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KEEPING WARM:

Urban Heating Options in the Kyrgyz Republic

Summary Report

March 2015

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List of Abbreviations

BTE	BishkekTeploEnergo
BTS	Bishkekteploset
CAPEX	Capital expenditures
CEEF	Commercializing EE Finance Program
CEF	Cost efficiency factor
CG	Credit guarantee
CHP	Combined heat and power
CSI	Clean Stove Initiative
DH	District heating
ECA	Europe and Central Asia
EE	Energy efficiency
EEO	Energy efficiency obligation
EPP	Electric Power Plants
ESCO	Energy service company
Gcal	Gigacalorie
GDP	Gross domestic product
HOA	Homeowner association
HOB	Heat only boiler
IFC	International Finance Corporation
IFI	International financial institution
JSC	Joint stock company
kWh	Kilowatt hour
KZhK	Kyrgyzhilkommunsoyuz
LCHS	Levelized cost of heat supply
m	Meter
MBPF	Monthly Benefit for Poor Families
MOF	Ministry of Finance
mtoe	Million tonnes of oil equivalent
MTTP	Medium term tariff policy
MW	Megawatt
MWel	Megawatt electric
MWth	Megawatt thermal
OJSC	Open joint stock company
OPEX	Operating expenditures
PIU	Project implementation unit
PVC	Polyvinyl chloride
SUE	State Unitary Enterprise
TPP	Thermal power plant
UNECE	United Nations Economic Commission for Europe
US$	Dollars American
VAT	Value added tax
VSD	Variable speed drive
yr	Year

Acknowledgements

This report draws on the findings and results of a technical assessment conducted by Fichtner – Engineering and Consulting, and has been prepared by Ani Balabanyan (Task Team Leader), Kathrin Hofer (co-Task Team Leader), and Joshua Finn and Denzel Hankinson (both DH Infrastructure). Overall guidance was provided by Ranjit Lamech and the Country Management Unit in the Kyrgyz Republic.

The team would like to thank the peer reviewers, Peter Johansen and Gevorg Sargsyan, for their valuable suggestions and comments. The report also benefitted from analytical input, editing and contributions provided by Chris Parcels and Jessica Merrill (all DH Infrastructure), and the expertise and contributions provided by Zamir Chargynov, Pekka Salminen, Marat Iskakov, Herkko Lehdonvirta, Sunil Koshla, Gailius Draugelis, Heather Worley, Aibek Baibagysh Uulu, Dinara Akmatbekova, Sascha Djumena and Dung Kim Le (all World Bank).

The team would like to express its gratitude for the cooperation extended by the representatives of the Working Group established by the Ministry of Energy and Industry for the purpose of this assessment. In particular, information and data provided by heating and electricity companies, the Ministry of Energy and Industry, the Regulatory Agency for the Fuel and Energy Complex, the National Statistics Committee, the municipality of Bishkek and the municipality of Tokmok were critical to conduct the analysis. The report also benefitted from feedback and guidance provided during the Heating Roundtables conducted in February 2015 with the participation of government officials, representatives of civil society organizations and other development partners.

The financial and technical support by the Energy Sector Management Assistance Program (ESMAP) and the Central Asia Energy Water Development Program (CAEWDP) are gratefully acknowledged. ESMAP – a global knowledge and technical assistance program administered by the World Bank – assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, Finland, France, Germany, Iceland, Lithuania, the Netherlands, Norway, Sweden, the United Kingdom, and the World Bank Group. CAEWDP – a knowledge and technical assistance trust fund program administered by the World Bank to catalyze a renewed long-term effort to build energy and water security for the Central Asia region through enhanced cooperation; by establishing sound energy-water diagnostics and analytical tools, strengthening regional institutions, and identifying high priority infrastructure investments. CAEWDP is governed by a Donor Advisory Committee comprised of official bilateral donors and multilateral institutions, representing the United States of America, the European Commission, Switzerland, the United Kingdom, and the World Bank Group.

Executive Summary

Access to reliable and adequate heat supply is critical for the wellbeing of the population and the delivery of public services in the Kyrgyz Republic. Given the cold climate and long heating seasons, lasting one-third to one-half of the year, access to reliable heating services is an essential need in the Kyrgyz Republic. However, in Bishkek and Tokmok alone, around 20 to 25 percent of residential and public heat demand remains unmet every year due to insufficient and unreliable heat and electricity supply in winter.

District heating (DH), once the principal heat source for the largest urban areas, is deteriorating. The majority of DH assets were commissioned 20 to 50 years ago and are in poor condition due to insufficient investments in maintenance and rehabilitation. As a result, generation assets operate at 20 to 50 percent of their installed capacity and heat losses often exceed 25 percent of the heat generated. Service quality is also deteriorating; during the heating season in 2013, DH customers in Bishkek experienced more than 300 network breakdowns, a six-fold increase compared to the early 1990s.

The main cause of the sector's decline is financial. Tariffs for heat and electricity are well below cost-recovery levels. Depending on the heating source, residential tariffs are estimated to be between 13 and 50 percent of the cost of heat supply. As a result, most heat suppliers operate at a loss and do not have sufficient funds for proper maintenance and rehabilitation. This contributes to the continued decay of assets and results in inefficiency and poor quality of service. Consequently, the heating sector has become highly dependent on subsidies, both direct subsidies from national or municipal governments and cross subsidies from electricity (where heat is generated by combined heat and power plants, or CHPs). At the same time, low electricity tariffs foster the use of electric heating and provide no incentive to end-consumers to invest in energy efficiency.

Around 35 percent of households in urban areas rely on electricity for heating, aggravating winter power shortages. The deteriorating DH supply has increased the reliance on electricity as a primary heating source, or to supplement insufficient DH supply. The widespread use of electricity for heating is the main driver of the growing residential electricity consumption during winter months – from 2009 to 2013, residential electricity consumption increased by more than 60 percent. Combined with the poor condition of the aging power infrastructure and low hydropower output during winter, this increase in electricity load aggravates winter power shortages.

Additionally, a substantial share of urban households use inefficient solid fuel-fired heating solutions, which negatively affects both health and poverty. With the increase in natural gas prices over the last decade and the lack of access to DH, about 40 percent of urban households rely on inefficient and polluting coal-fired stoves or boilers. As a result, the Kyrgyz Republic is one of the two worst-affected countries in the Europe and Central Asia (ECA) region for diseases resulting from indoor air pollution. Moreover, the use of inefficient solid fuel-fired stoves and boilers results in 20 to 30 percent more coal consumption (and thus, household expenditures on coal) compared to more efficient models.

The energy performance of residential and public buildings is poor, aggravating the gap between heat supply and customers' needs. The age of the building stock, the lack of maintenance and the absence of proper insulation result in high heat losses and low comfort levels in many buildings. Based on the results of energy audits performed, there is significant potential for improving the energy efficiency of the residential and public building stock (30 to 50 percent of consumption) by implementing basic energy efficiency measures.

A mix of investment and policy measures is needed to address the key challenges in the heating sector and meet heat demand in residential and public buildings in a sustainable manner. The levelized cost assessment (see Figure 1 and Figure 2) indicates that heat supplied by the CHP continues to be an economically viable heating solution for buildings currently served by the DH system. Small heat-only boilers (HOBs) are a cost efficient option for other multi-apartment and public buildings with an existing building-internal heating network. The replacement of traditional coal- and wood-fired stoves and boilers by more efficient models would be the most economically viable solution for individual houses.

Figure 1: Levelized Cost of Heating Options for Bishkek

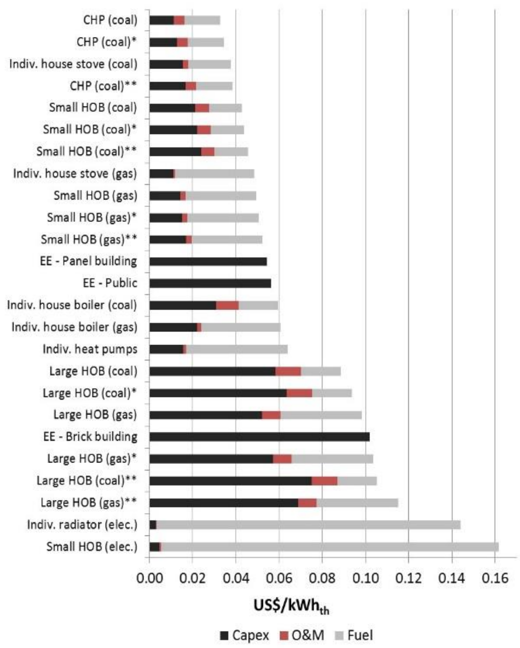
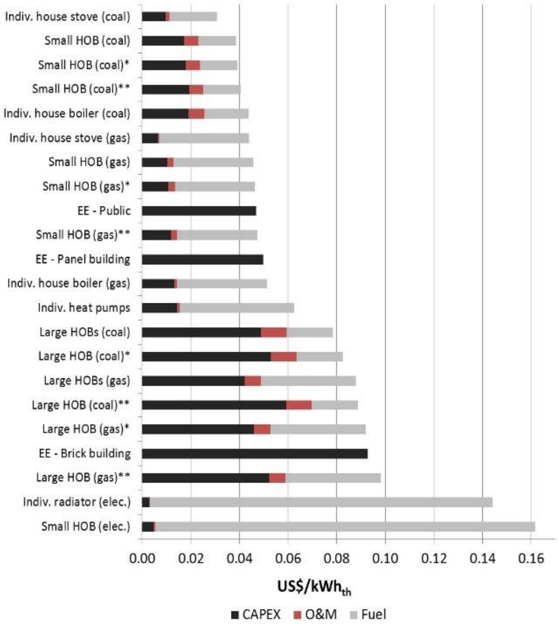


Figure 2: Levelized Cost of Heating Options for Tokmok



Note: * Indicates the levelized cost of a centralized heating option assuming that the existing building-internal heating systems are upgraded.

** Indicates the levelized cost of a centralized heating option assuming that new building-internal heating systems are constructued.

The investments and related policy and implementation measures must be customized for different residential and public buildings. The following investment and policy measures are recommended based on a multi-criteria assessment that combined economic analysis with technical, institutional, environmental and social considerations:

- **Implementation of tariff and social assistance reforms.** Tariff reforms are important for the sector to ensure that the heating companies have sufficient funds to invest in supply-side improvements and consumers have the incentive to use energy more efficiently. Tariff reform involves the consistent implementation of electricity and heat tariff revisions in line with the recently approved Medium Term Tariff Policy (MTTP), and the development and implementation of a clear and transparent methodology which ensures that tariffs gradually come to reflect the heat provider's actual cost of service and the consumers' actual consumption. To ensure that a basic level of heat consumption remains affordable to poor households, it will also be important to improve the targeting of the social assistance program.
- **Construction or gradual replacement of small HOBs**. The construction or gradual replacement of small HOBs by either efficient gas-fired models or an extension of the DH network supplied by the CHP in Bishkek is recommended for: all public buildings not connected to the DH system; multi-apartment buildings with an existing building-internal heating infrastructure (i.e., buildings currently served by large or small HOBs); and new public and multi-apartment buildings that will be built in the future.
- **Rehabilitation of the DH network.** To improve the reliability and efficiency of the DH system, the following priority investments for the DH network supplied by the CHP plant and large HOBs in good operational condition are recommended: installation of modern building-level substations, including heat exchanger, building-level heat meters and apartment-level hot water meters; the replacement or re-insulation of dilapidated pipelines; and the installation of variable speed drives at pumping stations.
- **Implementation of a scalable program to replace inefficient individual heating systems**. A scalable program to replace inefficient electric heaters and polluting solid fuel-fired stoves with the following efficient individual heating technologies is recommended: (i) efficient small gas heaters or boilers for households with access to natural gas in the next 2-3 years; (ii) efficient heat pumps for households currently relying on electric heaters and without access to gas in the medium-term; and (iii) efficient and less polluting small solid fuel-fired stoves or boilers for households currently using old coal-fired models and without access to gas in the medium-term.
- **Implementation of a national energy efficiency program for buildings**. As a priority, energy efficiency investments should be implemented in buildings where the heating systems will be upgraded. The experience in other ECA countries demonstrates that linking improvements of heating systems with building energy efficiency measures generates significant operational and financial synergies. It is also recommended that the Government considers developing a broader energy efficiency program for public and/or residential buildings with targeted implementation and financing mechanisms. Such a program would also need to be accompanied by pricing and billing reforms (i.e. cost-reflective energy prices and consumption-based billing), capacity building and public outreach activities as well

as other policy/program enhancements, such as better enforcement of building codes or strengthening of homeowner associations (HOAs).

The required investments to ensure reliable heat supply are sizable and should be carefully planned and sequenced, but the time for action is now. The implementation of the heating sector investments recommended for Bishkek and Tokmok alone are estimated to cost around US$225 million in the short-term (see Table 1 below) and close to US$550 million in the medium- to long-term. The investments would need to be carefully prioritized and financed through a combination of public (including concessional donor funding) and private sources. However, action should be taken now:

- The heating sector is of critical importance for addressing the recurrent winter power shortages the country is facing;
- Unless the DH system is improved, its continued deterioration will increasingly lead consumers to switching to electric heating and the related dismantling of building-internal heating networks, which will likely exacerbate winter power shortages and render the future restoration of the DH supply unviable;
- Without critical investments in the transmission and distribution network in Bishkek, the network will not be able to absorb the additional heat supplied by the modernized CHP plant in Bishkek;
- The MTTP adopted by the Government will gradually improve the financial viability of the heating sector but future tariff increases will not be accepted by consumers unless these increases are accompanied by improved supply quality and reliability;
- The availability and affordability of natural gas supply is improving since Gazprom acquired the majority stake in Kyrgyzgas.

Table 1: Summary of the Recommended Investment Measures in the Short-Term

Recommended measure	Short-term investment (US$ million)	Benefits
DH reliability and efficiency measures		
Modern building-level substations	37	▪ 17% heat and hot water savings ▪ Increased lifetime and capacity of network ▪ Avoid under-/over-heating
Replacement/reinsulation of network pipelines	40	▪ 23% reduction in heat losses ▪ 25% reduction in water leakages
Variable speed drive pumps	3	▪ 33% electricity savings
Program for efficient individual heating solutions		
Gas heaters and boilers	46	▪ 35% reduction in coal consumption ▪ 70% reduction in electricity consumption ▪ Reduced indoor air pollution ▪ Improved comfort levels
Heat pumps	10	
Efficient solid-fuel stoves and boilers	17	
Replacement of small HOBs with gas-fired HOBs	30	▪ 20-50% fuel savings ▪ Improved comfort levels ▪ Emission reduction
Energy efficiency program for public buildings	42	▪ 30-50% reduction in heat losses ▪ Improved comfort levels
TOTAL	**225**	

1 Introduction

This report identifies viable heating options and related investment measures to meet heating demand in urban residential and public buildings in the Kyrgyz Republic. The report analyzes the condition and performance of the urban heating infrastructure and building stock. It assesses in detail the heating situation in Bishkek and Tokmok. These two cities were selected for the following reasons:

- About 40 percent of the residential living area and 90 percent of the multi-apartment buildings in the Kyrgyz Republic are located in regions with similar climatic conditions as Bishkek and Tokmok.
- They are both located in the northern part of the Kyrgyz Republic, have long and cold heating seasons and therefore high heating demands.
- The four heating companies operating in Bishkek and Tokmok supply more than 80 percent of the total number of district heating (DH) customers in the Kyrgyz Republic and produce nearly 80 percent of the total heat produced in the country (about 3,100,000 Gcal per year).
- The building structure of both cities includes residential and public buildings, which are typical for the remaining urban areas in terms of heat demand.
- Their heating systems include all major heat supply options used in urban areas: Combined Heat and Power Plant (CHP); large and small Heat only Boilers (HOBs); and individual heating systems.

The remainder of this report is organized as follows. The report begins with an overview of the physical, institutional and regulatory characteristics of the urban heating sector in the Kyrgyz Republic (Section 2), which includes an analysis of the building stock. The following two sections (Sections 3 and 4) describe the heat supply and demand characteristics of Bishkek and Tokmok and quantify the unmet heating demand in these cities. Section 5 evaluates the available supply and demand-side measures that could be implemented to improve the heating sectors in the target cities based on a multi-criteria assessment. Section 6 recommends priority investment measures to pursue for each building type, identifies related policy measures to facilitate implementation of the recommended investments, highlights key implementation issues and describes the next steps necessary to implement them.

2 Overview of the Urban Heating Sector

Roughly 40 percent of the 5.6 million people in the Kyrgyz Republic live in urban areas, with half of the urban population (870,000 people) living in the capital, Bishkek. Other large cities include Osh (260,000 people), Jalalabat (90,000 people), Karakol (70,000 people) and Tokmok (60,000 people). Figure 2.1 shows the country’s major cities and oblasts.

Figure 2.1: Administrative Division of the Kyrgyz Republic

Source: The World Bank

There are three main climatic zones in the Kyrgyz Republic, which are identified by their approximate number of heating degree days per year. Table 2.1 describes these climatic zones.[1]

[1] The number of “heating degree days” in a region is an indicator of the energy consumption required to heat a building.

Table 2.1: Climatic Zones of Kyrgyz Republic

Number	Extent	Average Outdoor Air Temperature During Heating Season	Heating Season Length (Days)	Heating Degree Days
I	Osh and Jalalabat	+1.4°C	135	2,240
II	Bishkek and Talas, Kara-Balta, Tokmok and cities in the Chui valley	–1°C	160	3,040
III	Naryn province, south-eastern areas of Issyk-Kul province	–6.9°C	197	4,905

Source: Kyrgyzstan State University of Construction, Transportation and Architecture, 2002-2005.

2.1 Overview of the Building Stock

There are approximately 2,000 public buildings in the Kyrgyz Republic with a total heated volume of 20 million m^3. There are approximately 1.44 million residential buildings with floor space of about 83.7 million m^2.[2] The residential building stock consists of individual family houses and multi-apartment buildings. Individual family houses comprise almost 80 percent of the households in the country and 85 percent (or 70 million m^2) of the residential building area. There are 7,725 multi-apartment buildings, consisting of 255,000 apartments and approximately 14 million m^2 of floor space.[3]

Both residential and public buildings are characterized by low energy efficiency as the result of old building stock, inadequate maintenance and the absence of proper insulation. Newer buildings are in better condition. However, building codes are not properly enforced, so new buildings are not built for energy efficiency. Energy demand in individual family houses is particularly high, making this sector the largest consumer of heat energy in the country.

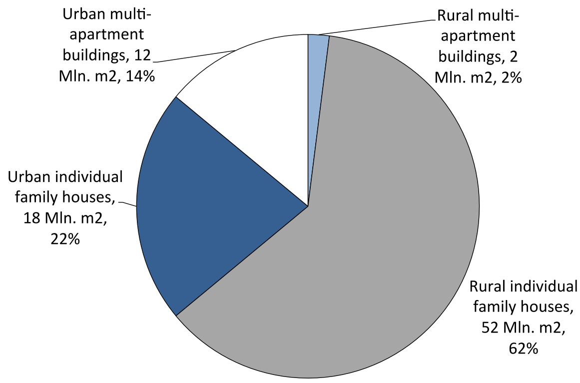
2.1.1 Residential Buildings

In the residential building sector, rural individual family houses account for the majority of the residential floor space, while the area of rural multi-apartment buildings in the Kyrgyz Republic is quite small by comparison. In urban areas, multi-apartment buildings represent a much larger portion of the total area, but the majority of the residential area is made up of individual family houses. Figure 2.2 shows the share of the total residential area by building type and location.

[2] Public building space is estimated in m^3 in the Kyrgyz Republic.

[3] National Statistics Committee, 2011.

Figure 2.2: Residential Floor Space by Building Type and Location



Source: National Statistics Committee, 2011.

Roughly 40 percent of the buildings and one-third of the total floor space are located in urban areas. About 40 percent of the urban population lives in multi-apartment buildings, with the remainder living in individual family houses. Table 2.2 shows the number of buildings, the floor space and the population for each housing type in urban areas.

Table 2.2: Urban Residential Building Statistics

	Buildings		**Floor space**		**Households**		**Population**	
	Number	Share	‘000 m^2	Share	Number	Share	Number	Share
Multi-apartment buildings	224,410	41%	13,300	34%	237,200	51%	507,100	39%
Individual family houses	320,800	59%	25,405	66%	229,400	49%	802,900	61%
TOTAL	**545,210**		**38,704**		**466,600**		**1,310,000**	

Source: National Statistics Committee, 2011.

There are four main types of multi-apartment buildings and two main types of single-family homes in urban areas in the Kyrgyz Republic:

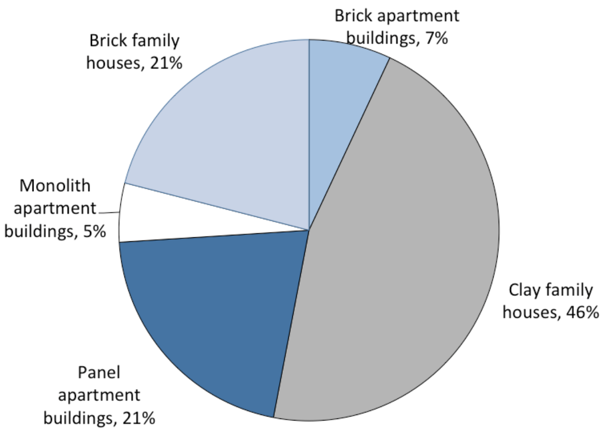
- **Brick masonry apartments.** These buildings are made from traditional metric perforated bricks. The standard thickness of the outside wall is 40 to 50 cm, depending on the level of the floor. The walls have exterior lime-cement render with paint finish or exposed masonry.
- **Panel apartment buildings.** The buildings are most commonly made with a three-layer wall panel which has an integrated middle layer of thermal insulation. These buildings have a wall thickness of 25 to 35 cm.
- **Monolithic concrete and concrete frame apartment buildings.** These buildings typically have outside walls made of expanded clay concrete with expanded clay as

thermal insulation. The outside walls have a thickness of about 35 cm. There is almost no additional thermal insulation.

- **Newly constructed apartment buildings.** These buildings usually have a skeleton structure with brick wall filling. They may also have sandwich panels, both with and without insulation. The outside walls have a thickness of about 25 to 30 cm.
- **Clay individual family houses.** This type of individual family house is made from mud bricks/blocks or cob.[4] The thickness of the outside wall is typically 30 to 40 cm. The walls are sometimes plastered by a straw/clay mixture and are coated with an aqueous solution of slaked lime.
- **Brick masonry individual family houses.** This type of house is made from traditional solid bricks. The standard thickness of the outer walls is 38 cm. The walls have exterior and interior lime-cement render and lime paint finish or exterior exposed masonry. There is almost no additional thermal insulation of the walls.

Clay individual family houses are the most prevalent type of building, followed by panel apartment buildings and brick apartment buildings. Figure 2.3 shows the proportion of each type of residential building in urban areas.

Figure 2.3: Percentage of Households[5] in Urban Areas by Building Type



Source: National Statistics Committee, 2011.

2.1.2 Energy Performance of the Building Stock

Residential buildings are a major consumer of both heat energy and electricity in the country. The residential sector accounts for about 19 percent of final energy consumption[6] and 60 percent of electricity consumption.[7] An important factor contributing to the high share of residential energy consumption is the relatively poor energy performance of the existing residential building stock, especially in multi-

[4] Cob is a mix of clay, sand and straw.

[5] There are an estimated 587,630 households in urban areas, including dwellings in multi-apartment buildings and assuming one household per individual family house.

[6] IEA Statistics, Energy Balances of Non-OECD Countries, 2013 edition.

[7] State Regulatory Agency of the Fuel and Energy Complex.

apartment buildings built before 2000. More than 60 percent of the multi-apartment buildings were built between the 1960s and 1980s.

Energy Performance of Residential Buildings

The different residential building types vary in their heat requirements, as indicated in Table 2.3. The table shows that individual family houses (made of clay or brick) tend to have the highest specific energy demand of all residential building types.

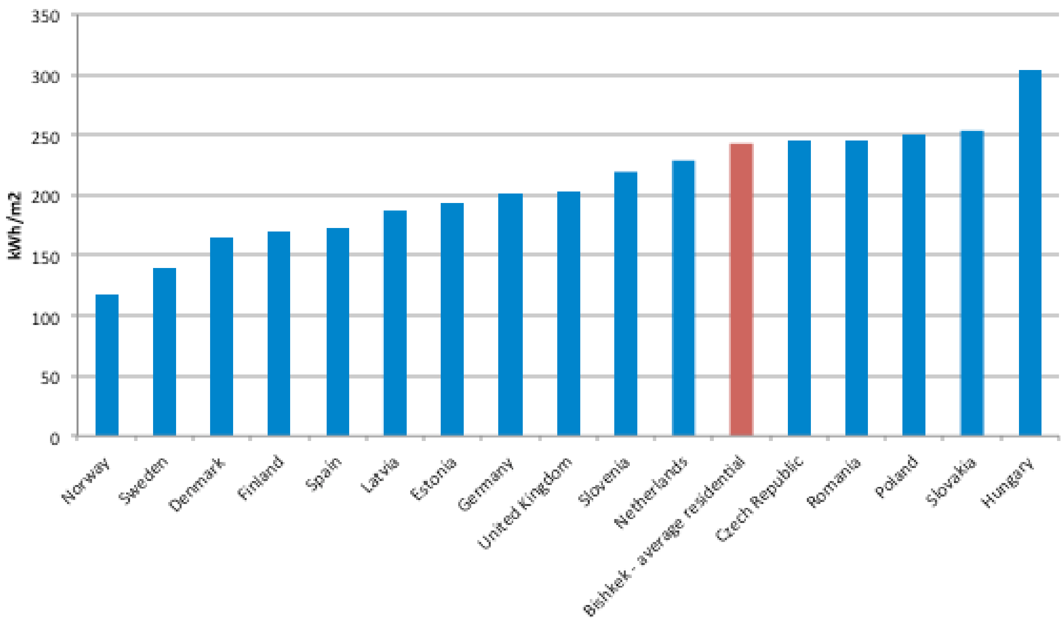
Table 2.3: Space Heat Demand of Residential Buildings by Building Type

Type	Construction type	Building height	Construction period	Average heat demand (kWh/m^2) per year
1	Brick	2-3 story	1940-60s	100-110
2	Panel	4-5 story		130-143
3	Panel	9 story	1960-70s	130-142
4	Monolith	9 story	1980s	130-143
5	Monolith	9+ story	1970s+	130-143
6	Newly constructed multi-apartment buildings	9+ story	Multi-apartment “Elite houses” built after 2004	100-110
7	Other brick/panel		Other multi-apartment buildings	130-143
-	Individual family house (clay or brick)	1-2 story		285-313

Source: Technical Background Report prepared by Fichtner based on walk-through energy audits and on-site interviews.

Walk-through energy-audits performed as part of this assessment indicate that the energy performance of residential building stock in the Kyrgyz Republic could be improved by an average of 35 to 50 percent. Figure 2.4 shows that average residential heat energy demand in Bishkek is higher than in a number of European countries.

Figure 2.4: Average Heat Demand in Multi-Apartment Buildings in Different Countries and Bishkek, Adjusted to Reflect Bishkek Heating Degree Days



Source: Analysis based on Eurostat and Enerdata.

Residential buildings in the Kyrgyz Republic are characterized by relatively high specific heat demand mainly for the following reasons:

- **The absence of proper thermal insulation.** In apartment buildings, heat losses are especially high on the first and top floors because basements are not heated and roofs are poorly insulated.
- **The poor condition of windows.** Windows typically are in poor condition within dwelling areas as well as in communal areas. As a result, they are highly air permeable, which contributes to heat losses.
- **Insufficient maintenance and repairs.** Due to the lack of funds and weak HOAs, common areas in buildings are not properly maintained or rehabilitated in many multi-apartment buildings.
- **Insufficient enforcement of building codes.** Overall, the energy performance of new buildings is better than in older buildings, but they are often not built to be energy efficient because the energy efficiency requirements in building codes are not well enforced.

A range of other legal, regulatory, institutional and financial issues impedes the implementation of energy efficiency investments and proper maintenance of the residential building stock. Section 2.4 further describes these barriers.

Many households do seek to improve the energy efficiency of their homes in order to increase comfort levels and reduce energy bills. However, the measures are relatively limited and do not have a major impact on energy performance. In the World Bank's recent Qualitative Assessment on Poverty and Social Impact of Energy Reforms in the Kyrgyz Republic, all respondents indicated that they implement some form of energy efficiency measures, including: (i) lining and covering windows and doors with insulation tapes; (ii) putting rugs on floors and walls; and (iii) closing ventilation vents.

Energy Performance of Public Buildings

The majority of public buildings in the Kyrgyz Republic were constructed between 25 and 60 years ago during the Soviet period, and are relatively energy inefficient. Specific heat demand tends to be highest in educational buildings, as shown below in Table 2.4. Walk-through energy audits performed in schools, kindergartens and hospitals indicated that basic energy efficiency measures (e.g., insulation of the building envelope, replacement of windows and doors, etc.) could reduce energy consumption in public buildings by around 30 percent.

