Republic of Uzbekistan
Scaling up Energy Efficiency in Buildings

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EUROPE AND CENTRAL ASIA
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<tbody>
<tr>
<td>AFUE</td>
<td>Annual Fuel Utilization Efficiency</td>
</tr>
<tr>
<td>APR</td>
<td>Annual Percentage Rate</td>
</tr>
<tr>
<td>CER</td>
<td>Center for Economic Research</td>
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<tr>
<td>DCEE</td>
<td>Department of Energy and Climate Change</td>
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<tr>
<td>DHW</td>
<td>Domestic Hot Water</td>
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<tr>
<td>ECO</td>
<td>Energy Company Obligation</td>
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<td>EE</td>
<td>Energy Efficiency</td>
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<td>EEO</td>
<td>Energy Efficiency Obligation</td>
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<td>EERF</td>
<td>Energy Efficiency Revolving Fund</td>
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<tr>
<td>EPC</td>
<td>Energy Performance Coefficient</td>
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<tr>
<td>ESA</td>
<td>Energy Service Agreement</td>
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<tr>
<td>ESCO</td>
<td>Energy Service Company</td>
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<tr>
<td>ESP</td>
<td>Energy Service Provider</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilation, and Air Conditioning</td>
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<tr>
<td>IEA</td>
<td>International Energy Agency</td>
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<tr>
<td>IFI</td>
<td>International Financial Institution</td>
</tr>
<tr>
<td>MEPS</td>
<td>Energy Performance Standards</td>
</tr>
<tr>
<td>MOF</td>
<td>Ministry of Finance</td>
</tr>
<tr>
<td>NIP</td>
<td>National Insulation Program</td>
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<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OFGEM</td>
<td>Office of Gas and Electricity Markets</td>
</tr>
<tr>
<td>PACE</td>
<td>Property-Assessed Clean Energy</td>
</tr>
<tr>
<td>PMU</td>
<td>Program Management Unit</td>
</tr>
<tr>
<td>R2E2</td>
<td>Renewable Resources and Energy Efficiency</td>
</tr>
<tr>
<td>SMUD</td>
<td>Sacramento Municipal Utility District</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Assistance</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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Acknowledgment

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Executive Summary

I. Objectives and Scope of the Study

This study was undertaken by the World Bank to inform the potential areas and means of assistance to the Government of Uzbekistan in scaling up energy efficiency (EE) investments in residential, commercial, and public buildings, focusing on energy use and efficiency in space heating. Considering the ongoing World Bank assistance in modernizing district heating services in selected cities in Uzbekistan, this study is explicitly concerned with residential, commercial, and public buildings that are not served by district heating.

The main objective of the study was to identify scalable EE interventions that could be deployed in the next 3 to 5 years. Three specific areas were investigated: (a) a market assessment for upgrading space heating and water heating equipment in detached homes and commercial buildings; (b) an analysis of the issues and options for scaling up investment in thermal retrofit of public buildings; and (c) a gap analysis on the compliance enforcement of building EE standards in newly constructed housing. The study did not look into thermal retrofit of existing residential buildings, which holds significant energy-saving potential, but also is among the most complex and challenging of EE interventions. A separate in-depth analysis would be required to adequately address the issues involved.

The three areas of investigation are broadly consistent with the priorities for improving EE in buildings stated in Presidential Decree No. PP-2343: Program of Measures to Increase Energy Efficiency and Introduce Energy-Saving Technologies in the Sectors of Economy and Social Sphere during 2015–2019. In particular, the presidential decree singled out actions in (a) replacement of nonstandard and inefficient boilers for space-heating and hot water supply in detached houses; (b) channeling of energy cost savings in state budget-funded organizations toward funding EE investments in these entities; and (c) improvement of rules and norms for EE requirements for new buildings.

The findings and recommendations of the study, summarized below, are intended to inform discussions between the Government and the World Bank on the issues and options to address the main constraints to implementing the priority actions identified in the Presidential Decree No. PP-2343. Detailed courses of action on specific EE interventions in buildings could then be developed based on the outcomes of these discussions.

II. Opportunities to Save Natural Gas in Residential, Commercial, and Public Buildings

From 2000 to 2013 the gross domestic product (GDP) of Uzbekistan increased by almost 2.5 times in real terms while the primary energy consumption of the country was reduced by about 16 percent, leading to a 65 percent reduction in the primary energy intensity of GDP and enabling Uzbekistan to double its natural gas export during the same period. Despite this impressive energy productivity gain, Uzbekistan remains one of the most energy-intensive economies in the world. Its primary energy intensity of GDP measured in purchasing power parity is almost 2.5 times of the average of the Organization for Economic Co-operation and Development (OECD) countries.
Continued reduction of primary energy intensity is important for Uzbekistan’s long-term energy security and for maintaining natural gas export at a steady level. By halving its primary energy intensity of GDP in 2015 over the following 15 years, Uzbekistan would be able to achieve its vision of doubling GDP in 2030 without additional primary energy requirement. This is an attainable goal but requires substantial efforts in scaling up EE investments.

Domestically produced natural gas provided almost 88 percent of primary energy supply and 69 percent of final energy consumption in Uzbekistan.\(^1\) Thus, loss reduction and efficiency improvement throughout the value chain of natural gas, from extraction, transportation, and distribution to transformation and end uses, are critical to realizing the government’s goal of resource-efficient growth.

Residential, commercial, and public buildings are the largest end users of natural gas in Uzbekistan, accounting for nearly 65 percent of the final consumption of natural gas. Most of this consumption is for space heating. Additional natural gas is also consumed for providing district heating services to some of these buildings. The technical potential for reducing gas demand in buildings is huge due to the widespread use of inefficient gas boilers and inadequate thermal insulation in most existing buildings. For example, the estimated average specific heat consumption of residential buildings in Uzbekistan is about 290 kWh/m\(^2\), compared with 95 kWh/m\(^2\) in the Netherlands, which is similarly dependent on natural gas for primary and final energy consumption, relies heavily on individual gas boilers for space heating, and has a slightly colder and longer winter than Uzbekistan. The Netherlands was a pioneer and leader in popularizing high-efficiency condensing gas boilers and has a long history of implementing progressively more stringent building EE standards (appendix B).

Replacing the nonstandard and inefficient (also known as ‘homemade’) gas boilers in detached houses and small commercial buildings with efficient modern gas boilers could reduce gas consumption by about 2.4 billion m\(^3\) per year, about 13 percent of the total gas consumption in residential, commercial, and public buildings in 2013. Enforcing the current building EE standards in the construction of new detached houses, which account for 99 percent of new residential construction, could cut heat energy demand of these new buildings by 50 percent, compared with those that do not implement the requisite EE measures. In schools and health care facilities, recent demonstration projects achieved over 40 percent reduction in space heating energy use through comprehensive thermal retrofit of buildings. All these energy savings can be attained with domestically available technologies, products, and materials. They remain largely untapped primarily due to financial, institutional, and informational barriers.

Unlocking the technical potential in gas savings requires stronger gas price signals to end users, broader awareness of options and associated costs and benefits, access to affordable financing for investments, wider availability of appropriate technologies and products, and effective delivery/implementation mechanisms, all of which will need deliberate government policies and/or programs of support to materialize.

\(^1\) Data in this section are from the International Energy Agency (IEA) 2013 data, [http://www.iea.org/statistics/](http://www.iea.org/statistics/)
The prospects of making significant inroads in the above areas are good: the government has steadily increased domestic gas prices in the past few years at an annual rate of about 10 percent; borrowing costs for EE investments can be reduced with government facilitation (as it has happened for industrial EE investments); cost of more efficient gas boilers can be reduced through bulk procurement and expanded domestic manufacturing capacity; and innovative delivery/implementation mechanisms could be piloted and scaled up. The main issues and potential interventions in the three priority areas are outlined in the following paragraphs.

III. Addressing Inefficiency in Distributed Residential and Commercial Space Heating

Opportunities. There are about 3.2 million individual gas boilers in use for heating homes and small commercial buildings. About 75 percent of these boilers have been in service for 10 years or more. About 35 percent of these boilers are ‘homemade’—gas boilers made by local craftsmen using nonstandard components and without proper safety compliance. These nonstandard boilers consume almost 50 percent more gas than gas boilers manufactured according to modern industrial standards.

Replacement of the current stock of nonstandard gas boilers with modern gas boilers would require investments of about Som 3.2 trillion, or about US$1.2 billion at end of 2015 cost estimate and official exchange rate. The financial simple payback periods for residential and commercial consumers are about 6.6 and 5.2 years, respectively, based on the end of 2015 retail gas price. The simple payback periods are shortened to about 3.4 and 2.7 years, respectively, based on the end of 2015 export gas price (appendix A).

Barriers. Based on surveys of households and business owners, the main barriers to the market uptake of high-efficiency gas boilers include (a) low domestic prices of natural gas; (b) high costs of modern gas boilers, especially compared with nonstandard alternatives; and (c) a lack of awareness of the costs and benefits of improving EE among residential consumers. The confluence of these factors poses a big hurdle to the implementation of the priority activity No. 14 (replacement of nonstandard and inefficient gas boilers) identified in the Presidential Decree No. PP-2343. So long as these conditions persist, the motivation of households and business owners to upgrade gas boilers will be low, and the regulation barring the installation of nonstandard gas boilers will be difficult to enforce.

Actions needed. In the short to medium term, there are two options that, if implemented together with broad-scale and intensive information and outreach campaigns, could potentially break the logjam and encourage upgrades: directly subsidizing investments in gas boiler upgrades, or, enabling access to affordable financing for investments in gas boiler upgrades. Specifically, the implementation of the priority activity No. 14 could be supported by a cash incentive program administered by the government, or a dedicated credit line through participating commercial banks. Over the longer term, with the support of higher retail gas prices and likely reduction of the cost of new boilers, the cycle of gas boiler upgrade could be sustained without a dedicated government program.

Option 1. Introducing a cash incentive program that offers to buy back existing nonstandard boilers if households or business owners replace them with eligible high-efficiency gas
The advantage of a cash incentive program is that it provides a well-defined and transparent signal to the market participants. The disadvantage is that it requires extra administrative resources from the government to ensure transparency and prevent potential misuse of funds. The subsidy (or cash incentive) is meant to be a temporary measure to incentivize economically cost-effective investments and to create a critical mass for the upgrade market to expand when the two critical constraints are loosened or removed—domestic gas prices approach or reach parity with the export price and the cost of high-efficiency gas boilers is reduced due to the increased market size.

Option 2. Introducing a dedicated consumer credit line for the purchase and installation of high-efficiency gas boilers. The arrangements will be similar to those of the current credit line for industrial EE using IDA financing. Low-cost, long-term capital such as IDA financing on-lent to participating commercial banks will enable them to reduce the borrowing cost of households and business owners. As revealed by the surveys conducted in the study, 54 percent of households and 65 percent of business owners indicated willingness to finance an upgrade if the bank’s lending terms are attractive. Using a dedicated credit line would mean a low administrative cost for the government. The other advantage of a credit line is that it could be easily expanded to cover other upgrades for space heating EE, such as window upgrade and roof insulation, if financial resources are available.

IV. Scaling up EE Investments in Education and Health Care Buildings

Opportunities. The existing stock of public buildings in Uzbekistan amounted to about 53 million m² in 2014, about 85 percent of which belonged to education and health care entities. Most of the existing public buildings have inadequate thermal insulation and are heated by inefficient gas- or coal-fired boilers. Replacement of 24,238 inefficient heating boilers in education and health care facilities was identified as a priority activity by the Presidential Decree No. PP-2343. The government also has an existing off-budget funding mechanism for reconstruction, basic repairs, and equipment of secondary schools, professional colleges, academic lyceums, and medical institutions.

Recent pilot projects of comprehensive thermal renovation in education and health care buildings demonstrated reduction in gas or coal consumption of at least 40 percent. Estimated simple payback periods based on energy cost savings are 26 years for school buildings and 22 years for hospital buildings. The simple payback periods can be halved if gas tariff reaches parity with the end of 2015 gas export price. More selective approaches than the full-menu measures applied in the pilots could also improve financial attractiveness of EE investments in education and health care facilities.

The overall investment needs for thermal renovation of existing education and health care facilities in Uzbekistan, including those heated by district heat, natural gas, or coal, are estimated to be up to US$1 billion, assuming that the comprehensive renovation measures adopted in the pilot projects were implemented and at the indicated cost levels. Investment cost reduction and improved cost-effectiveness are likely if broad-scale renovation is achieved. About 80 percent of the investment would go to educational facilities.

Barriers. The scale of thermal renovation of existing education and health care facilities is limited by the lack of dedicated funding and a mechanism that could capture energy cost savings.
savings to fund future EE projects, thus enabling the initial investment capital to revolve and support additional thermal renovation. Creating and operationalizing such a revolving financing mechanism is hampered by low energy tariffs, especially for natural gas, which leads to long payback times for thermal renovation projects, and by current budget provisions that are based on historical expenses and do not encourage energy-saving behavior. Uzbekistan has yet to develop the legal and regulatory foundation for the introduction of energy performance contracting, which could become an effective instrument for scaling up financing and delivery of EE projects in public buildings.

**Actions needed.** Increased investment in thermal renovation of public buildings is needed and could be paid for by future energy cost savings. But this will require dedicated initial incremental funding for EE measures to be implemented alongside the capital improvement program and the establishment of a revolving funding mechanism that enables the recovery and reinvestment of the energy cost saving cash flow.

There are successful models of such revolving funding mechanisms for EE investments in public buildings in other countries, such as the Energy Efficiency Revolving Funds (EERFs) in Bulgaria and Armenia. Similar schemes could be introduced in Uzbekistan to help catalyze sustainable EE financing in public buildings.

This study recommends the creation of an EERF within the current off-budget fund for reconstruction, repairs, and equipment. The new EERF, with committed EE investment capital over a 5-year period, could initially focus on financing EE projects in educational and health care facilities through energy service agreements (ESAs). Such a scheme will also enable the government to begin nurturing a private energy service industry through public procurement of energy savings services.

**V. Improving Compliance of Energy Efficiency Standards in New Buildings**

**Opportunities.** The main drivers for new building construction have been population and income growths. Since independence in 1991, the total area of housing in Uzbekistan has increased by 88 percent from 250 million m² in 1991 to 470 million m² by the end of 2014. Total floor area of nonresidential buildings stood at about 115 million m² by the end of 2014. Housing construction pattern in Uzbekistan has been moving away from multi-family dwellings, the share of which in total housing floor area declined from 17 percent to 13 percent between 2000 and 2012. About 99 percent of the annual new housing construction in recent years has been single-family houses, mostly in rural areas.

Building EE standards were first introduced in 1997 and most recently updated in 2011. But compliance has not reached satisfactory levels. Enforcement of the standards are problematic in the design and construction of single-family houses that dominate new housing construction.

**Barriers.** The three main challenges to compliance enforcement of building EE standards in new housing construction are (a) underdeveloped supply chain and compliance system for more energy-efficient buildings; (b) existing enforcement system unable to cope with the decentralized construction market due to the large share of rural housing; and (c) the weak
incentive and the lack of critical and credible cost-benefit information for complying with building EE standards.

**Actions needed.** Effectively addressing these challenges requires (a) a more focused approach to strengthen the compliance enforcement process for single-family homes, which may require the development of a third-party compliance enforcement system relying on private sector professionals; (b) deliberate efforts by the government to support the capacity building in the construction supply chain, including training programs and development of testing and certification capacity for compliance; and (c) a nationwide communications and outreach program to ensure homeowners understand and identify with the benefits of an energy-efficient home so they know clearly what financial benefits EE will deliver for them and at what costs.

To strengthen compliance enforcement, the following actions are recommended over the next two years (2016–17): (a) review and improve compliance enforcement process; (b) promote mandatory energy performance standards for mainstream building materials and components (for example, insulation materials, windows, and exterior doors); and (c) coordinate activities among international donors for demonstration projects, as well as training and technical support.

The longer-term action should focus on sustainability and continued progress (2018–20): (a) establish a schedule for building EE standards revisions and a mechanism for facilitating stakeholder contributions; (b) engage manufacturers of energy-efficient products and technologies on market expansion; and (c) establish a data collection mechanism and analysis process to better inform policy making and adjustments.

**VI. Role of International Financial Institutions and Donors**

For all three areas of interventions suggested earlier, international financial institutions (IFIs) and donors can play an important role in their design and implementation in two ways: (a) financial assistance in the form of loans and grants and (b) technical assistance for capacity building among key market participants and to the government.
1: Opportunities for Improving Energy Efficiency in Buildings

1.1 Key Characteristics of Energy Supply and Demand

Uzbekistan’s economy depends on domestically produced natural gas. In 2013, gas accounted for 88 percent of primary energy supply and 69 percent of final energy consumption. Thus, most short-to-medium-term improvements in EE are expected to come from the value chain of natural gas, from extraction, transportation, and distribution to transformation and end uses (Table 1.1).

Table 1.1. Natural Gas Supply and Demand in Uzbekistan, 2013

<table>
<thead>
<tr>
<th>Sector</th>
<th>Amount (million m³)</th>
<th>Percentage</th>
<th>Main Characteristics of Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy industry own use and losses</td>
<td>1,827</td>
<td>3.7</td>
<td>• Mostly transportation and distribution losses</td>
</tr>
<tr>
<td>Power and heat generation</td>
<td>19,191</td>
<td>38.6</td>
<td>• Mainly for thermal power and combined heat and power plants • Significant heat-only boiler plants for district heating • High potential for modernization of generation facilities • Indirect impact of EE improvement in all end-use sectors</td>
</tr>
<tr>
<td>Residential</td>
<td>15,410</td>
<td>31.0</td>
<td>• Predominantly for space heating and domestic hot water (DHW) • High share of low-efficiency homemade boilers • High retention rate of aging boilers (in operation for 10 years or more) • Low penetration roof and wall insulation • Low penetration of double glazing</td>
</tr>
<tr>
<td>Commercial and public services</td>
<td>3,082</td>
<td>6.2</td>
<td>• Mainly for space heating and service water heating • Significant share of low-efficiency homemade boilers • Low penetration of roof and wall insulation</td>
</tr>
<tr>
<td>Industry</td>
<td>6,808</td>
<td>13.7</td>
<td>• Industrial boilers and kilns • Generally low thermal efficiency levels of various steam and pyro-processes</td>
</tr>
<tr>
<td>Total domestic supply</td>
<td>49,692</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>


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2 For the remainder of primary energy supply, oil, coal, and hydro contributed 7 percent, 3 percent, and 2 percent in 2013, respectively.
Note: Heating value of Uzbekistan gas is assumed as $1,000 \, \text{m}^3 = 34 \, \text{GJ}$.

From 2000 to 2013, the GDP of Uzbekistan increased by almost 2.5 times in real terms while the primary energy consumption of the country was reduced by about 16 percent. Final energy consumption of every key end-use sector was lower in 2013 than in 2000 (figure 1.1). The substantial improvement in energy productivity of the economy enabled Uzbekistan to double its natural gas export during the period. The moderate increase in natural gas production in the same period was largely absorbed by increased demand from thermal power plants.

