating role and development of tariff scenarios is required to conduct life cost analysis. We develop 3 scenarios of tariff policy for natural gas and electricity (Table 4), details of tariff development are provided in Annex 1. Assumptions about the costs and energy efficiency potential of EE and LC homes are provided in Table 4

Tariff policy plays an important stimulating role and development of tariff scenarios is required to conduct life cost analysis

Table 4.
Scenarios of tariff policy

	Scenario 1	Scenario 2	Scenario 3
Natural gas	15% increase annually	15% increase initially and 17% increase annually further	20% increase initially and 17% increase annually further
Electricity	16% increase annually	20% increase initially and 21% increase annually further	25% increase initially and 26% increase annually further

[16] It is calculated on Net Present Value (NPV) basis. NPV reflects a stream of current and future benefits and costs, and results in a value in today's dollars that represents the present value of an investment's future financial benefits minus any initial investment. If positive, the investment should be made (unless an even better investment exists), otherwise it should not.

The present value of savings generated by the implementation of energy efficiency measures through less use of energy exceeds the upfront capital costs

Life cycle cost estimates are conducted for two alternative periods: during the lifetime of a mortgage (15 years) and during the lifetime of a house (25 years). The present value of savings generated by the implementation of energy efficiency measures through less use of energy exceeds the upfront capital costs (Table 5). For example, during lifetime of a mortgage 'EE home' green investment option produces $0.33 return to each $1 of green investment at most, while 'LC Home' green investment option produces negative rate of return. Increasing time horizon from 15 years to 25 years leads to 100%-300% return to green investment depending on the tariff policy development.

Table 5.
Standard mortgage vs. green mortgage

	15 years (lifetime of a mortgage)			25 years (lifetime of a house)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
EE Home						
Present value of savings from the less use of energy	$1,643.59	$1,978.633	$2,384.088	$3,971.866	$5,413.033	$7,423.400
Green premium	$1,790	$1,790	$1,790	$1,790	$1,790	$1,790
Savings/green premium	92%	111%	133%	222%	302%	415%
LC Home						
Present value of savings from the less use of energy	$1,927.066	$2,680.600	$3,450.899	$4,477.200	$7,911.466	$12,793 12,793
Green premium	3780	3780	3780	3780	3780	3780
Savings/green premium	51%	71%	91%	118%	209%	338%

4.1. EE Home Mortgage

The details of proposed green mortgage scheme for EE home are provided in Table 3. Comparing it to standard mortgage, it will cost $1790 more because of the following "Green" measures: insulation of walls and roofs, and radiator treatment. Homeowners preferring green mortgage have to pay extra $410 for down payment and monthly payment will also increase due to the larger amount of mortgage (Table 6). A homeowner will pay $368 more interest payments during the lifetime of a mortgage. However, green mortgage scheme includes reduced interest rate during the first five years of a mortgage and reduced down payment as a subsidy to decrease the burden of green cost premium: the cost of subsidy for incremental cost of down payment is $410 and the cost of subsidy for reduced interest rate during the first five years is $507.

EE home will cost $1790 more because of insulation of walls and roofs, and radiator treatment

Table 6.
Incremental costs for green mortgage in reference to Standard Home

Upfront Incremental Cost - Total	(USD)	$1,790
Covered by mortgage	(USD)	$1,380
Covered by downpayment	(USD)	$410
Incremental Cost of Each Monthly Payment (Principal & Interest)	(USD)	$1,790
Years 1-3 - Grace Period	(USD)	$(1.84)
Years 4-5 - Low Cost Mortgage	(USD)	$7.89
Years 6-15 - Central Bank Linked Rate	(USD)	$13.93
Incremental Total Cost of Interest Payments - Mortgage Lifetime	(USD)	$368
Years 1-3 - Grace Period	(USD)	$ (113)
Years 4-5 - Low Cost Mortgage	(USD)	$ (47)
Years 6-15 - Central Bank Linked Rate	(USD)	$529

Although homeowners pay more money for mortgage, he/she'll benefit from savings generated from less use of natural gas and electricity. Benefits depend on the scenarios of tariff increase.