Table 2.4: Characteristics of Public Buildings in the Kyrgyz Republic

<table>
<tr><th>Type of Public Building</th><th>Number in the Entire Country*</th><th>Number in Bishkek**</th><th>Specific heat demand in kWh/m³/year[8]</th></tr>
<tr><td>Educational buildings</td><td>3,339</td><td>686</td><td></td></tr>
<tr><td>Kindergartens</td><td>819</td><td>189</td><td>60-66</td></tr>
<tr><td>Schools</td><td>2,224</td><td>432</td><td>30-33</td></tr>
<tr><td>Professional schools</td><td>242</td><td rowspan="2">65</td><td rowspan="2">60-66</td></tr>
<tr><td>Universities</td><td>54</td></tr>
<tr><td>Health facilities</td><td>1,333</td><td rowspan="4">64</td><td rowspan="4">36-40</td></tr>
<tr><td>Hospital facilities</td><td>177</td></tr>
<tr><td>Facilities providing primary health care</td><td>153</td></tr>
<tr><td>Medical and obstetric facilities</td><td>1,003</td></tr>
<tr><td>Administrative buildings</td><td>N/A</td><td rowspan="6">255</td><td rowspan="6">45-50</td></tr>
<tr><td>Cultural facilities</td><td>825</td></tr>
<tr><td>Theatre</td><td>22</td></tr>
<tr><td>Museum</td><td>65</td></tr>
<tr><td>Kino</td><td>34</td></tr>
<tr><td>Club</td><td>704</td></tr>
<tr><td>Total</td><td>5,497</td><td>1,005</td><td></td></tr>
</table>

Sources: *Statistical Agency of Kyrgyz Republic, "Kyrgyzstan in numbers, 2012"; **Estimates provided in the Technical Background Report prepared by Fichtner and based on the available statistical data and information provided by heat suppliers.

[8] This range was estimated for Bishkek and Tokmok.

2.2 Overview of Heat Supply Systems

Heat in the Kyrgyz Republic is supplied by various systems, ranging in size from large, centralized DH systems to individual portable heating devices. Most of the DH system and HOBs were designed for gas, but many of them have been converted to burn coal or use electricity. This has reduced the efficiency of the boilers and (where coal is burned) contributed to air pollution.

As gas became more scarce and expensive in the wake of the collapse of the Soviet Union, many households that were not served by the DH system began to rely on electricity for heating. Households that are supplied with DH also use electricity for additional heating to supplement the heat supplied by the DH system. This increases demand for electricity at peak hours, which strains the power grid and has contributed to an increase in power outages during winter months.

While the decreasing availability and increasing price of gas has been a major factor impacting the heating situation over the last decade, recent developments in the restructuring of the gas sector in the Kyrgyz Republic suggest that natural gas might again become a more reliable and affordable source for heating purposes.

2.2.1 Main Heating Sources in the Kyrgyz Republic

Nationally, stoves are the most prevalent source of heating for urban households outside Bishkek, followed by electric heating (37 percent) and DH (9 percent). By contrast, in Bishkek, 43 percent of households rely on DH as a main source of heat, followed by electric heating (21 percent) and stoves (22 percent). Table 2.5 describes households' main sources of heating by settlement type.

Table 2.5: Households' Main Sources of Heating by Settlement Type

	DH	Electric radiators	Stoves/boilers	Other electric heating	Gas
Urban (non-Bishkek)	9%	31%	50%	6%	3%
Rural	1%	20%	73%	5%	2%
Poor	4%	19%	68%	5%	3%
Non-Poor	11%	24%	56%	5%	4%
Bishkek	43%	18%	22%	3%	14%

Source: World Bank Calculations based on Kyrgyz National Statistics Committee, "Kyrgyz Integrated Household Survey (KIHS)", 2012.

2.2.2 DH

DH provides heat to about 19 percent of the total urban population. DH is available in urban areas of the regions Chui (which includes Bishkek and Tokmok), Osh, Jalalabat, Talas, Naryn and Issyk-Kul. Table 2.6 below shows the penetration rate of DH in 11 major cities in the Kyrgyz Republic, which account for more than 90 percent of the urban population.

Table 2.6: DH Penetration in Urban Areas (2012) [9]

City/ town	Urban households			DH Company
	Total	Connected to DH	Share	
Bishkek	289,444	136,178	47%	Bishkekteploset JSC, BishkekTeploEnergo SUE
Kyzyl-Kiya	10,208	5,400	53%	Kyrgyzhilkommunsoyuz SUE
Jalalabat	21,687	12,000	55%	Kyrgyzhilkommunsoyuz SUE
Mailuu-Suu	6,415	3,000	47%	Kyrgyzhilkommunsoyuz SUE
Tash-Kumyr	7,579	1,250	16%	Kyrgyzhilkommunsoyuz SUE
Karakol	19,493	5,000	26%	Kyrgyzhilkommunsoyuz SUE
Balykchy	10,633	5,000	47%	Kyrgyzhilkommunsoyuz SUE
Naryn	7,936	5,000	63%	Kyrgyzhilkommunsoyuz” SUE
Talas	8,127	1,447	18%	Kyrgyzhilkommunsoyuz SUE
Osh	70,833	20,066	28%	Kyrgyzhilkommunsoyuz SUE, Osh CHP, Kizil-Kiya and Heat supply
Tokmok	17,478	10,280	59%	Kyrgyzhilkommunsoyuz SUE, Zhululuk SUE
Total	**469,833**	**204,624**	**42%**	**-**

Source: State Regulatory Agency of the Fuel and Energy Complex

Between 18 and 63 percent of the households living in these cities are supplied by DH systems. DH customers in Bishkek, Osh and Tokmok comprise about 80 percent of the DH customers countrywide. Other urban areas do not have large DH systems either because of the small heat loads and the prevalence of individual houses, or because DH systems are no longer operational due to the poor condition of DH assets and/or the lack of reliable and affordable gas supply.

Four state-owned companies provide approximately 90 percent of DH supply in the country. Small boiler houses, which are owned by regional or city administrations or government agencies (e.g., Ministry of Education and the Ministry of Health) supply the remaining 10 percent of DH. Box 2.1 describes the four state-owned companies.

[9] Differences between Table 2.5 and Table 2.6 are due to statistical inconsistencies between the KIHS and data from the State Regulatory Agency of the Fuel and Energy Complex.

Box 2.1: State-Owned DH Supply Companies in the Kyrgyz Republic

Electric Power Plants OJSC

Electric Power Plants (EPP) Open Joint Stock Company (OJSC) owns and operates the Bishkek and Osh CHPs. In Bishkek, heat and hot water are sold to Bishkekteploset, which is responsible for the transmission and distribution to end-consumers. Electricity is fed into JSC Severelectro's network, and steam is directly sold to 22 public and commercial customers, with heat loads between 20 and 60 ton/h.

Kyrgyzhilkommunsoyuz SUE

Kyrgyzhilkommunsoyuz (KZhK) State Unitary Enterprise (SUE), which is also known as "the state association of housing and utility companies and organizations" of the Kyrgyz Republic, is the largest DH service provider in terms of geographical coverage and the second largest service provider in terms of heat production. KZhK generates and distributes 17 percent of DH supplied throughout the country and provides DH services to 24 cities and district centers in six regions.

KZhK was established in 1991 as a voluntary association of Kyrgyz housing and utility companies and other various organizations. KZhK provides several types of services in the housing and utility sectors in addition to DH.

Bishkekteploset JSC

Bishkekteploset (BTS) Joint Stock Company (JSC) distributes heat generated by Bishkek CHP to DH customers in Bishkek city. BTS also distributes hot water and steam. For some multi-apartment buildings, BTS also performs maintenance and repairs of the building-internal heating infrastructure against a fee. These are based on separate agreements with the condominium owners. Heat distributed by BTS accounts for 69 percent of total thermal generation for DH.

BTS was established in 2001 when the state-owned, vertically-integrated electricity company, Kyrgyzenergo JSC, was unbundled. BTS is 80 percent owned by the State Property Fund of the Kyrgyz Republic.

BishkekTeploEnergo SUE

BishkekTeploEnergo (BTE) SUE is a vertically-integrated, municipally-owned DH company which serves the areas of Bishkek city not covered by BTS (approximately 60 percent of the city). Heat generated and distributed by BTE accounts for approximately six percent of total thermal generation for DH nationally. The company was founded by the Mayor's Office of Bishkek City in 1986.

In 2012, around 3,088,000 Gcal heat energy was produced by DH systems in the country. About 75 percent of the total heat energy was generated in Bishkek. Table 2.7 presents data about the size of the main DH companies' customer bases, as well as the amount of heat they generated for their respective service areas. EPP, the operator of the CHP in Bishkek, produces the vast majority of the district heat produced in the country.

Table 2.7: Overview of Major DH Suppliers, 2012

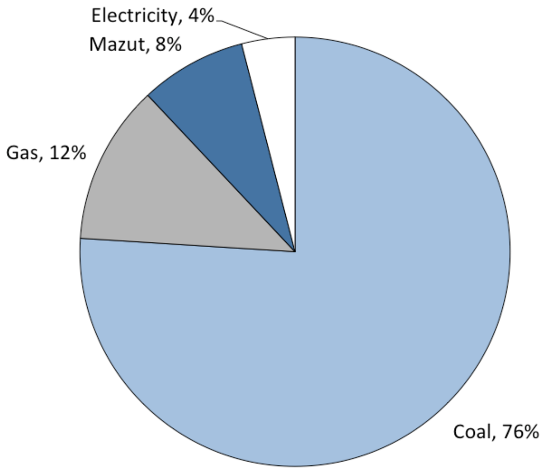
Supply companies/ regions	Total customers	Residential customers	Public customers	Industrial customers	Other customers	Heat generated ('000 Gcal/yr)	Heat generated (%)
KZhK SUE (heat supply in urban areas other than Bishkek)	3,083	52,335	302		446	525	17%
BTE SUE (heat supply by HOBs in Bishkek)	26,229	26,029	85		116	176	6%
BTS JSC (heat supply by CHP 1 in Bishkek)	113,048	110,149	414	41	2,444	2,142	69%
CHP plant in Osh	13,709	13,510	65	4	130	166	5%
Boiler of city Kyzyl-Kiya at thermal power plant (TPP) of city Osh and SE Heat supply in Osh municipality	1,915	1,906	7	1	1	78	3%
Total	**157,984**	**203,929**	**873**	**46**	**3,137**	**3,088**	**100%**
In Bishkek	139,277	136,178	499	41	2,560	2,318	75%
In other urban areas	18,707	67,751	374	5	577	769	25%

Source: BTS JSC; BTE SUE; KZhK SUE; Estimates provided in the Technical Background Reports prepared by Fichtner.

Heat supplied by these companies is produced in 269 boiler houses with an annual fuel input of about 5,320,000 Gcal (2012). Total fuel consumption of DH companies in 2012 amounted to 912,000 tons coal, 46,000 tons mazut, 214 GWh power and 80,000,000 m^3 natural gas.[10] As shown in Figure 2.5 below, coal accounted for 76 percent of primary fuel consumption, followed by gas (12 percent) and mazut (8 percent).

[10] Based on data provided by companies and the Technical Background Reports prepared by Fichtner.

Figure 2.5: Share of Primary Fuel Consumption by DH Companies, 2012



Source: Estimates provided in the Technical Background Reports prepared by Fichtner based on company data and interviews.

As indicated in Table 2.8, coal-based boilers are the most popular boiler type, followed by electricity-based and gas-based boilers.

Table 2.8: Number of Boiler Houses Operated by DH Companies and EPP by Fuel Used

	Coal	Mazut	Electricity	Gas	Total
BTE	23	1	12	24	**60**
KZhK	69	23	38	31	**161**
EPP (boiler house in Kyzyl-Kiya)	3	20	16	6	**45**
EPP (Osh and Bishkek)	2			1	**3**
Total	**97**	**44**	**66**	**62**	**269**

Source: DH company and EPP data; Technical Background Reports prepared by Fichtner.

2.2.3 Small HOBs

Small HOBs primarily provide heating for buildings that are not connected to the DH system. In addition to small HOBs operated by DH companies, there are about 2,500 small HOBs owned and operated by public institutions and used to heat schools, kindergartens, hospitals and other public buildings. As indicated in Table 2.9 below, more than half of these HOBs are electricity-based. Most of the rest of the small HOBs are coal-fired.

Table 2.9: Small HOBs Operated By Public Institutions and Administrations

Operator	Coal	Mazut	Electricity	Gas	Total
Ministry of Health	503	-	669	8	1,180
Ministry of Interior	72	-	3	-	75
Ministry of Social Development	20	-	46	-	66
Ministry of Defense	34	4	1	-	39
Ministry of Education	352		304	-	656
City administrations	161	10	219	8	398
Small boiler operators of diverse public institutions	43	2	47	2	94
Total public institutions/ administrations	**1,185**	**16**	**1,289**	**18**	**2,508**

Source: State Regulatory Agency of the Fuel and Energy Complex.

2.2.4 Individual Heating Systems

Individual heating systems for space heating in urban areas include individual coal or wood stoves and boilers, gas heaters and boilers, electric oil radiators, air conditioning units that can be used as heat pumps, individual space heaters and hot water boilers.

Solid fuel-fired stoves or boilers are used by 40 percent of the individual family homes in urban areas without connections to the DH system. Most of the stoves and boilers are characterized by low efficiency, which increases coal consumption by 20 to 30 percent compared to more efficient models. As a result of the high indoor pollution caused by the traditional stove models in use, the Kyrgyz Republic ranks among the two worst-affected countries in the ECA region for diseases resulting from indoor air pollution. In terms of indoor air pollution influenced mortality proportionate to the population, measured in terms of Daily Adjusted Life Years, the Kyrgyz Republic compares to India. According to the results of the recently conducted Qualitative Assessment on Poverty and Social Impact of Energy Reforms in the Kyrgyz Republic, households mainly opt for coal-based stoves and boilers over electric devices because of their low costs and because operation is not interrupted by frequent power outages.

Nearly 30 percent of urban households rely on electric radiators as their primary source of heating. Even where DH supply is available, residents of multi-apartment buildings use electrical appliances for heating either outside of the period of the year when DH heat is provided or to increase comfort levels. This high reliance on electricity for heating is a main driver for the high residential electricity consumption and contributes to winter power shortages, as further described in Section 2.3.3. Based on the findings of the above referenced qualitative assessment on energy reforms in the Kyrgyz Republic, electrical appliances are popular for residential heating because of their low capital costs, relatively low operational costs (as a result of highly subsidized electricity tariffs), and ease of installation and use. They also produce no local emissions.

2.3 Fuel Supply for Heating in the Kyrgyz Republic

The collapse of the Soviet Union and the Unified Energy System significantly altered the use of fuels for heating in the Kyrgyz Republic. Natural gas was the main design fuel for the heat supply system in the Kyrgyz Republic, but shortages in gas supply and substantial price increases since the 1990s have resulted in fuel switching for heating. Between 1992 and 2011, natural gas consumption dropped by around 80 percent from 2,400 million m^3 to 400 million m^3. The conversion of many HOBs from burning gas to burning coal caused substantial decreases in boiler efficiency and capacity. As of 2011, coal and electricity supplied a higher proportion of total primary energy for heating than gas.

2.3.1 Gas

Natural gas is mostly imported from Kazakhstan (supplying the northern part of the Kyrgyz Republic) and Uzbekistan (supplying the southern regions of the country). However, in the past, political and pricing issues led to recurrent interruptions of gas supplies. These interruptions decreased the reliability and availability of gas-fired DH in the country. The most recent incident occurred in April 2014 when gas exports were suspended from Uzbekistan to the southern regions of Osh and Jalalabat. These two regions account for around 15 percent of the overall gas consumption in the Kyrgyz Republic.

Recent developments in the Kyrgyz gas sector may improve gas supply reliability, which could affect the heating fuel mix. At the end of 2013, the Russian gas company Gazprom JSC bought the majority of shares in “Kyrgyzgas” SUE for 25 years. After this purchase, the gas import price decreased to US$165 per 1000 m^3. Retail gas tariffs for residential customers dropped from 16 Som/m^3 to 12.93 Som/m^3. Gazprom is currently developing a gasification plan through 2030 and has committed to invest in the rehabilitation of the existing gas infrastructure and the development of the Kyrgyz Republic’s indigenous natural gas reserves (estimated at six million m^3). Gazprom’s involvement could lead to more reliable gas supply, but the specific scope of gasification and rehabilitation is still unknown, as are the more general implications for the heating sector.

2.3.2 Coal

The Kyrgyz Republic has relatively large coal reserves, but there are significant bottlenecks for scaling-up domestic production.[11] Existing facilities for coal exploration are depreciated and in poor condition. The country also lacks large scale coal transportation infrastructure. Coal is mostly transported by truck.

Final coal consumption has more than doubled in the last decade, increasing from 0.2 mtoe in 2000 to about 0.54 mtoe in 2011. During the same period, local coal production increased by more than 160 percent to 0.42 mtoe (2012 estimate).

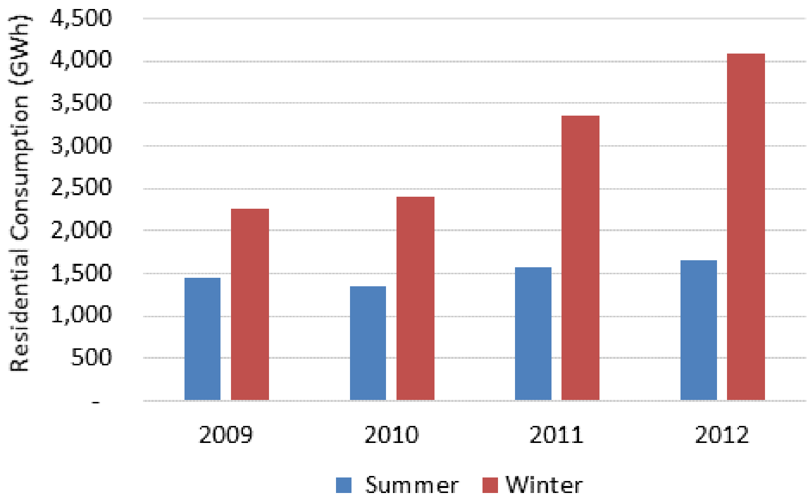
[11] Coal is found in the Issyk-Kul, Naryn, Jalalabat, Osh and Batken regions. There are about 70 known coal fields in four coal basins. Recoverable coal resources are estimated at 1.3 billion tons. The largest coal field is Kara-Keche.

Imports increased by around 40 percent to 0.44 mtoe (2012 estimate).[12] The largest consumer of coal is the CHP in Bishkek. The Government plans to further increase domestic coal production.

2.3.3 Electricity

Seventy-eight percent of electric generating capacity in the Kyrgyz Republic (2,870 MW) is provided by hydropower. Electricity consumption increased significantly in the last couple of years. The largest portion of that growth in consumption was attributable to residential consumers during winter months. From 2009 to 2012, winter consumption grew by 62 percent, while summer consumption increased by 16 percent (see Figure 2.6 below).[13]

Figure 2.6: Seasonal Residential Electricity Consumption 2009-2012



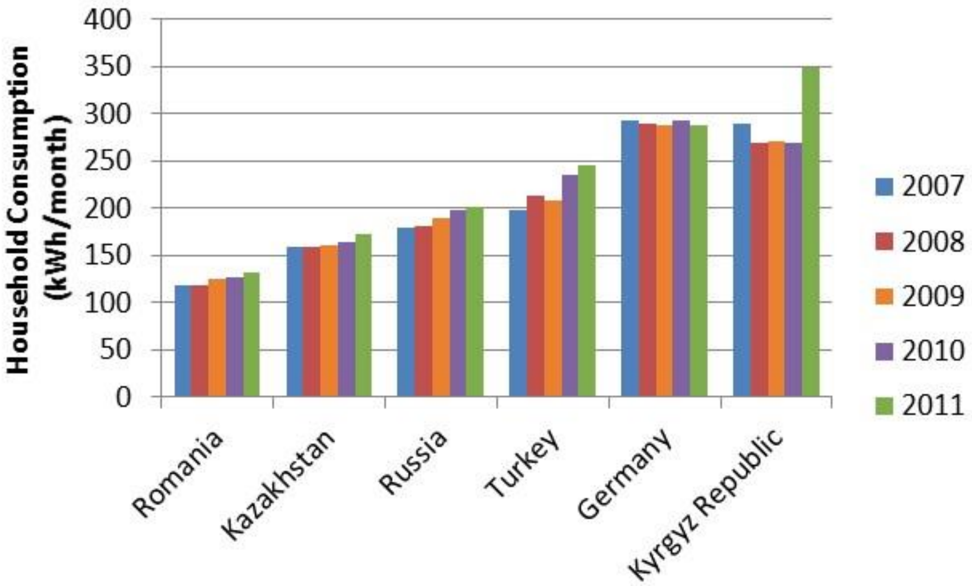
Source: World Bank, "Power Sector Policy Note for the Kyrgyz Republic," April 2014, available: http://documents.worldbank.org/curated/en/2014/04/19456135/power-sector-policy-note-kyrgyz-republic

As a result of this growth in electricity consumption, partly driven by the high reliance on electricity for heating purposes, the Kyrgyz Republic now has higher rates of household electricity consumption per month than many other countries in ECA. Figure 2.7 below compares monthly household electricity consumption rates in different countries from 2007 to 2011.

[12] IEA Statistics, Energy Balances of Non-OECD Countries, 2013 edition.

[13] World Bank, "Power Sector Note for the Kyrgyz Republic," April 2014, Available: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/01/000333037_20140501120946/Rendered/PDF/877980ESMAP0P10or0Policy0Note0final.pdf

Figure 2.7: Average Monthly Electricity Consumption per Household, 2007 to 2011



Source: World Energy Council, "Energy Efficiency Indicators," http://www.wec-indicators.enerdata.eu

The widespread use of electric heating adds significant load on the strained electricity network and aggravates winter power deficits. For instance, between January and May 2014, residential customers with three-phase electrical connections (used for heating) consumed almost 30 percent of the total electricity supplied in the country although they only account for a very small share of residential consumers. Box 2.2 describes the effects of electricity demand and consumption growth on the reliability of the power supply in the Kyrgyz Republic.

Box 2.2: Electricity Demand and Consumption Growth in Recent Years and the Effect on the Reliability of Power Supply in the Kyrgyz Republic

Electricity consumption has increased significantly in the Kyrgyz Republic in the last couple of years. The largest portion of that growth in consumption was attributable to residential consumers during winter months. From 2009 to 2012, winter consumption grew by 62 percent, while summer consumption increased by 16 percent. The heavy reliance on electricity for heating is one of the main reasons for the high winter electricity load. It puts increasing strain on the capacity of the aging power sector assets.

As a result of the condition and strained capacity of power assets, power supply reliability and quality is deteriorating. In recent years, there have been frequent emergency shut-downs of assets, especially during winter months. The four distribution companies reported an average of 43 outages per day between 2009 and 2012. Company data also show that the number of outages tends to be much higher in the first and fourth quarter of the year (i.e., the beginning and the end of the heating season, coinciding with the period before and after provision of DH supply). While the use of electricity for heating purposes aggravates winter power shortages, frequent power outages during winter months seriously affect the living conditions of the large share of the population relying on electricity for heating.

Source: World Bank, "Power Sector Note for the Kyrgyz Republic," April 2014, Available: http://documents.worldbank.org/curated/en/2014/04/19456135/power-sector-policy-note-kyrgyz-republic

2.4 Overview of the Institutional, Legal and Regulatory Framework in the Heating Sector

The Kyrgyz Republic has a relatively recent and robust foundation of heating sector policies and laws. Implementation, however, is weak because of a lack of enforcement, financing and capacity. The DH utilities, in particular, are constrained by tariffs which have long been below the cost of service. The low tariffs prevent them from properly maintaining and investing in the system. As a result, the utilities depend on subsidies from municipal governments and extensive cross-subsidies from the electricity sector.

2.4.1 Energy Policy and Laws

The principal policy document in the heating sector is the Long-term Strategy for Heat Supply in the Kyrgyz Republic (2004-2015). The strategy plans for: (i) the introduction of a new tariff system; (ii) the commercialization of HOBs and the creation of a decentralized heating market; (iii) support of condominium associations, and (iv) technical rehabilitation of the existing assets.

The laws "On Energy" and "On Electric Energy" (amended in July 2014) are the principal laws in the sector. They define the basic legal and organizational principles and methods for regulating economic activities in the sector. Other key legislative acts are the laws "On Energy Saving" (2013) and "On Renewable Energy Sources" (2012). These give a general framework for implementation of the priorities set forth by the national policy.

The principle documents in the building sector include the law “On Energy Efficiency in Buildings” (2013) and construction standards and regulations (SNIPs). The major standards, which have been adopted and amended in recent years, give comprehensive rules for residential, public and other buildings. The rules are generally in line with international practice. They introduce ambitious targets for specific energy demand as well as a certification system for the energy performance of buildings. However, the energy performance regulations for new buildings do not solve the problem of the overall poor condition and energy inefficiency of the existing housing stock.

While the legislative framework for energy efficiency and heating appears to be quite comprehensive, secondary norms and regulations (SNIPs) related to the use of efficient equipment and material (e.g., use of pre-insulated pipes for rehabilitating the transmission and distribution network) need to be updated. In addition, implementation and enforcement of sector legislation and regulation to date remain limited and ad hoc.

2.4.2 Institutional Framework

The heating sector is at the intersection of three major industries: energy, construction and housing. Many different institutions are involved in the sector. Key responsibilities, including policy-making and the development of laws and standards, are distributed across various governmental bodies at the central level. Other key functions, such as supervision and setting tariffs, are spread both horizontally and vertically. This arrangement gives rise to overlap and necessitates coordination. Table 2.10 below shows the heating sector responsibilities of the governmental bodies involved.

Table 2.10: Key Regulatory Responsibilities of the Government Bodies Involved in the Heating Sector

	Policy	Laws and Standards	Supervision	Asset ownership	Tariffs	Other
State Property Fund				X		
Ministry of Energy and Industry	X	X	X			X
State Regulatory Agency of the Fuel and Energy Complex			X		X	X
State Technical and Ecological Inspectorate			X			X
State Agency for Architecture, Construction and Housing and Communal Services under the Government of the Kyrgyz Republic (Gosstroi)	X	X				X
State Agency for Antimonopoly Regulation under the Government of the Kyrgyz Republic						X
Ministry of Finance						X
Municipality / City				X		

Each of the four heating companies is responsible for the operation and maintenance of the DH assets in their respective networks. Table 2.11 describes the roles of Government entities in the ownership, operation and regulation of the DH sector.

Table 2.11: Role of Government Entities in the Heating Sector

Role in the DH Sector	Entity
Ownership	▪ Ministry of State Property (KZhK and BTS) ▪ Mayor's Office of the City of Bishkek (BTE only) ▪ Municipalities (small boiler houses not owned by KZhK, BTS or BTE)
Service Provision	▪ KZhK SUE ▪ BTS ▪ BTE ▪ Other smaller companies: – Municipal DH "Zhululuk" SUE in Tokmok – Osh region companies in Kizil-Kiya and "Heat supply" – Osh City TPP OJSC
Regulation	▪ State Regulatory Agency of the Fuel and Energy Complex[14]
Investment Planning	▪ KZhK and BTS, in conjunction with the Ministry of Energy and Industry ▪ BTE, in conjunction with the Mayor's Office of Bishkek ▪ Small DH companies, in conjunction with municipalities
Financing	Each company is responsible for its own financing, but almost all funds for major investments are on-lent by the Ministry of Finance. BTE receives some financing as part of the municipal budget, because it is owned by the Mayor's Office of Bishkek.

Ownership of the major assets for heating systems is spread among various entities, including governmental bodies, companies, and end-users. Pricing and quality of supply depends on interactions between several entities in the supply chain. For example, BTS, which owns and operates the heat transmission and distribution network, depends on EPP, which owns the CHP plant in Bishkek and supplies the heat. Building residents are responsible for maintaining the piping and other heat facilities inside their own buildings (or contracting out the maintenance of these facilities either to third parties or the respective DH company).[15] As a result, the heat supply companies are dependent upon building residents for the maintenance of the heat supply pipes within their buildings.

The interdependencies lead to operational inefficiencies. The heating system was originally designed as a whole, but the fragmented institutional structure and the

[14] As of June 2014, the Government made amendments to the Energy Law, Electricity Law and Law on Natural Monopolies that give the Regulatory Agency sole responsibility for energy sector regulation, including tariff setting responsibilities.

[15] The heat supply companies were responsible for maintenance of the heat supply pipes within residential and public buildings, but the 1997 adoption of the Law on Condominiums passed responsibility for building-level utility infrastructure to building residents.

overlapping procedures and responsibilities among institutions hampers consistent and systematic efforts to improve the heating system.

At the end-consumer level, housing management and maintenance of the existing privatized stock create an additional challenge to improving infrastructure. Owners are obligated to pay for maintenance, management and cleaning services, but they lack funding. Even in buildings with Homeowner Associations (HOAs), maintenance and major repairs are difficult to organize.[16] Box 2.3 summarizes some of the key difficulties presented in financing investments in energy efficiency.