**Figure 1.1. Uzbekistan: Trends in Final Energy Consumption, 2000–13**

Despite impressive energy productivity gains, Uzbekistan remains one of the most energy-intensive economies in the world. Its primary energy intensity of GDP measured by purchasing power parity is almost 2.5 times the average of the OECD countries (figure 1.2). This gap indicates that there still are big energy-saving dividends to be captured by investing in EE.

**Figure 1.2. International Comparison of Energy Intensity, 2000–13**


*Note: TPES = total primary energy supply; PPP = Public-private partnership.*
The per capita primary energy consumption in Uzbekistan remains substantially lower than in high-income countries, about one-third the OECD average. As the economy continues to grow, the reduction in overall energy consumption is likely to level off. Historical global trends indicate that substantial increase in per capita electricity consumption is expected as household income grows and the economy industrializes. To sustain economic growth and continued industrialization, Uzbekistan also needs to secure and boost reliable and more efficient energy supplies.

1.2 Large Potential for Gas Savings in Existing Buildings

The residential sector is the largest end user of energy and natural gas, accounting for 54 percent of final gas consumption in Uzbekistan. Most residential natural gas is used for space heating and DHW, two end-use applications that are particularly inefficient due to the general lack of thermal insulation in existing buildings and the widespread use of low-efficiency gas boilers among individual households. A recent United Nations Development Programme (UNDP) study found that average specific energy consumption of Uzbekistan households (423 kWh/m²) is on par with the United States (450 kWh/m²) and higher than in Russia (398 kWh/m²), largely due to inefficient space heating (UNDP 2014).

Multi-family buildings, many of them served by district heating, accounted for only 13 percent of the total residential floor area in 2013, and the share had been decreasing since 2000. Penetration of district heating is low because of the dominance of single-family houses and is limited to a few city centers, particularly in and around Tashkent. Market penetration of natural gas is high, reaching about 85 percent of all households. The majority of households use individual gas boilers for space heating (table 1.2). Use of low-cost, nonstandard gas boilers, both unsafe and inefficient, is prevalent in single-family houses.

### Table 1.2: Prevalence of Individual Gas Boilers for Residential and Commercial Space Heating

<table>
<thead>
<tr>
<th>Building type</th>
<th>Number of buildings</th>
<th>Number of buildings with district heating</th>
<th>Number of buildings with individual gas heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential buildings (one-story, detached)</td>
<td>3,923,145</td>
<td>194,692</td>
<td>3,120,000</td>
</tr>
<tr>
<td>Residential buildings (multistory)</td>
<td>34,113</td>
<td>17,822</td>
<td>2,123</td>
</tr>
<tr>
<td>Commercial buildings (shops, hotels, ...)</td>
<td>135,255</td>
<td>Share expected to be low</td>
<td>109,000</td>
</tr>
<tr>
<td>Public buildings (schools, hospitals, ...)</td>
<td>21,340 **</td>
<td>Share expected to be low</td>
<td>Share expected to be high</td>
</tr>
</tbody>
</table>

Source: based on official data and expert estimates

* The average size of commercial buildings is about 160 m².
** Include some number of complexes, such as universities, actual number of buildings is bigger.

Table 1.2: Prevalence of Individual Gas Boilers for Residential and Commercial Space Heating
By the estimate of this study, replacing highly inefficient nonstandard gas boilers with modern gas boilers (figure 1.3) will reduce residential and commercial gas consumption by about 2.4 billion m$^3$ or about 13 percent of the total residential and commercial gas consumption in 2013. Significant additional savings can be achieved by improving the thermal insulation of existing buildings.

Figure 1.3. Pictures of Homemade Gas Boiler (left) and Modern Gas Boiler for Space Heating

Commercial and public buildings account for a small but significant share of gas consumption. Public buildings, which account for more than half of the floor area of the nonresidential building stock, are a particularly important EE opportunity not only because financing and implementation can be systematically organized but also for demonstrating government leadership in EE innovation. Results of recent EE renovation pilots indicated that heating energy savings of more than 40 percent can be achieved in school and hospital buildings. It is noted that, in the Presidential Decree No. PP-2343: Program of Measures to Increase Energy Efficiency and Introduce Energy-Saving Technologies in the Sectors of Economy and Social Sphere during 2015–19, the public sector is highlighted as an EE investment priority, including replacing a total of 24,238 heating boilers in 8,113 facilities of government-funded organizations. More can be done in thermal retrofit of public buildings by leveraging the ongoing capital improvement program for schools and health clinics, which has not explicitly targeted thermal insulation improvements.

1.3 Energy-Saving Opportunities in New Buildings

The total residential building stock by the end of 2014 was about 470 million m$^2$. The total public and commercial building stock by the end of 2014 was about 115 million m$^2$. Annual completion of residential floor areas surpassed 10 million m$^2$ in 2012 and was 10.7 and 11.3 million m$^2$ in 2013 and 2014, respectively. Most of the new housing constructions in the last decade or so are single-family houses. The share of single-family houses in total housing stock increased from 83 percent to 87 percent between 2000 and 2012 (UNDP 2014).
Implementation of the current mandatory EE standards for residential buildings is expected to cut heat load of new housing (energy required to maintain indoor temperature at 18°C during heating season) by up to 50 percent, compared with the situation where such standards are not applied (for example, most of the existing housing stock).

Deliberate efforts and policy support by the government are needed to develop an effective compliance enforcement system and capable supply chain for delivering more energy-efficient buildings. Although standards for EE of buildings were introduced in 1997 and updated in 2011, their implementation has been hampered by the general lack of compliance capacity: inadequate training and uptake by the design and construction professions, underdeveloped supply chain for energy-efficient products, materials and technologies (for example, building thermal insulation products and specialized construction techniques), and the lack of an effective enforcement system. According to local experts, compliance of mandatory standards is generally observed in new government buildings and new multi-family buildings that are subject to more rigorous regulatory oversight for design and construction. However, compliance enforcement is difficult in new single-family houses, which make up 99 percent of new residential construction. Most single-family houses are built by households themselves, making systematic checking and inspection more challenging, especially in rural areas.

1.4 Energy Efficiency of Electric Appliances

While electric appliance are not a subject of this study, it is important to point out that electricity demand is expected to drive the growth of residential energy consumption in Uzbekistan in the future. As household income grows, large appliances are expected to take a larger share of residential energy consumption. A particular area of rapid growth could be air conditioners due to their relatively low saturation rate at present and increasing desire and affordability for thermal comfort in the summer. EE interventions in the production and acquisition of electric appliances through progressively improving EE standards and accompanying labeling and consumer outreach programs have been successful in many countries. Since appliances and other electric equipment generally have much shorter life cycles than those of buildings, opportunities for EE upgrades are more frequent and could be captured through product replacement cycles.

1.5 Objective and Scope of the Study

This study was undertaken by the World Bank to inform the potential areas and means of assistance to the government of Uzbekistan in scaling up EE investments in residential, commercial, and public buildings, focusing on energy use and efficiency in space heating. Considering the ongoing World Bank assistance in modernizing district heating services in selected cities in Uzbekistan, this study is explicitly concerned with the residential, commercial, and public buildings that are not served by district heating.

The main objective of the study was to identify scalable EE interventions that could be deployed in the next 3 to 5 years. Three specific areas of investigation were carried out: (a) a market assessment for upgrading space heating and water heating equipment in detached homes and commercial buildings; (b) an analysis of the issues and options for scaling up investment in the thermal retrofit of public buildings; and (c) a gap analysis on the
compliance enforcement of building EE standards in new housing constructions. The study did not look into the thermal retrofit of residential buildings, which is often considered among the most complex and challenging of EE interventions and will require a separate in-depth analysis.

The three areas of investigation are broadly consistent with the priorities for improving EE in buildings stated in the Presidential Decree No. PP-2343: Program of Measures to Increase Energy Efficiency and Introduce Energy-Saving Technologies in the Sectors of Economy and Social Sphere during 2015–19. In particular, the presidential decree singled out actions in (a) replacement of nonstandard and inefficient boilers for space heating and hot water supply in detached houses; (b) channeling energy cost savings in state budget-funded organizations toward funding EE investments in these entities; and (c) improvement of rules and norms for EE requirements for new buildings.

The findings and recommendations of the study are intended for informing discussions between the Government and the World Bank on the issues and options related to addressing the main implementation constraints to the abovementioned priority actions identified in the Presidential Decree No. PP-2343. Detailed course of actions on specific EE interventions in buildings could then be developed based on the outcomes of these discussions.

This report summarizes the findings and recommendations of the abovementioned investigations and analyses. Chapters 2, 3, and 4 cover the three main topics identified earlier, respectively.
2. Addressing Inefficiency in Distributed Residential and Commercial

Box 2.1. Summary

**Opportunities.** There are about 3.2 million individual gas boilers in use for heating homes and small commercial buildings. About 75 percent of these boilers have been in service for 10 years or more. About 35 percent of these boilers are ‘homemade’—gas boilers made by local craftsman using nonstandard components and without proper safety compliance. These nonstandard boilers consume almost 50 percent more gas than gas boilers manufactured according to modern industrial standards.

Replacement of the current stock of homemade gas boilers with modern gas boilers will require investments of about Som 3.2 trillion or about US$1.2 billion at the end of 2015 official exchange rate. The financial simple payback periods for residential and commercial consumers are about 6.6 and 5.2 years, respectively, based on the end of 2015 retail gas price. The simple payback periods will be shortened to about 3.4 and 2.7 years, respectively, based on the end of 2015 export gas price.

**Barriers.** Based on surveys of households and business owners, the main barriers to the market uptake of high-efficiency gas boilers include (a) low domestic prices of natural gas; (b) high cost of modern gas boilers, especially compared with nonstandard alternatives; and (c) a lack of awareness of the costs and benefits of improving EE among residential consumers. So long as these conditions persist, households’ and business owners’ motivation to upgrade gas boilers will be low, and the regulation barring the installation of nonstandard gas boilers will be difficult to enforce.

**Actions needed.** In the short-to-medium term, there are two options that, if implemented together with broad-scale and intensive information and outreach campaigns, could potentially break the logjam and encourage upgrades: directly subsidizing investments in gas boiler upgrades or enabling access to affordable financing for investments in gas boiler upgrades.

**Option 1.** Introducing a cash incentive program that offers to buy back existing nonstandard boilers if households or business owners replace them with eligible high-efficiency gas boilers. The subsidy (or cash incentive) is meant to be a temporary measure to incentivize economically cost-effective investments and to create a critical mass for the upgrade market to expand when the two critical constraints are loosened or removed—domestic gas prices approach or reach parity with the export price and the cost of high-efficiency gas boilers is reduced due to the increased market size.

**Option 2.** Introducing a dedicated consumer credit line for the purchase and installation of high-efficiency gas boilers. Low-cost, long-term capital secured by the government and on-lent to participating commercial banks will help reduce the borrowing cost of households and business owners. As revealed by the surveys conducted in the study, 54 percent of households and 65 percent of business owners indicated willingness to finance an upgrade if the bank’s lending terms are attractive. Using a dedicated credit line will mean a low administrative cost for the government. The credit line could be expanded to cover other EE upgrades, such as windows and roof insulation, if financial resources are available.
Space Heating

2.1 Market Assessment of Gas Boilers for Residential and Commercial Space Heating

Under this study, surveys were carried out in Tashkent and Samarkand to understand the energy use and efficiency of space heating and service water heating (for DHW), as well as the interest of and incentive needed for investing in EE improvement among households and commercial businesses (for example, shops, restaurants, and hotels) that are not served by district heating. The analysis of the survey results formed the basis of the market assessment and recommendations to address the main issues that were identified.

Most residential and commercial buildings have poor thermal insulation but are generally adequately heated. While there are a significant number of homes (18 percent) with double-glazed windows, far fewer homes have thermal insulation for roofs, and almost none of the residential buildings surveyed have thermal insulation for exterior walls. Commercial buildings, most of which were built in the last 15 years or so, have a very high penetration rate of double-glazed windows, while also showing very poorly in thermal insulation of roofs and exterior walls (table 2.1)

Table 2.1. Survey Results of Building Thermal Insulation Conditions and Thermal Comfort

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Residential buildings</th>
<th>Commercial buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings with double glazed windows (%)</td>
<td>18%</td>
<td>95%</td>
</tr>
<tr>
<td>Buildings with insulated roofs (%)</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Buildings with insulated exterior walls (%)</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Occupants satisfied with thermal comfort (%)</td>
<td>80%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Source: Authors.

Most gas boilers for residential space heating and service water heating are in service for 10 or more years and the use of highly inefficient nonstandard boilers is widespread. The share of ‘homemade’ gas boilers, crude devices made with nonstandard parts by local craftsmen, is about 35 percent among surveyed households and 43 percent among surveyed commercial businesses (Table 2.2). The thermal efficiency of nonstandard boilers is around 50 percent, compared with 90 percent or higher of modern efficient gas boilers. They may also post safety hazards due to lack of testing and safety compliance that are normally applied in standardized industrial production of gas boilers. They remain popular in large part due to the low acquisition cost (about one-fifth of the price of a new high-efficiency boiler) and low operation cost because of low retail gas prices.

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3 The study carried out surveys among 530 households and 60 commercial businesses in Tashkent and Samarkand, as well as 14 gas boiler producers/vendors. Details of the surveys and findings are provided in appendix E.
The potential net economic value of improving the efficiency of residential and commercial natural gas consumption is large, and a significant part of it can be captured cost-effectively by replacing nonstandard gas boilers with modern efficient ones. The potential for energy savings through replacing unsafe and inefficient nonstandard gas boilers is estimated at 2,383 million m³ of natural gas. This is valued at about Som 498 billion (or US$181 million) at domestic retail gas price at the end of 2015 and about US$360 million at the export gas price by the end of 2015. Replacement of the current stock of homemade gas boilers with modern high-efficiency ones will require investments of about Som 3,237 billion. At end of 2015 domestic retail gas prices, the investment could be paid back by gas cost savings under seven years. At end of 2015 export prices, the investment could be paid back in a little over three years. Table 2.3 summarizes the key cost and benefit parameters of replacing homemade gas boilers. More detailed information on the cost-effectiveness analysis of replacing homemade gas boilers is provided in appendix A.

### Table 2.2. Vintage and Efficiency of Gas Boilers Used by Households and Commercial Businesses

<table>
<thead>
<tr>
<th>Building type</th>
<th>Share of gas space heaters, less than 10 years old</th>
<th>Share of gas space heaters, more than 10 years old</th>
<th>Share of service water heaters, less than 10 years old</th>
<th>Share of service water heaters, more than 10 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential buildings</td>
<td>20%</td>
<td>80%</td>
<td>32%</td>
<td>68%</td>
</tr>
<tr>
<td>Commercial buildings</td>
<td>75%</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Survey results of gas boilers in operation

<table>
<thead>
<tr>
<th>Boiler type</th>
<th>Estimated thermal efficiency</th>
<th>Share of residential boiler inventory</th>
<th>Share of commercial building boiler inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Homemade”</td>
<td>50%</td>
<td>35%</td>
<td>43%</td>
</tr>
<tr>
<td>Domestic</td>
<td>85-90%</td>
<td>54%</td>
<td>50%</td>
</tr>
<tr>
<td>Imported</td>
<td>92-94%</td>
<td>11%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: Authors, based on survey data.

<table>
<thead>
<tr>
<th>Building type</th>
<th>Total installed cost of high-efficiency gas boilers</th>
<th>Total value of gas savings at domestic retail gas price</th>
<th>Total value of gas savings at export gas price</th>
<th>Simple payback period at domestic gas price (end of 2015)</th>
<th>Simple payback period at export gas price (end of 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Som 3,043 billion</td>
<td>Som 461 billion</td>
<td>Som 904 billion</td>
<td>6.6 years</td>
<td>3.4 years</td>
</tr>
<tr>
<td>Commercial</td>
<td>Som 193 billion</td>
<td>Som 37 billion</td>
<td>Som 72 billion</td>
<td>5.2 years</td>
<td>2.7 years</td>
</tr>
<tr>
<td>Overall</td>
<td>Som 3,237 billion</td>
<td>Som 498 billion</td>
<td>Som 976 billion</td>
<td>6.5 years</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Source: Authors, based on survey data.
Low cost of natural gas, high acquisition cost, and the lack of awareness of the cost and benefit of improving EE are major barriers to households’ decision to invest in high-efficiency gas boilers. Although about 80 percent of the surveyed households have boilers that are at least 10 years old, the majority of the respondents are not willing to invest in upgrading their gas boilers. Most households do not know the costs and benefits of replacing nonstandard gas boilers. For those who know, the combination of relatively high cost of modern gas boilers and relatively low cost of gas dampens the financial-return-driven investment decisions. Financing to help spread the investment cost over a longer period will be desirable. But a simple payback period of over five years is not attractive to households. While the survey revealed a high level of consumer indifference toward EE, it also indicated that many were economically rational, if well informed. This gives hope to interventions that provide financial incentives and/or facilitated financing, a topic that will be revisited later in the recommended actions. Table 2.4 provide a summary of the key survey results on home heating and prospects of replacing homemade gas boilers.

Table 2.4. Challenges and Opportunities of Replacing Homemade Gas Boilers: Key Results of Household Survey

<table>
<thead>
<tr>
<th>Lack of Motivation</th>
<th>But Change of Mindset Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low cost of heating (residential tariff of Som 181 per m³ vs. export price of Som 625 per m³ in early 2015) with adequate thermal comfort (average room temperature 22°C)</td>
<td>• Subsidy is being reduced and gas bill is a significant share of household expenditure (3.7% of top quartile and 6.6% of bottom quartile)</td>
</tr>
<tr>
<td>• High cost of new efficient boilers: at the time of survey about Som 2.5 million per unit installed</td>
<td>• Significant cost reduction of gas boilers is expected if economy of scale is achieved</td>
</tr>
<tr>
<td>• Most households (89%) think there is no need to replace old inefficient boilers so long as they are not broken</td>
<td>• Households (54% of surveyed) are willing to borrow to finance boiler replacement if loan terms are favorable</td>
</tr>
<tr>
<td>• Low awareness of the cost and benefit of EE investments (84% of respondents did not know potential cost savings and 50% of respondents had never heard about EE)</td>
<td>• Consumer outreach and education is important</td>
</tr>
</tbody>
</table>

Source: Authors, based on survey results.

Most commercial businesses surveyed were concerned about cost of gas consumption and indicated interest in replacing inefficient gas boilers: 87 percent of surveyed commercial consumers were concerned about gas prices and were well aware of EE and potential cost savings; 65 percent of the respondents expressed a willingness to invest in upgrade of gas boilers if the investment pays back in five years or less and if credit is available; and 70 percent of respondents expressed willingness to pay an energy services company for the costs of an upgrade through the deductions from gas payments (Table 2.5).
### Table 2.5. Challenges and Opportunities of Replacing Gas Boilers: Key Results of Commercial Business Survey

<table>
<thead>
<tr>
<th>Some Reluctance</th>
<th>But Generally Willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>75% of gas boilers are less than 10 years old</td>
<td>87% of respondents were concerned about gas prices and thought improving EE would be necessary</td>
</tr>
<tr>
<td>New efficient gas boilers are expensive</td>
<td>65% of the respondents will be willing to invest in new efficient gas boilers if the investment payback period is shorter than 5 years and if favorable financing is available</td>
</tr>
<tr>
<td>Wishing that payback periods could be shorter and financing could be more favorable</td>
<td>70% of respondents expressed willingness to pay an ESP for the costs of upgrade through the reduction of gas payments</td>
</tr>
</tbody>
</table>

**Source:** Authors based on survey results.

**Note:** ESP = Energy Service Provider.

### Significant ramping up of domestic production of high-efficiency gas boilers is needed to support a national program to replace nonstandard boilers.**

This study estimates that the current stock of nonstandard boilers is about 700,000 units. The current domestic production capacity is about 40,000 to 50,000 units from 14 vendors or suppliers, several of them joint ventures with foreign manufacturers. Without a visible program and requisite financial resources to support gas boiler upgrades, thus pushing up demand for high-efficiency boilers, gas boiler suppliers will not be confident to invest in new technologies (for example, condensing boilers) and capacity expansion, impeding the improvements needed in productivity and economies of scale, both of which are needed to reduce the cost of gas boilers. The industry also faces other constraints such as restrictions in importing parts and components because many rely on foreign manufacturers for critical technologies and still others just assemble foreign made boilers in Uzbekistan. But most local gas boiler suppliers are positive on the outlook of their business and will be ready to participate in a program for replacing gas boilers.