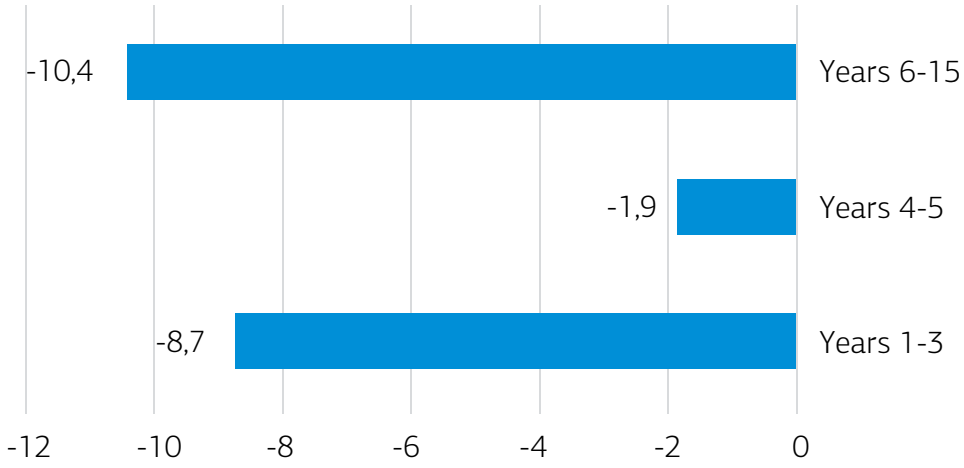
Scenario 1.

Under scenario 1 average monthly energy savings due to improved energy efficiency is $6.9 during grace period, $9.74 during low-cost mortgage period

Our estimates show that average monthly energy savings is $6.9 during grace period, $9.74 during low-cost mortgage period and $24.34 during central bank rate linked period. As a result, average monthly total cost of ownership of energy efficiency house becomes negative number or converts into savings (Diagram 3) .

Net present value of cash flows is $780 that shows the present value of monetary return to the homeowner of green mortgage: energy savings fully cover incremental cost of mortgage and generate additional $780 monetary reward. Return to the homeowner of EE home mortgage increases up to $3108 when we take into account energy savings generated during lifetime of a house which is 25 years. Moreover, if we included financial benefits of green buildings in terms of reduced emissions, waste and water value, decreased operating and maintenance cost value and improved productivity and health value during lifetime of a house, then net present value of these benefits would be at least ten-folds of green cost premium .

Diagram 3. Average Monthly Total Cost of Ownership "Scenario 1"



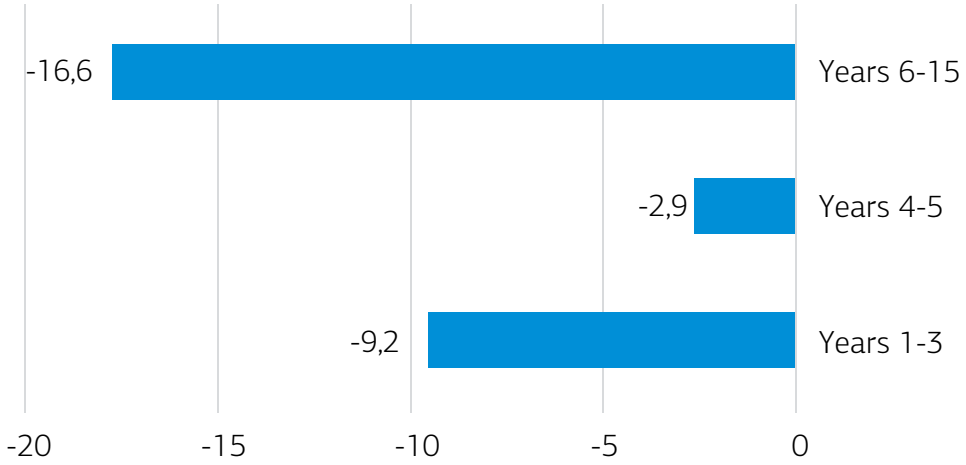
Scenario 2.

Under scenario 2, average monthly energy savings is $7.3 during grace period, $10.8 during low-cost mortgage period and $30.5 during the last ten years of a mortgage. As a result, average monthly total cost of ownership of energy efficiency house becomes negative number or converts into savings (Diagram 4).

[17] Average monthly total cost of ownership of energy efficiency house is calculated as the difference of incremental cost of monthly mortgage payment and average monthly energy savings.

[18] The costs and financial benefits of green buildings, A Report to California's sustainable building task force

Diagram 4. Average Monthly Total Cost of Ownership "Scenario 2"



The present value of monetary return to a homeowner is $1115 during the mortgage period and $4550 during the lifetime of a house. In other words, energy savings generated during 25 years (lifetime of a house) cover green investment fully and generate extra monetary reward worth of $4550 to a homeowner.