Box 2.3: Key Barriers to Energy Efficiency

There are a number of technical, institutional, financial, regulatory and policy barriers which impede energy efficiency investments in the residential and public building sector in the Kyrgyz Republic. Among these barriers are: the low market capacity for preparing, implementing and financing energy efficiency investments (e.g., energy auditing companies, design companies, financial institutions, construction companies, etc.); lack of awareness; lack of access to affordable financing for energy efficiency; the low financial viability and lack of incentives to invest in energy efficiency due to the low energy tariffs and norm-based billing practices; incomplete regulatory and enforcement framework for energy efficiency (e.g., standards for energy efficient appliance and materials; enforcement of building codes); etc.

In addition, a specific barrier to energy efficiency in the residential sector is a misalignment of incentives and responsibilities within multi-apartment buildings. Common spaces in residential buildings and centralized building-level heating systems often account for a large portion of energy savings potential. Simple repairs to doors, windows and hallways in common areas as well as heating system upgrades can yield substantial savings in heating costs to individual apartments. Experience from other countries in the ECA region indicates that low-cost weatherization can raises the indoor temperature by three to five degrees Celsius. More elaborate measures can save up to seven degrees Celsius.

HOAs in multi-apartment buildings could facilitate the implementation of energy efficiency improvements. However, even where HOAs exist, the contributions of tenants to repair funds are generally very low. A large proportion of tenants refuse to make any payments into these funds. Furthermore, although HOAs are legal entities, it is very difficult for them to gain access to financing for improvements. Banks are reluctant to lend because they cannot foreclose on residents if they do not repay their loans.

2.4.3 Tariff Regulation

Heat tariffs for residential consumers are applicable countrywide independent of the heating source. For public and other consumers supplied by HOBs, tariffs are linked partially to the actual cost of heat supply and can vary substantially depending on the source.

The Government recently adopted the Medium Term Tariff Policy (MTTP) and enacted tariff increases for heat and hot water supply in 2014 and 2015, increasing residential

[16] The organization of housing management is more efficient in up-new construction, as it is driven primarily by private developers. Private developers often contract-out maintenance, and the cost of such maintenance and future refurbishment are rolled into the apartment rental or purchase costs.

consumer tariffs by more than 28 percent from Som 715/Gcal to Som 917/Gcal (2014) and Som 1,134.76/Gcal in 2015. Table 2.12 below shows DH tariffs for residential and public consumers. Due to the lack of metering, heat and hot water is mainly billed based on norms determined from a number of factors, including the heated area and the number of residents.

Table 2.12: Residential Heat and Hot Water Tariffs

	2014		**2015**	
Consumer Categories	**DH**	**Hot water**	**DH**	**Hot water**
Residential consumers	917.78	664.96	1,134.76	981.76
All other consumers, including public institutions*	1,667.25	89.59	1,696.1	97.19

Source: Government of Kyrgyz Republic, "Medium-Term Tariff Policy of the Kyrgyz Republic for heat energy for period 2014-2017," 2014.

Note: * tariff for non-residential consumers served by BTS.

The residential DH and hot water tariffs are well below cost recovery levels. Depending on the heating source, residential tariffs cover between 13 and 50 percent of the cost of heat supply. For example, the average cost of heat supply by KZhK in 2013 was 5,446 Som/Gcal, but the residential tariff at that time was 715 Som/Gcal (approximately 13 percent of the cost of heat supply). The situation was similar for the non-residential tariff at KZhK.

For large and small HOBs, current tariffs are calculated for each particular facility based on actual billable costs for the heat it supplies. The heat supplier submits the calculated costs for each boiler for annual approval by the respective authorities. In the past, these authorities have included both the State Agency for Antimonopoly Regulation and the State Regulatory Agency of the Fuel and Energy Complex.

Table 2.13 below shows the costs of selected types of HOBs operated by BTE and Tokmok KZhK SUE.

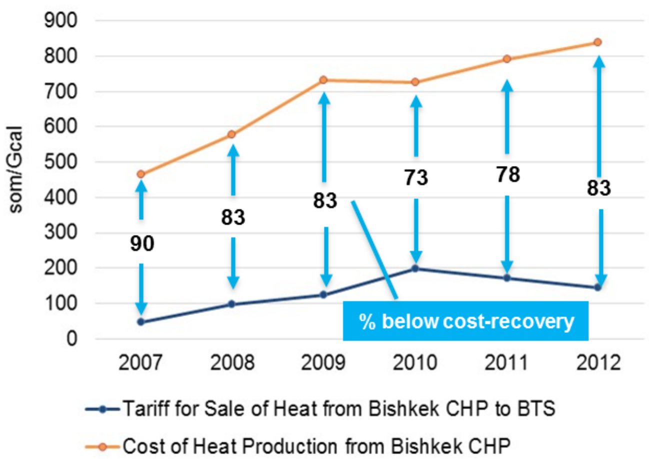
Table 2.13: Tariffs for Heat Supply by HOBs (2012)*

Type of HOB	Operational capacity [Gcal/h]	Specific costs* [Som/Gcal]
Large gas fired HOB**	7.97	4,550
Small gas fired HOB**	0.45	6,216
Large coal fired HOB**	3.78	3,907
Small coal fired HOB***	0.30-0.50	3,953
Electricity based small HOB**	0.23	3,690
Diesel fired boilers**	0.23	3,241

Notes: *reported by the DH companies in line with the energy sector methodology (incl. VAT, generation, transmission and distribution costs); 1 Som=US$0.0204; **BTE SUE; ***Tokmok KZhK SUE, 2010-2011.

BTS is different than the other heating companies in that the company only provides heat delivery services. EPP (which supplies heat from the CHP 1 plant to BTS) sells heat to BTS at a substantially discounted price. The wholesale tariff for BTS was 75 to 90 percent below the cost of heat production at the CHP 1 in 2007-2012, as shown in Figure 2.8 below. EPP makes up for the financial losses it incurs from selling below-cost heat to BTS by earning revenue from electricity exports.

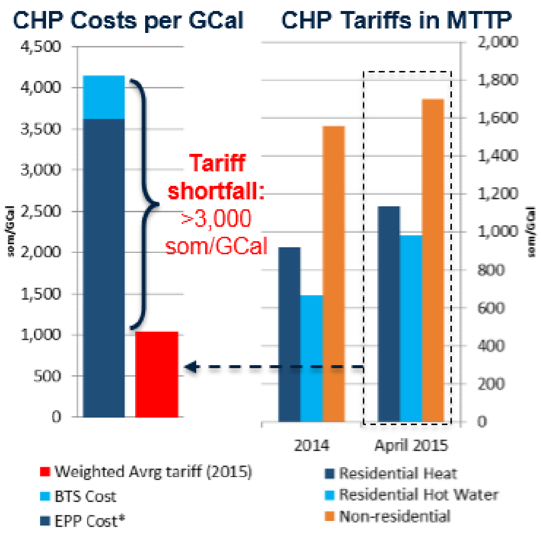
Figure 2.8: BTS Heating Purchase Tariff vs. Production Costs



Source: EPP OJSC

Even after the envisaged heat tariff increase in April 2015, weighted end-user tariffs remain 300 percent below the cost of heat supply incurred by BTS and EPP, as indicated in Figure 2.9 below.

Figure 2.9: CHP Costs per Gcal Compared to Weighted End-User Tariffs

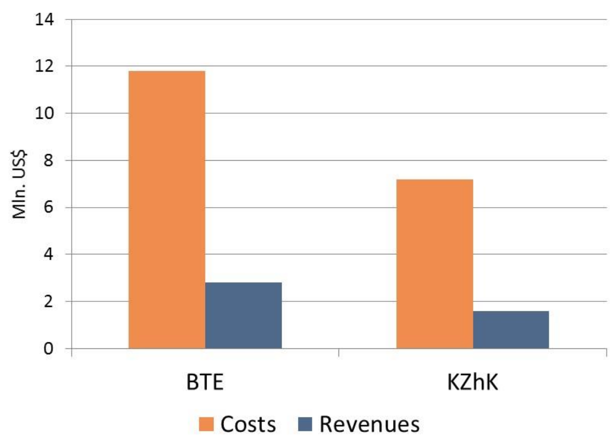


Source: Calculation based on EPP and BTS data.

Fuel costs are the primary driver of heat generation costs. In 2013, the average cost of supply for boilers operated by BTE was 3,666 Som/Gcal. The average cost by fuel was 3,729 Som/Gcal for gas; 3,381 Som/Gcal for coal; and 3,314 Som/Gcal for electricity. Operational costs are also dependent on the size and efficiency of the boiler. The cost of gas at gas boilers ranged from a low of 2,200 Som/Gcal to a high of 10,597 Som/Gcal. To minimize costs, the companies planned to or did convert gas-fired HOBs to coal. The companies have also discussed the conversion or replacement of electric HOBs with coal due to the low reliability of the electricity supply in recent years.

Because tariffs for most heat suppliers are so far below cost-recovery levels, most heat suppliers operate at a loss. For example, KZhK operated at a deficit of more than 1.2 billion Som in 2013. Figure 2.10 below shows costs and estimated revenues for KZhK and BTE in 2012. Costs were 77 percent higher than revenues for both companies.

Figure 2.10: BTE and KZhK Costs and Estimated Revenues, 2012



Source: BTE and KZhK

There are a number of additional regulatory issues related to the tariff setting process, which are further described in Appendix A. Box 2.4 discusses the subsidies that are provided to heat companies to help them cover their operational costs.

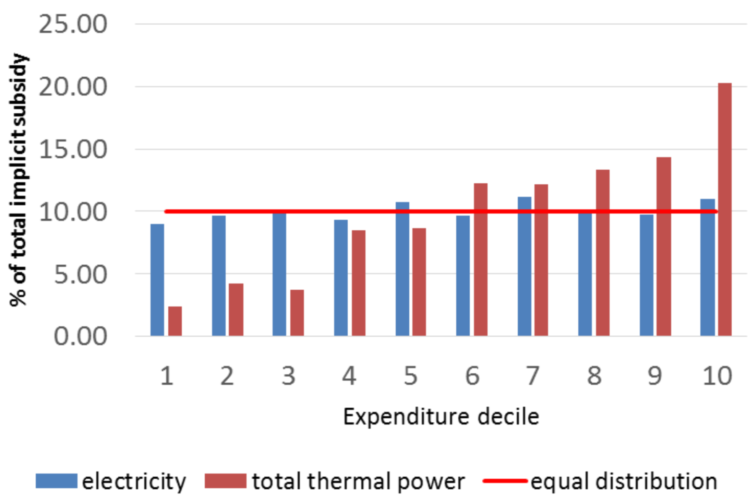
Box 2.4: Subsidy of Heat Supply Utilities

Municipally-owned heat supply companies receive financial support from the municipality to cover costs that are not covered by tariffs. The state-owned DH system in Bishkek does not receive direct subsidies but is extensively cross subsidized by the power sector. However, companies are not always fully compensated for their revenue gaps. In Bishkek and Tokmok, the city councils are supposed to pay the DH companies (BTE and KZhK, respectively) for the difference between the costs and revenue raised by the existing residential tariffs. However, there are often delays with the payments. Sometimes the compensation is only partial.

Furthermore, the direct and cross subsidies received only cover operational costs. As a result, all major DH companies lack funds for maintenance and rehabilitation of their existing assets. Heating tariffs are supposed to take depreciation expenses into account, but the allowed depreciation expenses are too low because the assets are undervalued. A lack of funds for maintenance and rehabilitation contributes to the continued decay of the existing infrastructure.

In addition, the implicit subsidies for heat and hot water (as a result of the below cost-recovery tariffs) are regressive and predominantly benefit the upper 50 percent of the population, as indicated in Figure 2.11 below.

Figure 2.11: **Distribution of Implicit Subsidies**



Source: World Bank calculations based on KHIS.

2.5 Affordability of Heat Supply

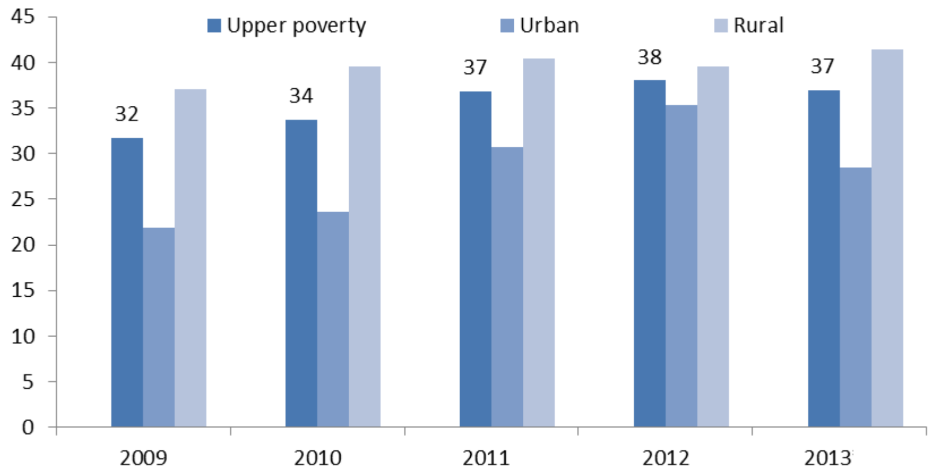
Energy poverty is on average lower than in some of the Kyrgyz Republic's ECA peers, but can vary considerably depending on the location and the population segment.

Moreover, energy poverty rates are low largely because end-user energy tariffs are substantially below cost-recovery levels.

2.5.1 Poverty and Energy Poverty in the Kyrgyz Republic

In 2013, 37 percent of the population of the Kyrgyz Republic lived in poverty, and an estimated 2.8 percent of the population lived in extreme poverty. Figure 2.12 below indicates that the gap in poverty between rural and urban areas narrowed between 2009 and 2012 but that this trend changed in 2013 due to a significant decline in urban poverty rates.

Figure 2.12: Percentage of the Kyrgyz Population Living in Poverty, 2009-2013

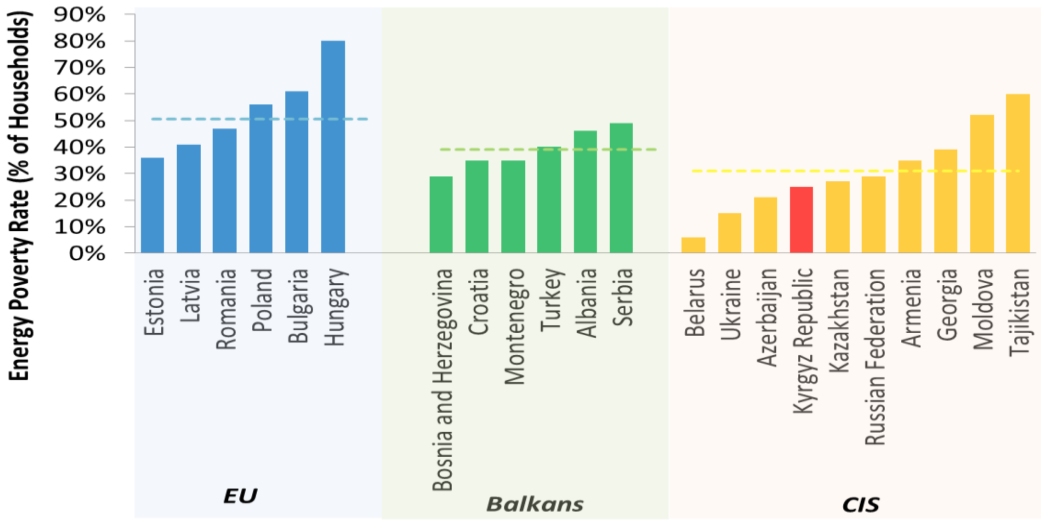


Source: National Statistical Committee of the Kyrgyz Republic.

Energy affordability is an important concern during the winter months in the Kyrgyz Republic when energy needs are highest. However, because of the exceptionally low electricity and heat tariffs, the Kyrgyz Republic has a lower prevalence of energy poverty than other ECA countries.[17] Figure 2.13 compares energy poverty rates in ECA countries and indicates that about 25 percent of households in Kyrgyzstan are energy poor.

[17] A household is considered to be in a state of energy poverty if it spends more than 10 percent of its total expenditures on energy such as electricity and heat.

Figure 2.13: Energy Poverty Rates in the ECA Region



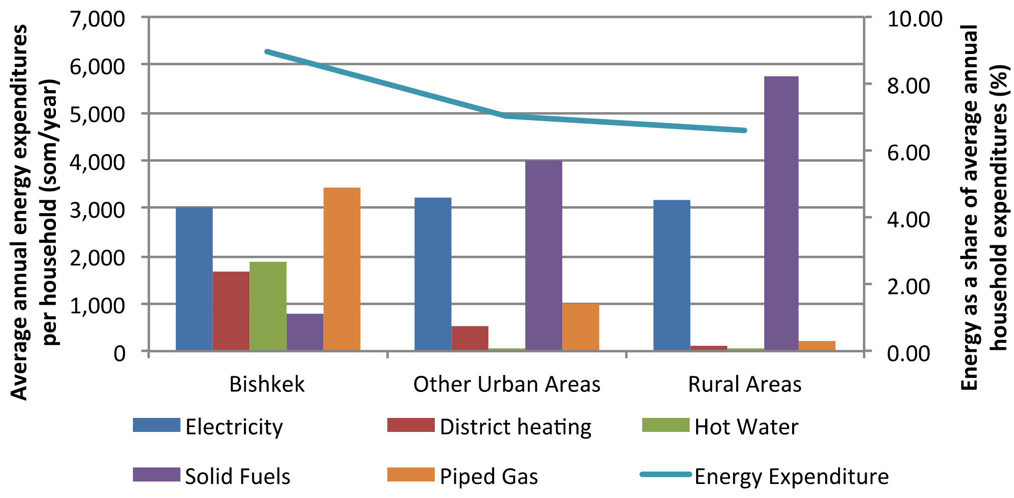
Source: Balancing Act, World Bank 2013.

Note: Horizontal dashed lines indicate average regional energy poverty rates.

The percentage of total household expenditures spent on energy varies by settlement type (urban or rural). On average, households spend 7.2 percent of household expenditures on energy. In Bishkek, the proportion of household expenditure on energy (9 percent) is higher than the national average. Households in urban areas other than Bishkek devote on average seven percent of their expenditures to energy, while rural households spend 6.6 percent.

Expenditure by heating source differs by location. In Bishkek, the average household spends 1.6 percent of its household expenditures on DH services, 2.5 percent on electricity, 2.7 percent on piped gas, 0.6 percent on solid fuels and 1.7 percent on hot water. In other urban and rural areas where households rely mostly on solid fuels such as wood or coal, households spend 2.9 and 3.9 percent of their energy expenditures obtaining them, respectively (other heat sources account for the other 4.2 and 2.7 percent of household energy expenditures for these two groups). Coal expenditures are higher in rural areas because of the higher reliance on coal, and the additional transaction and transportation costs. Figure 2.14 shows households' annual energy expenditure by source, settlement type and as a proportion of total household expenditures per capita.

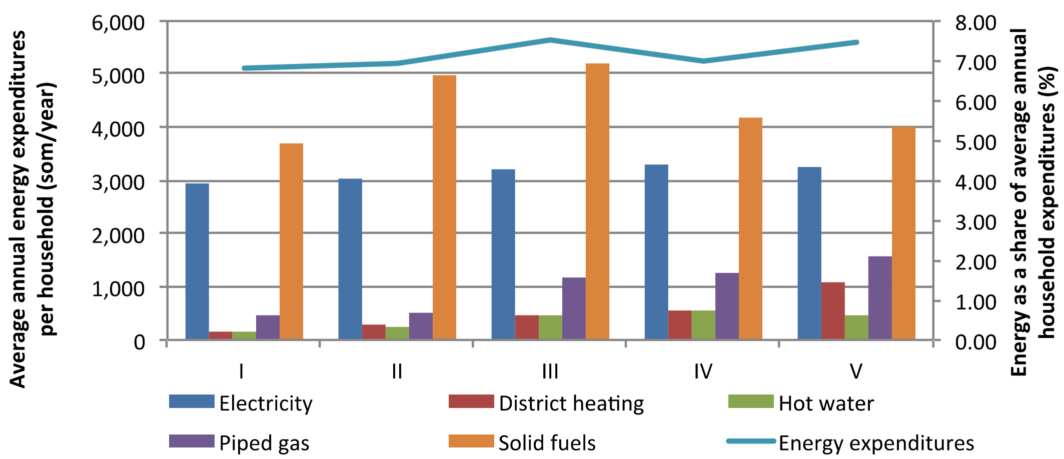
Figure 2.14: Energy Expenditures by Source, Settlement Type and as a Proportion of Total Household Expenditures



Source: Kyrgyz National Statistics Committee, KIHS, 2012.

Households across all income groups spend a similar proportion of their household expenditures on energy. Households in the poorest quintile spend about six percent while households in the highest quintile spend about seven percent (see Figure 2.15).

Figure 2.15: Energy Expenditures by Source, Expenditure Quintile and as a Proportion of Total Household Expenditures



Source: Kyrgyz National Statistics Committee, KIHS, 2012.

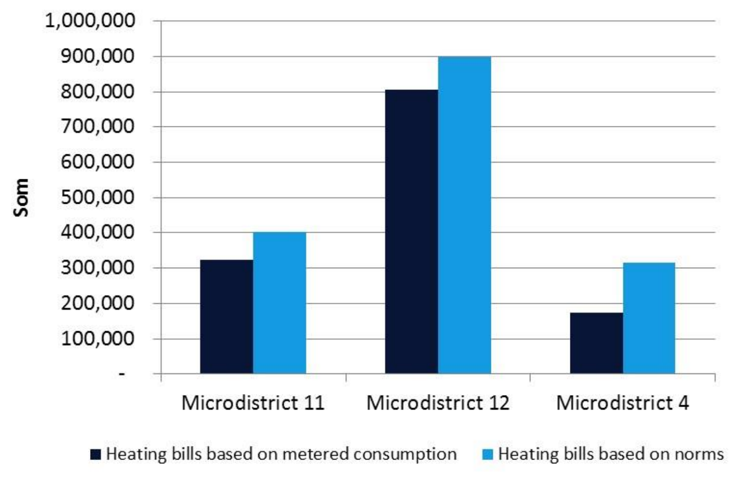
The recently conducted Quantitative Poverty and Social Impact Assessment indicates that the enacted increase in tariffs for DH and hot water will have only a marginal impact on the level of poverty. Based on simulations, the tariff increases are expected to result in the share of total household expenditures spent on heating increasing from 2.4 percent to 3.2 percent for DH and from 2 to 3.2 percent for hot water for those households connected to DH – a relatively moderate impact. The decrease in real income for the poorest quintile of the population is also limited, at only 0.9 percent for DH and 1.3 percent for hot water on average.

2.5.2 Coping Mechanisms for Managing Energy Expenditures in the Kyrgyz Republic

Focus group discussions revealed that households employ a variety of coping strategies to pay for heat energy in winter.[18] Urban households use budgeting and prepayment in order to cope with higher energy expenditures during winter months. Rural households sell livestock or crops. Borrowing money is a last resort for all households. Some households that use coal as a heating source attempt to purchase coal in bulk during the non-heating season. However, many poor households and farmers do not have sufficient funds before the harvest to pre-purchase coal. For households able to purchase coal in the non-heating season, coal storage has potential health hazards and can be risky. Coal must be kept in a dry and confined environment to prevent ignition or contamination. In addition to bulk fuel purchasing, households employ energy saving and efficiency techniques to lower their energy expenditures during winter. Most commonly, they insulate windows and doors. They also switch off lights or remove some light bulbs from light fixtures in the house.

In addition, switching to consumption-based billing for households could help to mitigate the impact of future tariff increases on DH customers. For instance, BTS compared heating bills for three buildings over two heating seasons, one when based on metered consumption and one when based on norms (see Figure 2.16 below). The heating bills in the three buildings (Microdistricts 11, 12 and 4) were 10, 20 and 45 percent lower, respectively, when billing was based on metered consumption.

Figure 2.16: Comparison of Heating Bills between Metered Consumption and Norm-Based Billing



Source: BTS

[18] The focus group discussions were conducted by a World Bank team as part of a recently-completed qualitative assessment of energy reforms in the Kyrgyz Republic.

3 Heat Supply and Demand in Bishkek

Bishkek is the capital and largest city of the Kyrgyz Republic. It has the status of both a city and a region. The official population is 874,400 people with an historical growth rate of roughly two percent per year. Bishkek has a continental climate and belongs to climatic region II with 2,970 degree days (0.2°C average outdoor air temperature during the heating season; 20°C design indoor air temperature). The average length of the heating season is 150 days.

The residential building stock in Bishkek consists of 89,000 individual family houses (44 percent of the residential floor space) and 2,500 apartment buildings, which make up the rest of the residential area. The city also has around 1,000 public buildings. The aging building stock is characterized by poor energy performance and high heat losses.

Most of the space heating in Bishkek is provided by two centralized DH systems. Small, building-level HOBs, individual electric radiators and coal- or wood-fired stoves and boilers are also used for heating (the latter, especially, in individual houses). There is a sizable gap between heat demand and supply in Bishkek. An estimated 20 percent of heat demand in residential buildings and 30 percent of heat demand in individual family houses is not met.[19] The gap is the result of the poor energy efficiency of most buildings and the poor condition of the heat supply infrastructure which has suffered for years from lack of maintenance and investment. These issues result in poor supply reliability and service quality.

3.1 Heat Supply in Bishkek

The following systems provide heat in Bishkek:

- EPP's CHP plant (CHP 1), and BTS' DH network which delivers heat from the CHP in Bishkek
- 57 large and small HOBs owned and operated by BTE
- 230 small HOBs owned and operated by various public buildings and private multi-apartment buildings
- Individual heating systems, including electric heaters and solid fuel-fired stoves

DH systems serve 98 percent of the multi-apartment buildings and 92 percent of the public buildings in Bishkek. Individual houses rely almost exclusively on individual systems. Table 3.1 summarizes how heat is supplied to residential and public buildings in Bishkek.

[19] Hot water demand numbers were not available, so the heat supply gap analysis was performed only for space heat demand.

Table 3.1: Coverage of Public and Residential Buildings by Different Heating Systems

	DH (CHP)		DH (HOBs)		Small HOBs		Individual		TOTAL
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	
Multi-apt bldgs.	2,080	83	364	15	55	2	-	-	2,499
Individual houses	1,339	2	129	0.1	-	-	87,546	98	89,014
Res. Area (Mln. m^2)	5.7	50	0.7	6	0.2	1	4.9	43	11.5
Households	115,505	51	16,821	7	5,380	2	89,014	39	226,720
Public Buildings	838	83	86	9	81	8	-	-	1,005

Source: Technical background report prepared by Fichtner.

Note: This table only shows the primary heating source used by different building types and excludes newly constructed 'elite buildings' due to the lack of available data. The share of households relying on individual heating systems would be significantly higher, if the use of individual solutions as secondary source were included. A recent survey conducted by Unison and USAid found that many households use multiple heat supply options. For instance, a large share of multi-apartment residents use some form of individual heat supply option in addition to DH or small HOB-based heat supply.

3.1.1 DH System Supplied by CHP 1

Most of the floor space in Bishkek is heated by EPP's CHP plant through BTS' DH network. Both the CHP and the distribution network are in poor condition because of age, under-maintenance and lack of investment.

CHP

CHP 1 operates primarily to meet winter heating demand, producing electricity as a byproduct. In 2012, the plant generated 2,142,000 Gcal of heat energy, 969,000 MWh of electricity and 152,000 Gcal of steam.

The CHP was commissioned in 1961. It was built with a capacity of 666 MW electrical and 1,679 MW thermal. The plant's poor condition, however, limits available capacity to 116 MW electrical and 1,030 MW thermal energy. According to EPP, 11 of 24 boilers are no longer in operation, the remaining boilers in operation have relatively low efficiency, and the level of wear and tear of the major equipment exceeds 80 percent. The plant is designed to burn gas, coal and mazut, but coal accounts now for 97 percent of the fuel burned at the facility. Table 3.2 compares the CHP's operations now to its operations when commissioned.

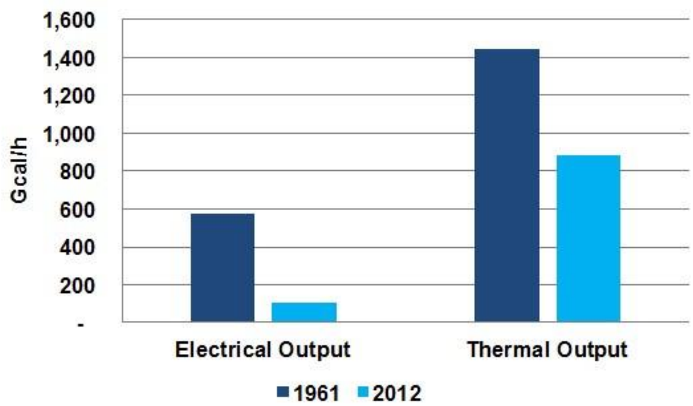
Table 3.2: Key Data on CHP 1 in Bishkek

	Today (2012)	At commissioning (1961)
Capacity		
Electrical output	100 Gcal/h (116 MW_{el})	572 Gcal/h (666 MW_{el})
Thermal output	886 Gcal/h (1,030 MW_{th})	1,444 Gcal/h (1,679 MW_{th})
Fuel		
Gas	40.46 million m^3 (3%)	(close to 100%)
Coal	799,710 tons (87%)	0
Fuel Oil (mazut)	21,668 tons (5%)	0
Supply temperature		
	63-76° C (max)	120° C
	Return temperature: about 40° C	
Supply		
Heat	2,142,000 Gcal (2,491,146 MWh)	-
Electricity	969,000 MWh	-
Steam	152,000 Gcal (176,776 MWh)	-

Source: EPP, 2012; Technical background report prepared by Fichtner.