### Table 2.6. Challenges and Opportunities of Replacing Gas Boilers: Key Results of Gas Boiler Vendor Survey

<table>
<thead>
<tr>
<th>Unfavorable Market Conditions</th>
<th>But Many See Good Prospects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low and uncertain demand for high-efficiency gas boilers</td>
<td>Production could be ramped up quickly if there is robust demand</td>
</tr>
<tr>
<td>Domestic production capacity low (estimated total annual production of 40,000 to 50,000 units) and mostly small-scale production (71% produce less than 2000 units per year)</td>
<td>Positive on long-term market outlook (over 79% of vendors think it is possible to persuade households to upgrade gas boilers even under current market conditions)</td>
</tr>
<tr>
<td>Lack of affordable credit (71% have difficulty obtaining credits) and limited access to imported parts and components</td>
<td>Mature technologies, including condensing boilers, are ready to be deployed</td>
</tr>
</tbody>
</table>

**Source:** Authors, based on survey results.
Other key stakeholders, including the national government, the national gas utility, and commercial banks, also have their respective challenges. For the national government, a major constraint is the need for offering financial incentives for households to upgrade gas boilers. Although the cost could be recovered from increased gas export or additional domestic sales, the initial capital will likely to be budget funded or borrowed from IFIs. The national gas utility, which has a monopoly on domestic gas distribution, needs to be a close partner for a gas boiler upgrade program. It could even be the main implementing agency for such a program. The commercial banks could play a key role to help bridge the financing gaps for households and in particular for commercial businesses. But they are concerned about potential credit risks of these consumers.

Table 2.7. Challenges and Opportunities of Replacing Gas Boilers: Government, Gas Utility, and Commercial Banks

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Opportunities</th>
</tr>
</thead>
</table>
| National government | • Difficulty of implementing subsidy reform  
• Limited fiscal space  
• Limited implementation capacity  
• Need to improve the technical standards of gas boilers |
| | • Investing in EE could mitigate financial impact on households  
• Significant potential for boosting gas export revenue  
• Could rely on the capacity of the national gas utility  
• Potential for growth and job creation  
• Prudent use of regulatory power |
| National gas utility | • Reduction in domestic gas sales  
• Unconventional business opportunity |
| | • Export or productive use of saved gas could more than compensate for the lost domestic sales  
• Help improve service quality and customer satisfaction |
| Commercial banks | • Providing credits that are attractive to households  
• Credit risks with micro or small commercial businesses |
| | • Could benefit from government facilitation (for example, obtaining favorable capital from IFIs)  
• Could benefit from risk mitigation facilities |

Source: Authors.

2.2 Financing and Delivery Options for Replacement of Inefficient Gas Boilers

The proliferation of highly inefficient nonstandard gas boilers has been aided by relatively low cost of gas and difficulties in enforcing the regulation to ban their installation. While the life-cycle cost of modern gas boilers is lower than nonstandard boilers, replacing the existing stock of nonstandard boilers is unlikely to take off without deliberate policy interventions (Table 2.8).
Table 2.8. Key Barriers to Replacing Homemade Gas Boilers

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential and commercial consumers</td>
<td>• Unattractive financial returns due to low gas prices</td>
</tr>
<tr>
<td></td>
<td>• High cost of modern gas boilers</td>
</tr>
<tr>
<td></td>
<td>• Unavailable or expensive financing</td>
</tr>
<tr>
<td></td>
<td>• Low awareness of options, costs, and benefits</td>
</tr>
<tr>
<td></td>
<td>• Continued price adjustment to reflect economic opportunity costs</td>
</tr>
<tr>
<td></td>
<td>• Providing financial incentives and financing facilitation for gas boiler upgrades</td>
</tr>
<tr>
<td></td>
<td>• Fact-based consumer education and information campaigns</td>
</tr>
<tr>
<td>Gas boiler suppliers</td>
<td>• Market uncertainty</td>
</tr>
<tr>
<td></td>
<td>• Small scale production</td>
</tr>
<tr>
<td></td>
<td>• Limited access to credit</td>
</tr>
<tr>
<td></td>
<td>• Improve enforcement of the regulation on gas boilers</td>
</tr>
<tr>
<td></td>
<td>• Boost market demand by launching a national program for gas boiler upgrade</td>
</tr>
<tr>
<td>Financing and delivery mechanism</td>
<td>• Fragmented and underdeveloped</td>
</tr>
<tr>
<td></td>
<td>• Government facilitation either through a government-implemented program or through a consumer credit line program</td>
</tr>
<tr>
<td></td>
<td>• Both could provide special support for private sector (gas boiler producers) participation</td>
</tr>
</tbody>
</table>

Source: Authors.

Domestic gas prices, while far from the export price parity, have been increasing steadily since 2008. The end of 2015 nominal price of residential gas was about Som 208.9 per m³, compared with Som 67.5 per m³ in 2010 and Som 151.7 per m³ in 2013. Despite a substantial drop in value, the estimated border price of Uzbek gas by the end of 2015 was about US$149 per 1000 m³ or about Som 409.7 per m³ using official exchange rate of the same time. The gradual upward adjustments of domestic gas prices are expected to continue, further improving the financial attractiveness of replacing homemade boilers. It is unclear whether there is a time line for domestic gas prices to reach the export price parity. Due to the usual gradual pace of pricing reforms, it is expected that the current deterrence to replacement of homemade boilers due to relatively low operating cost will persist in the next five years.

Thus, in the short to medium term, replacements of gas boilers will benefit greatly from a national program that could simultaneously address consumer incentives and facilitate financing and implementation, while also improving industry standards and supporting domestic production of high-efficiency gas boilers.

There are a number of international examples on government-supported residential programs to replace inefficient energy-consuming equipment. Some of these programs have a distinctive objective of assisting low-income households in acquiring high-efficiency equipment. These can include information campaigns and product labeling, bulk purchases

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4 There is an ongoing World Bank energy pricing study which will provide an in-depth review of Uzbekistan’s energy pricing policies and propose a reform agenda including addressing social protection issues.
(usually by utilities) to lower prices, financing and incentives, and equipment standards or bans. With regard to financial incentives or financing support, the commonly used instruments include (a) cash incentives, (b) subsidized loans, (c) facilitated financing, and (d) utility obligation. The basic characteristics and pros and cons of these approaches are summarized in Table 2.9. More details about these approaches and their relevant case studies are provided in appendix B.

Based on the market conditions in Uzbekistan, government financing support for replacement of nonstandard gas boiler could be devised either through a cash incentive program that offers to buy back homemade boilers if households or business owners replace them with eligible modern gas boilers or through a dedicated credit line through commercial banks that can offer a 3- to 5-year loan at interest rates attractive to households and commercial businesses. For example, the survey conducted by the study indicates that many business owners will be willing to borrow to buy high-efficiency boilers if offered a 3-year loan at an interest rate of 10–12 percent.

Further analysis will be needed to assess the potential cost and impact of either supporting scheme. The cash incentive program could be more costly than the credit line program but could be easier to implement, potentially having a larger immediate impact if well designed and executed. But the cash incentive may still not be sufficient to motivate a low-income household if the shortfall in capital remains. It will also require analysis of consumer needs and targeting to avoid free riders. But a short-term cash incentive may be sufficient to develop critical mass in the market, thereby bringing retail costs down and new suppliers into the market. A credit line program could potentially evolve into a sustainable commercial lending program for a broader array of EE measures in the residential sector, such as replacement of windows and roof insulation.
Table 2.9. Major Types of Financing and Incentive Support for Replacement of Inefficient Energy-Consuming Equipment

<table>
<thead>
<tr>
<th>Type</th>
<th>Key Features</th>
<th>Pros</th>
<th>Cons</th>
<th>Countries</th>
</tr>
</thead>
</table>
| Cash Incentives           | • Rebate programs use cash-back to promote qualified products (for example, ENERGY STAR label)  
  • Tax credits and tax deductions available for qualifying EE improvements (for example, installing condensing boilers) | • Available to everyone  
  • Simple program design, easy to administer (for example, no energy assessments or audits required, no lien on the property) | • Customers cover full cost of EE investment up front  
  • Less effective at promoting EE investments among low- and middle-income customers | The United States |
| Subsidized Loans          | • Low-interest loan available to finance eligible EE equipment  
  • Loans tend to be small and below US$10,000 and require qualifying assessment  
  • Usual loan terms: up to 10 years fixed rate with monthly payments | • Financial leveraging of public funds  
  • Large-scale potential  
  • Often combined with EE information or education | • Typically available only to property owners, not tenants  
  • Interest rate buy-down can be very expensive  
  • Less effective at promoting EE investments among low- and middle-income customers | The United States, Slovenia |
| Facilitated Financing (for example, guarantees and dedicated credit lines) | • Commercial lending for residential EE investments on more favorable terms either by loan guarantees backed by public funds or by using lower cost capital raised by the government (for example, selling municipal bonds, or borrowing from IFIs) | • Financial leveraging of public capital  
  • Encouraging commercial banks to finance residential EE projects  
  • Can lead to sustainable commercial financing | • Although available to all Income classes, the focus tends to be on creditworthy middle-income borrowers  
  • Require mature banking sector interested in EE financing | Hungary, Lithuania, Czech Republic |
| Utility Obligation        | • Legal obligation for energy companies to meet energy and carbon saving targets, by subsidizing qualified EE measures in eligible households  
  • Financing and cost recovery arrangements at energy company discretion, but typically costs passed on to consumers as rate increases  
  • Property assessments and installations carried out by authorized agents  
  • Government sets targets and monitors costs and results | • No up-front cost  
  • Spreading the cost across utility customers, leads to small bill increases  
  • Achieves EE gains in hard-to-treat properties and among vulnerable consumer groups, market segments unattractive to commercial EE schemes  
  • Ease of collection through on-bill financing | • Can cause tariff increase for energy company customers who do not benefit from the program  
  • Compliance through negative incentives (avoiding penalties)  
  • Complex administration, implementation, and oversight arrangements | The United Kingdom and a number of European Union countries |

Source: Authors
If a cash incentive program is envisioned, it could be coordinated through a centralized Program Management Unit (PMU) established by the central government (figure 2.1). In lieu of budget allocation, the government may consider using long-term capital from IFIs to finance the cash incentive program. Installation of new boilers will be carried out by accredited gas boiler suppliers, who are also responsible for buying back the old boiler at the rebate price. The gas boiler suppliers and qualified boilers and prices could be determined through a bidding process conducted by the PMU. The national gas utility will be responsible for verifying the installation. Based on the verification, the PMU can approve the rebate application sent in by boiler suppliers periodically. The national rebate account can then release the rebate funds to the boiler suppliers. Commercial banks may be involved to provide credit for the working capital of the boiler suppliers. While consumer borrowing is not envisioned in a cash incentive program, homeowners and businesses may wish to borrow to finance the balance of the installation cost.

**Figure 2.1. Potential Implementation Arrangements under a Cash Incentive Program**

In a dedicated credit line program, a central PMU will still be needed for program outreach and monitoring (Figure 2.2). But the government’s role is mainly in providing commercial banks with low-cost capital so they can on-lend at rates and terms attractive to households and businesses that want to replace their inefficient gas boilers. The initial capital for a dedicated credit line may come from an IFI, which will in turn help design the program and provide implementation support.
2.3 Recommendations for Short-to-Medium-Term Actions

The public and private benefits of replacing highly inefficient nonstandard gas boilers are clear and large. But without support from the government, the market participants, including households, commercial businesses, modern gas boiler suppliers, the gas utility, and commercial banks are unlikely to act in a concerted manner to replace nonstandard gas boilers at scale in the next five years or beyond, leading to substantial losses of economic value—about US$350 million per year forgone gas export value at end of 2015 prices.

The government could accelerate the pace of replacing nonstandard gas boilers by helping remove or reduce some of the key market barriers to private investments in boiler upgrades. This will require continued liberalization of domestic gas prices, large efforts to inform and educate residential consumers, removal of constraints to scaling up domestic production of high-efficiency gas boilers, sensible use of financial incentives in the short to medium term, and/or facilitating the use of commercial financing through dedicated EE credit lines for households and commercial businesses.

Table 2.10 summarizes important actions that the government could undertake to transform the market for distributed gas heating in residential and commercial buildings, focusing initially on a national program to replace installed and ban new nonstandard gas boilers.
### Table 2.10. Short-to-Medium-Term Actions for Accelerating Market Uptake of High-Efficiency Gas Boilers

<table>
<thead>
<tr>
<th></th>
<th>Year 1. Establishment</th>
<th>Year 2. Operationalization</th>
<th>Years 3–5. Scaling Up</th>
</tr>
</thead>
</table>
| Central Government | • Determine financing support instrument, for example, using cash incentive or using credit support  
|                  | • Establish the PMU                                                                    | • Launch program with adequate financial resources                    | • Review objectives, progress, performance, and adequacy of financial resources  
|                  | • Cooperate with banking sector to develop finance options  
|                  | • Develop a plan for the gas utility to cooperate with and assist with the national program  
|                  | • Develop Minimum Energy Performance Standards (MEPS) and EE labels for gas equipment  
| **PMU**          | • Develop clear technical guidelines (in consultation with industry) for gas boiler EE upgrade  
|                  | • Develop a marketing strategy to actively engage consumers, retail banks, and gas boiler industry  
|                  | • Develop a research plan to create solid end-use data and TA to improve awareness and identify options  
|                  | • Establish an evaluation program                                                       | • Market the scheme—effective marketing and communications             | • Program administration, implementation support, and annual evaluation |

*Source: Authors.*
3. Scaling up Energy Efficiency Investments in Public Buildings

<table>
<thead>
<tr>
<th>Box 3.1. Summary</th>
</tr>
</thead>
</table>
| **Opportunities.** The existing stock of public buildings in Uzbekistan amounted to about 53 million m² in 2014, about 85 percent of which belongs to education and health care entities. Replacement of 24,238 inefficient heating boilers in education and health care facilities was identified as a priority activity by the Presidential Decree No. PP-2343. The government also has an existing off-budget funding mechanism for reconstruction, basic repairs, and equipment of educational and medical institutions. Recent pilot projects of comprehensive thermal renovation in education and health care buildings demonstrated reduction in gas or coal consumption of at least 40 percent. Estimated simple payback periods based on energy cost savings are 26 years for school buildings and 22 years for hospital buildings. The simple payback periods can be halved if the gas tariff reaches parity with the end of 2015 gas export price. More selective approaches than the full-menu measures applied in the pilots could also improve financial attractiveness of EE investments in education and health care facilities. The overall investment needs for thermal renovation of existing education and health care facilities in Uzbekistan, including those heated by district heat, natural gas, or coal, are estimated to be up to US$1 billion, assuming that the comprehensive renovation measures adopted in the pilot projects were implemented and at the indicated cost levels. About 80 percent of the investment will go to educational facilities. Investment cost reduction and improved cost-effectiveness are likely if a broad renovation scale is achieved.  
| **Barriers.** The scale of thermal renovation of existing education and health care facilities is limited by the lack of dedicated funding and a mechanism that could capture energy cost-savings to fund future EE projects, thus enabling the initial investment capital to revolve and support additional thermal renovation. Creating and operationalizing such a revolving financing mechanism is hampered by low-energy tariffs, especially for natural gas, which leads to long payback time for thermal renovation projects, and by current budget provisions that are based on historical expenses and do not encourage energy-saving behavior. Uzbekistan has yet to develop the legal and regulatory foundation for the introduction of energy performance contracting, which could become an effective instrument for scaling up financing and delivery of EE projects in public buildings.  
| **Actions needed.** Increased investment in thermal renovation of public buildings is needed and could be paid for by future energy cost savings. However, this will require dedicated initial incremental funding for EE measures to be implemented alongside the capital improvement program and the establishment of a revolving funding mechanism that enables the recovery and reinvestment of the energy cost saving cash flow. This study recommends the creation of an EERF within the current off-budget fund for reconstruction, repairs, and equipment. The new EERF, with committed EE investment capital over a 5-year period, could initially focus on financing EE projects in educational and health care facilities through energy service agreements. Such a scheme will also enable the government to begin to nurture a private energy service industry through |
3.1 Energy Efficiency Opportunities, Costs and Benefits in Public Buildings

By the local expert estimate, the existing public building stock, including buildings owned and/or operated by central and local governments, educational and health facilities (most of them funded by the government), as well as other public facilities (for example, recreation centers), amount to about 53 million m² (end of 2014). Because the educational and health facilities account for close to 85 percent of the public building stock floor area, this study focused on these facilities. About 14 percent of education facilities and 12 percent of health care facilities, by number, are connected with district heating systems. The rest rely on their own heating boilers, mostly gas-fired. But the number of facilities using coal for heating is significant (table 3.1).

Table 3.1. Space Heating Mode in Educational and Health Facilities, 2015

<table>
<thead>
<tr>
<th></th>
<th>District Heating or Gas-Fired Boiler</th>
<th>Heated by Coal-Fired Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Entities</td>
<td>Floor Area m²</td>
</tr>
<tr>
<td>Preschool</td>
<td>3,465</td>
<td>3,811,500</td>
</tr>
<tr>
<td>Elementary and secondary education</td>
<td>5,356</td>
<td>12,545,327</td>
</tr>
<tr>
<td>Academic lyceum</td>
<td>133</td>
<td>645,260</td>
</tr>
<tr>
<td>Technical college</td>
<td>1,007</td>
<td>4,633,580</td>
</tr>
<tr>
<td>Higher education</td>
<td>80</td>
<td>1,986,487</td>
</tr>
<tr>
<td>Hospitals</td>
<td>445</td>
<td>2,000,250</td>
</tr>
<tr>
<td>Ambulatory and preventive services</td>
<td>1,746</td>
<td>1,885,632</td>
</tr>
<tr>
<td>Subtotal</td>
<td>12,232</td>
<td>27,508,000</td>
</tr>
</tbody>
</table>

Source: Estimates by local experts who worked on the study.

Demonstration projects undertaken by UNDP/Global Environment Facility (GEF) indicate potential cost-effective energy savings of 42 percent for schools and 44 percent for health care facilities are achievable (table 3.2) at costs of US$23–25 per m² floor area. The energy savings are consistent with experiences in European countries, such as Poland and Romania. But cost comparisons are difficult because of large differences in costs of labor and materials, as well as the inconsistency in foreign exchange rates between countries.