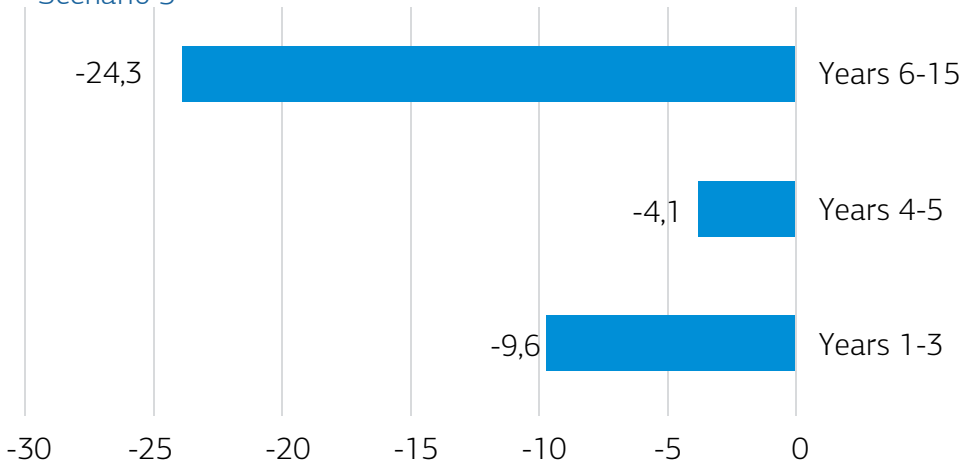
Under scenario 3, average monthly energy savings is $7.8 during grace period, $12 during low-cost mortgage period

Scenario 3.

Under scenario 3, average monthly energy savings is $7.8 during grace period, $12 during low-cost mortgage period and $38 during central bank rate linked period. As a result, average monthly total cost of ownership of energy efficiency house becomes negative number or savings (Diagram 5).

As a result, savings from green investment fully covers the green premium and generates additional $1520 monetary reward during the mortgage period. The return to a homeowner reaches to $6560 during the lifetime of a house.

Diagram 5. Average Monthly Total Cost of Ownership "Scenario 3"



4.2. Low Carbon Home Mortgage

Comparing it to standard mortgage, low carbon home mortgage will cost $3780 more because of insulation of walls and roofs, radiator treatment and solar PV

The details of the proposed green mortgage scheme are provided in Table 3. Comparing it to standard mortgage, it will cost $3780 more because of the following "Green" measures: insulation of walls and roofs, radiator treatment and solar PV. Homeowners preferring green mortgage have to pay extra $866.5 for down payment and monthly payment will also increase due to the larger amount of mortgage (Table 8). A homeowner will pay $1534 more interest payments during the lifetime of a mortgage. However, green mortgage scheme includes reduced interest rate during the first five years of a mortgage and reduced down payment as a subsidy to decrease the burden of green cost premium: the cost of subsidy for incremental cost of down payment is $866.5 and the cost of subsidy for reduced interest rate during the first five years is $523.

Table 8.
Incremental costs for Low carbon home mortgage in reference to Standard Home

Upfront Incremental Cost - Total	(USD)	$3,780
Covered by mortgage	(USD)	$2,913
Covered by downpayment	(USD)	$867
Incremental Cost of Each Monthly Payment (Principal & Interest)	(USD)	
Years 1-3 - Grace Period	(USD)	$6.79
Years 4-5 - Low Cost Mortgage	(USD)	$23.46
Years 6-15 - Central Bank Linked Rate	(USD)	$30.46
Incremental Total Cost of Interest Payments - Mortgage Lifetime	(USD)	$1,534
Years 1-3 - Grace Period	(USD)	$230
Years 4-5 - Low Cost Mortgage	(USD)	$149
Years 6-15 - Central Bank Linked Rate	(USD)	$1,155

Although homeowners pay more money for mortgage, he/she'll benefit from savings generated from less use of natural gas and electricity. Benefits depend on the scenarios of tariff increase.