Figure 3.1 below shows the generation capacity of CHP 1 at commissioning in 1961 compared to 2012. Electrical output was 82 percent below design capacity, while current thermal output was 39 percent below design.

Figure 3.1: Generation Capacity of CHP 1 (in Gcal/h), 1961 vs. 2012



Source: EPP, 2012; Technical background report prepared by Fichtner

The Government has secured a Chinese loan of US$390 million to modernize the CHP 1 plant. Reportedly, the rehabilitation will include dismantling of steam generation units (No. 1-8) and turbo sets (No. 1-4), and the installation of two new coal steam generation units (550 t/h) and two new turbo sets (150 MW). Modernization work was underway in 2014 with expected completion in 2016. This will result in a total capacity of 550 MW.

There is a second CHP (CHP 2) in Bishkek, which was only operational for one winter season. Box 3.1 below describes the history of CHP 2.

Box 3.1: Information on CHP 2 (Bishkek)

Construction of CHP 2 began in 1985 and included two phases: i) the installation of six steam HOBs; and ii) the installation of two steam 400 MWel units. In 1992, the first boiler began operations. Five km of transmission pipelines were constructed to supply the Bishkek DH system with hot water. A second boiler was commissioned in 1993.

The plant only operated during the 1992-1993 heating season. After the collapse of the Soviet Union, gas prices increased significantly, the number of industrial heat consumers dropped substantially because of the economic crisis in the country and new construction of residential buildings came to a halt. The plant was eventually shut down because of the financial burden of operating it and the reduction in heat demand.

CHP 2 is in poor condition. Considerable investment would be needed to make the plant operational again. Upgrades would have to be made to boilers and auxiliary equipment. EPP has estimated that rehabilitation would cost about 140 million Som (US$2.6 million), not including the costs of new pumping stations and a distribution system to connect with new residential areas.

BTS's DH Transmission and Distribution Network

As described in Section 2.2.2, heat generated by CHP 1 feeds into the transmission and distribution network of BTS to provide space heat and hot water to densely populated areas in the central and southern parts of Bishkek. The network operated by BTS includes 28 km overground and 112 km underground transmission pipelines, and 49 km overground and 197 km underground distribution pipelines. Figure 3.2 shows a map of BTS's DH transmission and distribution network.

In 2012, the company provided 1,372,075 Gcal heat to more than 100,000 customers, including about 83 percent of all residential multi-apartment buildings and 83 percent of the public buildings in the city.

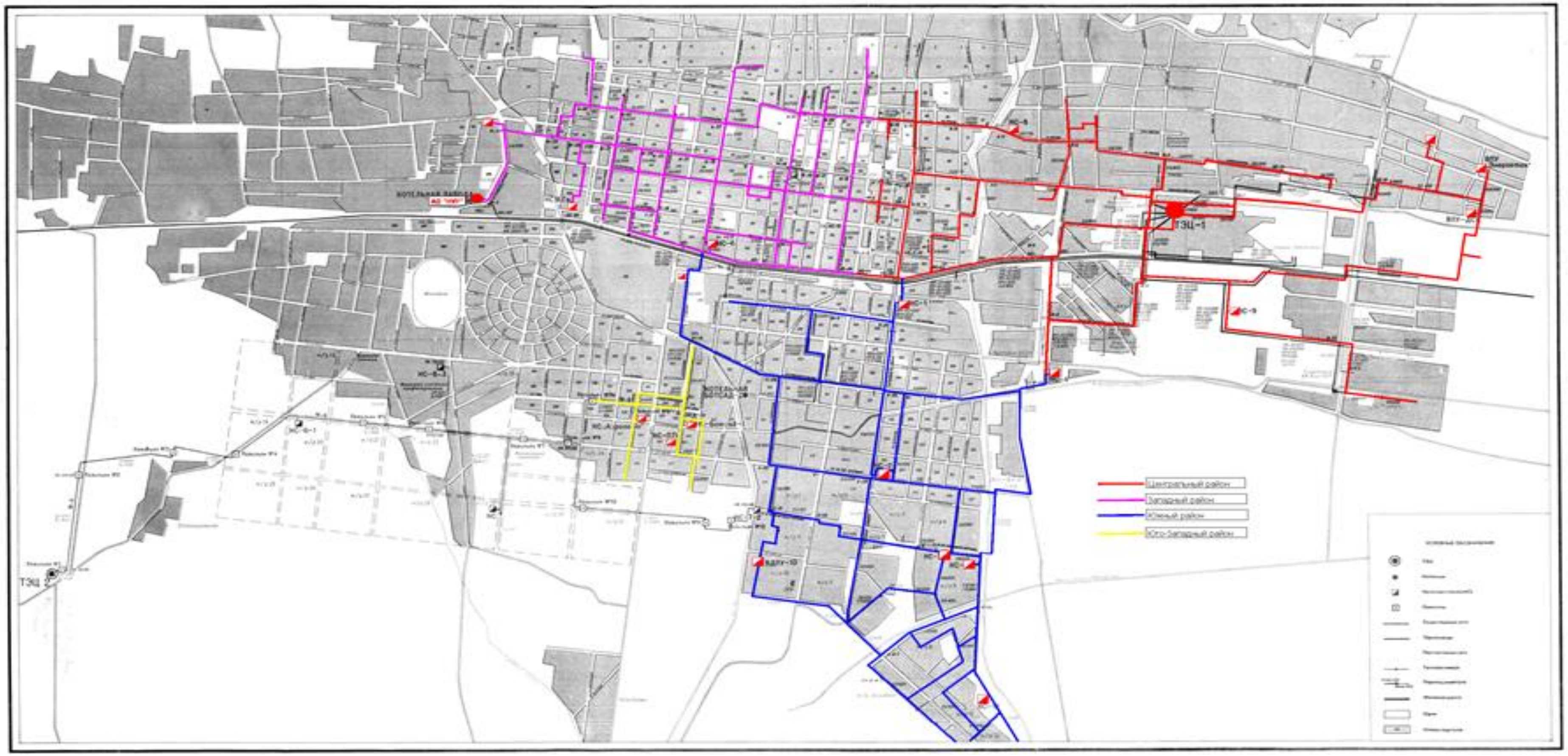
Table 3.3 shows the number of residential and public customers that receive heat from BTS, as well as the heated area/volume and the heat and hot water supplied in 2012.

Table 3.3: Customers Supplied by BTS (2012)

Type of customer	Number customers	Number buildings	Area or volume	2012 Hot Water Supply (Gcal)	2012 Space Heat Supply (Gcal)
Multi-apartment	98,469	2,080	5,590,160 m^2	408,299	577,046
Individual houses	1,339	1,339	122,964 m^2	11,226	43,581
Public	426	838	8,134,770 m^3	45,485	283,782
Industrial/ commercial	1,444	1,444	12,837 m^3	332	2,324
Total	**101,678**	**5,701**	**-**	**465,342**	**906,733**
Grand total				**1,372,075**	

Source: BTS, 2012

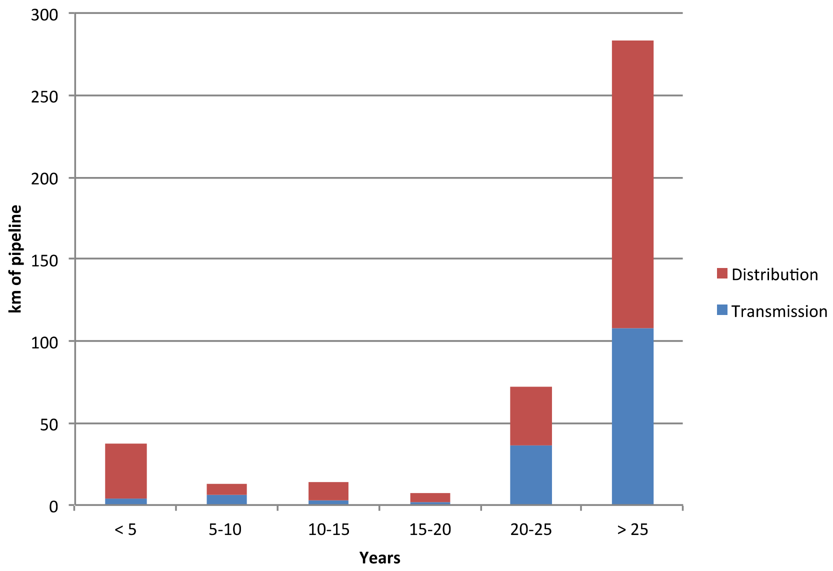
Figure 3.2: BTS's DH Transmission and Distribution Network



Source: BTS, 2012; pink: Western district, red: Central district, blue: South district and yellow: South-west district

Because of the age, under-maintenance and resulting poor condition of the pipelines that bring heat from CHP 1 to customers, technical losses are estimated at more than 26 percent of the heat dispatched by CHP 1.[20] Two-thirds of the two-pipe transmission and distribution network was built more than 25 years ago and need to be replaced. The underground pipelines that make up 75 percent of the network were originally well-insulated with mineral wool and covered by cement plaster but over time the condition of many pipelines has deteriorated. Leakages result in annual water losses estimated at 1.2 million m^3 (around seven percent of the water output from CHP 1). Figure 3.3 shows the age of transmission and distribution pipelines operated by BTS.

Figure 3.3: Age Distribution of CHP 1 DH Pipelines by Length of Pipeline



Source: BTS, 2012

Although more than 70 percent of the network pipelines are beyond their service life, BTS is only able to replace seven to eight km of pipelines per year due to insufficient funds. As a result, the number of network failures (i.e., breaks with related service interruptions) has increased from around an average of 50 per year in the early 1990s to an average of 220 per year between 2005 and 2013. In 2013, 317 network failures were reported – adding to high losses, decreasing heat supply reliability and increasing emergency maintenance costs. Figure 3.4 shows a picture of a damaged heat transmission pipeline.

[20] In similar DH systems that are in better condition, technical losses are around 10 percent.

Figure 3.4: Picture of Damaged CHP 1 DH Transmission Pipeline

Source: BTS, 2012

Part of BTS's transmission system consists of 19 DH pumping stations with a total installed electric capacity of 9,248 kW. This includes seven stations with capacities above 500 kW. Most of the pumping stations were built 30 to 40 years ago, but walk-through audits of five pumping stations showed that the pumps are generally well-maintained. Individual pumps have an average reported efficiency of 92 percent. However, the pumps are constant speed pumps, which means their speed cannot be adjusted, even if doing so would increase the efficiency of the entire system. As a result, the electricity consumption of the pumping system is high, amounting to 22,803 MWh per year. Five of the main pumps are equipped with variable speed drives (VSD), which can operate at different speeds dependent upon the needs of the system. The use of VSDs at these five pumps has resulted in electricity savings of about 30 to 40 percent. Figure 3.5 shows circulation pumps at DH Pump Stations 1 and 4.

Figure 3.5: Circulation Pumps at DH Pump Stations 1 (Left) and 4 (Right)

Source: BTS, 2012

The network also includes 2,030 open-circuit substations with automatic temperature and flow-control of supply, including 216 substations that are equipped with heat and hot water meters.[21] In total, about 75 percent of the multi-apartment buildings have building-level substations, while the remaining 25 percent use older hydro-elevators. Most of the substations were installed in the late 1990s, many with the support of the World Bank-financed Power and District Heating Rehabilitation Project, and are considered to have either exceeded their lifetime or are in need of urgent repairs.

The open system (providing both space heat and hot water) impedes the efficient operation and maintenance of the DH system, obstructs the introduction of modern controls and shortens the lifetime of the entire system (e.g., through high corrosion of the network pipes due to poor water quality/treatment). In addition, the open system could become a limiting factor in using the full heat supply capacity of the CHP. Specifically, the open system is one factor limiting the transmission flow temperature to around 80 to 90° C, cutting the transmission and distribution capacity to about half of the maximum. Using the full temperature regime instead would reduce capacity investment needs in pipes and pumps, reduce pumping costs and increase the amount of CHP heat delivered to end-consumers. This will be critical once the rehabilitation of CHP 1 is completed – without investments in BTS's transmission and distribution network, the network will not be able to absorb the additional heat supplied by the CHP1, and the sizeable investment in the plant's modernization will not generate the full benefits for the population, public service delivery and businesses. Using the full temperature regime would further increase comfort levels (by eliminating under-heating), enable the company to serve more customers and help optimize investments targeting the network and pumping capacity.

Only 16 percent of the public and residential consumers have building-level heat meters and 44 percent have hot water meters. In addition, customers are not able to regulate their consumption due to the lack of apartment-level thermostatic valves. As a result, most customers are billed based on norms, not actual heat and hot water consumption. This results in high commercial losses in particular for hot water (almost 40 percent of the water output)[22], impacts the efficiency and service quality of DH supply, inflates heating bills for customers (see Section 2.5.2) and provides no incentives for consumers to improve the energy efficiency of their dwellings. Figure 3.6 shows photos of worn out hot water pipelines and flow regulation technology at a heat substation.

[21] There are no heat exchangers at building- or apartment-level, which would hydraulically separate the DH circulation water, the building-internal heating circuits (radiators) and the domestic hot water. As a result, customers are directly tapping hot DH circulation water for domestic use, such as showers, washing, etc.

[22] Because customers are billed for hot water based on the number of registered people, almost 40 percent of the hot water is 'non-demanded' or billable (but consumed). Commercial losses for heat are estimated at 7 percent of the heat dispatched by the CHP 1.

Figure 3.6: Worn-Out Hot Water Pipelines (Left) and Flow Regulation at a Substation (Right)

Source: BTS, 2012

The design and condition of the internal piping network within apartment buildings is also problematic, preventing the even heating of apartments throughout individual buildings. Customers located at the beginning of the internal piping network tend to receive higher temperature heat than customers at the end of the piping network. For this reason – and because customers have no control over their heat consumption – some residential DH systems customers are "under-heated" while others are "over-heated."

3.1.2 Large and Small HOBs Operated by BTE

In 2012, BTE supplied 155,110 Gcal of space heat and hot water to residential, public and commercial consumers. Residential customers living in multi-apartment buildings represented the largest customer group, consuming about 75 percent (or 115,571 Gcal) of the heat and hot water supplied. Overall, 14 percent of multi-apartment buildings and eight percent of public facilities are connected to BTE's network. Domestic hot water is produced and delivered to customers during the heating season.[23] Table 3.4 below shows customers supplied by BTE in 2012, and the amount of heat and hot water supplied to each customer segment.

[23] During the off-heating season, hot water is produced at 15 large boiler houses with a capacity of one Gcal.

Table 3.4: Customers Supplied by BTE (2012)

Type of customer	Number of customers	Number of buildings	Area or volume	2012 Hot Water Supply (Gcal)	2012 Space Heat Supply (Gcal)
Residential (multi-apartment	13,108	364	669,450 m²	42,819	72,752
Residential (individual houses)	129	129	11,327 m²	0	3,637
Public	86	86	834,833 m³	3,932	26,098
Industrial/commercial	94	94	-	2,706	3,166
Total	**13,417**	**673**	**-**	**49,457**	**105,653**
Grand Total				**155,110**	

Source: BTE

To supply its customers, BTE owns and operates 57 boiler houses that contain a total of 74 boilers. Each boiler house supplies heat to one or more buildings via installed piping with a total length of about 108 km. The total installed capacity is 182 Gcal/h (212 MWth) and the operational capacity as of 2012 was 89.9 Gcal/h (104 MWth). Two-thirds of the operational capacity is provided by nine large HOBs. Data for the main facilities are presented in the tables below (large HOBs in Table 3.5, and small HOBs in Table 3.6).

Table 3.5: Large HOBs (BTE SUE, 2012)

Boiler location	Fuel	Distribution network [m]	Installed capacity [Gcal/h]	Operational capacity [Gcal/h]
Gagarina	Coal	4,210	12.6	3.8
Dzal	Gas	7,774	20.4	16.8
Rotor	Gas	10,551	19.2	12.5
Hospital	Gas	11,078	17.4	6.8
Botsad	Mazut	2,618	8.5	5.6
KZC-2	Gas	13,897	10.8	8.0
NGC	Gas	9,280	6.7*	4.0
Fakel	Gas	8,660	7.0*	4.2
Total		**68,068**	**103**	**62**

Source: BTE SUE, 2012; Note: * Estimated value.

Table 3.6: Small HOBs (BTE SUE, 2012)

Boiler location	Fuel	Distribution network [m]	Installed capacity [Gcal/h]	Operational capacity [Gcal/h]
School № 54	Coal	284	1.1	0.2
CSAD	Gas	157	1.2	-
School internat	Gas	1,315	3.4	1.0
V/cast 7705	Gas	830	3.0	0.4
BSM	Gas	3,276	n/a	2.3
KZC-1	Gas	3,835	n/a	3.3
M/Raion	Gas	1,682	n/a	2.8
Ilbirs	Gas	6,126	n/a	2.7
NII zemled	Gas	7,014	n/a	3.2
KTL	Electricity	1,464	n/a	1.3
Urickogo	Gas	3,142	n/a	1.5
Other (37)	Various	8,706	n/a	9.4
Total		**37,831**	**79***	**27.9**

Source: BTE SUE, 2012; Note: * Estimated value.

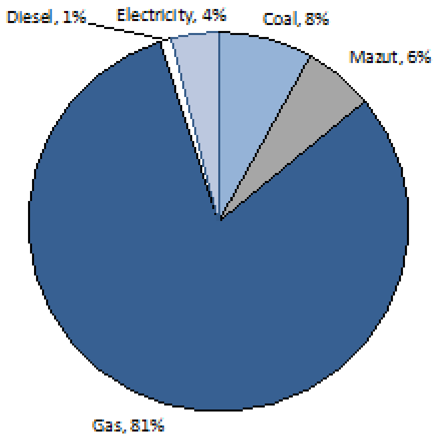
The majority of BTE's boilers were installed between 1960 and 1989 and most generation units were originally designed for natural gas. Because of the shortage and increasing costs of gas, some boiler houses have been redesigned and converted to burn coal or mazut.

The conversion of boilers from natural gas to coal significantly reduced their operational capacity and efficiency. Furthermore, flue gas cleaning systems were never installed to mitigate the air pollution created by coal burning, so the converted boilers have high emissions. The average combustion efficiency of the 23 coal-fired boilers (in 18 boiler houses) is estimated at 41 percent, while the average combustion efficiency of the mazut, gas and diesel-fired boilers is between 72 and 76 percent. The electric boilers have efficiencies of 100 percent. [24]

As indicated in Figure 3.7 below, gas-fired boilers still account for the majority of HOBs in terms of operational capacity. While all boiler houses are equipped with make-up water systems—including filtering, chemical treatment and degasification—only large gas-fired boilers are equipped with automatic burners. There are no heat meters at the outlets of the boiler houses.

[24] These 14 electricity boilers are mainly installed at the premises or near end-consumers (mostly public buildings). Their operational capacity ranges from 0.1 Gcal/h to 1.32 Gcal/h.

Figure 3.7: Percentage of BTE's Boilers' Operational Capacity Using Each Fuel Type



Source: BTE SUE, 2012

The length of the BTE pipeline network from the 57 boiler houses to end-consumers varies between 30 m and 14 km. Most of the networks are two-pipe systems, which provide both space heating and hot water (open systems).[25] Because of the lack of funding for adequate maintenance and replacement of worn-out pipes, the pipeline network is in poor condition and the insulation of many pipes is severely damaged. However, because the networks are relatively short, the overall heat losses are relatively low (compared to BTS), ranging from 12 to 21 percent.

Table 3.7: Pipeline Network of BTE SUE

	Total length [km]	**Underground [km]**	**Overground [km]**
Transmission	14	10	4
Distribution	94	47	47
Indoor (customer premises)	13	-	-
Total	**121**	**57**	**51**

Source: BTE SUE, 2012

BTE's network also includes roughly 167 electric water pumps with a total capacity of 3,416 kW and an annual electricity consumption of about 10.8 GWh per year. On average, there are two to four pumps with installed capacities of 15 to 200 kW per boiler house. Most of the pumps are between 25 and 50 years old and are at or beyond their service lives. None of the major pumps is equipped with variable flow control.

Many of the building-level problems with the DH network supplied by CHP 1 also apply to the BTE system. Where installed, most of the building-level substations use hydro-elevators and consumers have no heat metering or control devices. As a result, billing is based on calculated demand rather than actual consumption. In addition, many of

[25] The 15 networks distributing heat from larger HOBs (above one Gcal/h) have a 4-pipe configuration.

the building-level substations and internal piping infrastructure are in poor condition. These problems lead to the inefficient use of energy, result in high energy losses, and provide no possibility for consumers regulating their heat consumption and bills.

3.1.3 Small Building-Level HOBs

Small HOBs are dedicated boilers that are located on-site and supply one to several buildings (connected by a short network). Small HOBs are generally owned by the building that they supply.

Given that about 250 multi-apartment buildings and 82 public buildings are not connected to the DH network (because of their location and/or the limited capacity of the DH system), they depend on alternative heating sources. It is assumed that these multi-apartment and public buildings are using small HOBs. The total heat supplied by these small HOBs is estimated at 64,547 Gcal. Around 55 percent of the small HOBs (185 boilers) are estimated to be based on electricity, 25 percent (67 boilers) on gas and 20 percent (46 boilers) on coal.

Table 3.8: Customers Supplied by Small Building-Level HOBs

Type of customer	Number of buildings	Area or volume	Supply (Gcal)	Share of supply electric boilers	Share of supply coal boilers	Share of supply gas boilers
Residential (multi-apartment buildings)	55	153,515 m^2	14,547	55%	40%	5%
Public buildings	81	786,296 m^3	50,000			

Source: Technical Background Report prepared by Fichtner.

3.1.4 Individual Heating Systems

Individual heating systems are used to heat a single dwelling. These systems include oil or spiral radiators, coal or wood burning stoves or boilers, electric boilers or air conditioners. Only about one percent of individual family houses are connected to the DH system. The rest use individual heat devices as their primary source for heating. It is estimated that 364,000 Gcal—about 18 percent of all residential and public building space heat supply—is provided by individual electrical systems (mostly electrical oil/spiral radiators). Estimates also suggest that 576,000 Gcal–about 28 percent of all residential and public building space heat supply—is covered by individual coal stoves or boilers in individual family houses. About 41,000 Gcal or two percent of all heat supply is supplied by individual gas-based boilers. In total, about 39 percent of all households depend exclusively on individual heating system. As indicated earlier, a large share of households supplied by DH also use individual heating systems (mostly electricity-based) as secondary sources because DH is insufficient to meet their heat demand, particularly at the beginning and the end of the official heating season.

Table 3.9 shows the number of buildings, amount of heat supplied and share of total heat consumption that comes from individual systems in Bishkek.

Table 3.9: Heat Supplied by Individual Systems in Bishkek by Fuel Type

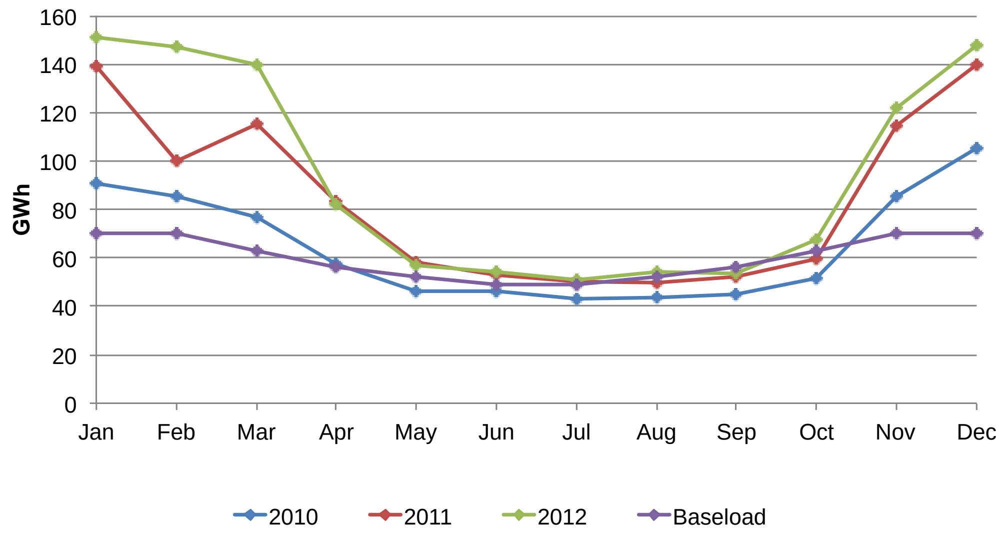
Type of customer	Number of buildings		Supply from individual systems (Gcal/yr)	Share of total 2012 heat supply for each building type supplied by individual systems		
	Total	Using ind. systems as primary heating source		Electricity	Coal or wood	Gas
Multi-apartment building	2,499	0	13,761	2%	-	-
Individual houses	89,014	87,546	959,999	34%	57%	4%
Public buildings	1,005	0	8,655	2%		
TOTAL	91,513	87,546	982,415			

Source: Technical background report prepared by Fichtner.

Note: Buildings may supplement DH-based heat supply with individual heating systems, which is why all buildings are shown in the "Total" column. Only those buildings listed in the "Using ind. systems as primary source of heat" column rely exclusively on individual systems for heating. The supply column shows all heat supplied by individual systems, whether primary or supplementary (for "topping-up").

As mentioned in Section 2.3.3, the popularity of electricity for heating contributes to high residential electricity consumption during the winter months. In 2012, residential electricity consumption in January and December in Bishkek was almost three times as high as residential electricity consumption in June and increased by more than 50 percent over the period since 2010. Figure 3.8 shows monthly electricity consumption in the residential sector for the years 2010 to 2012.

Figure 3.8: Monthly Residential Electricity Consumption in Bishkek (2010 to 2012)



Source: Severelectro.

As a result of the growth in residential electricity consumption during winter months, which was driven by the increasing reliance on electricity for heating, distribution networks in the city have become increasingly overloaded. Combined with insufficient investment in power infrastructure, the growing demand for heating accentuates the deteriorating power supply reliability in Bishkek. From 2010 to 2012, Severelectro reported an average of 20 outages per day during winter and 15 outages per day on an annual basis. This corresponds to around 360 hours without electricity supply per year.

3.2 Heat Demand in Bishkek

Heat demand was estimated for Bishkek based on the characteristics of the residential and public building stock in the city. The housing stock in Bishkek includes 91,513 residential buildings with a total residential area of 11.5 million m^2 and 1,005 public buildings with a total volume of 9.8 million m^3. Table 3.10 provides a breakdown of Bishkek's residential building stock area, population and households by type of building.

Table 3.10: Residential Building Stock in Bishkek

Parameter	Number	Proportion of total
Overview		
Total residential area (m^2)	11,493,200	100%
Total population	874,400	100%
Total residential area per capita (m^2/person)	13.1*	
Total number of households	226,720	100%
Individual houses		
Number of houses	89,014	97%
Total residential area (m^2)	5,080,076	44%
Average size of house (m^2)	57*	
Population	386,491*	44%
Number of households	89,014**	39%
Total area per capita (m^2/person)	13.1*	
Average size of household	4.3*	
Multi-apartment buildings		
Number of buildings	2,499	3%
Total residential area (m^2)	6,413,125	56%
Number of flats	137,706	
Flats per building	55*	
Average size of flat (m^2)	47*	
Population	487,909*	56%
Number of households	137,706	61%
Total area per capita (m^2/person)	13.1*	
Average size of household	3.5*	

Source: National Statistics of the Kyrgyz Republic, 2013; Note: * Calculated value.

In order to estimate total annual heat demand for each building type, a standardized set of assumptions about the amount of heat demand each year per unit of floor space was developed for each type of residential and public building described in Section 2.1. Based on the results of walk-through energy audits of typical residential and public buildings, heat demand assumptions were created.[26]

As is the case for most of the Kyrgyz Republic, the energy performance of the building stock in Bishkek is poor, especially in multi-apartment buildings built before 2000. This is partially due to the fact that most multi-apartment buildings in Bishkek have not undergone any refurbishment since construction and are poorly maintained. Where windows have been replaced, the replacements are of relatively poor quality and therefore do not improve the energy performance of the buildings as much as higher quality replacements might.

Individual houses and public buildings face a similar situation. Building envelopes and building-internal heating infrastructure have not been maintained or rehabilitated.

The total heat demand and heat demand by building type during a typical year in Bishkek were calculated by combining the estimated heat demand for each building type with data on the area of each building type in Bishkek. Table 3.11 and show the results of the heat demand analysis for different types of residential and public buildings for a typical year in Bishkek.

Table 3.11: Total Heat Demand of Residential Buildings (Bishkek, Average Year)

Type	**No. of bldgs.**	**Avg. heated area (m²)**	**Specific demand for space heating (kWh/m²)**	**Specific demand for hot water (kWh/m²)**	**Total specific heat demand**		**Total* heat demand (Gcal/yr)**
					kWh/m²	**Gcal/m²**	
Type I	886	2,730	100	50	150	0.13	314,441
Type II	680	2,830	130	50	180	0.15	288,660
Type III	459	2,255	130	50	180	0.15	155,257
Type IV	15	5,985	130	50	180	0.15	13,466
Type V	249	2,580	100	50	150	0.13	83,515
Other	210	1,445	130	50	180	0.15	45,518
Indiv. family houses	89,014	57	285	50	335	0.29	1,471,401
Total	**91,543**	**-**	**-**	**-**	**-**	**-**	**2,372,258**

Note: * This column includes demand for both space heat and hot water.