Table 3.2. Achievable Energy Savings in Educational and Health Facilities

<table>
<thead>
<tr>
<th></th>
<th>Energy Use before EE Renovation, kWh/m²-year</th>
<th>Energy Use after EE Renovation, kWh/m²-year</th>
<th>Energy Savings</th>
<th>Average Investment Cost, US$/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care facilities</td>
<td>223</td>
<td>125</td>
<td>44%</td>
<td>25</td>
</tr>
<tr>
<td>Education facilities</td>
<td>185</td>
<td>107</td>
<td>42%</td>
<td>23</td>
</tr>
</tbody>
</table>

Source: GEF 2009.
These opportunities are distributed across the construction and heating system features of these buildings as shown in figure 3.1, which outlines the distribution of intervention costs in pilot EE projects.

Figure 3.1. Cost Structure (%) of Energy Efficiency Renovation by Measure

Since there were no energy audit data available, the cost-effectiveness assessment of public buildings were based on a limited number of pilot thermal retrofit projects undertaken in the UNDP-GEF project. Since pilots tend to cost more than if the measures were implemented at a broader scale, a large-scale program should see more attractive returns. Table 3.3 summarizes the main results extrapolated to the entire stock of existing educational and health sector buildings that are heated by either district heating or natural gas. The estimates for building heated by coal-fired buildings were not carried out due to the lack of information on the costs of coal, which may also vary significantly by location.

Table 3.3. Costs and Benefits of Thermal Renovation of Educational and Health Facilities

<table>
<thead>
<tr>
<th></th>
<th>Total Floor Area Heated by Gas or District Heat</th>
<th>Renovation Cost</th>
<th>Annual Cost Savings (based on Domestic Gas Price)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>22,976,900 m²</td>
<td>US$23 per m²</td>
<td>US$0.88 per m²-year</td>
<td>26.1</td>
</tr>
<tr>
<td>Health</td>
<td>3,885,900 m²</td>
<td>US$25 per m²</td>
<td>US$1.14 per m²-year</td>
<td>21.9</td>
</tr>
</tbody>
</table>

Source: Estimates by local experts who worked on the study.

The simple payback periods using domestic gas prices for such renovation seem long, at about 22 and 26 years for health and education facilities, respectively. Using end of 2015 export prices, the simple payback periods will be halved. A simple payback period of 10 years or so is consistent with experiences of similar types of renovation projects in eastern European countries where gas prices closely follow international market prices. It is also noted that the rich distribution of end-use EE opportunities in figure 3.1 highlights the need for a degree of technical evaluation and customization of a cost-effective set of measures for each facility and suggests the need for skilled EE intervention implementers.
The overall investment needs for thermal renovation of existing educational and health facilities in Uzbekistan, including those heated by district heat, natural gas, or coal, could be up to US$1 billion if the comprehensive renovation adopted in the UNDP/GEF pilot projects were implemented. Investment cost reduction is likely if a broad renovation scale is achieved. About 82 percent of the investment would go to educational facilities.

3.2 Constraints to Financing and Delivery of Energy Efficiency Projects in Public Buildings

The operational budget allocation for educational and health care entities is generally determined by current year expenditures and projected increases based on formulas that include funding coefficients per head count (for example, per pupil for schools or per capita for health care facilities). For schools heated by district heat or natural gas, a heating cost coefficient is applied. For schools that rely on coal for heating, the cost is covered separately. For health care facilities, heating cost is not explicitly included in the budgetary formula. According to the Presidential Decree No. PP-2343, replacement of boilers in public buildings is planned. For these additional measures, additional funds will be allocated.

Budget for capital improvements, including purchase of equipment and building maintenance, repair and reconstruction are separate from operation budget and are allocated based on approved applications from beneficiaries. The government has an off-budget fund for capital improvements in secondary schools, professional colleges, academic lyceums, and medical institutions since 2010. This off-budget fund is managed by the Ministry of Finance (MOF). In 2015, the total capital improvement spending in educational and health care facilities was Som 1,254 billion, about US$456 million, using the end of year official exchange rate.

The Presidential Decree No. PP-2343 (2015) has a provision that allows that 60 percent of resources saved due to EE measures may be used for further improving EE by owners of buildings. But the implementation of such a policy faces challenges as detailed procedures and guidelines have yet to be fully developed. Moreover, there is no proven mechanism yet, such as energy performance contracting, which will enable the capture of the energy cost saving cash flow.

The most significant barriers to financing and delivery of EE investment projects in educational and health care facilities in Uzbekistan are identified as follows:

- Many capital improvement projects did not adequately address EE improvement needs, forgoing crucial opportunities for lasting energy savings.

- Low energy tariffs (especially for natural gas) that lead to financially unattractive returns for specific EE investments, especially those that reduce heat losses. This in turn reduces the scope to leverage budgetary resources.

- Limited access to capital for EE investments due to both overall liquidity or government budget constraints and the lack of suitable mechanisms to capture energy cost savings, thus enabling future EE investments without adding additional budgetary demand.
- Absence of incentive for budget-supported entities to save energy. The operating budget planning is based on current and historical expenses and does not incentivize energy-saving behavior.

- Lack of legal and regulatory foundation for introduction of energy performance contracting and eventually the development of domestic energy service companies (ESCOs). For example, budget-funded entities are not allowed to sign contracts beyond the end of the current fiscal year. This will prevent multiyear energy performance contracts that are usually required for most EE investment in buildings.

However, there is realistic potential for Uzbekistan to address these barriers by introducing some innovations into the current system of capital improvement financing in the short to medium term and by creating a broader enabling environment for sustainable EE financing in public buildings in the long term. The following sections first review international experiences and lessons learned in this regard and then discuss appropriate options for Uzbekistan.

3.3 Global Experience in Sustainable Energy Efficiency Financing for Public Buildings

Some of the common barriers (figure 3.2) to public sector EE financing observed in many other client countries of the World Bank also are prominent in Uzbekistan, as indicated in the previous section.

**Figure 3.2. Common Barriers to Sustainable EE Financing in Public Sector**

<table>
<thead>
<tr>
<th>Policy / Regulatory</th>
<th>Equipment/ Service Provider</th>
<th>End User</th>
<th>Financiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low energy pricing, consumption-based billing and collections</td>
<td>High project development costs</td>
<td>Lack of awareness</td>
<td>New technologies and contractual mechanisms</td>
</tr>
<tr>
<td>Public procurement and budgeting policies</td>
<td>Perceived risk of late/ non-payment of public sector</td>
<td>High upfront and project development costs</td>
<td>Small sizes/widely dispersed → high transaction costs</td>
</tr>
<tr>
<td>Limitations on public financing and borrowing capacity</td>
<td>Limited demand for EE goods/services</td>
<td>Ability/willingness to pay incremental cost</td>
<td>High perceived risks incl. public credit risks</td>
</tr>
<tr>
<td>Ad hoc planning</td>
<td>Diffuse/diverse markets</td>
<td>Low EE benefits relative to other costs and priorities</td>
<td>Other higher return, lower risk projects</td>
</tr>
<tr>
<td>Import duties on EE equipment</td>
<td>New contractual mechanisms (e.g., ESCOs)</td>
<td>Perceived risks of new technologies/ systems</td>
<td>Over-collateralization, restrictions on public assets as collaterals</td>
</tr>
<tr>
<td>Unclear or under-developed EE institutional framework</td>
<td>Limited technical, business, risk mgmt., skills</td>
<td>Low levels of comfort</td>
<td>Behavioral biases</td>
</tr>
<tr>
<td>Lack of appliance standards and building EE codes, lack of testing, poor enforcement</td>
<td>Limited access to financing/ equity</td>
<td>Mixed/lack of incentives</td>
<td>Lack of credible data</td>
</tr>
<tr>
<td>Limited and poor data</td>
<td></td>
<td>Behavioral biases</td>
<td>No discretionary budgets for special projects/ upgrades and limited ability to borrow</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cannot collateralize public assets</td>
</tr>
</tbody>
</table>

*Source: World Bank staff.*
Successfully addressing these barriers takes time and requires efforts in five key areas to create an enabling environment (Figure 3.3).

**Figure 3.3. Framework for Successful EE Programs**

- **Policy and Regulations**
  - Overarching EE legal framework (EE Law)
  - Cost-reflective energy pricing
  - Codes/standard w/ enforcement mechanisms
  - EE incentive schemes w/ funding sources
  - EE targets by sector
  - Public budgeting/procurement encourages EE

- **Institutions**
  - Dedicated entity with EE mandate
  - Clear institutional roles/accountability
  - Inter-ministerial coordinating body
  - Assignment of roles for monitoring and compliance enforcement
  - Authority to formulate, implement, evaluate and report on programs
  - Tracking on progress for EE targets

- **Information**
  - Database on energy consumption
  - Industrial and building stock
  - Information center/case study database
  - Database of service providers, EE technologies, equipment providers
  - Broad, sustained public awareness
  - Appliance labeling

- **Technical Capacity**
  - Energy auditor/manager training and certification programs
  - Private sector training programs (banks: E900x/EE service providers, end users)
  - EE project templates (audits, M&V plans, EPC bidding documents, contracts)
  - Energy management systems developed

- **Successful Energy Efficiency Programs**

- **Finance**
  - Commercial bank lending (credit lines, guarantees)
  - Cashflow-based EE financing
  - Commercial ESCO financing
  - Public sector EE financing
  - Residential home/appliance credit
  - Equipment leasing

**Source:** World Bank staff.

Uzbekistan has a number of strengths, especially in industrial EE, such as firm government policy support and requirements for the broad EE agenda as indicated in the Presidential Decree No. PP-2343, institutional leadership provided by the Ministry of Economy, available commercial bank financing in industrial EE, new initiatives to strengthen energy management capacity in large enterprises, and improving data and information gathering and analysis. However, Uzbekistan still lags in catalyzing sustainable financing for EE investment in public buildings. Many such investments will be economically cost-effective and could be fully or partially paid for by energy cost savings if domestic gas prices reach parity with export prices.

Various countries have implemented a range of financing and delivery mechanisms, either to enhance the financial leverage of public funds or to gain access to commercial funding for public sector EE projects. These are summarized in Figure 3.4, a spectrum or ladder of financing options ranging from all-grant (budget) investment requiring no obligations from beneficiaries, which is the current situation in Uzbekistan, to all commercial financing, oftentimes through ESCOs.
There is not necessarily a step-by-step order one country needs to go climbing up the ladder. Oftentimes multiple instruments could be used to address specific project financing constraints. Some projects may generate large energy cost savings that enable them to be financed entirely by commercial funds, while others may require grants to cover necessary capital improvements that do not generate sufficient energy cost savings to attract commercial financing or for repaying the full investment cost within a reasonable period of time (for example, buildings that are seriously under-heated or need structural improvements). A brief description of three of these options that are beyond all-grant financing and may be considered by Uzbekistan in the short to medium term is given in the following paragraphs. A comparison of all depicted options is summarized in Table 3.4.

**Budget capture.** Under this approach, financing is provided by a government agency, such as the MOF, using a combination of government budget allocations and IFI or donor funds. This funding covers the investment costs of the EE investments in public buildings or facilities of public agencies or local governments. The funding recipient ‘repays’ the funds using the savings generated by the investment project in the form of reduced budgets for energy bills of the beneficiaries in future years (Figure 3.5). The size of the reduced outlay is usually based on the amount of energy cost savings. The flow of funds to pay for EE improvements follows the same flow as the normal appropriations from the MOF. The repayment to the MOF could be complete or partial; the partial approach encourages benefiting public agencies to participate in the program because they retain a share of the savings achieved.

*Source: World Bank staff.*
EERF. Under a typical EERF, created using public funds and IFI loans, financing is provided to public agencies to cover the initial investment costs of EE projects; some of the resulting savings are then used to repay the EERF until the original investment is recovered, including interest and service charges. The repayments can then be used to finance additional projects, thereby allowing the capital to revolve and creating a sustainable financing mechanism. Because both the borrower and the lender are publicly owned, such funds may often offer lower-cost financing with longer repayment periods and less-stringent security requirements than typical commercial loans. This can help demonstrate the commercial viability of EE investments and provide credit histories for public agencies, paving the way for future commercial financing. The typical structure of an EERF is shown in figure 3.6.

Source: Authors.
The ESA approach illustrated in figure 3.6 is an innovative way to introduce simplified energy performance contracting in countries where the market for private ESPs is in its infancy and being developed. An ESA can be very effective for public agencies that lack the capacity to borrow funds or to effectively implement EE projects. An ESA can offer a full package of services to identify, finance, implement, and monitor EE projects. The public agency is usually required to pay some or all of its baseline energy bill into an EERF-established escrow account to cover the investment cost and associated fees during the contract period. One of the main advantages of Energy Services Window is that the ESA payments generally do not count as public debt, allowing public entities that are not allowed to borrow or municipalities that do not have sufficient debt capacity to implement EE measures. In this way, the model also helps public agencies use their limited budget or debt space for higher-priority investments while still being able to implement EE.

An actual application of the EERF scheme has been demonstrated in Armenia through a World Bank project (Box 3.1).

**Box 3.2 Armenia Renewable Resources and Energy Efficiency Fund (R2E2 Fund)**

The Fund was established in 2005 and capitalized with an US$8 million IDA credit. The Fund is overseen by a Board of Directors, which includes government, private sector and academia and
operates on a fully commercial basis.

The Fund currently implements a World Bank/GEF project that provides EE services in public sector facilities—such as municipal street lighting, schools, hospitals, and administration buildings (average size about US$100,000). It is expected to finance projects worth US$8.7 million between 2012 and 2015 and provide technical assistance for project preparation and capacity building.

The Fund provides loans to municipalities and public entities with revenue streams independent of the state budget, and energy service agreements (ESAs) to schools and other public facilities, which are not legally independent:

- Loans will be provided under an ESA, whereby the Fund will also provide additional services against a service fee (conduct a preliminary screening; carry out the procurement of design and works; oversee construction and commissioning; pay the contractors for services provided; and monitor the sub-projects). The loans will be treated as municipal debt, with fixed repayment obligations to be made within their budget provisions in future years. The amount of the repayments will be designed to allow fund clients to repay the investment costs and service fee from the accrued energy cost savings.

- Energy Service Agreements: The Fund will first determine the average baseline energy use, identify the general scope of a sub-project, develop bidding documents, conduct the procurement, finance the project, oversee construction and commissioning, and monitor the sub-project. The ESA will obligate the facility to pay the baseline energy costs (with adjustments for energy prices, usage, etc.) over the life of the agreement. In such cases, there is no loan or debt incurred by the client entity. With these payments, the Fund will pay the energy bills on the facility’s behalf and retain the balance to cover its investment cost and service fee of up to 10 years. The agreement will also be designed so that the duration can be adjusted if the Fund recovers its full investment earlier or later.

To support the build-up of an ESCO industry in Armenia, the Fund uses simplified ESCO contracts to shift some performance risks to private construction firms/contractors.


Public or super ESCO. Several countries have taken a more active role in promoting EE projects using the performance contracting approach by creating either public or ‘super’ ESCOs that are wholly or partly owned by the state. Often this was done to promote ESCOs in general. Such public ESCOs were typically formed when the local ESCO markets were nascent and some public effort was deemed necessary to catalyze them. The advantage of a public ESCO is that there is often no competitive process required for project development because a public agency is simply contracting with another public entity. The super ESCO is a special type of public ESCO. Established by the government, it functions as an ESCO for the public sector market (hospitals, schools, municipal utilities, government buildings, and other public facilities) while also supporting the capacity development and project development activities of existing private sector ESCOs. The government (possibly with help from IFIs) capitalizes the super ESCO with sufficient funds to undertake public sector EE projects and to leverage commercial financing. A super ESCO can be uniquely positioned to overcome a number of the barriers faced by smaller ESCO companies. With its size and credibility as a public institution, a super ESCO has the capacity both to support the growth of a nation’s private domestic ESCO business and to finance EE projects. Figure 3.7 illustrates the structure of a super ESCO.
Figure 3.7. Typical Structure of a Super ESCO

Source: Limaye 2013.
<table>
<thead>
<tr>
<th>Financing Option</th>
<th>Suitable Conditions</th>
<th>Pros</th>
<th>Cons</th>
<th>Examples</th>
</tr>
</thead>
</table>
| 1. MOF financing with budget capture: financing by the MOF using government budget allocations, IFI/donor funds, investment grant, or budget financing | • Credit barrier is too high; underdeveloped banking sector; collateralization is difficult  
• Financing should target new and underdeveloped markets; programs must be efficiently administered; initial subproject results should be intensely disseminated; need viable co-financing  
• Availability of funding for EE projects                                                                 | • Easy to implement                                                                                   | • Sustainability is questionable, even if repayment is obtained through budget financing      | • Hungary  
• Lithuania  
• Armenia, Belarus  
• Macedonia, FYR  
• Montenegro  
• Serbia                                                                 |
| 2. Direct lending by IFIs to municipal utilities                                   | • Large project size                                                                                   | • Higher probability of tariff reform to obtain cost-based tariffs  
• Collaborative project preparation and implementation  
• Long tenor concessional loan                                                                 | • Requires IFI appraisal of each investment  
• Unsuitable for small and medium utilities                                                                | • Krakow, Poland                                                                                   |
| 3. EERF                                                                          | • Insufficient liquidity in banking sector, major aversion to risk among lenders  
• Use of grant funds as subordinated debt can help mobilize commercial co-financing  
• TA to disseminate information on EE subproject performance or financial data critical to sustainability  
• Need for professional, well-incentivized fund management team                                           | • Can be structured to address financing needs and evolving capacity of municipalities               | • May require new legislation  
• May be difficult to cover administrative costs of the fund from its revenues                           | • Bulgaria  
• Romania  
• Armenia                                                                                       |
| 4. Risk-sharing program (partial credit guarantee) | • Well-developed banking sector; banks are liquid and willing to accept some risks  
• Sufficient market activity to develop project pipeline  
• Guarantees cannot solve systemic banking or credit problems | • Has worked well in some Central and Eastern European countries  
• May scale up commercial financing | • Needs a relatively mature banking sector and eligible borrowers  
• Poor experience of the World Bank and USAID in some countries  
• U.S. Agency for International Development (USAID) DCA in Macedonia, FYR, Bulgaria, and other countries  
• Bulgaria, Central/Eastern Europe, China, Croatia, Hungary, Poland |
|---|---|---|
| 5. Dedicated municipal EE credit line with commercial institution | • Well-developed banking sector, willingness of banks to accept risks and EE as line of business, sufficient market activity to develop project pipeline  
• Need for parallel TA to develop strong demand, create sustained quality pipeline | • Leveraging of private funds | • Needs municipalities or ESCOs that have borrowing capacity  
• Kreditanstalt für Wiederaufbau (KfW, a German government-owned development bank, based in Frankfurt) credit line in Serbia  
• Hungary  
• China, Turkey, Ukraine, Uzbekistan |
<table>
<thead>
<tr>
<th>6. Public ESCO or super ESCO</th>
<th>7. Commercial financing using private ESCOs/performance contracts</th>
</tr>
</thead>
</table>
| • No private sector ESCO industry, but interest or demand to develop ESCO industry
  • Contracting between public ESCO and public sector clients may be easier than with private sector service providers | • Supportive policies and enabling environment
  • Introduction of simpler business models first
  • Appropriate financing schemes
  • Early market development through public sector projects
  • Development of public-private partnership models to kick-start market |
| • Can address financing issues and build ESCO capacity | • Can address public sector EE implementation issues |
| • Need to create a new organization
  • Need to provide funding | • Needs a market with operating private ESCOs |
| • Ukraine public ESCO (European Bank for Reconstruction and Development)
  Croatia Hrvatska elektroprivreda d.d. ESCO (World Bank/GEF), Armenia, Uruguay, Energy Efficiency Services Limited (India) |

*Source: World Bank staff.*
3.4 Introducing a Revolving Funding Mechanism for Energy Efficiency Investments

The three options discussed in some detail in the previous section offer potential solutions to enable the government to capture at least a portion of the energy cost savings resulting from public investments and reinvest those cost savings in additional EE projects in public buildings. To determine which one merits further consideration by the government, their deployment implications are compared in table 3.5.