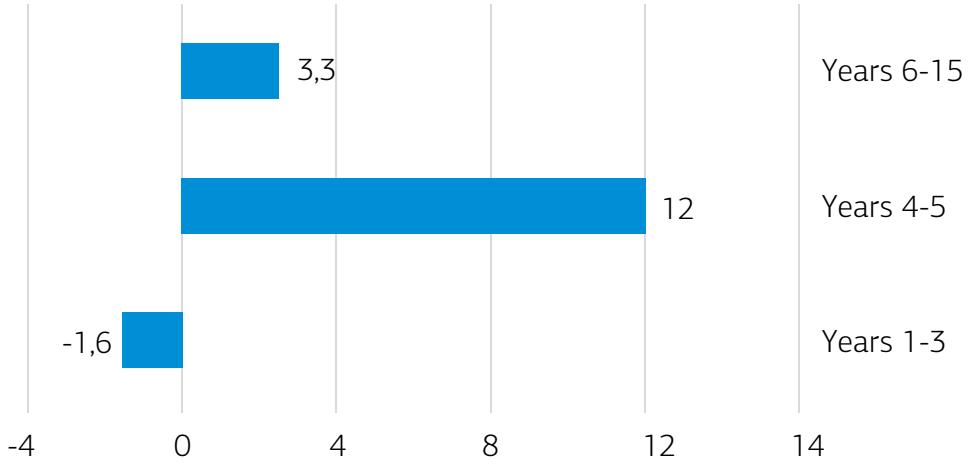
Scenario 1.

Our estimates show that average monthly energy savings is $8.4 during grace period, $11.5 during low-cost mortgage period and $27.2 during central bank rate linked period. Homeowner's average monthly total cost of ownership changes correspondingly as described in Diagram 6.

Under scenario 1 average monthly energy savings of low carbon home mortgage is $8.4 during grace period, $11.5 during low-cost mortgage period

Net present value of savings is -$473 that represents the net present value of monetary cost of low carbon home mortgage for homeowner: energy savings are not enough to cover incremental costs generated from green premium during the lifetime of a mortgage. However, energy savings generated during the lifetime of a house fully green premium and generates extra $2033. Moreover, if we included financial benefits of green buildings in terms of reduced emissions, waste and water value, decreased operating and maintenance cost value and improved productivity and health value during lifetime of a house, then net present value of these benefits would be at least ten-folds of green cost premium .

Diagram 6. Average Monthly Total Cost of Ownership "Scenario 1"

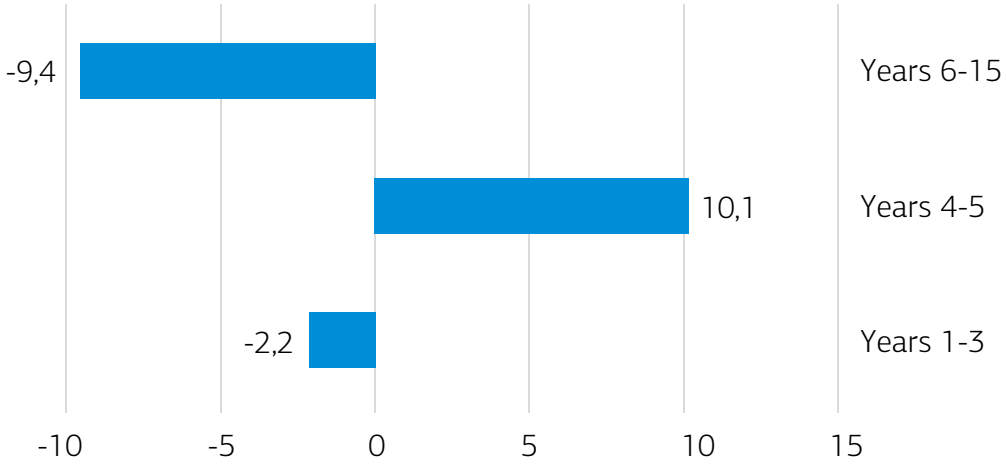


Scenario 2.

Under scenario 2, average monthly energy savings is $9 during grace period, $13.4 during low-cost mortgage period and $40 during the last ten years of a mortgage. As a result, average monthly total cost of ownership of energy efficiency house becomes negative number or converts into savings (Diagram 7).

Net present value of savings is $197 that shows the present value of monetary return to the homeowner of green mortgage: energy savings fully cover incremental cost of mortgage and generate additional $197 monetary reward. The amount of return to a homeowner exceeds $5000 if we include all energy savings generated during the lifetime of a house.