Source: Technical background report prepared by Fichtner based on walk-through audits.

[26] Walk-through energy audits were conducted at seven multi-apartment buildings and two individual family houses. Public building walk-through audits were conducted at four primary/secondary schools, two kindergartens, one administrative and social building and one hospital.

Table 3.12: Total Heat Demand of Public Buildings (Bishkek, Average Year)

Type	No. of bldgs.	Avg. heated vol. (m^3)	Specific demand for space heat (kWh/m^3)	Specific demand hot water (norm) (kWh/m^3)	Total specific heat demand		Total* heat demand (Gcal/yr)
					(kWh/m^3)	($Gcal/m^3$)	
Schools	432	11,000	30	0	30	0.026	122,580
Kinder-gartens	189	7,900	60	5	65	0.056	83,449
Other edu.	65	11,000	60	0	60	0.052	36,887
Health care	64	14,200	36	22	58	0.050	45,323
Other public	255	7,400	45	0	45	0.039	73,014
Total	**1,005**	**-**	**-**	**-**	**-**	**-**	**361,523**

Note: * This column includes demand for both space heat and hot water.

Source: Technical background report prepared by Fichtner based on walk-through audits.

The total estimated demand for heat and hot water in residential buildings in Bishkek amounts to 2,372,258 Gcal per year, as shown in Table 3.11 above. Hot water accounts for approximately 33 percent of residential heat demand. Individual family houses account for only 44 percent of the residential heated area in Bishkek, but make up 54 percent of the heat demand in the city.

As shown in Table 3.12, total demand for heat and hot water in public buildings is 361,523 Gcal per year. It is assumed that heat for hot water is used only in hospitals and kindergartens. Educational buildings account for about 67 percent of heat demand in public buildings. Current total peak heat demand for the residential and public sector is estimated at almost 3,000 MW.

Table 3.13 below summarizes the space heating demand by customer segment in a typical year based on the analysis above.

Table 3.13: Space Heat Demand by Customer Segment in Bishkek (Average Year)

Customer segment	Space heat demand (Gcal/yr)*
Multi-apartment buildings	637,977
Individual family houses	1,243,364
Public buildings	337,642
Total	**2,218,983**

Note: * This table only shows space heat demand; demand for hot water is not included.

Source: Technical background report prepared by Fichtner.

3.3 Heat Supply-Demand Gap

The estimated amount of heat demanded in 2012 was calculated and compared to the estimated amount of heat supplied (including by electricity) in 2012 to calculate the heat supply-demand gap in Bishkek. The heat supply-demand gap is the magnitude of unmet heating demand. The heat supply-demand gap was calculated based on data for 2012, the most recent year for which heat supply information was available. The Kyrgyz Republic had a substantially colder than average winter in 2012; there were 10 percent more heating degree-days than in a typical year. Therefore, in order to more accurately calculate the supply gap that occurred in 2012, adjustments had to be made to the demand numbers for an average year (as presented in Section 3.2) to account for the colder temperatures. These adjusted demand numbers were then used in the calculations to determine the heat supply-demand gap.

The heat supply gap for 2012 was estimated as follows:

- Total heat demand in residential buildings was estimated based on the characteristics of the building stock, taking into account the specific number of the degree days in Bishkek in 2012 and the normative requirements for indoor temperature.
- The amount of heat supplied in 2012 was then estimated based on supply data provided by heat and electricity companies. Estimates of the amount of electric 'top-up heating' were made based on available statistical data and data on electricity consumption patterns.
- The supply gap or unmet demand is assumed to be the difference between the calculated demand level and the amount of heat supplied as of 2012.

Table 3.14 below shows the amount of heat for space heating supplied to residential buildings by each heating source in Bishkek in 2012, as previously shown in Section 3.1. Table 3.15 shows the difference between the amount of space heat demanded (adjusted for 2012 from the baseline demand for an average year shown in Table 3.13) and the amount of space heat supplied for residential buildings in Bishkek in that year.

Table 3.14: Space Heat Supplied to Each Residential Customer Segment by Heat Supply System in Bishkek (2012)

	DH	**HOBs (BTE)**	**Small HOBs**	**Individual Systems**	**Total**
	Gcal/yr				
Multi-apartment buildings	577,046	72,752	14,547	13,761	**678,105**
Individual family houses	43,581	3,637	0	959,999	**1,007,217**
Total	**620,627**	**76,389**	**14,547**	**973,759**	**1,685,322**

Source: Technical background report prepared by Fichtner.

Table 3.15: Space Heat Supply-Demand Gap in Bishkek (2012)

	Space Heat Demand*	Space Heat Supply	Supply-Demand Gap	Supply-Demand Gap (% of demand)
	Gcal/yr			%
Multi-apartment buildings	702,573	678,105	24,468	3%
Individual family houses	1,371,427	1,007,217	364,210	27%
Total	**2,074,000**	**1,685,322**	**388,678**	**19%**

Note: * This table shows demand numbers that have been adjusted from baseline to account for the colder-than-average winter in 2012.

Source: Technical background report prepared by Fichtner.

This analysis shows that the estimated space heat supply gap was equal to 19 percent of overall demand in residential buildings.[27] The gap is greatest in individual family houses, where an estimated 27 percent of space heat demand was not met. The gap was lower in multi-family apartment buildings (three percent of demand).

The supply-demand gap is not presented for public buildings because the data for 2012 were found to be unreliable for this customer segment. Although anecdotal evidence indicates that there was severe under-heating in public buildings in 2012, the available data suggest that there was a very small space heat supply gap in public buildings in that year. Because of this discrepancy between the observed situation and the reported figures, the data for public buildings are assumed to be unreliable.

[27] Hot water demand numbers were not available, so the heat supply gap analysis was performed only for space heat demand.

4 Heat Supply and Demand in Tokmok

Tokmok is located in Chui province in the northern part of the Kyrgyz Republic, about 60 km east of Bishkek. The official population was 54,000 as of 2012. The population has decreased by almost 30 percent since 1989. Tokmok belongs to climatic region II with 3,212 degree days and an average duration of the heating season of 150 days.

The residential building stock in Tokmok consists of 7,000 individual family homes that house 56 percent of the population (54 percent of the residential floor space), and 234 apartment buildings (46 percent of the residential floor space). The city also has around 40 public buildings. Residential and public buildings are characterized by poor energy efficiency and high heat losses.

Similar to Bishkek, most of the space heating is provided by DH, while individual homes use electric radiators and coal or wood stoves and boilers. An estimated 25 percent of heat demand in residential buildings and more than 30 percent of heat demand in individual family houses is not met. The gap, as in Bishkek, is the result of the poor energy efficiency of most buildings and the poor condition of the heating infrastructure. The heat supply infrastructure has suffered from years of under-maintenance and under-investment resulting in poor supply reliability and service quality. Tokmok's DH system also has longer transmission pipes relative to load, resulting in higher heat losses than on Bishkek's networks.

4.1 Heating Systems in Tokmok

Heat in Tokmok is provided by the following systems:

- Seventeen large and small HOBs owned and operated by KZhK Tokmok SUE and Zhululuk SUE
- Individual heating systems

DH serves the majority of multi-apartment buildings and all public buildings. Individual family houses rely primarily on individual heating solutions, but the majority of households in multi-apartments reportedly also use individual heating systems to supplement the heating from the DH system. Table 4.1 shows the coverage of public and residential buildings by different heating systems.

Table 4.1: Coverage of Public and Residential Buildings by Different Heating Systems (Tokmok, 2012)

	DH (HOBs)		Individual		Total
	Number	%	Number	%	
Multi-apt bldgs.	234	100	0	0	234
Individual houses	140	2	7,058	98	7,198
Res. area (Mln. m^2)	0.53	47	1.12	47	1.12
Households	10,415	60	17,285	100	17,285
Public buildings	41	100	0	0	41

Note: This shows only data on the primary heating systems used by each building type. Most multi-apartment buildings also use individual heating sources in addition to the DH systems, but this is not shown here.

4.1.1 DH in Tokmok

The DH system in Tokmok consists of two large HOBs (with eight boilers installed) and three small HOBs (also with eight boilers installed) owned and operated by Tokmok KZhK SUE. There is also one boiler house with two boilers, owned and operated by the municipal company Zhululuk SUE. Each company owns and operates an associated transmission and distribution network.

Tokmok KZhK SUE and Zhululuk SUE collectively provide 37 percent of all space heat supplied to residential and public buildings in Tokmok. KZhK supplies approximately 90 percent of space heat for multi-apartment buildings and about 70 percent of the space heat for public buildings. Zhululuk provides approximately five percent of the multi-apartment building heat supply and 32 percent of the public building heat supply. Table 4.2 shows the number of customers of each type and the amount of space heat supplied by Tokmok KZhK SUE in 2012. Table 4.3 shows the number of customers of each type as well as the amount of space heat supplied by Zhululuk SUE in 2012.

Table 4.2: Customers Supplied by Tokmok KZhK SUE (2012)

Type of customer	Number of customers	Number of buildings	Area or volume	Supply (Gcal)
Residential (multi-apartment	9,372	213	469,452 m^2	54,162
Residential (individual houses)	140	140	12,040 m^2	474
Public	28	24	226,771 m^3	7,089
Industrial/commercial	36	36	7,552 m^2	293
Total	**9,576**	**413**		**62,018**

Source: Tokmok KZhK SUE

Table 4.3: Customers Supplied by Zhululuk SUE (2012)

Type of customer	Number of customers	Number of buildings	Area (m^2) or volume (m^3)	Supply (Gcal)
Residential (multi-apartment	903	21	46,284	3,263
Residential (individual houses)	-	-	-	-
Public	19	17	160,629	3,334
Industrial/commercial	-	-	-	-
Total	922	38		6,597

Source: Zhululuk SUE

Table 4.4 shows the principal technical characteristics of the boilers owned and operated by the DH companies in Tokmok.

Table 4.4: DH Facilities (Tokmok, 2012)

Boiler house	Number of boilers (backup boilers)	Fuel (secondary fuel)	Distribution network (km)	Installed capacity (Gcal/h)	Operational capacity (Gcal/h)
Facilities owned by Tokmok KZhK SUE					
1	4 (2)	gas (fuel oil)	16.6	8.9	5.6
2	3 (1)	gas (fuel oil)	29.9	25.0	8.8
3	5 (2)	gas (fuel oil)	21.1	45.0	16.0
4	2 (0)	coal	0.3	0.3	0.1
5	2 (1)	coal	0.5	0.6	0.4
Total	**16**	**-**	**68.3**	**79.8**	**30.9**
Facilities owned by Zhululuk SUE					
1	2 (1)	gas (fuel oil)	9.8	13	N/A

Source: Tokmok KZhK SUE, Zhululuk SUE

The DH boiler houses of both companies are in poor condition. Tokmok KZhK's boilers were installed between 1971 and 1993 and have been poorly maintained due to lack of funds. The Zhululuk SUE-owned boiler house was installed in 1975 and has not been rehabilitated or refurbished since.

The DH transmission pipes and substations in Tokmok are also old and dilapidated because funds have not been available for proper maintenance. The transmission pipes lack insulation. They are long relative to the load they serve (the DH network in Tokmok supplies 790 Gcal/km, compared to 4,400 Gcal/km over the Bishkek network). Heat losses on the networks of both companies are estimated to be as high as 35 percent, owing to the condition of the network and its length relative to load. As in Bishkek, Tokmok KZhK's DH system pumps have only constant speed drives (instead of variable speed drives), which leads to excessive electricity consumption at the pumps.

4.1.2 Individual Heating Systems in Tokmok

Individual heating systems supply about 62 percent of space heat in Tokmok. Table 4.5 shows the number of buildings heated with individual heat supply systems and the estimated share of total space heat supply by each fuel type.

Table 4.5: End-Users Heating with Individual Systems and Heat Supply from Individual Heat Systems by Fuel

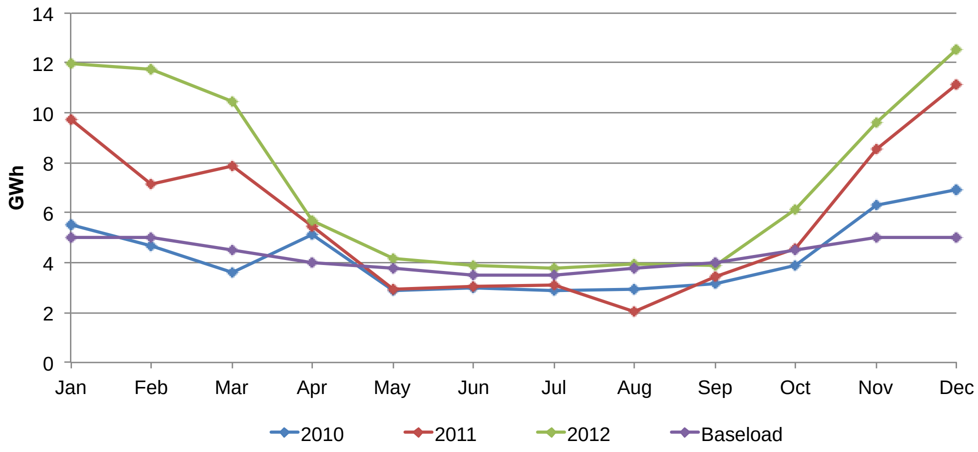
Type of customer	Number of Buildings		Supply from individual systems (Gcal)	Share of total 2012 heat supply for each building type supplied by individual systems		
	Total	Using ind. systems as primary heating source		Electricity	Coal/wood	Gas
Residential (multi-apartment	234	0	1,180	2%	-	-
Residential (individual houses)	7,058	6,918	113,399	26%	66%	7%
TOTAL	7,292	6,918	114,578			

Source: Technical background report prepared by Fichtner.

Note: Buildings may supplement DH-based heat supply with individual heating systems, which is why all buildings are shown in the "Total" column. Only those buildings listed in the "Using ind. systems as primary heating source" column rely exclusively on individual systems for heating. The supply column shows all heat supplied by individual systems, whether primary or supplementary (for "topping-up").

As in Bishkek, increases in the use of electricity as a heating fuel in Tokmok has led to progressively higher residential electricity consumption during the winter months. In 2012, residential electricity consumption in January and December was three times as high as residential electricity consumption in June. Residential electricity consumption has increased by almost 100 percent between 2010 and 2012. Figure 4.1 shows monthly electricity consumption in the residential sector in Tokmok from 2010 to 2012.

Figure 4.1: Monthly Residential Electricity Consumption in Tokmok (2010 to 2012)



Source: Severelectro.

4.2 Heat Demand in Tokmok

Heat demand was estimated for Tokmok based on the characteristics of the residential and public building stock in the city. The housing stock in Tokmok includes 7,292 residential buildings with a total residential area of 1.1 million m^2.

Table 4.6 provides a breakdown of Tokmok's housing stock area, population and households by type of building.

Table 4.6: Residential Building Stock in Tokmok

Parameter	Proportion of Total	Proportion of Total
Overview		
Total residential area (m^2)	1,123,783	100%
Total population	53,087	100%
Total residential area per capita (m^2/person)	21.3*	
Total number of households	17,478	100%
Individual houses		
Number of houses	7,058	97%
Total residential area (m^2)	608,047	54%
Average size of house (m^2)	84*	
Population	29,728	56%
Number of households	7,058	42%
Total area per capita (m^2/person)	20.6*	
Average size of household	4.2*	
Multi-apartment buildings		
Number of buildings	234	3%
Total residential area (m^2)	515,736	46%
Number of flats	10,227	
Flats per building	44*	
Average size of flat (m^2)	50*	
Population	23,359	44%
Number of households	10,227	59%
Total area per capita (m^2/person)	22.2*	
Average size of household	2.3*	

Source: National Statistics of the Kyrgyz Republic (2013)
Notes: *Calculated value

In order to estimate total annual heat demand for each building type, a standardized set of assumptions about the amount of heat demand per unit of floor space was developed for each type of residential and public building described in Section 2.1. Heat demand assumptions were created based on the results of the walk-through energy audits of residential and public buildings.

Similar to Bishkek, buildings in Tokmok suffer poor energy performance due to inefficient construction and under-maintenance.

Estimated heat demand for each building type and data on the area of each building type in Tokmok were used to calculate the total heat demand and heat demand by building type during a typical year. Table 4.7 and Table 4.8 show the heat demand assumptions for different types of residential and public buildings for a typical year in Tokmok.

Table 4.7: Total Heat Demand of Residential Buildings (Tokmok, Average Year)

Type	No. of bldgs.	Avg. heated area (m^2)	Specific demand for space heating (kWh/m^2)	Specific demand for hot water (kWh/m^2)	Total specific heat demand		Total* heat demand (Gcal/yr)
					(kWh/m^2)	($Gcal/m^2$)	
Type I	94	2,045	110	27	137	0.12	22,644
Type II	94	2,140	143	27	170	0.15	29,404
Type III	47	2,650	142	27	169	0.15	18,099
Indiv. family houses	7,058	86	313	27	340	0.29	177,451
Total	**7,293**	-	-	-	-	-	**247,598**

Note: * This column includes demand for both space heat and hot water.

Source: Technical background report prepared by Fichtner based on walk-through energy audits

Table 4.8: Total Heat Demand of Public Buildings (Tokmok, Average Year)

Type	No. of bldgs.	Avg. heated vol. (m^3)	Specific demand for space heat (kWh/m^3)	Specific demand hot water (norm) (kWh/m^3)	Total specific heat demand		Total* heat demand (Gcal/yr)
					(kWh/m^3)	($Gcal/m^3$)	
Schools	12	11,000	33	0	33	0.028	3,745
Kinder-gartens	4	7,900	66	5	71	0.061	1,929
Other edu.	7	11,000	66	0	66	0.057	4,370
Health care	2	14,200	40	22	62	0.053	1,514
Other public	16	7,400	50	0	50	0.043	5,090
Total	**41**	-	-	-	-	-	**16,648**

Note: * This column includes demand for both space heat and hot water.

Source: Technical background report prepared by Fichtner based on walk-through energy audits

The total demand for space heat and hot water in residential buildings in Tokmok amounts to 247,598 Gcal per year, as shown in Table 4.7 above. Heat demand for hot water accounts for about 10 percent of the total heat demand of the residential sector. Individual houses account for about 70 percent of total present heat demand, although they account for only 52 percent of the residential heated area.

Total demand for space heat and hot water in public buildings in Tokmok is 16,648 Gcal per year, as shown in Table 4.8. It is assumed that heat for hot water is only used in hospitals and kindergartens. Educational buildings account for over half of heat demand in public buildings.

Table 4.9 below summarizes the space heating demand by customer segment in a typical year based on the analysis above.

Table 4.9: Space Heat Demand by Customer Segment in Tokmok (Average Year)

Customer segment	**Space heat demand (Gcal/yr)***
Multi-apartment buildings	58,123
Individual family houses	163,360
Public buildings	15,976
Total	**237,458**

Note: * This table shows only space heat demand; demand for hot water is not included.

Source: Technical background report prepared by Fichtner.

4.3 Heat Supply-Demand Gap

As in Bishkek, heat demand figures for Tokmok in 2012 had to be adjusted to account for the colder-than-average winter (see Section 3.3 for a more detailed methodology). The only difference between the two analyses is that the amount of heat supplied to public buildings was estimated for Tokmok, because the data for Tokmok were considered to be more reliable than the data for Bishkek.

Table 4.10 below shows the amount of heat for space heating supplied to residential and public buildings by each heating source in Tokmok, as previously shown in Section 4.1. Table 4.11 shows the difference between the amount of space heat demanded (adjusted for 2012 from the baseline demand for an average year shown in Table 4.9) and the amount of space heat supplied for residential and public buildings in Tokmok in 2012.

Table 4.10: Space Heat Supplied to Each Customer Segment by Heat Supply System in Tokmok (2012)

	DH (KZhK)	DH (Zhululuk)	Individual systems	Total
	Gcal/yr			
Multi-apartment buildings	54,162	3,263	1,180	**58,605**
Individual family houses	474	0	113,399	**113,873**
Public buildings	7,089	3,334		**10,423**
Total	**61,725**	**6,597**	**114,578**	**182,900**

Source: Technical background report prepared by Fichtner.

Table 4.11: Space Heat Supply-Demand Gap in Tokmok (2012)

	Space heat demand*	Space heat supply	Supply-demand gap	Supply-demand gap (as a percentage of demand)
	Gcal/yr			%
Multi-apartment buildings	58,978	58,605	373	1%
Individual family houses	166,763	113,873	52,890	32%
Public buildings	16,280	10,423	5,857	36%
Total	**242,022**	**182,900**	**59,122**	**24%**

* This table shows demand numbers that have been adjusted from baseline to account for the colder-than-average winter in 2012.

Source: Technical background report prepared by Fichtner.

The analysis shows that the estimated supply gap was equal to 24 percent of overall demand in residential and public buildings. The gap is greatest in individual family houses, where 32 percent of space heat demand is unmet each year. Overall, the gap is higher in public buildings (36 percent of demand) and much lower in multi-apartment buildings (one percent of demand).

5 Assessment of Measures to Improve the Heating Sectors of Bishkek and Tokmok

Based on the current infrastructure and fuel availability, the options for meeting space heat demand in Bishkek and Tokmok range from the improvement of large-scale heating systems—such as the rehabilitation of the DH infrastructure—to the installation of small HOBs, the use of individual heating solutions and/or improved energy efficiency in buildings.

This section evaluates the economic viability of the main heating options and associated investment measures for meeting the space heat demand of residential and public buildings in Bishkek and Tokmok. Technical, environmental and social advantages and disadvantages of each measure follow. For each customer segment, the applicable investment measures are prioritized based on the results of this multi-criteria assessment to inform the recommendations outlined in Section 5.4.

5.1 Assessment Approach

Heating options and associated investment measures were evaluated in the following way:

1. **Identification of main supply- and demand-side options.** The main supply- and demand-side options for meeting residential and public heat demand were identified based on the existing heating infrastructure and availability of fuels in each city. These options include: DH with CHP (Bishkek only); DH with coal/gas-fired large HOBs; small coal/gas-fired or electric HOBs; individual coal stoves; individual gas heaters or boilers; individual electric radiators; individual electric heat pumps; and energy efficiency in residential and public buildings.
2. **Identification of investment measures.** A comprehensive 'long list' of 30 specific investment measures associated with each supply- and demand-side option was identified.[28]
3. **Development of short list of investment measures.** An initial economic/technical viability screening was applied to the long list of measures. Measures found to have very high investment costs, low potential for improving the heat supply or limited technical feasibility were excluded in order to develop a 'short list' of the most viable investment measures.
4. **Assessment of economic viability.** The economic viability of the 20 short-listed investment measures was assessed in two stages: (i) a levelized cost assessment of the main heat supply- and demand-side options to determine the most viable options for meeting the heat demand of different types of residential and public buildings; and (ii) a cost efficiency analysis of the 20 short-listed investment measures associated with each of the main heating options.
5. **Assessment of non-economic advantages and disadvantages.** Non-economic advantages and disadvantages of the short-listed investment measures were also

[28] The evaluation of the long listed measures was conducted as part of the technical background report prepared by Fichtner.

evaluated. These non-economic considerations primarily include technical, institutional, environmental and social advantages and disadvantages.

6. **Prioritization of investment measures.** The investment measures were prioritized for each customer segment based on the results of the multi-criteria assessments. The most cost efficient investment measures associated with economically viable heating options and without major social and environmental disadvantages were recommended for implementation.

Table 5.1 lists the main heating options and associated investment measures included in the long list[29]. Measures that were selected for the short list are highlighted in green and given an identifying code.

Table 5.1: Overview of Heating Options and Measures

Generation	Transmission/Distribution	End-use
Option: DH (CHP and large HOBs)		
• Rehabilitation of CHPs • Rehabilitation of large HOBs • Construction of new large HOBs • Installation of heat meters at the outlet of heat generation units • **Solar heat production for DH (M13)**	• Replacement of transmission pipelines • **Replacement of distribution pipelines (M8)** • **Re-insulation of over-ground distribution pipelines (M9)** • Construction of new transmission and distribution pipelines • **Installation of variable speed drive pumps (M10)** • Insulation of valves and related pipeline equipment • Processing of feed-water and circulating water in the DH system	• **Installation of automatic individual substations (M6)** • **Installation of temperature and hydraulic regulation of premises service connections (M7)** • **Installation of building-level heat and DHW metering (M2)** • Hydraulic balancing of heat flow in buildings • **Rehabilitation of building-internal distribution network (M11)** • **Installation of thermostatic valves on radiators in dwellings (M3)** • **Implementation of consumption-based billing (M4)**
Option: Autonomous Heating (small HOBs)		
• **Construction of new and replacement of existing small HOBs (M12)**	n/a	• **Rehabilitation of building-internal distribution network (M11)** • **Installation of thermostatic valves on radiators in dwellings (M3)** • **Implementation of consumption-based billing (M4)**
Options: Individual heating systems (various options)		

[29] The evaluation of the long listed measures was conducted as part of the technical background report prepared by Fichtner.

• **Installation of efficient individual coal-fired heat boilers (M18)** • **Installation of individual gas boilers (M19)** • **Installation of individual efficient coal-fired heat stoves (M17)** • **Installation of individual gas heaters (M20)** • **Installation of heat pump systems (M15)** • Installation of solar water heaters • Installation of electric oil radiators	n/a	n/a
Option: Energy Efficiency		
n/a	n/a	• **Replacement of windows (M1)** • **Insulation of attic (M1)** • **Insulation of external walls (M1)** • **Insulation of cellar ceiling (M1)**

Note*:* Although reliable and affordable gas supply is currently very limited in the Kyrgyz Republic, recent developments in the gas sector (as described in Section 2.3) are expected to improve the availability of natural gas and the gasification of urban areas. For this reason, gas-based heat supply options are also evaluated.

The remainder of this section describes the evaluation of the main heating options and related investment measures (Steps 4 through 6 above).

5.2 Analysis of the Economic Viability of Heating Options and Associated Specific Investment Measures

The most economically viable options were identified by analyzing the Levelized Cost of Heat Supply (LCHS) of each heat supply option and the cost efficiency factor (CEF) of specific investment measures. The analysis is presented in the subsections below.

5.2.1 Economic Viability of the Main Heating Options

The economic viability of the main heating options was estimated using the LCHS (see description in Box 5.1 below). The assessment takes into account the current heating infrastructure used by different customer segments as described in Sections 3 and 4 (e.g., individual family houses currently using different individual heating options, multi-apartment buildings with/without DH connection, public buildings with/without DH connection). The different heating options serving each customer segment were compared to determine the most viable solution for that segment.

Box 5.1: Levelized Cost of Heat Supply (LCHS)

The LCHS is the cost of a unit of heat supplied (US$ per kWh of thermal energy), discounted over the life of the supply option. For demand-side heating options, the LCHS is the cost of reducing a unit of heat demand over the life of that option. The LCHS analysis takes into account all capital, operating and fuel costs associated with an option. The LCHS in this report has been calculated using international and regional cost benchmarks adjusted to local conditions (local suppliers, local fuel costs, etc.)

The first two rows of Table 5.2 show the types of heating systems in use for each building type in Bishkek and Tokmok.[30] The remaining rows show the alternative options available in each case. The availability of different heating options also depends on the availability of fuel. In order to avoid switching to inferior heating solutions in terms of health and environmental impacts, it was assumed that the short-term use of individual efficient coal-fired stoves is an option only for those houses currently burning coal.

[30] The pairing of building types and heating systems is referred to as a "customer segment" in Table 5.2 and in the subsequent text.