Table 3.5. Key Deployment Implications of Potential EE Funding Mechanisms

<table>
<thead>
<tr>
<th></th>
<th>MOF Financing with Budget Capture</th>
<th>EERF</th>
<th>Super ESCO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time scale to delivery</strong></td>
<td>Fastest among the three options - the MOF makes investment funds available through existing platform for implementing capital improvements but with additional arrangements for recovering a part of or full investment through reduced energy expenditure</td>
<td>Needs time if legislative action is required but could be deployed relatively fast (for example, 1–2 years) if it can be established under the current regulatory framework and using an existing platform</td>
<td>Needs time if legislative action is required but could be deployed relatively fast (for example, 1–2 years) if it can be established under the current regulatory framework and using an existing platform</td>
</tr>
<tr>
<td><strong>Implementation costs</strong></td>
<td>Likely the lowest among the three options because no additional organization setup is needed.</td>
<td>Additional cost of possible new organization</td>
<td>Additional cost of possible new organization</td>
</tr>
<tr>
<td><strong>Quality management</strong></td>
<td>Quality standards at discretion of different public entities unless the MOF sets public sector standards</td>
<td>EERF administrator establishes uniform operational guidelines with consistent implementation</td>
<td>Super ESCO establishes uniform operational guidelines with consistent implementation</td>
</tr>
<tr>
<td><strong>Long-term impact on sustainable EE financing for public sector</strong></td>
<td>Limited</td>
<td>Can be significant if the EERF strives to support private ESPs and contractors and to leverage commercial financing</td>
<td>Can be significant if the Super ESCO strives to support private ESPs and contractors</td>
</tr>
<tr>
<td><strong>Operational and financial risks</strong></td>
<td>Low if the MOF develops and maintains operational and budget controls</td>
<td>Medium: public entities must accept accountability for repayment, a new habit requiring testing</td>
<td>Medium: public entities must accept accountability for repayment, a new habit requiring testing</td>
</tr>
<tr>
<td><strong>Conclusions</strong></td>
<td>Attractive in the short term but undesirable if the MOF is unwilling to shoulder the administrative responsibility of recovering energy cost savings. It also lacks a clear mandate to develop long-term sustainable EE financing in the public sector</td>
<td>Takes longer to fully establish but could help open new avenues of financing and help catalyze the ESCO industry</td>
<td>Takes longer to fully establish but could help catalyze the ESCO industry</td>
</tr>
</tbody>
</table>
The key issue for the government is in deciding how much or how quickly it wants to develop the market for energy performance contracting in the public sector, including how prepared it is to reform energy prices to drive change in the medium term. If a gradual and adaptive process is desired, the government could start the process by implementing the scheme of MOF finance with budget capture. This will help create a basis for sustainable EE financing in the public sector, that is, enabling the separation and capturing of energy cost saving cash flow in public entities, as well as establish public procurement procedures for energy-saving services.

If the government wishes to drive substantial changes in EE financing and delivery in the public sector, it could begin work on the establishment of an EERF or super ESCO. This may incur higher risks but, if successful, could bring greater and faster progress in the development of sustainable EE financing in the public sector. A working model of a potential setup for these two options, which could coexist under one management structure, is the Renewable Resources and Energy Efficiency (R2E2) Fund of Armenia (box 3.2).

This study recommends the creation of an EERF within the current off-budget fund for reconstruction, repairs, and equipment, following the example of the R2E2 Fund in Armenia. The new EERF, with a committed capital over a 3–5-year period, could initially focus on a super-ESCO-like function by directly financing EE projects in educational and health care facilities through ESAs (one of the two financing products of the R2E2 Fund in Armenia). The specifics of how such an arrangement could be organized under the existing off-budget fund will need further study. The key steps for establishing an EERF are depicted in figure 3.8.

Figure 3.8. Key Steps in Establishing an EERF

4. Improving Compliance of Energy Efficiency Standards in New Buildings

4.1 Challenges in Delivering More Energy-Efficient New Buildings

**Box 4.1. Summary**

**Opportunities.** The main drivers for new building construction have been population and income growths. Since independence in 1991 the total area of housing in Uzbekistan has increased by 88 percent from 250 million m² in 1991 to 470 million m² by the end of 2014. The total floor area of nonresidential buildings stood at about 115 million m² by the end of 2014. The housing construction pattern in Uzbekistan has been moving away from multi-family dwellings, the share of which in the total housing floor area declined from 17 percent to 13 percent between 2000 and 2012. About 99 percent of the annual new housing construction in recent years has been single-family houses, mostly in rural areas.

Building EE standards were first introduced in 1997 and most recently updated in 2011. But compliance has not reached satisfactory levels. Actual enforcement of the standards is particularly problematic in the design and construction of single-family houses that dominate new housing construction.

**Barriers.** The three main challenges to compliance enforcement of building EE standards in new housing construction are (a) the underdeveloped supply chain and compliance system for more energy-efficient buildings; (c) the decentralized construction market due to the large share of rural housing; and (c) the weak incentive and the lack of critical and credible cost-benefit information for complying with building EE standards.

**Actions needed.** Effectively addressing these challenges requires (a) a more focused approach to strengthen the compliance enforcement process for single-family homes, which may require the development of a third-party compliance enforcement system relying on private sector professionals; (b) deliberate efforts by the government to support the capacity building in the construction supply chain, including training programs and development of testing and certification capacity for compliance; and (c) a nationwide communications and outreach program to ensure homeowners understand and identify the benefits of an energy-efficient home so they know clearly what financial benefits EE will deliver for them and at what costs.

To strengthen compliance enforcement, the following actions are recommended over the next two years (2016–17): (a) review and improve compliance enforcement process; (c) promote mandatory energy performance standards for mainstream building materials and components (for example, insulation materials, windows and exterior doors); and (c) coordinate activities among international donors for demonstration projects, as well as training and technical support.

The longer-term action should focus on sustainability and continued progress (2018–20): (a) establish a schedule for building EE standards revisions and a mechanism for facilitating stakeholder contributions; (b) engage manufacturers of energy-efficient products and technologies on market expansion; and (c) establish a data collection mechanism and analysis process to better inform policy making and adjustments.
New Building Construction Trends

In Uzbekistan the main driver for housing is population growth. Since independence in 1991, the population of the republic has grown 47 percent from 21 million to 30 million in 2015. Over the same period, the total area of housing has increased by 88 percent from 250 million m² of housing in 1991 to 470 million m² by the end of 2014. Per capita housing floor area during the same period has increased from 12.4 m² to 15.4 m² per person, a reflection of growing affluence.

The housing construction pattern in Uzbekistan has been moving away from multi-family dwellings, the share of which in the total housing floor area declined from 17 percent to 13 percent between 2000 and 2012. About 99 percent of annual new housing construction in recent years has been single-family houses, mostly in rural areas where 60 percent of the population lives. The current urban development policy tends to discourage development of denser and larger urban centers.

To serve the expansion of education and health care facilities is also significant. For example, medical polyclinics (including rural health centers) grew from 1,415 in 2009 to 10,140 in 2014. Construction of education facilities is also increasing with demand.

The main technical and economic factor in housing construction in Uzbekistan is earthquake resistance. Most of the country is in earthquake zones with potential earthquakes of 7 to 9 on the Richter scale. Seismic-resistant structural design and construction are a top priority.

As with most countries, housing and public facilities have been previously built without due regard to EE, even after deployment of construction standards to increase EE of buildings in 2011. The main focus in construction continues to concentrate on minimizing first costs and improving seismic resistance. Unsurprisingly, with low energy prices, ongoing heating expenses are not a significant factor when households consider investing in new housing.

The predominant structure of new multistory buildings has an earthquake-resistant structural frame of reinforced concrete columns and floor joists and with 38-cm-thick exterior brickwork in-fill walls. Internal walls and partitions are also made of brick, heavy or lightweight concrete blocks, gypsum boards or blocks, and so on. There is strong synergy required between the use of lightweight building materials to reduce potential earthquake damages and the use of building materials to increase thermal insulation. So far the synergy has not been adequately developed and harnessed.

Single-family houses, mostly in rural areas, are traditionally built of brick with exterior walls of 1.5 brick thickness without heat insulation. Rural housing projects need to increase their thermal insulation and EE in accordance with regulation KMK 2.01.04-97*/23/. Demonstration work started in 2014.

Regulatory Controls on Energy Efficiency in New Building Construction

Construction sector regulation is a component of the National Standardization System. Current construction regulatory documents include over 300 regulatory documents in 3 normative regulatory areas: KMK (construction norms and regulations), ShNK (urban
construction regulations), SN (construction norms). Each includes subsystems of regulatory documents.


KMK (construction norms and regulations) 2.01.04-97 was used to set standard values of thermal resistance of walling depending on three levels of thermal insulation of buildings. The owner of the building under design could select the level of thermal resistance depending on their financial condition. At that time, the regulations required only marginal levels of thermal insulation. The stringency of the regulation was increased in 2004 and 2011.

Table 4.1 compares the current ‘regulated minimum thermal resistance’ (R value) standards for ‘residential buildings’ in Uzbekistan, Germany, and Russia. It is cautioned that such comparison is only indicative of the required thermal insulation, which varies significantly depending on climate zones to maintain similar heat losses. In Uzbekistan new residential and private commercial buildings are mandated to meet level 1 thermal resistance. For government funded (that is, public) new buildings, compliance with level 2 thermal insulation is mandatory.

| Table 4.1. Comparison of Minimum R Value for External Wall Assembly |
| --- | --- | --- | --- |
| Country | Years | R\text{\textsuperscript{99}} at a Given Value of Outer Air |
| | | −15°C | −20°C |
| **1997 regulation** | First level | 0.67/0.54 | 0.77/0.62 |
| | Second level | 0.80/0.63 | 1.15/0.87 |
| | Third level | 1.60/1.50 | 1.90/1.70 |
| **2004 regulation** | First level | 0.75/0.62 | 0.86/0.71 |
| | Second level | 1.30/1.00 | 1.90/1.30 |
| | Third level | 2.40/2.10 | 2.80/2.40 |
| **2011 amendment** | First level | **0.94/0.75** | **0.94/0.90** |
| | Second level | 1.80/1.50 | 2.20/1.80 |
| | Third level | 2.60/2.20 | 3.00/2.60 |
| **Germany** | Before 1978 | 1.08 | 1.24 |
| | Before 1985 | 1.84 | 2.12 |
| | After 2006 | **3.80** | **4.46** |
| **Russia** | 1997–2000 | 1.2 | 1.6 |
| | Since 2003 | 2.1/1.8 | 2.8/2.4 |
| | Since 2012 | **2.1/1.8** | **2.8/2.4** |

*Source: Compiled by local experts based on respective countries’ regulation.*
Main Challenges to Compliance of Building Energy Efficiency Standards

The main challenges for compliance of building EE standards in Uzbekistan are threefold:

- **The construction market is highly decentralized with a large share of informal construction in rural areas.** In such a market, it is inherently more difficult to apply regulatory control on EE standards for buildings, compared with a more urban-centered construction market.

- **The supply chain for more energy-efficient buildings and the compliance infrastructure are underdeveloped.** Although EE standards for building were introduced in 1997, compliance enforcement still is patchy: more rigorous for multi-family buildings, large commercial buildings and public buildings, better implemented at the architectural design phase, but inconsistently implemented during construction. The supply chain and compliance infrastructure are particularly inadequate to deal with the single-family housing market.

- **Building owners are not well informed about and incentivized to comply with building EE standards.** This is a general issue with new residential buildings. As revealed in the surveys conducted in Tashkent and Samarkand by this study, household awareness of EE is low. Heating cost, while steadily increasing in recent years, does not register as a significant factor when households make investment decisions on new homes.

The current reliance on owners of new single-family houses to manage compliance warrants attention. Homeowners are indifferent to EE and its benefits, are not suitably skilled to assess compliance, and may not know when to engage professionals or enforce corrective actions for inadequate EE features in new homes.

A consistent challenge in most building code systems around the world is the reliance on local governments to enforce compliance. Typically local governments’ priorities are focused on necessary health and safety codes, and code requirements for attributes that do not directly threaten life and limb are often under-resourced. The general situation of compliance with the current building EE standards has not been systematically evaluated. Consistently assessing compliance performance and identifying corrective actions is an area deserving attention and efforts by the national government.

This study recognizes that significant energy pricing and financing issues exist and that changes to these are under development. The focus of the following sections is on solutions for increasing regulatory compliance of building EE standards based on lessons learned from international experiences.

4.2 Issues and Solutions in Implementation of Building Energy Efficiency Standards

Potential actions to address the three main challenges in the implementation of building EE standards are discussed in the following paragraphs.
Focus on the Compliance Process for Single-Family Houses

Improving compliance with the EE standards for residential buildings in Uzbekistan at two critical compliance checkpoints is a priority:

- Construction permitting
- Construction compliance certification on building completion and before the building is registered

The main issues are identified and potential solutions suggested in table 4.2.

<table>
<thead>
<tr>
<th>Identified Issues</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no evidence of an effective compliance management system and therefore no efficient control of conformance with the EE requirements of KMK and ShNK.</td>
<td>Review compliance levels and the processes that manage compliance. There may be a need to establish a coordinated national compliance management system.</td>
</tr>
<tr>
<td>Poor levels of compliance exist at both compliance checkpoints: design compliance at construction permitting and completion of construction.</td>
<td>The reason for these failures should be identified and addressed with corrective actions. Best practices in compliance management are based on the theory of responsive regulation.</td>
</tr>
<tr>
<td>Central policy, operational regulations, regional government, and especially the accountabilities for compliance do not seem to be adequately integrated.</td>
<td>The review process will also clarify roles for regional and local authorities, for example, empowering and providing regulatory compliance for local authorities.</td>
</tr>
<tr>
<td>There is a low awareness that the EE requirements exist, that they are mandatory requirements, and that compliance must be demonstrated. What is actually required to achieve compliance may be poorly understood.</td>
<td>A communications program to ensure all actors in the building process including clients are aware of code requirements and benefits.</td>
</tr>
<tr>
<td>It is not clear that the EE requirements are understood to be mandatory—there seems to be confusion between the mandatory minimum and recommend higher insulation levels in the code.</td>
<td>Rationalizing code requirements, using another policy to promote the voluntary guidance standards, and reinforcing a stronger and unequivocal minimum energy performance requirement should help resolve uncertainty.</td>
</tr>
</tbody>
</table>

International experiences indicate that the following components are important to develop a robust compliance program for building EE standards (Liu et al. 2010).

- Administration and enforcement structure. The agency, or the subgroup within an existing agency, responsible for overall administration and enforcement of the standards must be established with budget and staffing, even if ultimately enforcement most likely will take place within the structure of the department in charge of enforcing the general building codes. This agency will be responsible for the development and implementation of the remaining components.
Compliance process with development of compliance forms, checklists and procedures, user manuals or guidebooks, compliance tools and software, and administrative procedures for checking compliance and for documenting, recording, and publishing compliance results.

Training programs and capacity building for code officials, designers, architects and engineers, manufacturers, and suppliers.

Outreach and public information programs for the building industries and the general public.

Demonstration of building programs in the first phase of adopting a new standard. These often provide incremental funding for the additional costs of designing more energy-efficient buildings, installing more efficient equipment and materials, installing monitoring equipment, commissioning the buildings, and monitoring and evaluating the buildings during their operation.

Setting a firm date for enforcement (with as much lead time as necessary) and then sticking with it, so that developers, designers, contractors, manufacturers, and suppliers all know when the new rules will take effect so that they can compete fairly with each other.

Evaluation of energy savings and the effectiveness of the standards. For future revisions of the standards, evaluation of actual results and experiences is important. This can include formal surveys but should also be based on issues raised by designers and other involved parties.

At the heart of any successful compliance system is the widespread belief by actors that they will be penalized for noncompliance. This threat may be inferred or real, but it is this belief, along with a strong degree of self-interest in achieving the benefits that accrue from conformance, that motivates conformance with the law. This failure is central to the concern of compliance failures in Uzbekistan, and this is where action must be targeted. The following actions are recommended for the government:

- **Implement a review of compliance results and processes** to identify the degree of compliance and areas where compliance is failing.

- **Establish a regular compliance monitoring function** to survey compliance with the standards and identify points of failure, identify solutions, and implement them. This should include surveying the resourcing, availability, and skills of local building inspectors that are undertaking EE compliance checks.

- **Institute a communication strategy** targeting designers and builders to widely inform the mandatory code requirements for EE and the penalties for noncompliance.

- **Review and if required implement a compliance management and penalty system.** If a penalty system has not been included in the regulations, this should be developed quickly and made widely known. Include a structured system of penalties,
from refusing building registration until faults have been remedied escalating to
deregistering professionals who repeatedly ignore the codes requirements. Publish
both the rate of successful compliance and identified noncompliance to create
awareness that this aspect of building quality management is observed and taken
seriously.

Due to the nature of highly decentralized new housing construction in Uzbekistan and
current reliance on homeowners’ own due diligence to follow through with compliance of
building EE standards, the government may consider developing a compliance system that
relies on certified professionals (third party). The pros and cons of the three main types of
compliance enforcement system around the world are presented in table 4.3.

Table 4.3. Institutional Options for Enforcement of Building EE Standards

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Key features</td>
<td>Government department or agency wholly responsible</td>
<td>Private third party is certified by the government</td>
<td>Builder provides compliance statement to the owner or government</td>
</tr>
<tr>
<td>Support infrastructure needed</td>
<td>Government inspectors</td>
<td>Trained and certified third-party staff. Some training of public sector staff, if spot checking</td>
<td>Checking of compliance statements; perhaps, certification of builder</td>
</tr>
<tr>
<td>Cost to government</td>
<td>High, but may be recovered from builder</td>
<td>Moderate</td>
<td>Low. Moderate if builders are certified</td>
</tr>
<tr>
<td>Cost to owner or developer</td>
<td>Low, unless agency charges</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Information and infrastructure needs</td>
<td>Trained government assessors</td>
<td>Trained private assessors. Certification process</td>
<td>Knowledgeable builders and owners. Energy labels and certificates for buildings. Some trained public sector staff to check compliance</td>
</tr>
<tr>
<td>Noncompliance risk</td>
<td>Low, provided adequate funding</td>
<td>Low. Third party depends on certification for income (but also on satisfied builders)</td>
<td>High, unless owner places high value on EE. Moderate if self-certification to the government. Lower if builders are certified</td>
</tr>
<tr>
<td>Examples</td>
<td>United States: prevailing option</td>
<td>France, Mexico, China (with public oversight), some in the United Kingdom, some in the United States, pilot in Turkey</td>
<td>Germany (to owner)</td>
</tr>
</tbody>
</table>

Source: Liu et al. 2010.