Diagram 7. Average Monthly Total Cost of Ownership "Scenario 2"



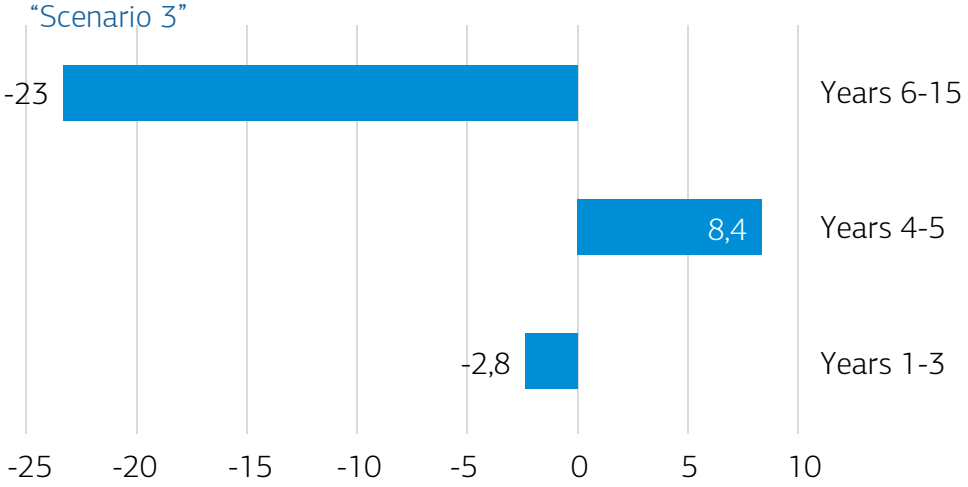
Under scenario 3, average monthly energy savings of low carbon home mortgage is $9.5 during grace period, $15 during low-cost mortgage period

Scenario 3.

Under scenario 3, average monthly energy savings is $9.5 during grace period, $15 during low-cost mortgage period and $53.4 during central bank rate linked period. As a result, average monthly total cost of ownership of energy efficiency house becomes negative number or savings (Diagram 8).

Net present value of savings is $895 that shows the present value of monetary return to the homeowner of green mortgage during the lifetime of a mortgage. The return to a homeowner increase more than ten folds and reaches to $9376 when we take into energy savings generated during the lifetime of a house.

Diagram 8. Average Monthly Total Cost of Ownership "Scenario 3"



Chapter 5. Recommendations for the Project

Findings of this study can be summarized with the following points:

- **First,** there is a large energy efficiency potential of rural housings. Incorporating green principles in existing traditional rural homes allows to consume 33% less energy, while energy efficiency potential of newly built standard rural homes is 25% on average.
- **Second,** introduction of "green mortgages", tied to certified homes with improved energy and environment performance - can provide affordable innovative financing mechanism of green investment and significantly reduce homeowners' total monthly cost of ownership relative to a standard home.
- **Third,** tariff policy for energy plays an important role encouraging people to invest in energy efficiency. Keeping the tariffs to follow their historical trend (i.e. 16% for electricity and 15% for natural gas) without any additional policies to stimulate energy efficiency may be not enough to encourage homeowners to improve energy efficiency of their houses.
- **Finally,** raising public awareness about benefits and advantages of low-carbon housing is very important to realize green mortgage scheme.

Prolonging the term of the mortgage from 15 to 20 years will provide additional incentives in the form of lower monthly payments and allow the realization of the full benefits of energy efficiency

The results of the study provide the rationale to implement the Project "Market Transformation for Sustainable Rural Housing in Uzbekistan". The Project is aimed at transforming the rapidly growing rural housing sector in Uzbekistan towards a more sustainable and low-carbon development pathway by designing, piloting and scaling-up a green mortgage market mechanism, which will boost the demand for energy efficient housing among the rural population of Uzbekistan.

To fully employ energy efficiency potential of rural housing through creating a favorable market environment and scalable business model for investment in both energy-efficient and low-carbon rural houses the Project needs to focus on implementing the complementary policy measures related to the improving financial attractiveness of the green mortgage scheme, strengthening domestic supply chain and capacities for construction of low-carbon housing, introducing policies and regulations for low-carbon housing and settlements and raising public awareness about benefits and advantages of low-carbon housing:

1. Increasing financial feasibility of the green mortgage scheme through offering favorable mortgage terms and conditions:

- Increasing the term of the mortgage from 15 years to 20 years. Prolonging the term of the mortgage will provide additional incentives in

the form of lower monthly payments and allow the realization of the full benefits of energy efficiency because the lifetime of energy efficiency measures proposed in this project is 20-25 years on average. According to our estimates, present value of return to homeowner in 20-year green mortgage exceeds $6000 during the lifetime of mortgage.