Table 5.2: Heating Options and the Customer Segments Served

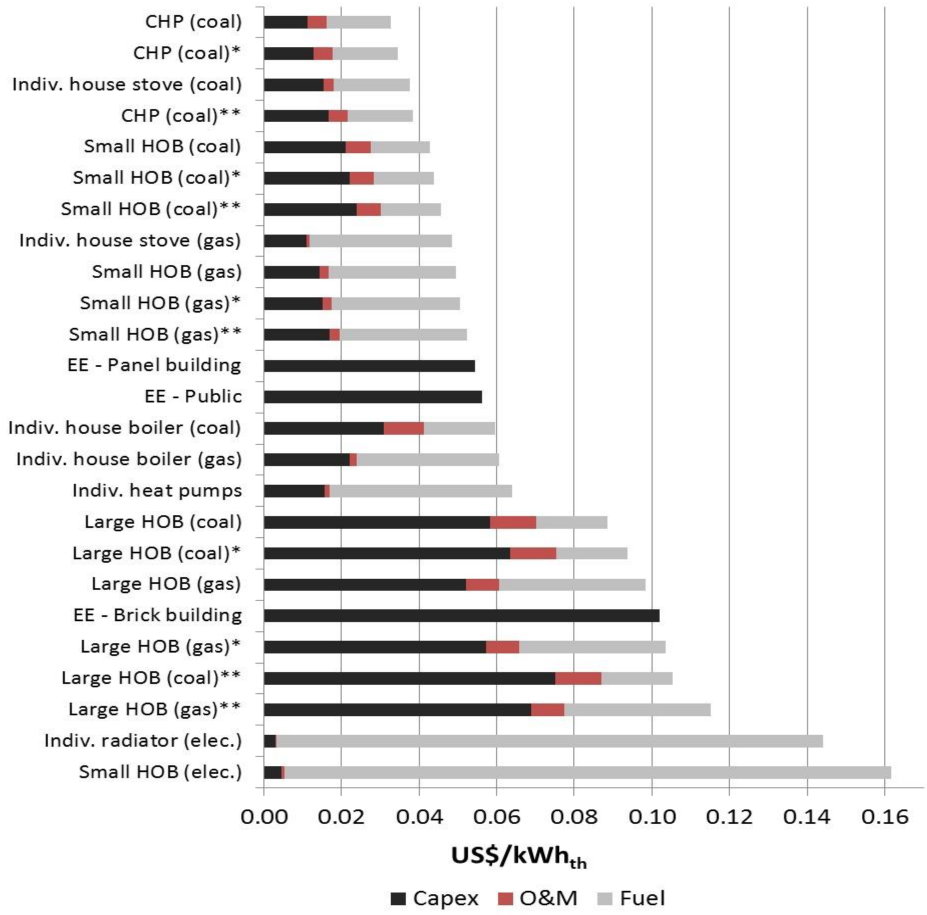
Customer segment:	Individual family houses		Multi-apt. buildings			Public buildings	
Primary heating system currently used:	**Coal/gas stoves/ boilers**	**Electric boilers/ radiators**	**DH (CHP or large HOBs)**	**Small HOBs**	**Individual electric heating**	**DH (CHP or large HOBs)**	**Small HOBs**
Heating options available							
Coal-fired CHP (Bishkek only)			X	X		X	X
Coal-fired large HOBs			X	X		X	X
Gas-fired large HOBs			X	X		X	X
Small coal-fired HOBs			X	X	X	X	X
Small gas-fired HOBs to			X	X	X	X	X
Small electric HOBs			X	X	X	X	X
Building energy efficiency*	X	X	X	X	X	X	X
Individual heat pumps	X	X	X	X	X	X	X
Individual coal stoves	X						
Individual coal boilers	X						
Individual gas stoves/heaters	X	X	X	X	X	X	X
Individual gas boilers	X	X	X	X	X	X	X
Individual electric radiators	X	X	X	X	X	X	X

Notes: * Building energy efficiency can, in theory, be applied in all residential and public buildings. However, specific cost estimates were calculated for multi-apartment brick and panel buildings, and public schools only.

** Heat pumps can, in theory, be used in all residential and public buildings. However, specific costs were estimated for individual family houses only.

The results of the LCHS analysis for each heating option are presented for Bishkek in Figure 5.1 and for Tokmok in Figure 5.2 below.

Figure 5.1: LCHS of Heating Options for Bishkek



Notes: * Indicates the levelized cost of a centralized heating option assuming that the existing building-internal heating systems are upgraded.

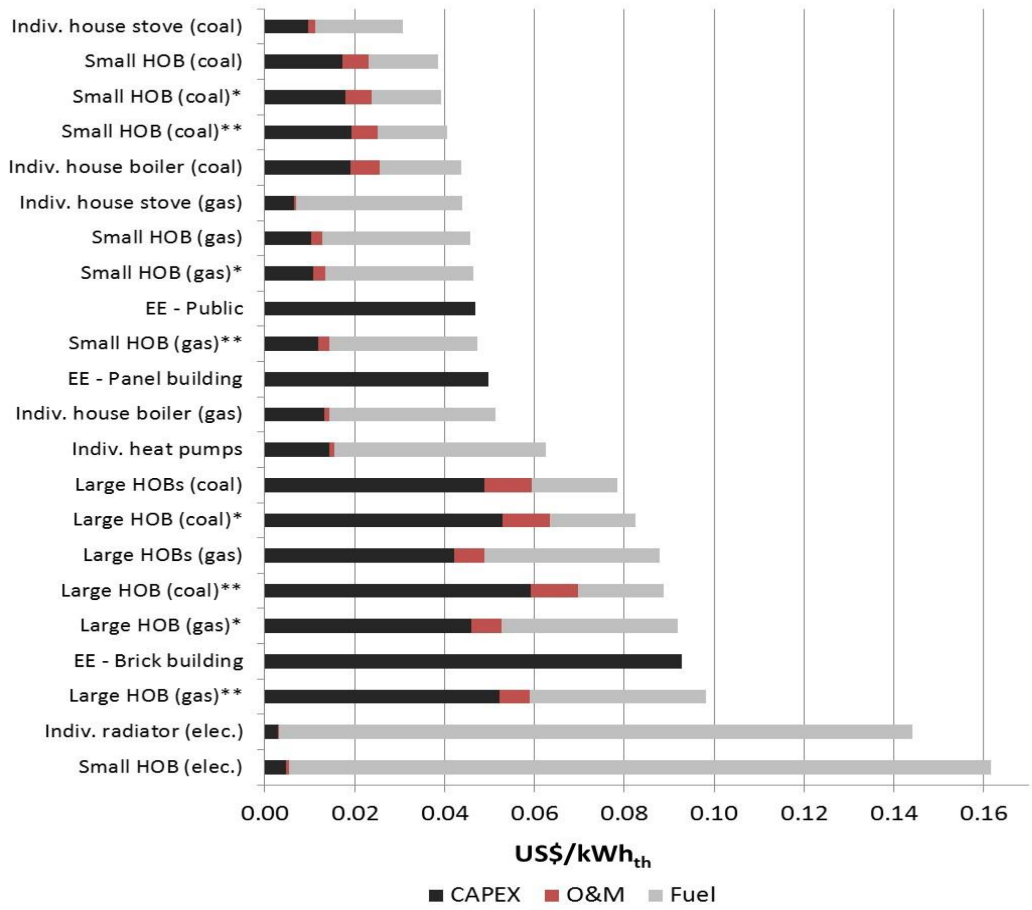
** Indicates the levelized cost of a centralized heating option assuming that new building-internal heating systems are constructued.

The LCHS of CHP excludes generation costs given that the modernization of the CHP is already ongoing (and is therefore a sunk cost). However, the LCHS assumes some basic reliability and efficiency DH system upgrades, namely: (i) the replacement of BTS' underground heat transmission and distribution lines older than 25 years, the replacement of 50 percent of BTS' over-ground transmission and distribution pipelines and the re-insulation of the remaining 50 percent; (ii) the installation of automatic building-level DH substations at all multi-apartment and public buildings served by DH; and (iii) the deployment of variable speed drives at water pumps and network pumps. The LCHS of large HOBs assumes the aforementioned basic reliability and efficiency upgrades to the DH system in addition to the cost of replacing existing boilers.

The coal price is assumed to be US$52.41/t for CHP, US$57.66/t for large HOBs and US$61.23/t for small HOBs; the gas price is estimated at US$330/thousand m^3; cost estimates for electrical appliances are based on long-run average incremental cost of electricity (0.14 US$/kWh)

The LCHS of energy saved from building energy efficiency measures is calculated as if the energy efficiency measures were an energy generating resource and the energy "generated" by that resource is the amount of energy saved by the energy efficiency measures, in other words the capital cost of the energy efficiency measures is levelized over the energy saved over the measures' lifetime.

Figure 5.2: LCHS of Heating Options for Tokmok



Notes: * Indicates the levelized cost of a centralized heating option assuming that the existing building-internal heating systems are upgraded.

** Indicates the levelized cost of a centralized heating option assuming that new building-internal heating systems are constructued.

The LCHS of large HOB options assume some basic reliability and efficiency DH system upgrades: (i) the replacement of existing large HOBs; (ii) the replacement of 50 percent of underground and over-ground heat transmission and distribution lines that belong to Tokmok KZhK, and the re-insulation of the remaining 50 percent of overground distribution lines; (iii) the installation of automatic building-level DH substations at all multi-apartment and public buildings served by DH; and (iv) the deployment of variable speed drives at water pumps and network pumps.

The coal price is assumed to be US$52.41/t for CHP, US$57.66/t for large HOBs and US$61.23/t for small HOBs; the gas price is estimated at US$330/thousand m^3; cost estimates for electrical appliances are based on long-run average incremental cost of electricity (0.14 US$/kWh).

The LCHS of energy saved from building energy efficiency measures is calculated as if the energy efficiency measures were an energy generating resource and the energy "generated" by that resource is the amount of energy saved by the energy efficiency measures, i.e., the capital cost of the energy efficiency measures is levelized over the energy saved over the measures' lifetime.

The lowest cost heat supply options for each customer segment are described below.

Economic Viability of Heating Options for Individual Family Houses

For individual family houses currently using coal stoves, the option with the lowest LCHS is a more efficient and cleaner coal stove. Gas stoves could become economically viable options as gas becomes available and affordable for use in individual family houses. For individual houses currently using coal boilers, gas boilers will also become economically viable with more widespread access to reticulated gas networks.

For individual family houses currently using electric boilers and radiators, switching to gas-fired heaters and boilers or electric heat pumps would be more economically viable. This assumes that the house is connected to the gas network. If gas is not yet available, heat pumps still make much more efficient use of electricity for heat production, and therefore have much lower operating costs, though their capital costs are higher than the capital costs of electric radiators. Although heat pumps take advantage of the heat in the outside air, they can operate in colder climates. Box 5.2 describes the applicability of air-to-air heat pumps in cold climates.

> **Box 5.2: Applicability of heat pumps in cold climates**
>
> Air-to-air heat pumps (the type of heat pumps evaluated in this report) use the heat present in the outside air to heat the air indoors. These devices use refrigerants that absorb heat from the outside air and release it indoors even when that air temperature is as low as -30°C (as shown in Table 2.1, the average winter ambient temperature in Bishkek and Tokmok is -1°C). For especially cold days, modern air-to-air heat pumps also typically have a built-in “peak load” heating element.
>
> Unlike electric resistance heaters that convert electric energy to heat energy, heat pumps use electricity to run compressors and circulate refrigerants that absorb the heat in outdoor air. Air-to-air heat pumps are therefore capable of generating more thermal energy than is required to operate them. For instance one kWh of electric energy can be used to generate three kWh of thermal energy (based on a realistic Coefficient of Performance of 3.0). While the efficiency of heat pumps decreases with lower ambient temperature, the coefficient of modern heat pumps does not drop below 1.5 even with very low temperatures, making them more efficient than traditional electric oil radiators.

Economic Viability of Heating Options for Multi-Apartment Buildings

For multi-apartment buildings currently served by a CHP via the DH system, heat supply by CHP is clearly still the economically most viable option.

For multi-apartment buildings currently served by large HOBs, the analysis suggests that switching to individual gas heaters/boilers or installing small gas-fired HOBs are more viable than large HOBs. Energy efficiency measures are also an economically viable option to help reduce the heat demand of this customer segment.

For multi-apartment buildings currently served by small HOBs, the analysis suggests that individual gas heaters/boilers have slightly lower levelized costs than small HOBs. However, the analysis of gas heaters/boilers does not take into account the investments necessary to connect buildings and houses to a gas network. Therefore, further analysis will be needed to verify this finding once gasification plans are finalized.

For multi-apartment buildings that rely on individual electric radiators, switching to gas heaters would be the most economically viable option. If the building has no access to natural gas, switching to individual heat pumps is more viable than using electric radiators. When gas becomes available, installing small HOBs would also be a more viable option than electric radiators.

Energy efficiency measures also appear to be an economically viable option to help reduce demand in all multi-apartment buildings, but especially in those that are not served by DH.

Economic Viability of Heating Options for Public Buildings

Public buildings have almost the same heating options available to them as multi-apartment buildings, except it is not assumed that individual heating options (such as individual gas heaters) should be deployed in these buildings. Under this assumption, the most economically viable heating options for public buildings would be continued use of the heating systems that currently serve them (DH with CHP or small HOBs), with the exception of public buildings that are served by large HOBs. For public buildings that are served by large HOBs, switching to small HOBs and implementing energy efficiency measures appear to be more economically viable than using heat from rebuilt large HOBs.

5.2.2 Economic Analysis of the Short List Investment Measures

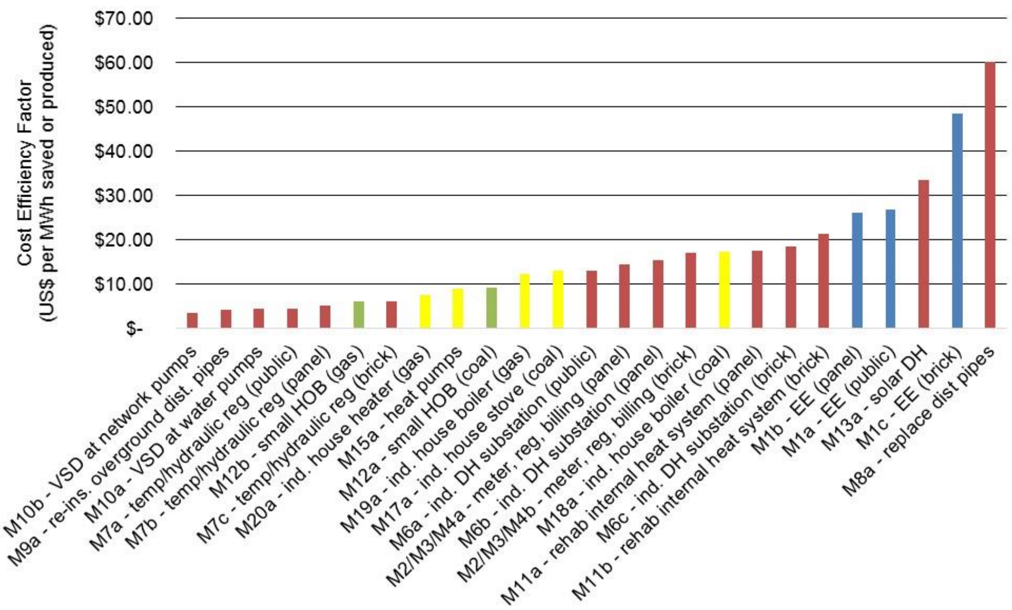
The CEF was calculated for each specific investment measure, and the measures were compared on the basis of their CEFs. The CEF of each measure was taken into account when selecting measures for recommendations. Box 5.3 describes the CEF.

Box 5.3: Cost Efficiency Factor (CEF)

The CEF evaluates the investment cost per unit of energy saved or produced by a given measure. The CEF is calculated by dividing the total investment cost of a given measure by the total amount of energy that it will save or produce over that measure’s lifetime. The CEF provides a rough estimate of the cost of an energy infrastructure investment per unit of energy saved or produced. However, the CEF should be used with caution because it does not account for the operating costs of a given investment. Measures with low capital costs but high operating costs may therefore appear economically viable using the CEF. The CEF is useful nonetheless, because it provides insight into the economic viability of the non-heat producing measures (e.g., installation of variable speed drives, transition to consumption based-billing, etc.) compared with the heat producing measures.

Figure 5.3 and Figure 5.4 show the CEFs of all measures short-listed for Bishkek and Tokmok, respectively. The analysis indicates that many of the rehabilitation measures to improve the efficiency of the DH system are economically viable, in particular the installation of variable speed drives, the re-insulation of overground distribution pipes, the installation of building-level temperature and hydraulic regulation or the installation of building-level substations, and a package of metering, temperature regulation and consumption-based billing. The analysis also shows that individual coal or gas stoves or gas heaters, small gas-fired HOBs and individual heat pumps are economically viable. The building energy efficiency-related measures, on the other hand, have relatively high CEFs, which is largely because they are quite capital-intensive, and the CEF only takes into account capital costs.

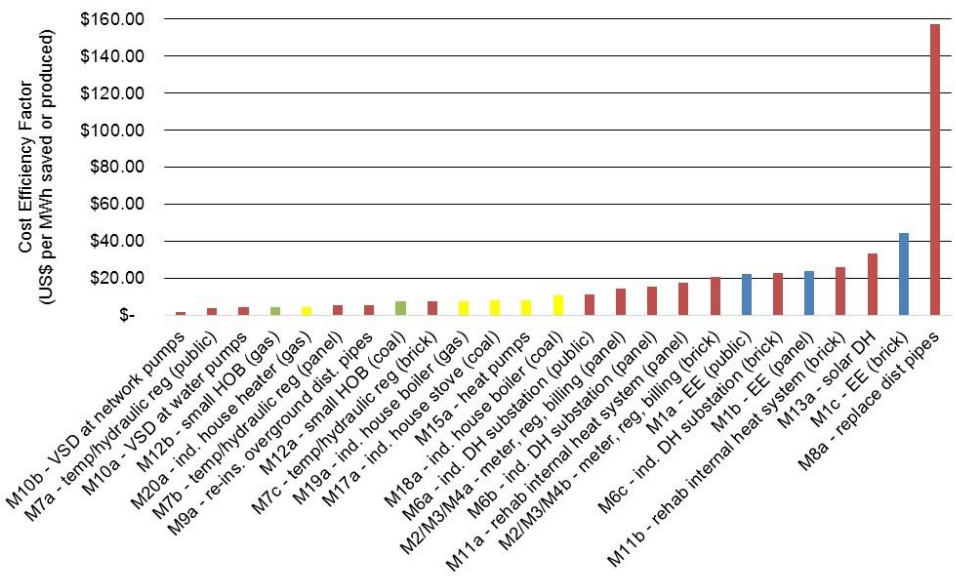
Figure 5.3: CEF by Measure (Bishkek)



Notes: Red columns denote DH options, green columns relate to supply from small HOBs, yellow columns to individual heating options, and blue columns to energy efficiency options.

The codes preceding investment measures denote different applications of these measures (such as panel or brick multi-apartment buildings). Appendix B shows which code matches which application.

Figure 5.4: CEF by Measure (Tokmok)



Note: Red columns denote DH options, green columns relate to supply from small HOBs, yellow columns to individual heating options, and blue columns to energy efficiency options.

The codes preceding investment measures denote different applications of these measures (such as panel or brick multi-apartment buildings). Appendix B shows which code matches which application.

5.3 Assessment of Non-Economic Advantages and Disadvantages

The non-economic advantages and disadvantages of each short list measures were also evaluated. These non-economic considerations primarily include technical, institutional, environmental and social advantages and disadvantages. These are presented in Table 5.3.

Table 5.3: Environmental and Social Advantages and Disadvantages of the Heat Supply Options

Option	Measure	Non-economic advantages	Non-economic disadvantages
DH by CHP or large HOBs	M2 – metering, M3 – temperature regulation, M4 – consumption-based billing*	+ Allows customers to control their own energy use and bills + Pre-requisite for creating incentives related to energy efficiency measures in buildings + Improved quality of service through better indoor climate for customers	- Requires a coordinated effort among regulator, homeowners and companies, which adds complexity - Access and approval of building/apartment-owners required to install thermostatic valves at radiators in private homes - Need for suitable financing and implementation mechanisms - Reforming heat tariff-design for end-user requires broad stakeholder consultations, information campaigns and targeted mitigation measures for the poor
	M6 - Installation of automatic individual DH substation	+ Improved quality of service through better indoor climate for customers + If installed with heat exchangers, improves water quality, ensures safer operation and less corrosion of network pipelines, allows higher flow temperature and increases supply capacity	- Requires appropriate implementation arrangements given that the service connection point is common property between the building-owner and the DH company
	M7 - Temperature and hydraulic regulation of house service connections	+ Widely available technology + Installation does not require special skills	- Outdated technology compared to modern building-level substations - Requires appropriate implementation arrangements given that the service connection point is common property between the building-owner and the DH company
	M8 - Replacement of distribution pipelines	+ Longer lifetime and lower maintenance than old pipelines + Reduce heat losses and water leakages and better supply reliability (less breakdowns)	- Time and labor intensive for underground pipelines - Potential safeguard issues (e.g., asbestos)
	M9 - Re-insulation of overground distribution pipelines	+ Better supply would improve comfort levels for the population supplied by DH + No excavation in public streets necessary	- Insulation might outlive the pipelines to which they are applied

	M10 -Variable speed drive pumps	+ Reduce electricity consumption + Step-by-step implementation possible + Old worn-out pumps should be replaced anyway	
	M11 - Rehabilitation of internal heating system	+ Better indoor climate due to the increase of flow through radiators + Improved supply reliability, safer operation and avoiding 'under-heating' for customers at the end of the piping network	- Close cooperation and appropriate implementation arrangements required among DH company, housing association and residents (building users) - Challenging incentive structures for financing of the measure, in particular at the absence of HOA and sufficient funds
	M13 - Solar heat production for DH	+ Reduced dependency on fuel imports + No direct emissions and low CO2 emissions	- Magnitude of output is seasonally dependent, i.e., the output of a solar DH system will be lowest in the winter when it is needed most - Availability and quality of local products
Small HOBs	M12 - Construction of new efficient autonomous small HOBs	+ Improve reliability and efficiency of heat supply + Reduce electricity loads due to heating in winter + Local employment through the production, installation and operation of the HOBs + Coal boilers can be equipped with flue gas cleaning and thus reduce emissions from existing inefficient coal boilers + Replacing coal boilers with gas boilers will reduce emissions + For existing HOBs, infrastructure within the building (piping and radiators) is the same as for the DH system	- For coal-based boilers: coal will produce flue gas emissions in the inner city and greenhouse gases; coal requires transport by truck, which can aggravate pollution and congestion in the city; financing by development partners may be challenging due to coal use - Natural gas boilers require natural gas supply, which is currently under planification and dependent on progress made - The use of new gas-based boilers where coal or electricity was used before will increase dependence on imported fuel sources
Energy efficiency	M1 - Insulation of Buildings	+ Better indoor climate/comfort levels for customers + Reduced energy bills and loads on the electricity network (in case of electric heating) + Multiple co-benefits, including improved noise protection, reduced number of sick days, improved building aesthetics + Local job creation through labor-intensive rehabilitation works	- High upfront investments for building-owners (in particular as other works on worn-out building structures are likely to be required) - Insufficient incentives for customers given the low tariffs - Small and dispersed projects requiring targeted financing/implementation and delivery mechanisms - Savings are dependent upon the overall condition of the building, the existing comfort level (many buildings are under-heated) and behavior patterns of the residents/users

Individual heat supply options	M15 -Installation of heat pump systems	+ Makes more efficient use of scarce electrical energy when electric resistance-based heaters are replaced + Small and can be installed in nearly every room + Fully automatic with low maintenance	- No heat supply during blackouts - Electrical heat pumps are sensitive to frequency and voltage fluctuations - No local suppliers for the heat pumps - Efficiency decreases when ambient air temperature is very low - Lack of incentives for customers to switch to more efficient devices given the low electricity tariffs - Need for adequate implementation and financing mechanisms to enable and incentivize installation of more efficient pumps
	M17 - Installation of efficient small coal stoves	+ Improved efficiency and emissions profile compared with existing coal stoves + Reduce indoor air pollution + Reduce coal consumption compared to current models	- Negative environmental and health impacts associated with the continued use of coal - "Locks in" customers to a coal-fired technology and slows the transition to low emissions heating sources - Need for adequate implementation and financing mechanisms to enable and incentivize customers to switch to more efficient stoves
	M18 - Installation of efficient coal boilers	+ Improved efficiency and emissions profile compared with existing boilers + Reduce coal consumption compared to current models	
	M19 – Installation of gas boilers	+ Improved efficiency and emissions profile compared with existing boilers (and with new efficient coal-based boilers)	- Natural gas boilers require natural gas supply, which is currently under planification and depending on progress made - The use of new gas-based boilers where coal or electricity was used previously will increase dependence on imported fuel sources - Need for adequate implementation and financing mechanisms to enable and incentivize customers to switch to more expensive fuel and to switch to more efficient stoves
	M20 – Installation of gas heaters	+ Improved efficiency and emissions profile compared with existing coal stoves (and with new efficient coal-based stoves) + Reduce winter power shortages if replacing electric heaters + Reduce indoor air pollution if replacing coal stoves	

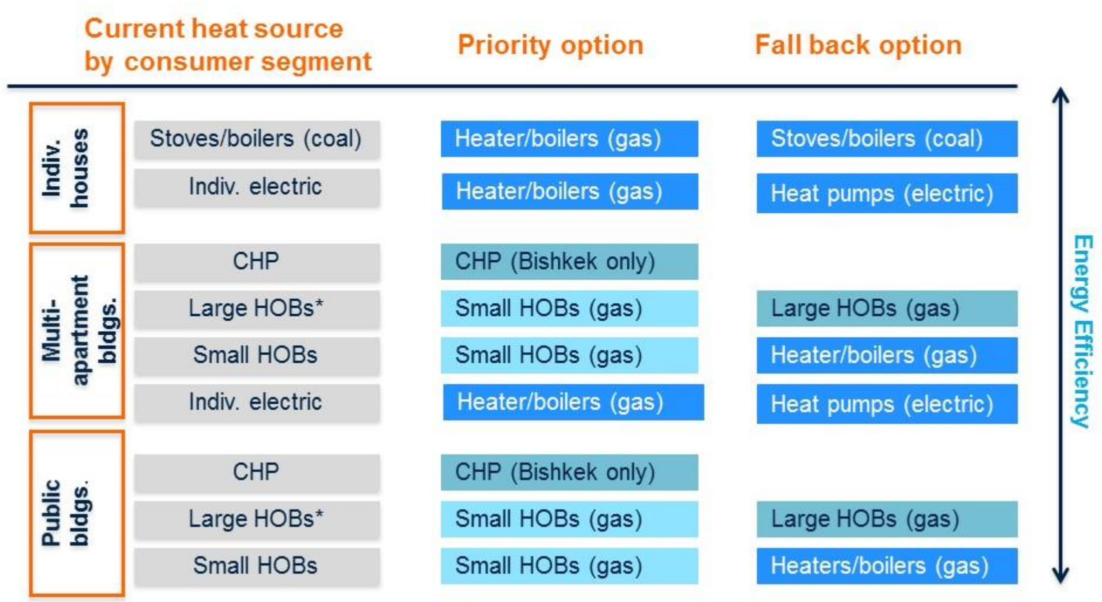
Notes: *These three measures are only effective if they are implemented together, so for the purposes of this analysis they evaluated together.

5.4 Summary of the Analysis of the Heating Options and Short List Measures

Based on the results of the economic assessment and the evaluation of other advantages and disadvantages, the applicable investment measures for each customer segment were prioritized to help inform the recommendations. The prioritization was done taking into account (i) the economic viability of the main heating options; (ii) the results of the cost efficiency analysis for the specific investment measures; and (iii) the other advantages and disadvantages associated with each measure. The weighting of the latter is a policy choice; for the purpose of this report, advantages/disadvantages related to the impact on winter power shortages and comfort levels were weighted the most. This multi-criteria approach was used to determine priority heating options as well as fallback heating options for each customer segment.

Figure 5.5 provides an overview of the priority and fallback heating options for each customer segment in Bishkek and Tokmok, based on the multi-criteria assessment of economic and non-economic benefits of each heating option.

Figure 5.5: Priority and Fall-back Heating Options by Customer Segment



Note: *Priority and fallback options for large HOBs would need to be determined based on the results of a feasibility study and depending on the specific operational condition of each boiler house.

6 Recommendation of Measures to Improve the Heating Sectors of Bishkek and Tokmok

The investment needs of the heating sectors in Bishkek and Tokmok are sizable, at an estimated US$225 million in the short-term and an estimated US$550 million in the medium- to long-term. The implementation of the investment measures will therefore need to be adequately phased and prioritized. This could be achieved by preparing a detailed investment plan for each of the heating companies based on the viable investment measures recommended in this study. The investment plans could also be used by the companies to ensure a well-planned and coordinated effort in mobilizing funding from bilateral and multi-lateral development partners and from the private sector. In addition, deployment of efficient autonomous and individual heating solutions—such as switching to small HOBs or replacing inefficient coal stoves and heaters by more efficient models—will require demand-driven programs supported by public consultation and outreach campaigns. They also will require appropriate implementation, financing and incentive mechanisms.

This section summarizes the recommended investment measures and related policy actions needed to improve the reliability and efficiency of heat supply in Bishkek and Tokmok. For each recommendation, the investment measures and the scope of their implementation are described. Some of the most important implementation issues are highlighted, and immediate next steps are outlined.

It is important to note that the implementation of some of the recommended priority investment measures is subject to the availability of natural gas for the targeted customer segments in the future. Alternatives are provided for residential and public buildings without access to gas, but the development and implementation of a clear and time-bound gasification plan will be critical to the heating options that are recommended in this report.

6.1 Recommendation 1: Implementation of Tariff and Social Assistance Reforms

Tariff reforms are the single most important policy action needed to improve the financial viability of the heating sector and to incentivize end-user energy efficiency. As described in Section 2.4.3, below-cost recovery tariffs have resulted in severe under-spending on maintenance and investment in the sector. They have accelerated the deterioration of heat supply reliability and quality, and they have contributed to the inefficient use of energy in residential and public buildings.

With the adoption of the MTTP and the enactment of higher end-user tariffs for heating and electricity in 2014 and 2015, the Government has made a critical step towards cost-reflective energy pricing. It is important to note, however, that heating tariff increases should be implemented in parallel with increases to electricity tariffs. Increasing heating tariffs without also increasing electricity tariffs may accelerate fuel switching from DH to electricity, which will put further strain on the power grid during peak winter months.