Adopting a third-party compliance enforcement system will require significant efforts to
develop the capacity in the private sector. But it enables the government to leverage its
limited resources while also normalizing compliance checks within regular construction
supervision practice. China is a good example of the third-party compliance enforcement system. A case study of Ningbo City is presented in box 4.2.
Ningbo has developed a strict supervision system for overseeing third-party verification companies involved in building code implementation. While the Ningbo construction administration department is responsible for local oversight of code enforcement, the actual implementation and enforcement processes are carried out by third-party professionals and other building industry stakeholders. Code implementation begins after the developer is granted a land use permit. The developer then seeks bids from licensed architects and other certified third-party professionals, including construction, design verification, and construction supervision companies. In Ningbo, there are five drawing inspection companies and dozens of construction supervision companies (Shui et al. 2011). These third-party professionals have to successfully complete training courses and pass the national licensing exams to receive their licenses directly from the Ministry of Housing and Urban-Rural Development. Because the third-party professionals are hired directly by developers and may face conflicts of interest in code enforcement, cities such as Ningbo have provided strong deterrents against fraud and corruption in the form of heavy fines, liability, and suspension or revoking of licenses.

The code implementation process begins with the architects and the design verification company using an integrated design and code compliance software, such as PKPM-Energy, which dominates the market, to check for compliance while designing the building and includes trade-off options for meeting code requirements. After the project design has been finalized and verified by the drawing verification company to meet building energy code requirements, the next steps of the code implementation process and the division of responsibilities in the construction phase are illustrated in the figure below. In addition to hiring a construction supervision company to supervise and oversee code compliance during construction, construction companies in Ningbo must also develop a quality control system.

Ningbo has four testing labs, which are certified by the central government, and there are hundreds of certified testing labs across China. The quality control and testing stations, which are funded and authorized by the local government, are responsible for conducting both scheduled and random inspections. Staff conduct on-site inspections during major milestones in the construction process such as the pouring of the foundation and the completion of the main structure.

Source: BEE Best Practice Policies and Policy Packages Chapter 6 – Case Studies (China); Evans, Shui, Halverson, and Delgado 2010.
Develop Building Industry Supply Chain

While standards are central to effect EE improvements in new buildings, they are not effective without implementation support. Developing the capacity of local industry to deliver the technologies required for energy-efficient buildings not only enables compliance with building code EE objectives, but also develops local jobs and industry capability and spills over to improved sector capacity. The instruments available to the government include industry training, awareness, software tools, product and material testing, certification, and labeling, which can be applied across the entire industry value chain. In essence this section describes actions that ensure products and processes that are necessary to achieving code compliance are compliant before designers apply them and builders construct with them and before they are tested by the compliance checks.

Table 4.4. Key Issues in the Building Industry Supply Chain and Potential Solutions

<table>
<thead>
<tr>
<th>Identified Issues</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is not obvious that designers and builders can select products and design or building systems with confidence that will enable compliance with standards.</td>
<td>Undertake a supply line study to identify what is available, the awareness of better options, and the prospects for higher-efficiency products and materials. Identify product and material testing, certification, and labeling constraints and options.</td>
</tr>
<tr>
<td>Inadequate manufacturing capabilities for thermal insulation products. Both local and imported construction materials are high cost. Industrial organizations do not develop due to a lack of demand for thermal insulation materials. As a result, imported materials cost more and occasionally are unaffordable to common construction organizations.</td>
<td>Review and update, if required, all EE product and materials standards, and implement a targeted training program for suppliers and manufacturers. Undertake product testing and identify the parts of supply chains that require compliance or corrective actions. Corrective actions may include direct subsidy for improved product manufacturing and quality control.</td>
</tr>
<tr>
<td>Lack of skills and experience in designing and construction of energy-efficient buildings. The degree to which designers and builders understand the code requirements and their roles and accountabilities in enabling and implementing compliance may not be clear to all.</td>
<td>Develop industry training and awareness. Training in EE features for new and existing conventional buildings and passive and low-energy design and construction techniques for architects, designers, and builders.</td>
</tr>
<tr>
<td>While some designers use design aids that enable better performance, it is not clear that consistency in design capability and design tools exists or can provide the underlying design quality required for code compliance.</td>
<td>Enable the use of effective software tools, by promoting design tools that meet globally recognized performance standard and offering shortcuts to compliance for designers that use these tools.</td>
</tr>
<tr>
<td>The level of computational methods to evaluate technical and economic efficiency of the measures and payback of investments (on a short-, medium-, and long-term basis)</td>
<td>Ensure that both performance and prescriptive requirements in the code can be practically understood and easily implemented. The use of both calculation and schedule methods offers</td>
</tr>
</tbody>
</table>
into EE of buildings does not reach the level required by current regulations. This complicates the choice of economically rational level of thermal insulation and makes it difficult to decide on the application of thermal insulation improvement measures.

different players in the building industry a choice of options toward compliance whether they have access to computational tools or not. As part of this action, determine the practical quality requirements for different tools.

The following short-to-medium-term actions are recommended:

**Evaluate industry supply chains.** Survey the supply chains, both local manufacturers and importers of products available in the market, to give insight into gaps and capacity-building needs. Consult with all parts of the industry including consumer groups, and develop robust product profiles of key building technologies, working with suppliers to understand product supply dynamics.

**Produce an industry development strategy for the EE supply industry.** Identify and address opportunities to develop innovative EE building technologies and a more competitive and dynamic industry. Develop the capacity to develop local resources to produce new EE materials that also enable lower mass seismic-resistant buildings. Consult with industry.

**Develop testing and certification of building materials and components.** Institute an EE product testing regime to assure designers, builders, or clients that selected products will perform as intended and designers and builders can use products that they can be confident will meet code requirements when correctly installed. Establish a certification process to improve the supply chains that provide energy-efficient products and materials that enable compliance with government objectives and the building code.

**Support a nationwide training and communications program** for the following:

- Publicize the EE requirements and information tools (like certification schemes) so industry can be assured they are selecting good EE products (making it an easy choice for designers and builders).

- Train designers, in partnership with the architectural guilds, so they understand the compliance they must achieve and know how to ensure they can reliably achieve construction permits.

- Train builders and contractors, in partnership with building industry leaders, so that builders correctly install compliant products to ensure construction compliance on completion and before the building is registered.

**Increase Stakeholders’ Buy-in with Complementary Strategic Market Development Measures**

The building industry includes a diversity of actors. One of the challenges with EE in buildings is that it is not tangible or obvious to most of these actors. Each of these actors is driven by, and responds to, different motivations. Coordination between these various...
stakeholders is difficult, and aligning these different interests to produce buildings with desired EE attributes is very challenging. This disparity of interests is one of the main reasons why mandatory standards are a common policy option to ensure implementation of cost-effective EE measures by building owners, designers, and builders of buildings.

While there is recognition of the value of EE among technical professionals in Uzbekistan, and indeed a sense of an imperative for EE among those with experience in thermal and building sciences, other professions and especially consumers are focused elsewhere and maintain a high level of disinterest in EE. But the general lack of awareness and indifference to EE has been described a number of times as the largest barrier to EE in Uzbekistan.

There is a need to develop a nationwide communications and outreach program to ensure homeowners understand and identify with the benefits of an energy-efficient home so they know clearly what financial benefits EE will deliver for them and at what costs. This may start with the development and implementation of simple information tools for consumers (such as labeling and certification schemes).

4.3 A Road Map for Increasing Compliance of Building Energy Efficiency Standards

International best practices on building EE standards show the importance of a multifaceted approach. Policy alone will not result in energy-efficient buildings and requires appropriate technical guidance and resources to demonstrate how to achieve energy savings through compliance. When EE standards are available, they can often be ignored if policy and capacity do not exist to enforce them or if materials and expertise are not available to support implementation.

To achieve a sustained and coordinated effort for ensuring compliance of building EE standards in Uzbekistan, a clear plan or road map for the government is needed to ensure that key activities that will support long-term success take place. By focusing on key gaps, including coordination of activities and providing a strong policy framework for enforcement, the government is poised to be successful in reducing energy use in new buildings. This report recommends a focused approach that tackles a few key opportunities to leverage government resources. This simplified road map recommends a framework for both government and nongovernment activities to complement each other, achieve energy savings, and work toward transforming the building sector.

Near-Term Recommended Priorities (2016–17)

The following actions are recommended over the next two years:

(a) Review and improve compliance enforcement process

The current building design and construction process used in Uzbekistan has certain reviews and checkpoints that can be leveraged and enhanced to develop a strong mechanism for enforcing compliance with the energy code. The consistency and strength of the code enforcement process are a major driver for compliance in many countries, and enforcement
is typically most effective when integrated into an existing construction quality control framework.

Adherence to the EE standards will involve significant attention to building up a process of monitoring and verification, incentives, penalties, and technical support. Nonetheless, there are points of approval where checks on compliance could be easily inserted.

Models for compliance enforcement vary by country, and their success is dependent on a large number of factors. Projects are needed to pilot approaches to enforcement and should incorporate support to local construction departments in evaluating building designs according to the code before granting permits (including training staff or engaging qualified consultants), as well as investigating the viability of third-party compliance from private sector and from other agencies with resources and/or capacity. Independent inspections and verification of compliance can lift the burden off of local governments but require a substantial support network to keep the private sector in check. Other variations of enforcement models include focusing inspections on only several code measures in the beginning of an enforcement program and then expanding to include the entire code over time. Demonstration programs could focus on achieving strong implementation in just a few locations to start and then seek to share strategies and practices and inform roles for central and local governments and the private sector.

(b) Promote mandatory energy performance standards for building materials and equipment

Movement toward requiring key building components (for example, windows) and materials (for example, insulation) undergoes mandatory testing, and labeling for efficiency is needed to differentiate them from other products and will have a strong near- and long-term impact. By including mass-produced products commonly used in building construction, this action will serve to increase broad awareness of EE by making choices available to the public that can save them money and affect the environment. Similar programs, notably the U.S. ENERGY STAR, have been significant in increasing public awareness of EE.

A new focus on building materials and technologies will require performance testing and labeling so that developers seeking to follow the code in new construction or achieve EE outcomes in existing buildings can identify necessary products. The scope of such a program requires in-depth analysis and coordination with the private sector and government parties and is beyond the scope of this study. Nevertheless, leveraging donor support to develop testing and rating capabilities and a labeling program to convey EE characteristics in the market is recommended as a top priority to support strong code implementation over time. Such a program, once established, will also offer the opportunity to address additional aspects related to green building in the future, such as the energy and carbon associated with building materials through life-cycle assessments.

The government should support the development of a strategy for EE labeling of construction products and building equipment, with initial materials or products along with time lines identified for each, and continue their work on labeling appliances. This should work toward mandatory performance certification. In addition, broadening the current appliance standards program will achieve near-term energy savings while building code
implementation expands, while at the same time saving energy in the smaller buildings market. All technical standards for industry should be developed as appropriate for Uzbekistan, not just translations of other countries’ standards

(c) Coordinate activities among international donors for demonstration projects, as well as training and technical support

A significant source of resource support, international donors are very interested in addressing building efficiency and have been involved in supporting the revisions to the building EE standards in Uzbekistan. The government can continue to use information regarding the program activity of different stakeholder organizations and international donors to identify needs and gaps in activity. However, this information should be available to all those delivering services in the market. For example, there is a valuable opportunity for donors to avoid duplicating program efforts and developing complementary activities, even in the early planning stage. Open access to reports and materials developed by these programs through a website will be a productive first step and will also enable further investigation, and improvement, of them in the market.

As a near-term priority, donors should coordinate to significantly scale up efforts to support demonstration projects by engaging the private sector. While some are already planned, a much larger number is required to have an impact on public awareness, as well as to demonstrate processes for working through compliance and enforcement. The government could additionally launch and maintain a website that communicates about the ongoing and past projects delivered by all stakeholders, including the government, local organizations, international donors, and regional programs to facilitate information exchange.

Longer-Term Recommended Actions (2018–20)

After near-term activities focus on enforcement, deliver outreach on building EE standards, and move forward a series of donor-sponsored activities, longer-term planning should focus on sustainability and continued progress. The following are recommended activities to consider:

Establish a schedule for building EE standards revisions and a mechanism for facilitating stakeholder contributions. As experienced firsthand in Uzbekistan, it is important that EE requirements are dynamic and can be revised to reflect new understandings of effective EE strategies, changes in the market, and new needs for energy savings. A scheduled process, past the next 10 years, which involves stakeholder participation, will accomplish these goals as well as build strong support in the market through the participation of trade associations and others.

Engage manufacturers of energy-efficient products and technologies on market expansion. To continue to expand the market and increase efficiency in buildings, international companies that manufacture energy-efficient products should be engaged on supporting Uzbekistan in achieving these goals. A strong system for standards compliance will provide assurances that the market is a reliable investment for these companies. Uzbekistan should look at advantageous arrangements for importing quality products as well as developing these products within the country.
Establish a data collection mechanism and analysis process. For EE standards to continue to be seen as an effective strategy for contributing to building energy performance improvement, data are needed to assess the effectiveness of activities and the overall impact of the standards. Data availability will also enable building energy performance benchmarking, which is a strategy being followed in many countries. Data collection is a major undertaking that requires significant resources, and Uzbekistan should look to collect data from government buildings, from donor projects, and through energy audits, as a starting point.
5. Conclusions

The Presidential Decree No. PP-2343 provides an effective foundation and action plan for implementing solutions to EE barriers in Uzbekistan. It recognizes a need to motivate consumers, industry, and the government in all sectors and sets measurable targets for identified priority sectors. Importantly the plan recognizes that a multipronged approach is required: policy changes, improved finance access, industry development, and consumer awareness all need to play their roles to advance EE.

This study report outlined three priority areas that the government could deploy resources to for cost-effective interventions. They are as follows:

- Replacing inefficient non-standard gas boilers in households and small commercial businesses
- Supporting cost-effective EE renovation in public buildings through a revolving funding mechanism
- Improving compliance of EE codes in new single-family homes by focusing on a few critical areas of the compliance system

As annotated in table 5.1, these three priority opportunities are consistent with the policies and activities in the Presidential Decree No. PP-2343.

Table 5.1. Alignment Between Priority EE Interventions Identified by This Study and Key Actions in the Presidential Decree No. PP-2343

<table>
<thead>
<tr>
<th>Replacing inefficient gas boilers in residential and commercial buildings</th>
<th>Selected relevant clauses from Presidential Decree No. PP-2343</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Step-by-step replacement of nonstandard and ineffective boilers for space heating and hot water supply in individual houses with modern energy-efficient boilers including solar heating systems. Development and approval of a schedule to replace boilers currently used by the population with energy-efficient boilers between 2015 and 2019 throughout the country</td>
<td></td>
</tr>
<tr>
<td>15. Gradual introduction of renewable energy sources solar water heating systems and energy-efficient boilers for space heating, Preferably, locally produced starting in 2016 during construction of individual homes according to standard projects in rural areas</td>
<td></td>
</tr>
<tr>
<td>17. Scale-up domestic production of modern energy-saving equipment, devices, and materials with their ubiquitous introduction in all economic and social sector. Approval of organizational and technical measures and targeted programs</td>
<td></td>
</tr>
<tr>
<td>28. Attracting a credit line of the International Financial Institutions for funding projects within the private sector aimed at the introduction of renewable...</td>
<td></td>
</tr>
</tbody>
</table>
| Supporting cost-effective EE renovation in public buildings through a revolving funding mechanism | 30. Granting the right to state-funded organization to dispose at least 60 percent of their funds saved as a result of decreased costs on energy consumption to be channeled towards funding projects aimed at reducing energy intensity
| Improving compliance of EE codes in new single-family homes by focusing on a few critical measures | 3. The revision of city planning norms and rules to check for EE requirements and equipment with modern electronic meters of energy resources set up for buildings and facilities under construction.
Amendments to current city planning rules and regulations
31. Education and advanced training of experts, engineers, and builders in the following domains:
- EE of residential and office buildings
- EE in production processes in core economic sectors
- Energy audit of industrial enterprises
- Renewable energy sources |

Source: Republic of Uzbekistan 2015.

The benefits of implementing these short-to-medium-term priority interventions in the building sector are substantial. Replacement of homemade gas boilers alone is estimated to result in potentially US$360 million per year additional gas exporting revenue even at the current low point of export prices. Comprehensive EE retrofit of educational and health care facilities, which account for 80 percent of the floor area of public buildings, will on average cut 40 percent of more energy expenditures, enabling repayment of building renovation through energy cost savings and increasing public sector fiscal space in the long term. A robust compliance enforcement of EE standards for buildings will ensure substantial reduction of gas demand from new buildings.

These benefits can be realized sooner with deliberate government support efforts in adjusting domestic gas prices to reflect economic costs, enabling capturing and revolving energy cost saving cash flow in public buildings, broad-based information and outreach campaigns on EE, and development of a robust compliance infrastructure for EE standards in new buildings, especially in construction of single-family houses, and in leveraging private investments through financial incentives and facilitation of commercial financing.
Appendix A: Cost-effectiveness Analysis of Replacing Nonstandard Gas Boilers

Introduction

A cost-benefit analysis was undertaken to evaluate the cost-effectiveness of replacing inefficient homemade gas boilers with efficient imported gas boilers in residential and commercial buildings in Uzbekistan. Gas consumption in residential and commercial buildings is high in Uzbekistan primarily due to the lack of EE design in building envelope and wide use of energy-inefficient homemade gas boiler. According to findings of a recent survey of building stocks in the cities of Tashkent and Samarkand, in the residential sector, more than 90 percent of the surveyed homes were constructed without insulation and do not comply with the current EE standards; in the commercial sector, most of the surveyed buildings are relatively new; however, it is alarming to find that only 4 percent of surveyed commercial buildings have roof insulation. In both sectors, high shares of inefficient homemade boilers usage were observed.

Assumptions

To carry out the cost effectiveness analysis, two sets of assumptions were made: (a) building stocks and energy consumption of gas boilers based on the survey data and (b) gas price and exchange rate based on official data from the MOF and team estimates (see table A.1). The remaining part of this section describes several key assumptions in greater details.

Table A.1. Assumptions Made in the Cost-Benefit Analysis

| 1.1 Assumptions on building characteristics and energy consumption of boilers |
|---------------------------------|-------------------|-------------------|-------------------|-------------------|
| Total number of homes/buildings heated by gas* | Share of homemade gas boilers* (%) | Gas consumption using homemade boilers* (m³ gas/m² floor/year) | Gas consumption using high efficiency boilers* (m³ gas/m² floor/year) | average heated floor area per household* (m²) |
| Residential | 3162460 | 35% | 74 | 48 | 78 |
| Commercial | 109000 | 43% | 74 | 47 | 139 |

| 1.2 Assumptions on prices and exchange rate |
|---------------------------------|-------------------|-------------------|-------------------|-------------------|
| Domestic retail price*** (soms/m³) | Export price** (USD/1000 m³) | Exchange rate**** (soms/usd) | Installation cost of Residential high efficiency boiler** (UZS/unit) | Installation cost of Commercial high efficiency boiler** (UZS/unit) |
| Gas | 208.92 | 149 | 2750 | 2750000 | 4125000 |

Note: *Bank Survey Data; **Bank team estimate; ***Ministry of Economy, end-2015 price; ****Official exchange rate, end-2015 rate.

