KEEPING WARM:
URBAN HEATING OPTIONS FOR THE KYRGYZ REPUBLIC

Summary Presentation
April 2015
Foreword

This presentation summarizes the key results and recommendations of the World Bank Report on Urban Heating Options in the Kyrgyz Republic. The Report was initiated because of the importance of the heating sector in addressing the recurrent winter power shortages, the precarious condition of the heating infrastructure in urban areas and the related repercussions on the wellbeing of the population.

The objective of the Report was to identify viable heating options and associated investment measures to meet heating demand in urban residential and public buildings in the Kyrgyz Republic. To that end, the Report analyzed the condition and performance of the urban heating infrastructure and building stock, and evaluated in detail the available heating options in Bishkek and Tokmok. The two cities were selected because they are largely representative of current heat demand and supply characteristics in urban areas.

The Report draws on the findings and results of a technical assessment conducted by Fichtner Engineering and Consulting and is based on data provided by the Ministry of Energy and Industry, the companies operating in the sector, the Regulatory Agency for the Fuel and Energy Complex, the National Statistics Committee, the municipality of Bishkek and Tokmok, and the results of a qualitative and quantitative Poverty and Social Impact Assessment conducted by the World Bank. The Report aims to inform the Government's priorities in the heating sector and to facilitate coordination among development partners in the sector.

The World Bank is available to continue the policy discussion with the Government on the findings and recommendations of the Report. To further these discussions, the World Bank is currently supporting: (i) the development of a transparent tariff-setting methodology and performance monitoring and reporting framework for the heating sector; and (ii) preparation of an investment and implementation plan targeting efficiency and reliability improvements of the heat network supplied by the Combined Heating and Power (CHP) plant in Bishkek.
Acknowledgements

The financial and technical support by the Energy Sector Management Assistance Program (ESMAP) is 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.

The financial support by the Central Asia Energy Water Development Program (CAEWDP) is gratefully acknowledged. 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.
Synopsis – Challenges

Access to reliable and adequate heat supply is critical for the wellbeing of the population and the operation of public services. 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 20-25% of the residential and public heat demand remains unmet every year due to insufficient and unreliable heat and electricity supply in winter.

Once the principal source for heating in the largest urban areas, District Heating (DH) systems now serve only about one fifth of the urban population and are in poor condition with deteriorating service quality. The majority of the DH infrastructure was commissioned 20-50 years ago and is under-maintained due to the lack of funds. As a result, generation assets operate at 20-50% of their capacity, heat losses are high and service quality is deteriorating. DH customers supplied by the Combined Heat and Power (CHP) plant in Bishkek experienced more than 300 network breakdowns during the heating season in 2013.

As a result, around 35% of households in urban areas rely on electricity for heating, which accentuates winter power shortages. The high reliance on electricity for heating purposes is a key driver for the growing residential electricity consumption during winter months – in 2009-2013, residential electricity consumption increased by more than 60% in the Kyrgyz Republic. Combined with the poor condition of the ageing power infrastructure and low hydropower output during winter, this increase in electricity load aggravates winter power shortages.

With the increase in natural gas prices and the lack of access to DH, about 40% of urban households use inefficient coal-fired stoves or boilers. Due to the high reliance on inefficient solid fuel-fired stoves, the Kyrgyz Republic ranks among the two worst-affected countries in Europe and Central Asia (ECA) for diseases resulting from indoor air pollution. Also, the use of inefficient stoves and boilers results in 20-30% higher coal consumption compared to more efficient models.
Synopsis – Recommendations

A mix of investment and policy measures are needed to meet heat demand in residential and public buildings in a sustainable manner:

- Rehabilitation of the DH network supplied by the CHP plant in Bishkek
- Gradual replacement of dilapidated small Heat-only-Boilers (HOBs) by efficient gas-fired HOBs or an extension of the DH network supplied by the CHP plant
- Implementation of a scalable program for urban and rural individual houses to replace inefficient electric heaters and polluting solid fuel-fired stoves with:
  - Efficient small gas heaters/boilers in buildings with access to natural gas in the short-term
  - Heat pumps for households currently relying on electric heaters without access to gas in the medium-term
  - Efficient small stoves/boilers for households using solid fuel-fired stoves without access to gas in the medium-term
- Implementation of an energy efficiency program for buildings in urban and rural areas
- Continued implementation of tariff and social assistance reforms