Going forward, the following tariff policy actions are recommended.

Consistently implement tariff reforms: The enactment of annual tariff increases in accordance with the MTTP will be critical to improve the sustainability of the heating sector.

Adopt a clear and transparent tariff-setting methodology for sector companies and non-residential end-users: Residential end-user tariffs until 2017 are defined in the MTTP, but the State Regulatory Agency of the Fuel and Energy Complex should develop and adopt a clear methodology to determine the revenue requirements for heating companies. This would help to clearly determine the financing gap and subsidies required to ensure adequate maintenance and investments of sector assets. A transparent approach should be taken to allocate sector revenues between heating companies (in the case of EPP and BTS, in particular) in order to enhance the predictability of revenues for heating companies and improve sector transparency. In addition, it is recommended that the tariff-setting approach for non-residential end-user tariffs[31] be simplified; one option would be to set non-residential end-user tariffs for each heating company rather than for each individual boiler. Appendix A contains further details on the regulatory arrangements in the sector.

Deregulate tariff-setting for small, greenfield HOBs: As indicated in Section 6.4, the supply of heat through small, greenfield HOBs may present an opportunity for private sector participation. To promote private sector participation and to eliminate the excessive regulatory burden associated with setting tariffs for small HOBs, the Government should consider deregulating tariffs for greenfield HOBs. Because consumers have alternatives to the heat supply from the new, small HOBs, such an arrangement does not constitute a natural monopoly activity that would need to be regulated.

Transition to consumption-based billing: A transition to consumption-based billing should accompany tariff reforms. This will ensure that consumers can control their consumption and match it with what they can afford. Consumption-based billing will also increase pressure on heating companies to show value-for-money by improving service quality and reducing network losses. Experience from other countries in the ECA region indicates that building-level heat metering and consumption-based billing can generate substantial energy savings (around 25 to 30 percent of the heat consumed). BTS' experience also indicates that end-consumers paid up to 45 percent less for heating after their bills were based on metered consumption at building-level compared to previously norm-based billing practices. However, transitioning to consumption-based billing especially at apartment-level is politically and institutionally challenging to implement. It will require careful planning and phasing and should be accompanied with extensive public outreach campaigns. The investment measures recommended under Section 6.2 represent a first step in this direction. A time-bound transition path towards consumption-based billing should be developed, including the associated legal, regulatory and institutional reforms needed (e.g., heat metering requirements, clearly assigned responsibilities for installing, financing and maintaining meters and thermostatic valves, and revision of the design of end-user tariffs for heating).

[31] This only concerns non-residential tariffs for customers not served by the CHP plant in Bishkek.

Provide targeted support to poor customers: Mitigation measures must accompany tariff increases to ensure that poor households can afford a basic level of heat consumption. The Kyrgyz Republic has extensive yet poorly targeted social safety nets that Government should consider restructuring.[32] Existing social assistance programs targeting the poor could be topped-up while other programs aimed at categories of consumers which may contain the non-poor should be phased out. Energy efficiency retrofits should also be considered as a possible mitigation measure as tariffs move closer to cost-recovery levels. A World Bank estimate in 2013 showed that energy poverty for poor households in the Kyrgyz Republic could be reduced by more than 10 percent following the introduction of a basic energy efficiency program.[33]

6.2 Recommendation 2: Improving the Efficiency and Reliability of the DH Network

Measures targeting efficiency improvements of the DH systems in Bishkek and Tokmok have been identified among the most viable investment opportunities. Given the extent of the DH system in each city, these measures have the potential to improve the reliability and efficiency of heat supply for a large number of people.

6.2.1 Recommended Measures

It is recommended to implement a package of priority reliability and efficiency investments. Overall, the investments in the DH network have the potential to reduce losses by as much as 696,000 MWh per year in Bishkek and as much as 51,000 MWh per year in Tokmok. The recommended priority measures are:

- **Install building-level substations (M6).** Modern substations with heat exchangers will allow supply to be matched with demand through better temperature control at the building level, and should be installed in all multi-apartment and public buildings. Transitioning to a 'closed' DH system (via heat exchangers at substations) will further enable an increase of the heat delivery to end-consumers, improved water quality, safer operation and less corrosion of network pipelines.
- **Implement metering (M2), temperature regulation (M3) and consumption-based billing (M4).** These measures will allow heat service companies to bill customers based on the amount of energy consumed, rather than simply on the area heated. The transition to consumption-based billing also enables households to control their heat consumption and bills and provide them with an incentive for more economic use of thermal energy. Given the limited resources, it is recommended to focus in a first step on the installation of building-level heat meters and apartment-level hot water meters. The second phase could then involve the installation of temperature regulation and heat cost allocators at apartment level.
- **Replace priority transmission and distribution pipelines (M8) and re-insulate overground distribution pipelines (M9).** Replacing worn-out pipelines with pre-

[32] Public spending for social transfers in 2013 accounted for about 2 percent of GDP. However, one of the social assistance programs – the Monthly Benefit for Poor Families with Children – explicitly targets the poor but coverage is low (less than one third of the poorest 20 percent of the population and only about 8 percent of their total consumption is subsidized). Other programs are aimed at certain social categories (e.g., households with widows, veterans or disabled children) independent of their income levels.

[33] World Bank, Balancing Act, 2013.

insulated and accurately dimensioned pipes and re-insulating overground pipelines would improve supply reliability and service quality, decrease heat losses within the network by up to 70 percent and reduce service interruptions.

- **Install variable speed drives in DH substation pumps (M10)**. Variable speed drives allow the system to adjust the output of DH substation pumps to match the required fluid throughput, rather than running at a single, high throughput level all of the time. Estimates indicate that this would reduce electricity consumption in pumping stations by more than one third.

In principle, the measures listed above could be implemented separately. In best practice, building-level substations (M6) should be implemented together with metering (M2), temperature regulation (M3) and consumption-based billing (M4). Combining these measures with the replacement or re-insulation of pipelines (M8 and M9) and variable speed drives in DH substation pumps (M10) would further help to ensure maximum efficiency gains and technical sustainability of investments at the network level.

6.2.2 Scope of Implementation

As a priority, implementation of these reliability and efficiency measures is recommended for the DH network operated by BTS. This would ensure that the network is actually able to absorb the additional heat supplied by CHP 1 after its modernization. In addition, in order to ensure the operational sustainability of the investments, the generation facilities should be in good condition, which is not the case for the majority of large HOBs (in Bishkek and Tokmok). Accordingly, the investment package should only be implemented for large HOBs in good operational condition.

6.2.3 Implementation Issues

Efficiency improvements at the apartment level: One of the most challenging implementation issues will be the implementation of improvement measures within individual apartments, such as thermostatic valves and heat cost allocators. This will require: (i) careful planning; (ii) extensive information and public outreach campaigns to inform customers about the benefits of these improvements; and (iii) adequate financing/implementation arrangements (e.g., direct-to-consumer subsidy and distribution programs through the heating utilities). Therefore, it is recommended to prioritize the installation of building-level heat and apartment-level hot water meters before moving to the institutionally more complex implementation of thermostatic valves and heat cost allocators in individual apartments. Other issues related to the transition to consumption-based billing are highlighted under Section 6.1.

Ensuring technical sustainability of investments: To ensure the technical sustainability of efficiency measures, it is important to evaluate the total network (over- and underground transmission and distribution). This will help to identify and address urgent rehabilitation needs. This evaluation also should include internal heat piping within buildings.

Financing: The current financial condition of DH companies, coupled with the low end-user tariffs, means that DH companies will struggle to attract commercial financing for the investments recommended above. DH companies and the Government may want to consider mobilizing different sources of concessional financing. As highlighted above, the rehabilitation of the building- and apartment-level heating infrastructure (usually not owned by the DH company) is expected to require special financing and implementation schemes in addition to regulatory changes.

Box 6.1 describes how similar actions were implemented in Poland.

Box 6.1: World Bank Program Supporting DH Reforms in Poland

During the mid-1990s, Poland experienced many of the problems facing the Kyrgyz Republic today. In the early 1990s, the Government of Poland transferred ownership and responsibility for DH companies to the municipalities. The decentralization of ownership and a phasing out of investment subsidies meant DH companies lacked funds to effectively operate, maintain, and rehabilitate their infrastructure. This, in turn, led to high heat and hot water losses, which further deteriorated the financial sustainability of DH companies.

The World Bank supported the Government in tackling some of the key issues in the DH sector. From 1991 to 2000, the World Bank provided US$340 million for the Heat Supply Restructuring and Conservation Project in Poland. The project included support for: (i) energy restructuring, commercialization of restructured enterprises, introduction of a transparent regulatory framework, and pricing policy reform; (ii) rehabilitation and modernization to extend DH infrastructure asset life; and (iii) energy conservation and pollution reduction through investments in energy efficiency improvements.

The Government's support for energy efficiency and conservation investments and pricing policies led to gradual increases in residential tariffs. The Government also reduced budget layouts for energy subsidies. These two efforts were key to the project's success. Energy efficiency measures carried out by DH companies achieved a 50 percent reduction in heat transmission and distribution losses. This led to a 22 percent energy savings, equivalent to roughly US$55 million per year.

Building-level heat metering was a crucial component of these energy efficiency improvements. Metering in the buildings covered by the five DH companies targeted in the project increased from 21 percent at the start of the project to 100 percent by project completion. Further evaluation of the project underlined the significance of metering. Without accurate measurement of the heat supply, DH companies often vastly underestimated the level of heat transmission losses in the network. Heat transmission losses can reach 20 percent of heat purchased and represent up to 17 percent of variable operating costs. As a result, the companies failed to properly prioritize heat loss mitigation and lost major opportunities for cost savings. Evaluation of the project concluded that: "Future Bank projects with DH companies should assign top priority to metering of total purchases and sales of heat as early as possible during project implementation."

Source: World Bank. Implementation Completion Report: Heat Supply Restructuring and Conservation Project in Poland. 5 June 2000.

6.2.4 Next Steps

Detailed investment and implementation plan: BTS should develop a detailed investment and implementation plan to improve the efficiency and reliability of the distribution network. Based on a request from the Ministry of Energy and Industry, the World Bank mobilized grant-funding to support BTS with technical assistance. The investment and implementation plan will include: (i) scope of implementation and priorities for each measure; (ii) detailed cost estimates and economic-financial analysis for each investment measure; (iii) estimated energy (cost) savings and other benefits; and (iv) detailed sequencing and implementation.

Mobilizing resources: This could include a mix of the company's own funds, concessional financing and grants or government funds (in particular to support the installation of heat cost allocators and thermostatic valves in apartments).

Revision of heat tariffs: Section 6.1 further describes next steps related to the transition to cost-recovery tariffs and consumption-based billing.

6.3 Recommendation 3: Implementation of a Program for the Replacement of Inefficient Individual Heating Systems

The prevalence of inefficient individual heating systems represents a major challenge for the urban heating sector in the Kyrgyz Republic. Coal-fired stoves and boilers are inefficient, dirty and harmful to human health and the environment. Individual electric heaters are an inefficient use of scarce electricity resources. Proliferation of individual electric heaters has destabilized the power grid and increased the frequency of blackouts and power shortages.

6.3.1 Recommended Measures

A scalable program for more efficient small heating technologies is needed, including more efficient individual stoves, boilers and heat pumps. International experience shows that such programs can bring substantial benefits to residential consumers in terms of reduced fuel consumption and costs, lower indoor air pollution and higher comfort levels. Such a program would also have a high replication potential in both urban and rural areas given the large share of households currently relying on inefficient individual heating solutions.

6.3.2 Scope of Implementation

Residential consumers relying on inefficient individual heating solutions (traditional coal-fired stoves or boilers or inefficient electric oil radiators) as a primary heat source should be targeted for this program. The following actions are recommended:

- **Replace inefficient coal-fired stoves or boilers with more efficient models.** For residential consumers with access to gas in the near term, inefficient coal-fired stoves or boilers should be replaced by individual gas heaters or boilers. For residential consumers without access to gas in the medium-term and currently using traditional coal-fired stoves, the deployment of more efficient coal-based models should be promoted. This could help to reduce coal consumption by up to 25 percent, reduce indoor air pollution and improve comfort levels in buildings.[34] As gas becomes available, coal boilers and stoves should be replaced with gas-fired models.
- **Replace inefficient electric oil radiators with heat pumps in buildings without access to centralized heat or gas.** For residential consumers relying on electricity-

[34] The coal-based stoves/boilers currently have a maximum efficiency of 50 percent and are not equipped with any filtering systems. Modern coal-fired models are estimated to have an average efficiency of around 70 percent. Source: Technical Background Report prepared by Fichtner.

based resistance heaters and with access to natural gas, individual gas heaters or boilers should be promoted to help mitigate winter power shortages the country is facing. For residential consumers without future access to gas and currently relying on electric oil radiators, the deployment of efficient heat pumps could be promoted. Heat pumps used in place of electric resistance heaters can reduce household electricity consumption for heating by up to 70 percent (see Box 5.2 in Section 5). Night storage heaters should also be considered because they would help shift electricity demand for heating to off-peak times and decrease the burden on the power grid during peak hours.

6.3.3 Implementation Issues

Ensuring adequate equipment supply and efficient distribution channels: To ensure that the individual heating technologies promoted as part of the program (i.e., coal/gas stoves and boilers, heat pumps) result in significant efficiency gains and comply with safety and emission requirements, the supply chain for such equipment needs to be strengthened. To this end, potential design elements for the program should take into account: (i) adoption of technical, environmental and safety performance standards for products; (ii) eligibility criteria for products and suppliers, including supply capacity of producers; (iii) quality verification and enforcement mechanisms to ensure adequate performance of products; (iv) regulating supply chains and distribution channels to avoid non-compliant copy-cat models (e.g., through dedicated distribution centers); (v) eligibility criteria for households to ensure targeted replacements and incentive schemes; (vi) organizing efficient return and disposal systems for old equipment; and (vii) capacity building and technical assistance for local producers as needed.

Enhancing demand through dedicated financing and incentive mechanisms and public outreach campaigns: Financing and perception are major challenges to the development and implementation of a program for efficient individual heating technologies. Experience in the region suggests that households are reluctant or unable to fund the higher upfront investment for new, individual heating solutions, unless payback periods can be shortened. Given the relatively high unit price of more efficient models compared to traditional options (stoves, boilers and electric heaters), the market penetration of efficient technologies at scale would require dedicated financing mechanisms, a well-targeted incentive program from the Government and large public outreach and awareness raising campaigns. International experience from countries with similar programs could offer useful lessons learned and design options for implementation and financing schemes. Examples include the development of dedicated (micro-) credit-lines for eligible households combined with targeted subsidy schemes (e.g., disbursement after verified installation). The subsidy schemes could be designed to: (i) reflect the affordability of target households; (ii) reward the use of models with higher performance; and/or (iii) promote rapid penetration of new equipment. Box 6.2 and Box 6.3 include examples of programs in Mongolia and Armenia.

Box 6.2: Clean Stove Initiative in Mongolia

The Clean Stove Initiative for Mongolia (Mongolia-CSI) sold nearly 98,000 subsidized, low-emission stoves in five districts in Ulaanbaatar between June 2011 and November 2012, reaching 55 percent of all households in the target area. The program was funded by the Millennium Challenge Corporation and the Mongolian Clean Air Fund, and followed a number of smaller pilot programs that were financed by the Asian Development Bank, Gesellschaft for Internationale Zusammernarbeit, Millennium Challenge Corporation, the World Bank and World Vision.

In order to identify models of stoves to subsidize, the Mongolian University of Science and Technology tested the emissions performance of 14 models of energy efficient solid fuel-based stoves, and four were selected for the program. Two of the models were manufactured in Turkey, and two were from China. Stoves were sold in "Product Centers" in each administrative subdivision, and each household was eligible to purchase one subsidized stove. Many of the product centers were operated by XacBank, a commercial bank that supplied sales and support staff and offered micro-loans to households who could not afford even the subsidized prices. Depending on the model of stove, subsidies ranged from US$195 to US$319 per stove. After subsidies, the stove price to the consumer was 60 to 75 percent below the market prices for the same stove. To receive the subsidy, households were required to turn in their old stove. This ensured that polluting stoves were no longer in use. New stoves were delivered to the household, and customers completed a training program to learn proper use of the stove.

Mongolia's program contains several key lessons and best practices that should be applied to stove and heat pump subsidy programs in the Kyrgyz Republic. These are as follows:

- Subsidy programs should allow consumers to choose among several models, and subsidy payments should only be made after installation is confirmed.
- Final prices after subsidy should not be so low as to allow purchases by consumers who will not use and maintain the equipment properly.
- Equipment should be distributed through local product centers to ensure quality of the product and eligibility for the subsidies.
- Confirming installation of the equipment and training consumers ensures that equipment is used properly, and prevents re-selling of subsidized products.
- Removing old equipment from use ensures large and sustainable improvements in efficiency.
- Programs should be implemented in partnership with the private sector in order to provide good customer service and respond to market demands.

Source: World Bank Group, "Stocktaking Report of the Mongolia Clean Stoves Initiative," 2013.

Box 6.3: Efficient Gas Stove Subsidies in Armenia

As its gas distribution network gradually expanded, Armenia launched a program to distribute efficient gas stoves to poor urban households with limited access to heating. The Global Partnership on Output-Based Aid, the World Bank's Urban Heating Project and the Government of Armenia funded the program.

Families were eligible for participating in the subsidy program if they were enrolled in the Poverty Family Benefit Program, a social protection program for Armenia's low-income households. In addition, families had to live in an urban multi-apartment building that was connected to a functioning gas network. Finally, the family had to contribute US$25 to 50.

Armenia's Renewable Resources and Energy Efficiency Fund (R2E2) administered the program. The R2E2 Fund publicized the program and encouraged poor urban families to apply. After determining eligibility, the R2E2 Fund collected the family cash contribution and worked with the gas company to organize installation and connection of new stoves. The R2E2 Fund then independently verified the installation of the stoves and delivery of gas service. It refunded the payments made by the gas company to the contractors who installed the stoves.

Armenia's experience in subsidizing gas stove installations provides several key lessons that are worth noting if a similar program is implemented in the Kyrgyz Republic:

- Early preparation for implementation is crucial to adjust reporting and monitoring mechanisms to the program's requirements.
- Households should be made to apply for the program and provide cash payment, as these activities foster a sense of ownership and commitment to the program.
- Procurement needs adequate planning, including the ability to allow contract extensions with the providers who win the bidding for the project.

Source: "Output-Based Aid in Armenia: Connecting Poor Urban Households to Gas Service," *OBA approaches* Note Number 23, 2009.

6.3.4 Next Steps

The next steps for developing and implementing a program promoting efficient individual stoves, boilers and heat pumps are described below:

Conduct a detailed market assessment. The scope of the market assessment should include a review of: (i) the current use of inefficient coal stoves/boilers and electric heaters, including the types of devices, average lifetime in use, market prices, equipment suppliers and available products; (ii) the efficiency, environmental and safeguard performance of internationally available efficient models; (iii) the supply chain and local market for more efficient technologies; (iv) the energy savings potential and pollution reduction benefits that are possible from the deployment of more efficient models; and (v) for heat pumps, the evaluation of grid stability and frequency fluctuations and their potential for damaging heat pump equipment and measures to mitigate this risk.[35]

[35] For instance, one potential mitigation option could be the installation of adequate protection devices such as surge protectors, power conditioners or Uninterruptible Power Supply (UPS).

Develop and design targeted implementation and financing schemes, including the mobilization of grant resources. As indicated above, international experience from countries with similar program could offer useful lessons learned and design options for implementation and financing schemes. Potential financing/delivery instruments include demand-side management programs, micro-credit lines, results-based financing mechanisms or climate finance instruments, accompanied by targeted subsidies for low income households.

Implement pilot projects. Pilot projects should be developed to: (i) demonstrate the benefits of more efficient individual heating models in terms of energy (cost) savings, indoor air pollution, and comfort levels; (ii) test the adequacy of the selected implementation and financing schemes; and (iii) investigate the willingness of consumers to adopt new stoves and boilers under the chosen implementation and financing schemes.

Conduct early public outreach campaigns. International experience confirms that extensive awareness and promotion campaigns help to educate the public about benefits related to more efficient individual heating options. They also inform people about the dedicated financing and implementation mechanisms.

6.4 Recommendation 4: Construction and Rehabilitation of Small HOBs

The levelized cost assessment indicates that small HOBs continue to be a cost-effective heating solution and could also be a viable alternative for buildings currently served by large HOBs in both Bishkek and Tokmok (see Section 6.5 below). As described in Section 3, many of the small HOBs are in dilapidated condition with low efficiency levels (as a result of their conversion from gas to coal) and/or run on electricity, which aggravates power shortages in winter months.

6.4.1 Recommended Measures

It is recommended to gradually replace existing small HOBs in dilapidated condition[36] with either more efficient gas-fired models or, in Bishkek, through an extension of the DH network supplied by the CHP 1, if the buildings are close to BTS' network. The replacement of old and inefficient HOBs by efficient gas-fired models can reduce the fuel consumption by 20 to 50 percent, improve heat supply reliability, enhance comfort levels in buildings and either reduce pollution in urban areas (if replacing coal-fired HOBs) or help mitigating winter power shortages (if replacing electricity-based boilers).

In addition, the construction of new, small HOBs should be considered for buildings currently served by large HOBs in poor condition or buildings located at the outskirts of the service area supplied by large HOBs (see Section 6.5). Small, efficient HOBs should also be considered as a viable heating option during the construction of new multi-apartment buildings going forward.

[36] There are currently about 74 small HOBs operated by BTE in Bishkek. Only one was recently constructed (2011) and is considered to be efficient. In most cases, the condition of the boilers is so poor that rehabilitation would technically result in dismantling and replacement of old boilers. Given that some of the existing structures and auxiliary equipment can be re-used, the investment costs would be reduced by around 10 percent.

The installation of small and efficient HOBs should be combined with energy efficiency measures (see Section 6.6) and the installation of thermostatic valves and heat cost allocators (see Section 6.2) in targeted buildings.

6.4.2 Scope of Implementation

In Bishkek, the replacement or construction of small HOBs is recommended for the following building types: (i) all public buildings without access to the DH system, taking into account future decisions on the continuation of large HOBs operated by BTE; (ii) multi-apartment buildings with existing building-internal heating infrastructure (i.e., buildings currently served by large or small HOBs); and (iii) new multi-apartment buildings that will be built in the future.

In Tokmok, the construction of small, efficient HOBs should be considered for new public and multi-apartment buildings, or buildings currently served by large HOBs (see Section 6.5).

6.4.3 Implementation Issues

Environmental impact: The replacement of coal-, fuel oil- or gas-fired HOBs with more efficient and cleaner gas-fired models will have a positive environmental impact. However, this will depend on access to gas in the short- or medium-term.

Building-internal heating infrastructure: All of the buildings targeted by this recommendation have an internal building heating infrastructure or are under construction. As small HOBs are replaced, the rehabilitation needs of the buildings' internal heating networks should be assessed and thermostatic valves and heat cost allocators should be installed in apartments. For new buildings, measures should be taken to ensure that the internal heating network has a horizontal design to allow for the disconnection of individual apartments (for non-payment) and individual metering.

Financing: As described in Section 2, heating companies are in poor financial condition. They lack the funding to pay for the up-front capital cost of new small HOBs. Because the companies operate at a loss, their borrowing capacity is seriously constrained. Securing sufficient financing for rehabilitation may be quite challenging and is likely to require a mix of funding sources. However, greenfield installations in newly constructed multi-apartment buildings, or replacement of boilers owned by public institutions may offer new business opportunities for engaging private sector participation (e.g., private heat suppliers or private maintenance companies).

6.4.4 Next Steps

A detailed investment and implementation plan should be developed for the replacement of small HOBs operated by BTE to determine priorities, detailed investment requirements and technical implementation aspects. This would include: (i) assessing the condition of the boilers and internal heating infrastructure; (ii) evaluating the fuel availability and space requirements for the boiler; (iii) conducting an economic and financial analysis; (iv) clarifying ownership issues, in particular for small HOBs in public buildings; (v) installing apartment-level temperature control and heat cost allocators; and (vi) other issues.

6.5 Recommendation 5: Replacement of Large HOBs

Large HOBs currently supply heat for 579 public and residential buildings in Bishkek and 415 buildings in Tokmok. As described in Sections 3 and 4, many of the large HOBs are in poor operational condition and in need of major rehabilitation. The levelized cost assessment indicates that small HOBs are a more viable heating option than large HOBs, in particular as the continued use of large HOBs would require substantial upgrades to the boilers and the DH distribution network.

6.5.1 Recommended Measures

To determine whether it is economically and technically preferable to continue operating large HOBs or to replace them with efficient centralized or individual gas-fired heating options, it is recommended to conduct a detailed feasibility study for each facility. As part of this assessment, the following options should be evaluated in detail:

- For large HOBs that are in poor operational condition and in need of major rehabilitation, their replacement by either small, efficient HOBs or by efficient individual gas-based heating solutions.
- Redrawing the service areas of the three large HOBs operated by Tokmok KZhK to improve efficiency. The long distance between the boiler houses and end-consumers located at the outskirts of the service area results in unnecessarily high heat losses. Changing or decreasing the service area of large HOBs and constructing new, small HOBs for buildings removed from the DH system could reduce losses.
- Implementing the efficiency and reliability measures described under Section 6.2 for large HOBs in good operational condition.

6.5.2 Scope of Implementation

The specific scope of implementation would depend on the results of a detailed feasibility study. Currently, about 15 percent of the multi-apartment and nine percent of the public buildings in Bishkek are served by large HOBs. Almost all multi-apartment and public buildings in Tokmok are served by large HOBs.

6.5.3 Implementation Issues

Environmental impact: As described in Section 3.1.2, a number of large HOBs use fuel oil as primary fuel (instead of gas) or have been converted from gas to coal with low combustion efficiency. Their replacement by small, efficient gas-fired HOBs would have a positive environmental impact. However, this will depend on the availability and access to gas, and the results of the detailed feasibility study.

Efficiency gains of alternative heating solutions: The levelized cost assessment found that individual heat pumps and individual gas boilers/heaters are slightly more cost-effective than small HOBs. However, the customer segment targeted for this intervention already relies on a centralized solution and has a functioning internal heating system. For this reason, the installation of small HOBs should be considered as a priority option. If households have to switch to individual heating solutions (without some program promoting and subsidizing efficient models), they would likely opt for inexpensive electric oil radiators or inefficient individual heating solutions.

Other implementation issues: There are a number of other implementation issues, such as the redundancy of existing generation, transmission and distribution infrastructure, which will need to be assessed in detail as part of the feasibility study. Specific implementation issues related to the installation of small HOBs are highlighted in Section 6.4.3.

6.5.4 Next Steps

A detailed feasibility study should be conducted for the nine large HOBs operated by BTE and the three large HOBs operated by Tokmok KZhK SUE in order to determine whether their continued operation or their replacement by small HOBs or individual gas-based heating solutions are the more viable investment. For each boiler house, this should include (but not be limited to) an assessment of: (i) the operational condition of the boiler house and related heat network; (ii) the heat load density of the service area; (iii) rehabilitation or replacement costs, including the need for rehabilitating the transmission and distribution network; (iv) investment costs to replace large HOBs in poor condition with small HOBs/individual gas heaters or boilers and related technical requirements; and (v) access to gas-fired options.

6.6 Recommendation 6: Implementation of an Energy Efficiency Program in Buildings

Improving the efficient use of energy in buildings is one of the most cost-effective and environmentally friendly ways to help meet heat demand in the Kyrgyz Republic. Estimates suggest that energy efficiency improvements could reduce energy consumption by 30 to 50 percent, and generate savings of up to 480,000 MWh per year in Bishkek and Tokmok alone. Given the poor energy performance of the majority of buildings in the Kyrgyz Republic, this would also have a number of other co-benefits, including improved comfort levels in buildings, reduced air pollution and reduced energy expenditures for households and public institutions.

6.6.1 Recommended Measures

Energy efficiency retrofits in public and residential buildings are recommended in both Bishkek and Tokmok. Depending on the conditions of the public and residential buildings, recommended retrofit measures (besides improvements related to the heating systems) to reduce heat demand/losses should include: (i) the insulation of walls, basements and/or attics; (ii) repair/replacement of external doors and windows; (iii) window optimization (partial replacement of existing windows with walls while complying with daylight requirements); and (iv) improved operations and maintenance practices.

6.6.2 Scope of Implementation

The economic analysis of heating options finds that in some multi-apartment buildings energy efficiency has a lower LCHS than DH with large HOBs. Energy retrofits in all building types appear to have an LCHS that is lower than individual electric radiators.

As a priority, energy efficiency measures should be implemented in all public and residential buildings where the heating systems will be upgraded. The experience in other ECA countries demonstrates that linking heating system improvements to building energy efficiency measures generates significant operational and financial synergies. In addition, the Government should consider developing a broader energy efficiency program for public and/or residential buildings. To streamline limited resources, it is advisable to focus initially on a selected target segment (either public or residential buildings). Factors for such a decision should include:

- the objective of the program;
- the potential for economically and financially viable energy efficiency investments – in this regard, the low heating and electricity tariffs will be one of the key barriers in incentivizing households to invest in energy saving measures; while the same is true for the public sector, the economic viability of investments is typically valued more highly in the public sector; and
- the ease of implementation – in ECA, many countries decided to start first with an energy efficiency program in the public buildings sector before moving to the more complex residential sector; reasons for this choice include: (i) the lack of well-functioning collective decision-making structures in multi-apartment buildings; (ii) insufficient financial incentives for private investments; (iii) the lack of access to affordable financing for many households; and (iv) the demonstration effect and social benefits of improved energy efficiency in public buildings, such as schools, hospitals and kindergartens, for a large segment of the population.