- Increasing the grace period of mortgage from 3 years to 5 years : providing longer grace period increases the attractiveness of green mortgage

- Taking the projected utility savings generated from home upgrades into account when setting the loan amount

Successful realization of green mortgage scheme requires promoting application of a wide range of low-carbon technologies and approaches in the planning and construction of new rural settlements

2. The successful realization of green mortgage scheme requires promoting the application of a wide range of low-carbon technologies and approaches in the planning and construction of new rural settlements and strengthening domestic supply chain and manufacturing capacities for design and construction of low-carbon housing:

- Creating favorable conditions for domestic producers of construction materials and equipment used in improving energy efficiency of building that enables to reduce the cost of green investment.

- Identifying the most cost effective technologies available in the region through preparing and testing prototype designs for EE and LC homes
- Conducting supply chain analysis of EE and LC technologies and materials based on international good practice and current practice in Uzbekistan

3. Introducing policies and regulations for low-carbon housing enforcing minimum energy performance standards into building codes enable to scale up the construction of low carbon housing and settlements:

- Developing appraisal methodology and guidance on how to check compliance of EE and Low-Carbon houses with design requirements at building construction and commissioning stage

- Developing home energy rating systems, energy service companies and energy saving consultant services needed to appraise the energy efficiency potential of buildings, to conduct energy audit and to produce energy inspection reports

- Establishing energy performance database to collect and store information about the buildings constructed, any certifications issued, compliance rate, etc

- Revising and strengthening building codes to enforce minimum energy performance standards in the current construction practices

4. Boosting public demand for green mortgages and confidence in energy efficient and low-carbon housing via a series of outreach and awareness-raising activities at the national and local level must be the important direction of policy measures:

It is important to boost public demand for green mortgages and confidence in energy efficient and low-carbon housing via a series of outreach and awareness-raising activities

- Organization of public awareness campaigns to draw the attention of people to the economic and environmental benefits of green investment

- Increasing knowledge of population about opportunities of energy efficiency through efficient energy use, letting consumers regulate energy consumption at the house or apartment

- Formulating the system of demand management by attracting stakeholders, mainly population and their participation in decision-making of strategic directions of infrastructure development and tariff policy

- Increasing awareness of public by making widely available manuals, online software and calculators. These tools allow them to understand and quantify the cost and benefits of such investments.

Chapter 6. Expected effects of transition to the green rural housing construction

By employing the green mortgage mechanism and implementing green principles for buildings in rural areas the Project would contribute to ensuring economic, social and environmental sustainability and attainment of Sustainable Development Goals (SDGs) towards 2030.

In fact, scaling-up the Project results for rural areas in Uzbekistan could generate the following effects:

1. People

Every 1 mln invested in rural green construction will generate $358,000 extra income for households

Implementation of energy efficient solutions in rural buildings will reduce payments for energy public utilities (household running costs), thus providing every household with extra $165 per year to be spent on food and public services and contributing to improvement of the well-being of rural people. In addition, every 1 mln invested in rural green construction will generate $358,000 extra income for households.

This would be an important step in attaining SDGs 1 and 2 seeking to improve people's welfare and ensure better access to food.

Transition to the green principles in buildings will also contribute to achieving the target on SDG 7 through increasing access to affordable, reliable, sustainable and modern energy for households in rural and remote areas . In fact, transition to a resource-efficient pattern of energy use in rural buildings will save energy resources that is enough to power and supply 14970 homes per year .

Moreover, sustained access to energy in rural areas reduces household drudgery, provides at least 1-3 hours of extra spare time for women, thus expanding their opportunities for work and leisure and contributing to the transformation of lifestyle, behavior and gender stereotypes.

The project will also bring social benefits in the form of increased comfort to

[21] Authors' estimations based on the results of CER survey "Scaling-up energy efficiency in buildings of Uzbekistan"
[22] Authors' estimations, based on the analysis of multiplier effects estimated for input-output tables for Uzbekistan economy
[23] Authors' estimations based on the Policy Paper «Improving energy efficiency of buildings in Uzbekistan: strategies and expected results», CER, 01/2015
[24] Authors' estimations based on the data of Ministry of Economy (the number of rural homes) and data from the CER survey "Scaling-up energy efficiency in buildings of Uzbekistan"
[25] Authors' estimations based on http://www.adb.org/sites/default/files/institutional-document/32604/women-uzbekistan.pdf

rural residents and improved air quality. According to the preliminary estimations, green buildings will improve the temperature regime inside and air quality outside thus reducing the frequency of communicable respiratory diseases by 9-20%, allergies and asthma – by 18-20% . Non-specific health and discomfort effects will be reduced by 20-50% . This is important to ensure healthy lives and promote well-being for all at all ages stated as a key objective for SDG 3.