Total number of homes/buildings heated by gas is derived based on official data and expert estimates (see table A.2 for more details). Residential units heated with individual gas boilers are disaggregated into two categories: 3.12 million residential single-family buildings and 2,123 multistory buildings. Assuming each multistory building has 20 households on average, the total number of gas-heated residential homes reaches 3,162,460.⁵

⁵ 3,120,000+(2,123 * 20)
Table A.2. Breakdown of Building Stocks by Sector and Heating Method

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Number of Buildings</th>
<th>Number of Buildings with District Heating</th>
<th>Number of Buildings with Individual Gas Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential (one-story, detached)</td>
<td>3,923,145</td>
<td>194,692</td>
<td>3,120,000</td>
</tr>
<tr>
<td>Residential (multistory)</td>
<td>34,113</td>
<td>17,822</td>
<td>2,123</td>
</tr>
<tr>
<td>Commercial (shops, hotels, and so on)*</td>
<td>135,255</td>
<td>Share expected to be low</td>
<td>109,000</td>
</tr>
</tbody>
</table>

*Source: Based on official data and expert estimates.

Note: *The average size of commercial buildings is about 160 m².

Gas consumption using homemade boilers and high-efficiency imported boilers is derived based on the survey data (see table A.3). According to the survey findings, in the residential sector, 54 percent in the survey sample use domestically manufactured boilers, 35 percent use homemade boilers with an average efficiency of 50 percent, and only 11 percent use modern boilers with efficiencies of 92–94 percent; in the commercial sector, 50 percent in the survey sample use domestically manufactured boilers, 44 percent use homemade boilers, and only 7 percent use imported boilers. Additionally, it is assumed that for homemade gas boilers, 70 percent of monthly total gas consumption was used for space heating; for modern gas boilers, 65 percent of monthly total gas consumption was used for space heating.

Table A.3. Survey Results on Monthly Gas Consumption and Efficiency of Gas Boiler by Type

<table>
<thead>
<tr>
<th>Type of Boiler Used for Heating</th>
<th>Monthly Total Gas Consumption per m²</th>
<th>Efficiency (Estimation Based on the Survey Results)</th>
<th>Efficiency (Estimation Based on Experts Assessment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homemade</td>
<td>8.8</td>
<td>58%</td>
<td>50%</td>
</tr>
<tr>
<td>Domestically manufactured</td>
<td>7.4</td>
<td>81%</td>
<td>85–90%</td>
</tr>
<tr>
<td>Imported</td>
<td>6.2</td>
<td>100%</td>
<td>92–94%</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homemade</td>
<td>8.8</td>
<td>53%</td>
<td>50%</td>
</tr>
<tr>
<td>Domestically manufactured</td>
<td>7.2</td>
<td>80%</td>
<td>92–94%</td>
</tr>
<tr>
<td>Imported</td>
<td>6</td>
<td>100%</td>
<td>85–90%</td>
</tr>
</tbody>
</table>

*Source: World Bank survey data.

The low efficiency of homemade gas boilers is because its manufacturing does not follow accepted standards on the design and manufacture; for example, the quality of pipes, diameter of pipes, and flue configurations do not meet accepted standards. The controls are simple with unreliable operation.

Baseline Results

The potential net economic value of the switching from inefficient homemade gas boilers to high-efficiency imported ones is substantial, and such switching is cost-effective (see table A.4). The potential annual energy savings are estimated at 2,383 million m³ of natural..
gas. The resulted overall economic value is estimated at about Som 498 billion if valued at domestic retail gas price at the end of 2015 or about Som 977 billion if valued at export gas price by the end of 2015. The total investment cost for the switching is estimated around Som 3,237 billion. At domestic retail gas price, the investment could be paid back by gas cost savings in 6.5 years. At gas export price of end of 2015, the investment could be paid pack in 3.3 years.

Table A.4. Estimated Direct Costs and Benefits of Replacing Homemade Boilers, End of 2015

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Commercial</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed cost of high-efficiency gas boilers</td>
<td>Som 3,043 billion</td>
<td>Som 193 billion</td>
<td>Som 3,237 billion</td>
</tr>
<tr>
<td>Total value of gas savings at domestic retail gas price</td>
<td>Som 461 billion</td>
<td>Som 37 billion</td>
<td>Som 498 billion</td>
</tr>
<tr>
<td>Total value of gas savings at export gas price</td>
<td>Som 904 billion</td>
<td>Som 72 billion</td>
<td>Som 977 billion</td>
</tr>
<tr>
<td>Simple payback period at domestic retail gas price (end of 2015)</td>
<td>6.6 years</td>
<td>5.2 years</td>
<td>6.5 years</td>
</tr>
<tr>
<td>Simple payback period at export gas price (end of 2015)</td>
<td>3.4 years</td>
<td>2.7 years</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Source: Authors, based on survey data.

Sensitivity Analysis

Sensitivity analysis was also carried out to evaluate impacts of uncertainties in key variables to the baseline scenario results. Three sensitivity scenarios were designed to take into account uncertainties in the gas savings potential associated with the boiler switching and volatility in foreign exchange rate, which are described as follows:

- Scenario 1: Gas savings potential reduced by 20 percent
- Scenario 2: Foreign exchange rate increased by 30 percent
- Scenario 3: A combination of Scenario 1 and Scenario 2

Under Scenario 1, a 20 percent reduction in gas consumption savings would lead to a 20 percent decline in total economic value of gas savings valued at domestic retail gas price and export gas price. Given that total boiler replacement costs remain the same, the estimated payback periods will be increased by 25 percent valued at domestic retail gas price and export gas price.

Table A.5. Estimated Direct Costs and Benefits of Replacing Homemade Boilers, End of 2015

<table>
<thead>
<tr>
<th>Scenario 1: Gas Savings Potential Reduces by 20%</th>
<th>Residential</th>
<th>Commercial</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed cost of high-efficiency gas boilers</td>
<td>Som 3,043 billion</td>
<td>Som 193 billion</td>
<td>Som 3,237 billion</td>
</tr>
<tr>
<td>Total value of gas savings at domestic retail gas price</td>
<td>Som 369 billion</td>
<td>Som 30 billion</td>
<td>Som 398 billion</td>
</tr>
<tr>
<td>Total value of gas savings at export gas price</td>
<td>Som 723 billion</td>
<td>Som 58 billion</td>
<td>Som 781 billion</td>
</tr>
</tbody>
</table>
Under Scenario 2, a 30 percent rise in foreign exchange rate would lead to a 30 percent increase in total replacement cost and in the total value of gas savings at export gas price. Because the total value of gas savings at domestic retail gas price remains the same, the payback period valued at domestic gas price would be increased by 30 percent.

**Table A.6. Estimated Direct Costs and Benefits of Replacing Homemade Boilers, End of 2015**

<table>
<thead>
<tr>
<th>Scenario 2: Foreign Exchange Rate Increases by 30%</th>
<th>Residential</th>
<th>Commercial</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed cost of high-efficiency gas boilers</td>
<td>Som 3,957 billion</td>
<td>Som 251 billion</td>
<td>Som 4,208 billion</td>
</tr>
<tr>
<td>Total value of gas savings at domestic retail gas price</td>
<td>Som 461 billion</td>
<td>Som 37 billion</td>
<td>Som 498 billion</td>
</tr>
<tr>
<td>Total value of gas savings at export gas price</td>
<td>Som 1,175 billion</td>
<td>Som 94 billion</td>
<td>Som 1,269 billion</td>
</tr>
<tr>
<td>Simple payback period at domestic retail gas price (end of 2015)</td>
<td>8.6 years</td>
<td>6.8 years</td>
<td>8.5 years</td>
</tr>
<tr>
<td>Simple payback period at export gas price (end of 2015)</td>
<td>3.4 years</td>
<td>2.7 years</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Under Scenario 3, the worst case in which gas savings is reduced by 20 percent and foreign exchange rate is increased by 30 percent, the total investment costs for the switching would increase by 30 percent, cost savings valued at domestic retail price would decline by 20 percent, and cost savings valued at gas export price would increase by 4 percent (due to the increase in foreign exchange rate). As a result, the payback period would increase by 63 percent if valued at domestic gas retail price and increase only by 25 percent if valued at gas export price.

**Table A.7. Estimated Direct Costs and Benefits of Replacing Homemade Boilers, End of 2015**

<table>
<thead>
<tr>
<th>Scenario 3: Gas Savings Potential Reduces by 20%; Foreign Exchange Rate Increases by 30%</th>
<th>Residential</th>
<th>Commercial</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed cost of high-efficiency gas boilers</td>
<td>Som 3,957 billion</td>
<td>Som 251 billion</td>
<td>Som 4,208 billion</td>
</tr>
<tr>
<td>Total value of gas savings at domestic retail gas price</td>
<td>Som 369 billion</td>
<td>Som 30 billion</td>
<td>Som 398 billion</td>
</tr>
<tr>
<td>Total value of gas savings at export gas price</td>
<td>Som 940 billion</td>
<td>Som 75 billion</td>
<td>Som 1,016 billion</td>
</tr>
<tr>
<td>Simple payback period at domestic retail gas price (end of 2015)</td>
<td>10.7 years</td>
<td>8.5 years</td>
<td>10.6 years</td>
</tr>
<tr>
<td>Simple payback period at export gas price (end of 2015)</td>
<td>4.2 years</td>
<td>3.3 years</td>
<td>4.1 years</td>
</tr>
</tbody>
</table>
Appendix B: The Netherlands Experience in Improving Space Heating Efficiency

Summary

The Netherlands is among the best performing among European Union countries in space heating. It is a useful reference for what could be potentially achieved in Uzbekistan. The two countries are similar with regard to reliance on natural gas for heating and the number of heating degree days. However, the heating energy consumption per square meter of the Netherlands is only one-third that of Uzbekistan.

One important factor that contributes to low energy consumption in space heating in the Netherlands is the wide spread of highly efficient condensing boilers. In the 1960s, conventional non-condensing gas boilers with relatively low efficiencies of around 80 percent were widely used for space heating in the Netherlands (Weiss et al. 2009). Triggered by increasing energy prices after the first oil crisis in 1973 and by expectations in a growing replacement market for technically obsolete gas boilers, the first condensing gas boiler was successfully introduced into the Dutch boiler market in 1981. Initially, the sales remained low due to high consumer investment costs and falling natural gas prices. In response, the Dutch government provided subsidy to support installation of condensing boilers, which eventually started diffusing widely in the market from the 1990s onward.

At the same time as condensing boilers were introduced into the market, the Dutch government had a series of policies in parallel to improve building insulation. The first of these policies, the National Insulation Program (NIP) was introduced in 1978 and supported renovation of 1,803,000 homes. To promote building insulation, the government published a brochure for consumers, which explained the technical knowledge regarding the effectiveness and application of common insulation materials. Later on, in the 1990s, the government gradually introduced the Dutch Building Code, the Energy Performance Coefficient (EPC), the energy label, and an Energy Index, which regulate the minimal building thermal resistance and the maximum energy consumption of buildings and label the energy performance of new and existing buildings.

The social housing sector in the Netherlands represents 30 percent of all the housing stock. To overcome the split incentives issues between the landlords and tenants, the government allowed the Dutch social housing corporations to obtain upfront financing through guaranteed, long-term commercial bank loans with low (3 percent) interest rates. Landlords were also allowed to increase the rent if the energy label improved, so as to recuperate part of the investment costs for EE upgrades.

As such, the success of the Dutch space heating policy can be explained by a large diffusion of gas condensing boilers, continued updating of thermal regulations, the implementation of programs to speed up the retrofitting of the existing dwellings, and cost-reflective energy prices.
Popularizing Condensing Boilers

Before the 1970s, conventional gas boilers with relatively low efficiencies of around 80 percent were the standard technology for space heating in most Dutch homes. Condensing boilers with high efficiencies were introduced into the market in 1981. Initially, the sales remained low, but by 2006, condensing boilers accounted for over 90 percent of annual sales of all gas boilers and 68 percent of dwellings were equipped with condensing boilers. Throughout this period, subsidies had been used to support market uptake of condensing boilers, covering up to 40 percent of the investment and installation cost (Weiss et al. 2009). Government support for research and technology development as well as the outsourcing of component production to specialized companies allowed economies of scale to take place, thus reducing the production cost of condensing boilers to a large extent and decreasing the investment payback period to five years. It is estimated that €70 million equivalent were spent in direct support of installing condensing gas boilers.

In retrospect, the takeoff of condensing gas boilers in the 1990s was mainly due to three important factors. First, the continual introduction of a subsidy scheme throughout the periods of 1981–87, 1990–93, and 1994–02 made condensing boilers attractive for consumer investment. Second, technological developments in conventional non-condensing gas boiler manufacturing led to a switch from inexpensive open to more expensive closed boiler systems, making condensing gas boilers also attractive for the replacement market. Third, continuous cost decline in production, installation, and maintenance of condensing gas boilers allowed the prices to reduce (Weiss et al. 2009).

Enforcing Regulations on Building Insulations

Before 1978, less than 10 percent of the Dutch dwellings had insulation materials. In 1978, the NIP was put into place, aiming at insulating 2.5 million dwellings to save 1.6 billion m³ of natural gas per year. The NIP provided subsidies for insulating techniques and allowed dwellings without a central heating system to apply for the subsidy. In addition, social housing organizations were enabled to invest in insulation by offering them a special type of loan in cooperation with banks. This ambitious program has brought a broad scope of influence on consumers, industries, and institutions. Consumers became aware of energy saving techniques and subsidies. Industries flourished because of the high demand on insulation materials. Institutions were stimulated to execute the policy and research on energy saving techniques. By the end of the program in 1987, 1,803,000 subsidies with a value of €820.9 million were approved. The annual energy consumption of buildings was reduced by around 50 PJ, which equaled a cost reduction of almost €800 million.

More regulations were gradually put into place. In 1992, the Dutch Building Code was introduced to regulate the thermal resistance of new buildings. The EPC was introduced in 1995, which limited the total energy consumption of buildings according to the surface area. The EPC has been gradually reduced over the years to improve the energy quality of new buildings. Then, in 2008, the energy label ranking the energy performance of houses from A++ to G became compulsory when dwellings are sold.
Overcoming Split Incentive

The latest National Energy Saving Plan, put in place in January 2008, proposes to annually improve the energy performance of 200,000 to 300,000 buildings by the end of 2020. The rental sector aims at an average label B by the end of 2020, which indicates a reduction of natural gas consumption by 2.0 billion m$^3$.

Energy saving and sustainability are high on the agenda of the Dutch social housing organizations. Due to the large proportion of rental housing, a potential barrier to achieving these goals is the split incentive, where the landlord pays the efficiency measures but the benefits accrue to the tenants. To address this problem, the Dutch government passed a bill in 2011 to incorporate the energy performance of the dwelling in the criteria list of rent evaluations, which means that landlords can increase the rent if the energy label improved and thereby recuperate part of the investment costs for EE upgrades. In addition, a ‘total housing costs guarantee’ was imposed, which means that tenants must be assured an overall reduction in their total housing costs as a result of the intervention.
Appendix C: International Experiences on Financing Energy-Efficient Equipment Upgrade

Governments often rely on financial incentives to increase the EE investments. Access to finance is usually one of the key barriers to reaching optimal investment levels in efficiency, and financing efficiency improvements in households can be particularly costly given the smaller size of projects. Financial incentives take the form of tax credits or reductions, pricing measures, grants, and subsidies. They are commonly designed to work in combination with other types of incentives such as voluntary agreements and partnerships, capacity building, information, and regulatory measures.6

The following is a brief overview of the key types of financial incentives for residential EE, followed by examples of incentive-based schemes that could be instructive in designing a program to incentivize investments in more efficient water boilers in Uzbekistan. The examples include ongoing or recently closed programs from the United States and the United Kingdom. While none of these programs are fully applicable to conditions in Uzbekistan, and their scope extend beyond heating equipment, they have been selected to illustrate a range of incentive options from the very simple to highly complex schemes that require legal and regulatory changes as well as multiple layers of institutional management and oversight.

In practice, many of the incentive-based programs combine financial incentives with regulatory measures, capacity building, and information programs. Decades of experimenting shows that the combined programs tend to deliver better results. It is also quite common for programs to include different types of financial incentives. The more elaborate schemes in particular tend to incorporate elements of different types of programs, combining, for instance, facilitated financing and tax credits.

There are four basic types of incentives for financing residential EE improvements, as viewed from the customer’s perspective:

(a) Cash-back schemes
(b) Subsidized loans
(c) Facilitated financing for energy efficiency
(d) Energy company obligations

Cash-back Schemes: Tax Incentives, Grants, and Rebates

The most common cash-back schemes used to promote investments in residential EE improvements are tax incentives, grants, and rebates. Tax incentives and rebate programs are typically offered to end consumers, while grants are often used toward funding of EE programs.

Fiscal incentives can be used to promote investments in energy-efficient heating equipment in households. In the United States, tax credits, and tax deductions return some of the cash invested in EE improvements back to taxpayers who report qualifying purchases within regular tax reporting process. The difference between tax credits and tax deductions is the way the return is calculated; the tax credits reduce the tax amount by the amount of eligible investment while the tax deductions reduce the tax amount by a fixed percentage. Tax incentives are funded through forgone tax revenue. Funds are not recovered.

Although the purpose of residential energy-efficiency tax credits is to motivate additional EE investment, the amount of the investment resulting from these credits is unclear. Tax deductions and tax credits tend to be less effective in stimulating efficiency investments among taxpayers with limited tax liability.\(^7\)

**Grants** are less commonly used to incentivize residential EE improvements. Providing grants, or subsidies, as direct transfers to customers is not a common way to incentivize residential EE improvements. Nonrefundable payments tend to be reserved for development of technology, innovation, educational, and information programs.

However, large programs in both the United States and the United Kingdom are often funded through grants from the central government to lower level agencies or utilities where the programs are designed to fit local conditions (for example, the DoE Grant to Pennsylvania). In the United States, many state governments have their own grant programs such as Michigan Energy Efficiency Grants that are awarded to nonprofit organizations, governmental agencies, educational institutions, and/or businesses.\(^8\)

**Rebate programs** return cash to customers who make qualifying investments, typically highly efficient household equipment. The programs provide an opportunity for customers to receive a partial refund, either a set U.S. dollar amount or a percentage of the cost of qualifying purchase, usually a high-efficiency product with standard certification such as ENERGY STAR. They are voluntary and generally made available to all who provide a proof of purchase within a limited period, typically a few months. Similar to a discount, rebates are normally available to customers for a limited period, usually no longer than several months, and customers are expected to provide a proof of purchase of the qualified product with EE certification such as the ENERGY STAR label.

The programs can be financed with public funds raised through a charge to all electric utility customers. Utilities often include rebate schemes as part of their EE programs. Its appeal for the utilities is a simple program design, as well as an opportunity to meet their marketing objectives at a relatively low cost.