6.6.3 Implementation Issues

Energy efficiency building programs supported by the World Bank and other development partners in ECA have demonstrated that substantial energy savings (between 20 and 50 percent) and co-benefits (e.g., better comfort levels) can be achieved. However, effective implementation requires a strong enabling environment and targeted financing and implementation mechanisms. Decisive government actions and long-term commitment are required to enact and enforce legislation, adopt policy and regulatory enhancements, improve market conditions, build local capacity and provide access to affordable financing. Priority actions and implementation issues include:

Tariff reform: The key policy action to improve the financial viability of energy efficiency investments is the transition to cost-reflective energy prices for both heat and electricity. In addition, the introduction of consumption-based billing practices for customers connected to the DH system is a pre-requisite for the generation of energy cost savings for households and public institutions investing in energy efficiency.

Developing targeted financing and implementation mechanisms: The Government should consider developing effective financing mechanisms to support the implementation of an energy efficiency program targeted either for public or residential buildings.

<u>Financing mechanisms for public buildings:</u> International experience indicates that there are a number of different financing options ranging from public financing (e.g., grant-financed pilot programs) to commercial financing (e.g., credit lines, partial credit guarantees, ESCO financing, etc.). Based on the local market capacity and the maturity of the financial and credit markets in the Kyrgyz Republic, the following two mechanisms may be the most suitable short-term financing options for energy efficiency investments in public buildings:

- **Budget financing with piloting of more sustainable models:** To build capacity, demonstrate energy efficiency benefits, reduce public energy cost spending and improve comfort levels in schools, hospitals, kindergartens and other public facilities, the Government may want to consider implementing a budget/grant-financed energy efficiency program for public buildings. Under such a program, the Government provides funding (e.g., as part of a project financed by development partners) to public facilities/municipalities to cover the upfront costs of energy efficiency investments. Gradually, the program could phase in more sustainable financing features, such as 'budget capture models'. In this case, future (energy) budgetary provisions for the benefitting public institution are reduced until the loan has been (partially or fully) repaid. The Government could use some of the cash saved through the budget capture system to finance additional projects. Another option would be the phasing-in of co-financing arrangements with the beneficiaries. Budget/grant-financed energy efficiency programs are typically implemented through a project implementation unit (PIU), which provides support for selecting buildings, conducting technical preparatory activities and related procurements (e.g., energy audits, designs), supervising and implementing the energy efficiency measures and monitoring of results.
- **Revolving Fund for energy efficiency:** Some developing countries (e.g., Armenia, Bulgaria, India, Romania, Uruguay, Macedonia, Bosnia and Herzegovina) have created or are planning to create revolving funds to finance energy efficiency measures in public buildings. In this case, a Fund (typically an independent entity established by the government) provides the up-front investments and technical assistance for preparing and implementing energy efficiency measures. The benefitting public institution repays the investment costs based on the estimated or verified energy cost savings achieved. This allows the funds to revolve (by re-investing the repaid funds) while the benefitting public institution is able to maintain a positive cash flow. In most countries, the Fund offers different financial products and technical assistance services to cover the needs and capacity of different public institutions (e.g., loans, grants, guarantees for commercial bank loans, technical assistance for energy auditing, procurement, supervision, etc.). Key issues in the Kyrgyz Republic that could hamper implementation of a revolving fund scheme and would need to be taken into account include: (i) the low energy tariffs; (ii) the low comfort levels in public buildings reducing actual energy cost savings and repayment reflows; (iii) the limited technical and financial market capacity; and (iv) public budgeting/procurement rules. Box 6.4 provides an example of experience with a revolving energy efficiency fund in Armenia.

Box 6.4: Energy Efficiency Revolving Fund in Armenia

The R2E2 Fund was established in 2005 initially as a PIU for a World Bank-supported energy efficiency/renewable energy project. The Fund operates on a fully commercial basis and is governed by a board of trustees made up of representatives from the government, private sector, NGOs and academia. A government-appointed executive director, supported by technical and financial staff, manages day-to-day activities. The Fund currently implements a World Bank/GEF-supported energy efficiency program in public sector facilities (e.g., schools, hospitals, administration buildings, street lighting) using a revolving fund scheme. The Fund offers two financing products to eligible public entities:

Energy Service Agreements (ESA) are used for schools and other public entities that are not legally or budget independent. Under the ESA, a public entity pays the Fund its baseline energy costs (with adjustments for energy prices, usage and other factors) over the 7-to-10- year contract period. The Fund designs the project, hires subcontractors, oversees construction and commissioning and monitors the subproject. In this case, the client entity incurs no debt. Rather, the Fund directly pays the energy bills to the utility on the client's behalf. The Fund retains the balance to cover its investment cost and service fee. The ESA is designed so that the duration can be adjusted if the Fund recovers its full investment earlier (or later).

For municipalities and public entities with revenue streams independent of the state budget, loans are provided. These loans count as municipal debt, with fixed repayment obligations to be made within their budget provisions in future years. The repayment amounts are designed to allow clients to repay the investment costs and service fees from the estimated energy cost savings. The client can pay additional fees for the Fund to implement the project on its behalf.

R2E2 uses simplified performance contracts to shift some performance risks to private construction firms/contractors. Under these contracts, firms are selected based on the net present value of the projects they propose. A portion of their final payment (around 30 percent) is based on a commissioning test.

The R2E2 Fund is expected to finance an estimated 85 projects worth about US$6 million between 2012 and 2015 and to demonstrate a sustainable financing and implementation model for the public sector. As of January 2014, the Fund signed 20 loans and ESAs valued at US$3.05 million since 2011.

Source: World Bank, Project Appraisal Document for an Energy Efficiency Project in Armenia, March 2012.

Financing mechanisms for residential buildings: International experience indicates that there are four major financing options for a residential energy efficiency program: energy efficiency funds, commercial bank financing, partial credit guarantees and utility energy efficiency programs. Energy efficiency funds and commercial bank financing, combined with grant-based incentive schemes, appear to be the most suitable financing options for kick-starting energy efficiency in residential buildings in the Kyrgyz Republic. There is already a credit-line supported by EBRD, which provides loans and grants (10 to 35 percent) for energy efficiency investments in residential buildings and industrial enterprises. Industrial energy efficiency investments currently account for the large majority of the investment volume. Instead of creating a new financing instrument for residential buildings, the Government may want to consider focusing on evaluating the reasons for limited adoption in the residential sector. The Government should explore ways to enhance the coverage of the credit-line and pipeline development and to develop policy/program enhancements.

Utility energy efficiency programs may also be a viable option. Utilities are well-placed to deliver energy efficiency programs because of their established relationships with customers and knowledge of local energy use patterns. They also have billing systems in place that can be used to recover costs from customers. Because utilities in the Kyrgyz Republic currently lose money on each unit of heat supplied, they have financial incentives to implement programs that reduce demand.

A program could be developed that would replace inefficient radiators with heat pumps (for electric customers) or individual gas heaters (for gas customers) in accordance with the recommendation on the replacement of inefficient individual heating systems (see section 6.3). The electricity distribution companies or the gas company could provide the equipment and use customers' monthly bills for full or partial recovery of the cost over multiple billing periods. Gazprom could implement a similar program for new gas customers which provides efficient, high quality gas heaters with the new connection, with Gazprom recovering the cost through the gas bill.

Strengthening HOAs: Split incentives in multi-apartment buildings and weak HOAs are key challenges to both energy efficiency investments and upgrades of collective heating solutions (small HOBs or DH). If decision-making structures for investments and mechanisms for financing more capital-intensive upgrades are not well established, it will be very difficult in multi-apartment buildings to reach consensus about upgrading/switching to collective heating solutions or implementing building-level energy efficiency measures. Experience in the ECA region has shown that governments can support the development of HOAs by drafting better legislation for decision-making in multi-apartment buildings. For instance, the government can set and enforce standards for apartment-building maintenance and provide training and public outreach on collective decision-making, building management and maintenance.

Experience in the region has also shown, however, that many efforts to strengthen HOAs meet obstacles which prove difficult to overcome. Such obstacles include:[37]

- The mix of residents from different economic levels living in the same building. This can result in poorer residents refusing to make contributions toward maintenance expenses, while wealthier residents subsidize their neighbors.
- The technical capacity of HOAs. It is difficult for apartment owners to establish and operate HOAs on their own, especially for low-income households, whose buildings are typically in the most need of repair. HOAs typically hire professional managers, but it is important for individual apartment owners to understand their rights and responsibilities as HOA members.

[37] International Housing Coalition, Homeowners Associations in the Former Soviet Union: Stalled on the Road to Reform, prepared by Lipman, Barbara J., 2012.

- The poor condition of the buildings. Residents may fear that they will not have enough money to address the magnitude of the problems.
- The absence of incentives. Low tariffs have kept services affordable, but have also led to poor service quality and reliability. Meanwhile, a lack of metering and controls gives residents no reason to cut their consumption.
- Limited access to financing. HOAs have difficulty borrowing because banks do not view them as creditworthy and are typically unwilling to lend on a project finance basis.

Given the difficulty of working through HOAs, the Kyrgyz Republic also should consider other approaches. Lithuania offers an example of an alternative approach in which a municipality initiated and managed energy efficiency improvements in buildings. The program retrofitted more than 2,400 residential buildings between 1996 and 2013—saving about 82.3 GWh per year—despite the lack of borrowing and technical capacity on the part of homeowners and HOAs. Box 6.5 provides insight on improving homeowner associations in Lithuania.

Box 6.5: Approach to Address the Lack of Borrowing Capacity by Homeowners and HOAs in Lithuania

The residential energy efficiency program in Lithuania, initiated in 1996, provided loans and subsidies, combined with technical assistance, to support energy efficiency investments in residential buildings. To address the limited technical and borrowing capacity, the lack of awareness and split incentives of homeowners and HOAs, the program allowed building renovations to be initiated by the municipality.[1] The municipality appointed a project administrator for multi-apartment buildings with weak or inexistent HOAs. The appointed building administration company (mostly municipally owned) took loans on behalf of the homeowners to finance the energy efficiency investment costs. The company recovered the investment costs through a monthly building-management fee paid by homeowners based on the estimated energy cost savings achieved. Homeowners were not obliged to borrow. The municipal project administrator assumed the loan repayment risk. While the consent of homeowners was required to implement the energy efficient retrofits in their buildings, the program also provided additional incentives to facilitate consent from low-income households. After completion of the renovations, all low-income households received a subsidy covering 100 percent of the preparation and renovation costs. The state reduced the heating subsidy by 50 to 100 percent over three years for low-income households that opposed the implementation of energy savings measures.

Source: ESMAP, Case Study on the Residential Energy Efficiency Program in Lithuania, prepared by Viktoras Sirvydis, 2014.

Ensuring enforcement of building codes for new buildings: The Kyrgyz Republic has an advanced legislative framework for efficient energy performance standards. However, less than 10 percent of the newly constructed buildings comply with these building codes. If newly constructed buildings would comply with the enacted energy performance standards, specific heat demand in those buildings could be reduced by

15 to 25 percent (or about 50 Gcal per building per year).[38] In order to establish an enforcement system, the following components are typically needed: (i) a dedicated unit/department with sufficient budget and staffing to administer and implement building codes; (ii) a clear compliance process with administrative procedures, compliance forms, checklists and procedures, user manuals or guidebooks, compliance tools, etc.; (iii) awareness raising, training and capacity building among officials, designers, architects, engineers, manufacturers and other key stakeholders; and (iv) evaluation and monitoring arrangements.[39]

6.6.4 Next Steps

Select the target buildings for an energy efficiency investment program and define the objective. As indicated above, in order to develop and design an effective energy efficiency program, the Government would need to determine the objective and scope of such a program (public or residential buildings).

Conduct a comprehensive market assessment. A market assessment is needed to: (i) analyze the technical, economic and financial energy efficiency potential for various building types; (ii) evaluate the energy efficiency supply market (e.g., energy auditors, equipment suppliers, design and construction companies, etc.) to provide an overview of the market capacity and quality of services/products; (iii) assess key policy, regulatory, financial and institutional barriers to realize the energy efficiency potential and identify specific ways that these barriers can be addressed; and (iv) inform the selection and design of an adequate implementation and financing scheme.

Select and design a targeted implementation and financing mechanism for the energy efficiency program. To incentivize energy efficiency investments, careful design of effective implementation and financing schemes is needed. In addition, broad stakeholder consultations are recommended to ensure that the selected mechanism(s) and design features reflect the needs of the target market segment and other stakeholders involved (e.g., engineering companies, energy auditors, commercial banks, etc.). The Government may want to explore different financial sources to support such a program, which could include bilateral and multilateral development partners, GEF allocation, etc.

6.7 Action Plan for Bishkek and Tokmok

As the recommendation sections highlighted, a comprehensive package of policy reforms and investment measures is needed to improve the operational and financial performance of the heating sector, and adequately meet residential and public heat demand. Table 6.1 recommends a roadmap with a timeframe in which actions should be implemented, and demonstrates which challenge these actions will help address.

[38] Based on energy performance of building class B requirements (SNIP 23-01-2009), calculated for three compliance scenarios: 50 percent, 80 percent and 100 percent.

[39] ESMAP, Improving Energy Efficiency in Buildings, 2014.

Table 6.1: Investment Action Plan

Recommendation	Short-term (next 24 month)	Medium-term (next 2-5 years)
Improve financial viability	▪ Enact annual DH and electricity end-user tariffs in accordance with the MTTP ▪ Adopt a clear tariff setting methodology for DH companies and non-residential end-users (served by HOBs)* ▪ Adopt an effective performance reporting and monitoring framework for the heating sector, including key performance indicators and clear monitoring and verification procedures and templates* ▪ Strengthen capacity of the State Regulatory Agency to consistently apply the tariff-setting methodology (both for heating and electricity) and the performance reporting and monitoring framework* ▪ Provide training to DH companies to prepare tariff filings in accordance with the adopted methodology and performance framework* ▪ Adopt a plan for transitioning to consumption-based billing for existing and new buildings (for existing buildings, in the short-term, the focus could be on building-level metering and in the medium-term on consumption-based billing at apartment level)* ▪ Adopt a plan for restructuring the social assistance system by topping-up the programs with better targeting of the poor while simultaneously phasing out other programs	▪ Adopt a new multi-year tariff policy to be effective from 2018 for both DH and electricity, based on the revenue requirements of the power and heating sectors and enabling cost-recovery levels ▪ Implement consumption-based billing at apartment-level ▪ Implement the restructuring plan for the social assistance programs
Enhance the performance of the heating infrastructure through:	▪ Agree on and adopt a nation-wide gasification plan with specific timelines and customer segments in different regions	▪ Ensure that the upgrading of natural gas infrastructure is completed according to the gasification plan

– Expansion of the natural gas infrastructure	▪ Ensure that the upgrading of natural gas infrastructure is implemented according to the gasification plan	
– Improvement of the reliability and efficiency of the DH network	▪ Develop and adopt a detailed investment and implementation plan for BTS with prioritized reliability and efficiency measures* ▪ Conduct hydraulic analysis of the transmission and distribution network operated by BTS to configure the network and dimension of pipes and the capacity of pumping stations ▪ Mobilize funding to support implementation of the investment plan ▪ Start implementing priority investment measures to improve reliability and efficiency of the DH system operated by BTS (subject to change based on the results of the investment plan): – Rehabilitate depreciated heat substations and replace hydro-elevators with modern building-level substations (including efficient control and metering functions) – Install apartment-level hot water meters – Adopt consumption-based billing (at building-level for heat and apartment-level for hot-water) – Require installation of horizontal design for building-internal pipes in all new buildings and buildings undergoing rehabilitation – Replace old network pumps with efficient variable speed pumps, install modern SCADA systems and adjust dimensioning of the pumping capacity based on hydraulic analysis of the transmission and distribution network	▪ Complete the implementation of priority investment measures to improve reliability and efficiency of the DH system operated by BTS ▪ Install apartment-level thermostatic valves and heat cost allocators for all buildings served by BTS, as appropriate ▪ Develop and adopt a detailed investment and implementation plan for BTE and KZhK with prioritized reliability and efficiency measures

	– Replace/re-insulate priority sections of the DH transmission and distribution network with pre-insulated and properly dimensioned pipes based on the hydraulic analysis and prioritized investment plan	
– Implementation of a scalable program for more efficient small heating technologies (stoves, heater, small boilers and pumps)	▪ Conduct a detailed (qualitative and quantitative) market assessment on the deployment of efficient small heating technologies, including gas-fired heaters and boilers, coal- or biomass-fired stoves and boilers, and electric heat pumps ▪ Determine the eligibility criteria for households, products and suppliers to be included in the program based on the results of the market assessment and the objectives of the program ▪ Design the financing, subsidy and implementation schemes of the program (e.g., credit-lines or demand-side management program; level and beneficiary of subsidies; distribution channels through local product centers, utilities or housing management companies; etc.) ▪ Mobilize funding for implementation of an efficient heating program (including pilot phase and implementation of full-scale program) ▪ Pilot the designed program for more efficient small heating technologies, including measurement of results and adjustment of the design of the program ▪ Conduct public outreach campaigns to raise awareness about the benefits of more efficient small heating technologies	▪ Deploy full-scale program for small efficient heating technologies based on the results of the pilot phase
– Rehabilitation or replacement of small HOBs or expansion of the DH	▪ Develop and adopt a prioritized investment and implementation plan for the gradual replacement of dilapidated small HOBs by more efficient gas-fired HOBs, the	▪ Complete replacement/ rehabilitation of small HOBs

network supplied by the CHP in Bishkek	construction of gas-fired HOBs for new buildings or through the expansion of the DH network supplied by the CHP ▪ Deregulate non-residential end-user tariffs for small HOBs to attract investments by private heat suppliers or private maintenance companies, and mobilize concessional financing to improve reliability and efficiency of small HOBs supplying residential and public buildings ▪ Begin replacement of small HOBs based on the priorities identified in the investment plan (including replacement by efficient gas-fired HOBs or through DH network expansion supplied by the CHP)	
– Rehabilitation or replacement of large HOBs by small, gas-fired HOBs, individual gas-based heating solutions or the expansion of the DH network supplied by the CHP in Bishkek	▪ Conduct a detailed feasibility study to determine whether large HOBs should continue their operation, or if part or all of their service area should be served by small gas-fired HOBs or the CHP in Bishkek (through the expansion of the DH network) in the future ▪ Adopt a prioritized investment and implementation plan based on the feasibility study and mobilize funding for implementation	▪ Decommission or rehabilitate large HOBs based on the findings of the feasibility study
Improve the energy performance of buildings	▪ Select target segment (i.e., either public or residential) of the energy efficiency program and define its objective ▪ Conduct a detailed market assessment to define the energy efficiency potential and inform the design of the program; as part of this assessment, evaluate the key reasons for the limited demand under the ongoing credit-line for energy efficiency in residential buildings ▪ Design the implementation and financing scheme of the program	▪ Continue implementation of the energy efficiency program for the target segment and gradually transition towards more sustainable schemes (e.g., revolving funds) ▪ Implement a full-scale energy efficiency program

	▪ Develop policy/program enhancements to support energy efficiency (e.g., strengthen HOAs/ professional management companies, adopt and enforce standards for appliances/ construction materials, provide training for energy auditors, etc.) ▪ Mobilize funding and initiate implementation of the energy efficiency program for the selected target segment starting with simple financing models (e.g., budget financing for public buildings)	

* Note: These areas are supported under ongoing technical assistance activities of the World Bank.

6.8 Investment Cost Estimates

The investments to implement the recommended measures are sizeable and will need careful planning, prioritization and funding from both public and private sources. Table 6.2 and Table 6.3 provide a rough estimate of the investment costs for Bishkek and Tokmok, respectively, based on the recommendations and the action plan.

Table 6.2: **Estimated Investment Costs – Bishkek**

Recommended Measures	**Investment cost estimates (US$ million)**	
	Short-term	**Medium-/long-term**
DH reliability and efficiency measures		
Building-level substations, including metering	37	18
Temperature regulation, consumption-based billing		71
Replacement and reinsulation of network pipelines	40	58
Variable speed drive pumps	3	1
Program for efficient individual heating systems		
Efficient small coal stoves and boilers	14	30
Gas-fired stoves and boilers	43	42
Efficient heat pumps	9	9
Replacement of small HOBs with gas-fired small HOBs	30	-
Replacement of large HOBs with gas-fired large HOBs*		
Energy Efficiency Program for Buildings		
Public buildings	38	58
Residential buildings		210
TOTAL	**214**	**497**

Note: * The economic and financial viability of the continued operation of large HOBs needs to be determined based on detailed feasibility studies for each case. For the purpose of the investment cost estimates, it was assumed that large HOBs will be replaced by modern gas-fired large HOBs.

Table 6.3: **Estimated Investment Costs – Tokmok**

Recommended Measures	Investment cost estimates (US$ million)	
	Short-term	**Medium-/long-term**
DH reliability and efficiency measures		
Building-level substations, including metering		7
Temperature regulation, consumption-based billing		6
Replacement and reinsulation of network pipelines		22
Variable speed drive pumps		1
Program for efficient individual heating systems		
Efficient small coal stoves and boilers	3	3
Gas-fired stoves and boilers	3	3
Efficient heat pumps	1	1
Construction of small HOBs with gas-fired small HOBs*	n/a	n/a
Replacement of large HOBs with gas-fired large HOBs*		8
Energy Efficiency Program for Buildings		
Public buildings	4	
Residential buildings		18
TOTAL	**11**	**69**

Note: * The investment costs related to the construction of new small HOBs will depend on the results of a detailed feasibility study determining the economic and financial viability of continuing the operation of large HOBs. For the purpose of the investment cost estimates, it was assumed that large HOBs will be replaced by modern gas-fired large HOBs.

Appendix A: Problems with the Current Energy Tariff-Setting Process and Recent Tariff Reform Efforts

Improving the financial performance of the heating companies through tariff reform has proven difficult due to several constraints in the tariff setting process and regulatory structure. Specifically, the problems with the existing tariff approach include:

- **Unclear tariff methodology**. The Regulatory Agency of the Fuel and Energy Complex does not currently have a clear tariff setting methodology and formal procedure for setting heat tariffs. Best practice regulation requires that regulators implement a tariff methodology that establishes the standard tariff setting approach they will follow. A tariff methodology provides utility companies and the public with a clear and transparent set of procedures for how tariffs are determined and specifies the role of the regulator. The methodology should define the costs that will be recovered through tariffs, the procedures for allocating these costs to different customer groups and the approach to designing end-user tariffs. In addition, a clear tariff methodology should lay out the tariff review process by defining the procedures for reporting costs, cost review and approval, public hearings and publication of tariff proceedings.
- **Inefficient tariff design**. The Regulatory Agency currently sets national residential heat and hot water tariffs and then approves tariffs for non-residential customers not served by the CHP separately for every boiler in the country. As a result, the regulator approves more than 80 sets of tariffs. This creates a burden on the regulator. It is an inefficient approach to tariff design. A more efficient approach would be to aggregate the costs of the individual boilers for each company, then set individual tariffs for each heating company. Companies with multiple boilers would be responsible for determining how to allocate the revenue among each of the facilities under their control.
- **Overlapping regulatory responsibilities**. One of the main barriers to tariff reform has been confusion over the jurisdiction of tariff setting between the Anti-Monopoly Agency and the Regulatory Department (the predecessor of the Regulatory Agency). While it was clear that the Regulatory Department was in charge of setting tariffs, it was unclear which organization had the responsibility for approving the costs that could be recovered. This issue was addressed by recent legal and regulatory changes, which assigned economic regulatory functions—including tariff regulation—exclusively to the Regulatory Agency. Giving the Regulatory Agency exclusive responsibility for tariff reform solves the problem of overlapping responsibilities. However, the Regulatory Agency now needs to make a concerted effort to establish public confidence in the regulatory process by establishing clear and consistent tariff setting procedures and conducting regular public hearings on key regulations to be adopted. A first step was made in December, when the Regulatory Agency adopted a methodology for setting

electricity tariffs. As a next step, the adoption of a transparent tariff setting methodology for the heating sector is needed.

- **Use of normative tariffs**. A lack of end-user metering in the heating sector requires the use of normative tariffs. Normative tariffs are fixed charges that are usually based on either some assumed number of family members in a household or the area (in m^2) of the customer served. The existing approach for the majority of residential customers is to charge customers by area for heating and number of family members for hot water. A normative tariff thus assumes an average consumption pattern for all customers based on the size of the premise being heated (combined with building characteristics) or the number of people being served. The problem with normative tariffs is that the price paid for energy services is not connected to consumption. Customers have no incentive to conserve heat. As a result, heating companies also do not cover the costs to serve consumption that is outside the pattern assumed in the normative tariff. Heat meters, thermostatic valves and heat cost allocators need to be installed to gradually transition to consumption-based tariffs.

The Government and Regulatory Agency must account for these issues as they work to reform tariffs and improve the financial condition of the heating companies. This should include formal tariff methodology and more efficient tariff design.

Tariff Reform

The Government has recently embarked on electricity and heat tariff reforms aimed at a phased increase of end-user tariffs. The draft MTTP for the power and heating sectors for 2014-2017 envisions annual tariff increases for different consumer groups to achieve short-term cost recovery by 2017. A more than two-fold increase for residential DH and hot water tariffs is envisioned for 2014/2015. Appendix Table A.1 below shows the tariff rates for heat, hot water and electricity across different types of consumer groups before and after the increases.

Appendix Table A.1: Electricity, DH and Hot Water Tariff Revisions in the MTTP

Consumer Categories	Electricity (Som/kWh)			DH (Som/Gcal)				Hot water (Som/Gcal)		
	Before Increase	After Increases		Before Increase		After Increases		Before Increase	After Increases	
		2015	2017		2014	2015	2017		2015	2017
Residential consumers (below pre-determined thresholds)[40]	0.70	0.84	1.21	715	917.8	1134.8	1615.4	n/a	981.8	1615.4
Industrial, Agricultural and Other consumers	1.33	1.48+ import price[41]	1.69+ import price[42]	929.2	1557.3	1695.1	1981.3	929.2	1695.1	1981.3
Budgetary consumers	1.33	1.48	1.69	929.2	1557.3	1695.1	1981.3	929.2	1695.1	1981.3
Pumping stations	0.70	0.78	0.89	n/a	n/a		n/a	n/a	n/a	n/a

[40] Below 700 kWh consumption for electricity and below lifeline consumption for district heating

[41] Weighted average

[42] Weighted average

Appendix B: Description of Different Applications of Each Short List Measure

Many of the short list measures can be applied to multiple customer segments or building types. Appendix Table B.1 shows the specific assessment basis of each short list measure to estimates investment costs and energy saved/generated, and the number letter combination that indicates each application.

Appendix Table B.1: Specific Application of Each Short List Measure

No.	Measure	#	Application
M1	Insulation of Buildings	M1a	Average public building
		M1b	Average panel building (Type 2)
		M1c	Average brick building (Type 1)
M2	Heat and hot water metering	M2a	Average panel building (Type 2)
		M2b	Average brick building (Type 1)
M3	Installation of thermostatic valves - temperature regulation at dwelling level	M3a	Average panel building (Type 2)
		M3b	Average brick building (Type 1)
M4	Implementation of consumption-based billing	M4a	Average panel building (Type 2)
		M4b	Average brick building (Type 1)
M6	Installation of automatic, individual DH substation	M6a	Average public building
		M6b	Average panel building (Type 2)
		M6c	Average brick building (Type 1)
M7	Temperature and hydraulic regulation of house service connections	M7a	Average public building
		M7b	Average panel building (Type 2)
		M7c	Average brick building (Type 1)
M8	Replacement of distribution pipelines	M8a	Over- and underground distribution pipelines
M9	Re-insulation of over-ground distribution pipelines	M9a	Over-ground DH distribution network
M10	Variable speed drive pumps	M10a	Replacement of DH water pumps by pumps with variable speed drive at pumping stations
		M10a	Installation of variable speed drives at DH network pumps
M11	Rehabilitation of internal heating system	M11a	Average panel building (Type 2)
		M11b	Average brick building (Type 1)
M12	Construction of new efficient autonomous small HOB (coal-fired/gas-fired)	M12a	Small HOB (coal)
		M12b	Small HOB (gas)
M13	Solar heat production for DH	M13a	Simple solar flat plate collector system

M14	Installation of solar water heater for hot water (domestic hot water)	M14a	Average kindergarten
		M14b	Average hospital
M15	Installation of heat pump systems	M15a	Average individual family home
M16	Rehabilitation of CHP	M16a	CHP
M17	Individual house stoves (coal)	M17a	Average individual family home
M18	Individual house boilers (coal)	M18a	Average individual family home
M19	Individual house boilers (gas)	M19a	Average individual family home
M20	Individual house heater (gas)	M20a	Average individual family home

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