Investment needs are sizable and need careful prioritization, sequencing and funding from both public and private sources – but the time to act is now:

- Investment needs for Bishkek and Tokmok are estimated at around US$225 million in the short-term and US$584 million in the medium- to long-term
- The availability and affordability of natural gas supply is improving since Gazprom acquired the majority stake of Kyrgyzgas
- Without investments in the transmission and distribution network in Bishkek, the DH system will not be able to absorb the additional heat supplied by the modernized CHP1
- The Medium Term Tariff Policy adopted by the Government will gradually improve the financial viability of the heating sector but future tariff increases need to be accompanied by improved supply quality and reliability
## Synopsis – Priority Investments

<table>
<thead>
<tr>
<th>Recommended measures</th>
<th>Short-term investments (US$ million)</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH reliability and efficiency measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modern building-level substations, incl. heat exchangers and metering</td>
<td>37</td>
<td>▪ 17% heat and hot water savings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Increase lifetime and capacity of network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Avoid under-/over-heating</td>
</tr>
<tr>
<td>Replacement of network pipelines</td>
<td>40</td>
<td>▪ 23% heat loss reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ 25% water leakages reduction</td>
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<tr>
<td></td>
<td></td>
<td>▪ <strong>US$ 3million</strong> annual repair and maintenance cost reduction</td>
</tr>
<tr>
<td>Variable speed drive pumps</td>
<td>3</td>
<td>▪ 33% electricity savings</td>
</tr>
<tr>
<td>Program for efficient individual heating systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficient small coal stoves and boilers</td>
<td>17</td>
<td>▪ 35% coal consumption reduction</td>
</tr>
<tr>
<td>Gas-fired stoves and boilers</td>
<td>46</td>
<td>▪ Reduce indoor air pollution</td>
</tr>
<tr>
<td>Efficient heat pumps</td>
<td>10</td>
<td>▪ 70% electricity consumption reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Improve comfort levels</td>
</tr>
<tr>
<td>Replacement of small HOBs with gas-fired small HOBs</td>
<td>30</td>
<td>▪ 20-50% fuel savings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Improve comfort levels and reduce emission</td>
</tr>
<tr>
<td>Energy efficiency program for public buildings</td>
<td>42</td>
<td>▪ 30-50% heat loss reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Improve comfort levels</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>225</strong></td>
<td></td>
</tr>
</tbody>
</table>
Outline

1. Heating Sector Overview
   - National overview
   - Heating sector in Bishkek and Tokmok

2. Key Challenges
   - Poor performance of the heating infrastructure
   - Lack of financial viability
   - Poor energy performance of buildings

3. Analysis and Recommendations

4. Roadmap
Heating Sector Overview
Nationally, individual stoves/boilers are the most common primary heating source, followed by electricity-based heating.

Both poor and non-poor urban households rely heavily on electric heating:
- 40% of urban households use electricity as their primary source of heating.

Biomass and coal are popular heating sources among both rural and urban households:
- 70% of rural and 40% of urban households rely on individual coal- or wood-fired stoves and boilers.

DH is the primary source of heating for 19% of all urban households:
- 40% of households in Bishkek but less than 10% of households in other urban areas rely primarily on DH.

Source: Kyrgyz Integrated Household Survey (KIHS), 2012
In Bishkek and Tokmok, most apartment and public buildings rely on DH and most individual houses use individual heating solutions

- 75% of the DH is generated in Bishkek, supplying 88% of all DH customers in the country
- Coal accounts for 76% of the fuel used by DH companies
- DH supply covers over 55% of the residential floor space in Bishkek and more than 45% in Tokmok
- More than 90% of public buildings in Bishkek and almost all in Tokmok are supplied by DH
- Almost all individual houses rely on individual heating systems such as wood/coal stoves and electric radiators

### Primary heating source by building type, Bishkek

<table>
<thead>
<tr>
<th>Building Type</th>
<th>'# buildings'</th>
<th>'% Res. area'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-apartment buildings</td>
<td>2,399</td>
<td>56%</td>
</tr>
<tr>
<td>Individual houses</td>
<td>89,014</td>
<td>44%</td>
</tr>
<tr>
<td>Public buildings</td>
<td>1,005</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### Primary heating source by building type, Tokmok