Relative to other incentive programs, rebates are rather simple to design and easy to administer. They help customers bear the costs of EE improvements, while helping utilities implement their EE programs and to meet their marketing objectives at a low cost. There are no special requirements for customers beyond application for rebate (for example, no energy assessments/audits required, and no lien on the property). They are available to everyone, and can potentially reach large numbers.

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7 CRS (Residential Energy Tax Credits: Overview and Analysis).
8 [https://www.michigan.gov/documents/LIEE_RFP_2_77809_7.pdf](https://www.michigan.gov/documents/LIEE_RFP_2_77809_7.pdf)
Perhaps, the greatest weakness of the rebate programs is low consumer interest. Customers must cover the full cost of EE investment up front, limiting the pool of potential beneficiaries. Rebate programs therefore tend to be less effective at promoting EE investments among low- and middle-income customers. Given that the programs benefit those who can afford to pay the full cost up front, it is difficult to show their additionality. Political opposition to ‘public goods surcharge’ is not uncommon, and it can make funding less stable and reliable.

**Example: GasNetworks Home Heating System Rebate**

GasNetworks, a collaborative representing natural gas companies in Massachusetts with an objective to promote EE and use of high-efficiency gas technologies in New England, runs a 2016 cash-back program on behalf of its members. Residential customers of one of the represented utilities can apply for home heating system rebates upon purchase of eligible high-efficiency equipment and its installation by a licensed heating contractor or plumber.

The eligibility criteria places minimum requirement for participation in the rebate. Anyone listed as a Massachusetts customer of one of the five participating natural gas utilities—Blackstone Gas, Columbia Gas of Massachusetts, Eversource, Liberty Utilities, and National Grid—can apply for the refund.

The program guidelines define the process for claiming the refund, qualifying equipment and installation-related requirements. To qualify for the rebate, the products must have the prescribed annual fuel utilization efficiency (AFUE) rating, set to ensure compliance with the highest EE standards, while the installations must be performed by a licensed contractor and adhere to applicable codes. The essential rebate information about GasNetworks home heating system rebate is summarized in table C.1.

**Table C.1. Rebate Information about Gas Networks Home Heating Systems**

<table>
<thead>
<tr>
<th>New Equipment</th>
<th>AFUE Rating</th>
<th>Rebate (Up To)</th>
<th>(in US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace (equipped with an electronically commutated motor)</td>
<td>97% or greater</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Furnace (equipped with an electronically commutated motor)</td>
<td>95% or greater</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Boiler (forced hot water system)</td>
<td>95% or greater</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>Boiler (forced hot water system)</td>
<td>90% or greater</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Condensing boiler with on-demand DHW</td>
<td>95% or greater</td>
<td>1,600</td>
<td></td>
</tr>
<tr>
<td>Condensing boiler with on-demand DHW</td>
<td>90% or greater</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>Heat recovery ventilator</td>
<td>n.a.</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>After-market boiler reset controls*</td>
<td>n.a.</td>
<td>225</td>
<td></td>
</tr>
</tbody>
</table>

*Add-on unit attached to a natural gas forced hot water boiler.

The rebate applies to both the cost of equipment and its installation. The amount of rebate credit may not exceed the cost of equipment, fifty percent of the total cost of equipment and the installation, or US$100,000 amount per project.
The rebate applications are screened for adherence to the guidelines and are approved within two months from receipt of the application. GasNetworks may perform random house inspections to verify that the purchased equipment has been installed according to the guidelines at the customer premises at the address listed with the utility and that the equipment is operational. If the house is selected for an on-site verification, the company agents will conduct the visit before honoring the rebate. The terms and conditions of the rebate place no restrictions or obligations for the customer once the rebate is redeemed.

**Subsidized Loans**

Relying on commercial lending to finance residential EE improvements, such as HVAC systems, can be expensive. Access to low-cost financing options is essential to accelerate the uptake of efficient equipment and enable residential efficiency improvements.

Low-interest or interest-free credit lines for investments in EE home improvements are sometimes funded by subsidies. Government capital subsidies are channeled to end borrowers through one nodal agency, which is responsible for program administration and monitoring, and a number of primary lending institutions. Capital subsidy can also be passed on to consumers using interest rate buy-down.

Primary lending institutions are sometimes commercial banks, but the program is often implemented by the electric utilities as part of mandated EE initiatives or low-income support programs (in the United States, these are usually state-level programs). Utilities can also offer low- or zero-interest loans to help customers finance energy-efficient equipment as part of their demand-side management strategy. For instance, Georgia’s Electric Membership Corporations offers loans to promote efficient electric water heating and heat pumps.

The source of funding is frequently a dedicated Public Benefit Fund that is supported by a charge to all electric utility customers (that is, system benefits charge). Rather than offering direct subsidies to the customers, the funding is leveraged by making private sector lending more attractive, through partial subsidies for commercial EE financing schemes.

These subsidized loans are typically made available to qualifying homeowners, building owners, or managers, for purchasing of specified energy-efficient equipment. The financing terms vary, but most programs offer loans up to 10 years or less with interest rates ranging between 0 and 8 percent. Loans tend to be small, on average below US$10,000, and a qualifying assessment and loan application fees is usually required. The loans program is often combined with sharing information and increasing awareness on the benefits of EE.

These subsidized loans are generally low-risk investments with low default rates. The subsidy schemes have a potential to attract more capital so the loan programs tend to have large-scale potential. The main disadvantage of the subsidized loan is reliance on subsidy that creates market distortions, while interest-rate buy-down can be very expensive. In addition, political opposition to ‘public goods surcharge’ can become an issue for funding. With regard to the program design, a common issue is that loans are normally available only to property owners. Excluding the tenants may, depending on a market, leave out a
potentially large segment of the market for energy-efficient equipment that would respond positively to financial incentive.

**Example: Sacramento Municipal Utility District Residential Loan Program**

Sacramento Municipal Utility District (SMUD) is a publicly owned utility that runs a variety of EE programs since 1976. Its residential loan program is one of the most successful utility-run programs providing finance for replacement of old, inefficient equipment. With 84,000 loans closed between 1990 and 2011, about 16 percent of SMUD residential customers benefited from the program, which shows a very high participation rate for a utility finance program.

SMUD customers can apply for secured or unsecured loans up to US$30,000 for purchases of qualifying central HVAC and water heating equipment, and some envelope improvements, including windows, attic, and wall insulations. Replacing old HVAC equipment with more efficient, new models—certified by ENERGY STAR or Consortium for Energy Efficiency—in most cases qualifies for a secured loan, with loan terms of maximum 15 years, 10 years on average, and annual percentage rate (APR) 8.75 percent fixed interest rate. Average loan amount for both secured and unsecured loans is US$9,100.

The most important eligibility criteria are that customers own the property where installations are to be made, their creditworthiness, as established by a good payment history with SMUD, and an independent credit report. Customers applying for unsecured loans are required to provide additional proof of income but the loans are income-based only insofar as the program aims to limit the risk of nonpayment. Applicants’ debt-to-income ratio must not exceed 0.4.

The process begins with a home energy audit performed by a SMUD-approved, licensed contractor. Customers must obtain the loan approval from SMUD before purchasing the equipment, and once the loan is issued, the new equipment must be installed by a SMUD-approved, licensed contractor within 60 days. The contractors guide the customers through the application process and, in most cases, also obtain all necessary permits on behalf of the customer, and perform the post-project energy assessment.

Loan payments are billed monthly but are separate from the electricity bill. SMUD discourages entering new agreements that affect the loan team such as home refinancing or additional borrowing before the loan is repaid, and any modification of loan terms will always result in higher monthly payments.

The loans are financed by the utility using funds from public goods charge, a legally mandated surcharge collected from all customers to support utility investments in EE and conservation programs, among other objectives. The administrative costs of the program are covered by fees.

Relative to commercial financing, the terms of SMUD financing are attractive but they are also typical for EE loans offered by utilities in the United States so the terms alone cannot explain the unusually high customer participation rate. The American Council for an Energy Efficient Economy analysis of EE financing programs attributes the success of SMUD loans to
the exceptional promotion of the available financing options through customer-friendly home evaluations and assistance with the application process.

**Facilitated Financing for Energy Efficiency**

For the current purpose, facilitated financing denotes commercial lending for residential EE investments with attractive finance terms made possible by credit enhancements that do not involve a subsidy. Governments and IFIs use credit enhancements to lower the risk of loss for the private lenders and investors and enable them to offer better terms to borrowers.

Providing loan loss reserve, usually as partial risk coverage, is the most common approach to encourage private investors for lower interest rates, longer-term, or less-stringent underwriting criteria. Interest rate buy-downs are another form of credit enhancements that are used to promote residential EE investments, but given the element of subsidy, that type of support is treated here as a subsidized loan.

In the United States, state and local governments often provide the loss reserve, and state energy departments are usually institutions responsible for the program (for example, Pennsylvania Department of Environmental Protection). Typical loan terms are up to 10 years, fixed rates, and APR of 5–7 percent.

The scheme usually involves a specialty energy lender (for example, AFC First) that manages the program, administers lending, and oversees contractors. Lenders use established EE certification (for example, ENERGY STAR) to offer loans, secured or not, at longer term and lower rates than otherwise commercially available for purchases and installation of efficient technologies. A pool of approved contractors implement measures funded through the program.

From the perspective of the end borrower, the incentive in the forms of attractive finance terms is the same as the incentive created by subsidized loans. The incentives provided by the two financing mechanisms also rely on government support. Facilitated financing schemes are often funded with public investment capital (for example, Pennsylvania Treasury) in addition to credit enhancement. However, unlike subsidized loan schemes, for facilitated financing public funds are invested for an acceptable return on investment.

A key advantage of facilitated financing is the large-scale potential. The investments are low risks, and returns can be reinvested, which makes the program more sustainable over the longer period and increases the potential for scaling up. Another important advantage of facilitated financing is that loans can be tailored to the needs of both reactive and proactive consumers. For instance, lenders can offer unsecured loans without energy audit to finance reactive, time-sensitive EE investments such as boiler replacement; and they can extend loans on more favorable terms for proactive EE improvements based on energy audit recommendations. Eligibility criteria can also be used to target income groups (for example, household income below US$150,000).
Even though facilitated financing aims to improve availability of financing for income classes, the commercial lenders still tend to focus on the creditworthy middle-income borrower. In spite of the credit enhancements that could relax lending criteria, a large market segment is left out when credit ratings are used as qualifying criteria. Also, the effectiveness of the incentive for customers who make additional investments in EE rather than responding to a need appears to be limited. The majority of loans are extended to clients who are interested only in reactive EE investments. Finally, most programs limit the credit to homeowners, leaving out tenants who are in some areas, a significant market segment.

Example: Residential Property-Assessed Clean Energy Financing

The Office of Energy and Sustainable Development of the City of Berkley runs a Property-Assessed Clean Energy (PACE) financing program to allow property owners to borrow money with low interest to pay for renewable energy systems, EE improvements, water conservation, and/or seismic retrofits and spread the cost of the upgrade over a period of time. The PACE program is an innovative financing solution that helps property owners overcome the barrier of high up-front costs. Property owners voluntarily choose to participate in a PACE program and repay their improvement costs over a set time period—typically 10 to 20 years—through property assessments, which are secured by the property itself and paid as an addition to the owners' property tax bills. In the event of sale, the assessment stays with the property and the loan repayment obligation is automatically passed onto the new owner.

The program is backed by the state and local governments with a debt reserve fund and motivated by development objectives such as environment protection and job creation. This model has many advantages for the borrower and the investor. The automatic transfer of loan obligation from one owner to the next keeps transaction costs low; tying the loan to the property rather than the property owners, enabling lenders to offer favorable terms irrespective of the homeowner’s credit history; and most importantly, the overall low risks for investors allow for long tenor and low interest rates for the borrowers.

To apply for PACE financing is easy. The process begins with the customer submitting the project proposals to a PACE provider. Once the application is approved, the customer selects a product and contractor certified by the PACE provider to install the product. Upon project completion, satisfaction to the customer, and assessment of compliance with local building requirements, the contractor will be paid. The customer then repays it on the property taxes over the course of up to 30 years, depending on the specific PACE provider.

The customers can apply for up to 15 percent of the property value, but PACE providers may set a maximum amount. The combined amount to be financed under the program as well as the mortgage-related debt must not exceed 100 percent of the value of the property. The interest rate varies from 6.75 percent to 8.39 percent, depending on the years for repayment.

The eligibility criteria varies for different programs, but generally they are based on (a) the property’s estimated market value; (b) the amount of the property owner’s equity in the property; (c) the property owner’s recent mortgage and property tax payment history; and
(d) the U.S. dollar value of the proposed renewable energy and energy- and water-saving improvements. Qualifying is not based on personal credit scores.

Residential PACE programs have significant positive economic and fiscal impacts. An econometric study conducted by ECONorthwest\(^9\) found that US$4 million in PACE funding generates US$10 million in gross revenue, US$1 million in combined federal, state, and local tax revenue, and 60 jobs. So far, 97,000 homes have been upgraded with US$2,065 million of total residential PACE financing, and 17,500 jobs have been created. Among the homes being upgraded, EE projects account for 67 percent, renewable energy projects 19 percent, and mixed projects 14 percent.

PACE financing is, however, not without its weaknesses. Setting up a PACE program is a long and costly process with many administrative hurdles. It requires introduction of special legal provisions concerning home ownership and property tax and creation of clean energy assessment districts and debt-service reserve funds. Adding to this is resistance from mortgage lenders who stand to lose their priority in the event of bankruptcy because PACE investments have a senior lien position over existing mortgages. The slow turnaround of PACE financing also makes it less suitable for smaller projects, and borrowers may still prefer to make a series of smaller investments over creating a long-term obligation on the property.

**Energy Company Obligation**

Energy efficiency obligations (EEOs), also known as energy savings obligations, supplier obligations, EE resource standards, and so on can be an effective tool in achieving energy and carbon savings, particularly in the domestic sector. Used as a regulatory mechanism, EEOs are usually dictated by long-term annual energy savings targets set by a central authority (that is, the government).

The ECO program in the United Kingdom is to date the EEO for residential energy efficacy. ECO creates a legal obligation for energy suppliers to achieve energy and carbon savings by subsidizing residential EE improvements in eligible households. Property assessments and installations are carried out by authorized agents while the government sets targets and monitors costs and results. The utilities have a strong incentive to comply, as failure to meet the fixed annual targets results in severe penalties.

Financing and cost recovery arrangements are left at the energy company’s discretion, but typically costs are passed on to consumers. To ensure that the program does not harm the businesses, utilities are allowed to pass the cost of the program onto the customers as tariff increases, provided that price hikes do not result in higher gas bills for the participating customers. The costs for the companies are monitored by the government and the on-bill financing significantly lowers the risk of nonpayment.

While the compliance of energy suppliers is achieved though negative incentive, the elimination of up-front costs makes this program highly attractive to the customers. A great appeal of the program from the policy perspective is that it achieves EE gains in hard-to-

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treat properties and among vulnerable consumer groups and market segments that are unattractive to commercial EE schemes.

One of the drawbacks of this overwhelmingly successful scheme is that it results in tariff increases for energy company customers who do not benefit from the program. However, spreading the cost across utility customers has led to small bill increases, which explains why ECO remained largely popular despite the tariff increases. A more important disadvantage of the scheme is its complexity: As the example illustrated, the ECO program entails complex administration, implementation, and oversight arrangements.

In practice, the ECO subsidies function much like a low-interest loan program with on-bill financing, especially a residential PACE program. Besides different incentives and targeting, there are nonetheless a few important distinctions between the two programs: ECO, unlike PACE, is fully funded by energy companies: companies decide how to recover the costs of installing ECO measures and they have a right to spread the cost across their customer base. Moreover, the ECO scheme is established to finance unattractive measures that are not suitable for the traditional EE financing.

**Example: ECO Financing, the United Kingdom**

The ECO program is the principal instrument in the United Kingdom for alleviating fuel poverty and increasing EE in properties where improvements are most needed. It is an example of the EEOs; legal obligations on energy suppliers to save energy. The ECO scheme supports economically but financially unattractive measures that are not suitable for the Green Deal commercial scheme because the expected energy cost savings are not large enough to repay the investment costs.

The ECO program applies to energy companies that serve at least 250,000 domestic customers, and provide at least 400 GWh of electricity or 2,000 GWh of gas. The first ECO program, referred to as ECO1, ran from January 2013 until March 2015 when it was succeeded by ECO2 (April 1, 2015–March 31, 2017).

There are three obligations under the ECO scheme, each with individual objectives, targets, and different eligibility criteria. The home heating cost reduction obligation is designed to increase affordability of home heating for low-income households. The carbon emissions reduction obligation is primarily aimed at properties with a hard-to-treat solid wall or cavity insulation and connections to district heating systems. The carbon saving community obligation focuses on thermal insulation measures and connections to district heating systems in the communities that are most in need of EE improvements, with quotas for rural and deprived communities.

The ECO delivery process consists of six key steps that transform regulatory obligations into actual investments in energy savings:

- The secretary of state, Department of Energy and Climate Change (DCEE), sets the countrywide number of ECO points for each obligation and monitors the delivery of the measures and the cost to the energy companies, through reports of scheme administrator reporting and the brokerage market.
• The Office of Gas and Electricity Markets (OFGEM) administers ECO on behalf of the DCEE. The OFGEM distributes the points among the obligated energy suppliers based on each supplier's share of the gas and electricity supply market.

• ECO suppliers deliver EE measures to households. They decide how to meet their obligation. They can purchase ECO points through a brokerage platform, or they can subcontract or use their own ECO installers to carry out EE measures. British Gas, for instance, delivered measures through their own subsidiary firms that were set up specifically for carrying out insulations and other ECO measures. Suppliers also choose what homes to treat, which qualifying measures to carry out, and how much subsidy they provide to each heating or insulation measure.

• Suppliers calculate and notify the OFGEM of achieved ECO savings. Suppliers are required to conduct technical and score monitoring inspections of measures to ensure that the required standards of installation are met and measures are accurately scored. Carbon and cost savings are calculated using appropriate approved methodologies.

• The OFGEM processes the reported savings and approves ECO points that suppliers earned toward their obligation. Together with the OFGEM, the brokerage platform provides transparent information to the government on progress and the costs of delivering measures in the wider marketplace.

• The OFGEM notifies the secretary of state that a supplier has met its obligation.

The ECO scheme is fully funded by energy suppliers up front. However, the energy companies are expected to recover the costs of measures by passing them onto all domestic consumers through levies on household energy bills. The government closely monitors costs to suppliers. The ECO scheme was estimated to cost energy companies around £1.3 billion per year on average to deliver. The actual total cost of delivering ECO1 as reported by suppliers up to March 2014, is at about £1.546 billion.

Between January 2013 and March 2014, the ECO scheme benefited around 648,000 households, surpassing by far other programs for energy-saving home improvements in the United Kingdom (that is, Cash-Back and Green Deal measures). It is overall a popular program, in part because it did not significantly increase the energy bills. Customers felt only modest bill increases as they were already accustomed to paying the costs of earlier schemes that were also passed through electricity and gas bills. Still, the lower consumption dampens the effect of increases attributed to ECO financing, and the average bills are expected to fall over time.
Bibliography