Improved temperature regime in rural buildings and related reduction of disease frequency improves attendance in schools thus upgrading average performance by 10-12% and contributing to inclusive and quality education.

2. Prosperity

Investments in improved energy efficiency in buildings in rural area will have the overall economic effects thus contributing to attaining the targets on SDG 8 and SDG 10 aimed at promoting sustained, inclusive and sustainable economic growth, full and productive employment, decent work for all and reducing inequalities within and between countries.

Every 1 mln $ invested in green construction generates 0.6 mln $ demand for goods and services of associated industries (manufacturing, industrial services and innovation)

Through generating multiplier effects, energy efficiency solutions will expand demand for the goods and products of associated industries (e.g. equipment and materials for "green" construction: heat insulation materials, energy efficient boilers for space and water heating). Transition to green economy in the sector of housing construction in rural areas will generate additional demand for energy efficiency services, energy efficiency technologies and materials. For example, every 1 mln $ invested in green construction generates 0.6 mln $ demand for goods and services of associated industries, particularly, manufacturing, industrial services and innovation, thus creating 138 new productive and decent jobs in the sector of construction and associated industries .

Taking into account that green jobs will be mostly generated in manufacturing industry, where the share of employed women is much higher than in extracting ones, introduction of green buildings in rural areas will also contribute to gender equality and women's empowerment stated as a key outcome for SDG 5.

Implementation of energy efficiency standards and norms will also transform consumers' behavior and consumption pattern thus contributing to acceleration of structural transformations of the economy, promoting inclusive and sustainable industrialization and fostering innovation that is stated as the key objective for SDG 9. The overall demand for the output of manufacturing industries will expand substantially.

[26] Fisk, William J. (2000). Health and Productivity Gains from Better Indoor Environments and their Implications for the U.S. Department of Energy. Accessed Sept. 24, 2012 via http://energy.lbl.gov/ie/viaq/pubs/lbnl-47458.pdf

[27] Fisk, William J. (2000). Health and Productivity Gains from Better Indoor Environments and their Implications for the U.S. Department of Energy. Accessed Sept. 24, 2012 viahttp://energy.lbl.gov/ie/viaq/pubs/lbnl-47458.pdf

[28] Presentation of the Director of School 39 of Andijan viloyat, "Promoting Energy Efficiency in Public Buildings in Uzbekistan", UNDP-GEF Project

[29] Authors' estimations

3. Planet

Improved energy efficiency reduces energy consumption thus slashing 140,571 tCO of greenhouse gas emissions per annum and 2.81 MtCO2 over the 20-year lifetime of the buildings. This would formulate an efficient base for combatting climate change and minimizing its adverse impacts towards 2030 thus enabling to attain SDG 13.

4. Partnership

Improved energy efficiency reduces energy consumption thus slashing 140,571 tCO of greenhouse gas emissions per annum

The use of GEF funds for green mortgage mechanism will leverage substantial government and private investments and activities in the housing sector, thus creating the effective model for partnership, involving international organizations, private sector, government, national financial institutions, academia, international organizations and funds and contributing to attainment of SDG 17 focuses on partnership for sustainable development.

In fact, the Project involves Ministry of Finance, Ministry of Economy, State Committee for Architecture and Construction (Gosarchitectstroy), State Committee for Land, Geodesy, Cartography and State Cadastre, Centre of Hydro-meteorological Service under the Cabinet of Ministers of the Republic of Uzbekistan, State Committee for Nature Protection, Chamber of Commerce and Industries of Uzbekistan, National Bank of Uzbekistan, Quishloq Qurilish Bank, Ipoteka Bank, selected institutes, regional, district and local authorities, NGOs and residents in rural areas.

The innovative product developed within the Project could be replicated broadly in Uzbekistan by the Government and other sources of funding, such as the Green Climate Fund.

Annex 1

Tariff development scenarios

80% of surveyed households tend to invest in energy efficiency if the payback period of such investments is less than five years. This illustrates that tariff policy plays an important stimulating role and development of tariff scenarios is required to conduct life cost analysis.

The survey conducted by CER (2015) indicates that only 33% of surveyed households are willing to invest in energy efficiency if tariff for natural gas increases by 15-20%. 72% of households are ready to improve energy efficiency of their houses only if tariff for natural gas increases by 30-50%. Based on these findings, we develop 3 scenarios of tariff policy for natural gas:

1. Scenario 1. It assumes that the price of natural gas follows its historical trend: 15% increase annually.

2. Scenario 2. This scenario is developed under assumption that the price of natural gas under this scenario is high enough to induce people to invest in energy efficiency: 20% increase initially, 17% increase annually further

3. Scenario 3. This scenario assumes that new price for natural gas will be enough to cover long-run average costs of producers and providers: 25% increase initially, 19% increase annually further

Tariff scenario for electricity

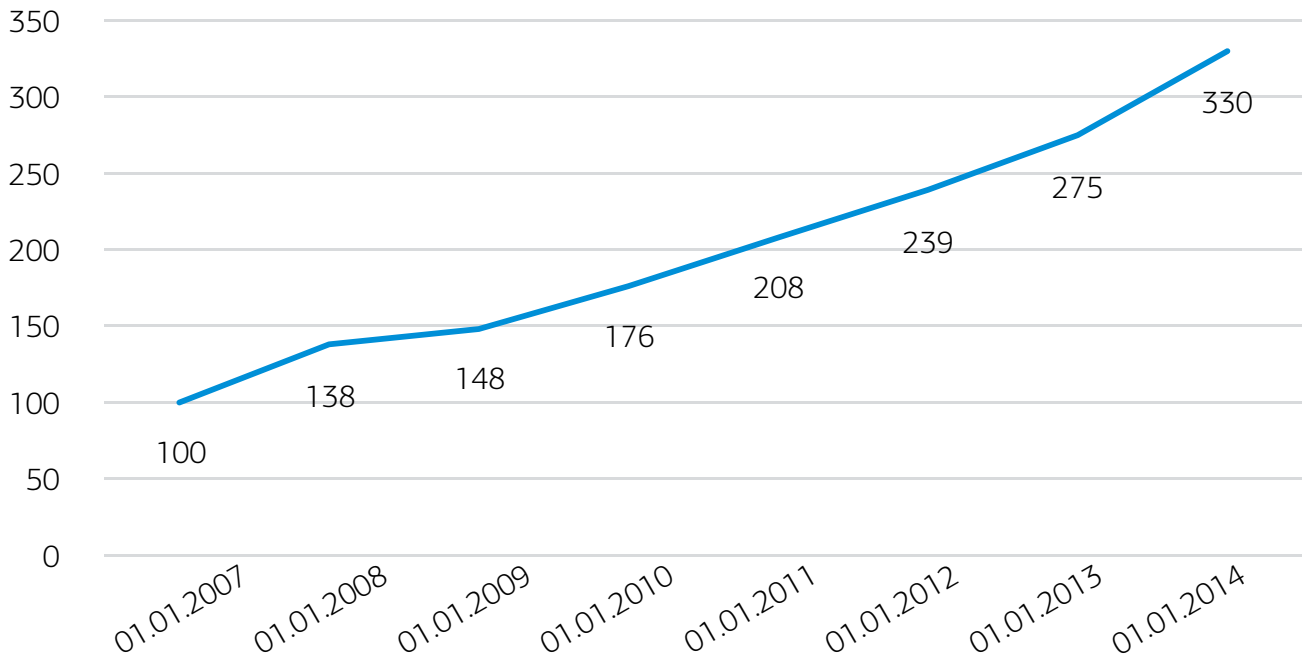
We develop 3 scenarios of tariff policy for electricity based on the historical trend analysis of the price of electricity and cost structure of electricity:

1. Scenario 1. It assumes that the price of electricity follows its historical trend: 16% increase annually. Diagram 1 shows dynamics of tariff for electricity from 2008 to 2014. It has a sustainable upward trend and average rate of increase is 16% per year.

2. Scenario 2. This scenario is developed under assumption that the price of electricity under this scenario is high enough to induce people to invest in energy efficiency: 20% increase initially, 21% increase annually further.

Annex 1

Diagram 1. The rate of increase of tariffs for electricity, 2008-2014 (2007=100)



3. Scenario 3. This scenario assumes that new price for natural gas will be enough to cover long-run average costs of producers and providers. We expect the decrease in the cost of production of electricity due to the fall of world prices of energy (that is 60% of total cost of production). However, modernization and reconstruction costs of production capacity are expected to increase due to the realization of recent government programs directed to the modernization of electricity producing companies and improving energy efficiency. Our estimates indicate that 25% increase initially and 26% increase annually further will provide enough financial resources to cover long-run average costs of producers.