<table>
<thead>
<tr>
<th>Building Type</th>
<th>'# buildings'</th>
<th>'% Res. area'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-apartment buildings</td>
<td>234</td>
<td>46%</td>
</tr>
<tr>
<td>Individual houses</td>
<td>7,058</td>
<td>54%</td>
</tr>
<tr>
<td>Public buildings</td>
<td>41</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Key Challenges

- Poor Energy Performance of Buildings
- Poor Performance of the Heating Infrastructure
- Lack of Financial Viability
DH assets are in poor condition

- In Bishkek, generation assets and pumping stations were commissioned **20-50 years** ago.
- Around **70%** of BTS’s transmission and distribution (T&D) network is older than 25 years.
- The thermal output of the CHP1 in 2012 was **39%** below its installed capacity.
- Technical network losses **exceed 25%** of heat and 6% of hot water dispatched by the CHP.
- Commercial losses amount to 7% for heat and 39% for hot water (‘non-demanded heat’).
- Switching to consumption-based billing decreases heating bills for customers (only 16% of public/residential buildings are metered).

**Generation Capacity of CHP1 (in Gcal/h), 1961 vs 2012**

- **Electrical Output**
  - 1961: 82% below design capacity
  - 2012: 886 Gcal/h

- **Thermal Output**
  - 1961: 39% below design capacity
  - 2012: 572 Gcal/h

**Comparison Heating Bills for 2 Heating Seasons (2012-2014)**

- **Microdistrict 11**
  - 2012: 20% difference
  - 2014: 10% difference
- **Microdistrict 12**
  - 2012: -20% difference
  - 2014: -45% difference
- **Microdistrict 4**
  - 2012: -10% difference

**Age of Bishkekteploset’s (BTS) Transmission and Distribution Network**

- **Transmission**
  - 0-5 km: 300 km
  - 5-10 km: 200 km
  - 10-15 km: 150 km
  - 15-20 km: 100 km
  - 20-25 km: 50 km
  - >25 km: 0 km
- **Distribution**
  - 0-5 km: 300 km
  - 5-10 km: 200 km
  - 10-15 km: 150 km
  - 15-20 km: 100 km
  - 20-25 km: 50 km
  - >25 km: 0 km
DH service quality is deteriorating and bottlenecks remain even after the modernization of the CHP1 plant

Pipeline breakages during the heating season have increased 6 fold from 50 to 317 in 1990-2013 with serious repercussions for the population, businesses and public service delivery during cold winter months

- Yet heating companies lack sufficient funds to replace old and dilapidated pipelines

There is a growing dissatisfaction by DH customers with low quality of heat supply (e.g. under-heating)

- Customers would be willing to pay on average 30% higher tariffs for energy services if the quality improves (Qualitative Assessment, 2014)

The poor condition of the DH T&D network and the "open system" design may prevent the full utilization of the modernized CHP: because the open system design limits max. flow temperatures to 90-95°C, the T&D network capacity is reduced to about 50%

- Operating the system at higher temperatures in a "closed" system would increase the amount of heat delivered to end-users, ensure safer operation and better service quality and reduce investment needs in pipes and pumps
Fuel switching and under-maintenance has reduced the efficiency of HOBs and increased losses

The decreasing availability and affordability of gas over the past two decades has resulted in fuel switching for HOBs

- The share of coal- and electricity-fired HOBs has increased (46% and 48% of the boiler houses use coal and electricity, respectively), especially in small HOBs operated by public institutions
- Coal-fired HOBs have no modern flue-gas cleaning systems and are significantly more polluting than modern boilers
- Electricity-based HOBs add load to strained power networks

The majority of HOBs in Bishkek and Tokmok are in poor condition and under-maintained

- Most HOBs and related networks in Bishkek and Tokmok were built in 1960-1989
- The operational capacity of HOBs in the two cities is less than half of the installed capacity
- The average efficiency of coal-fired boilers is 41% and 75% for gas-fired boilers - modern coal and gas boilers have efficiencies of up to 80% and 95%, respectively
- T&D losses in Tokmok are estimated at 35% because of the poor condition and relative length of the network compared to the small load served

*Small HOBs: installed capacity< 5 Gcal/h; ** EPP only includes the boiler house in Kyzyl-Kiya, not CHPs in Osh and Bishkek; *** Operational capacity for Tokmok only includes KZhK SUE boilers;
35% of urban households use electricity for heating purposes
- Electricity accounts for 34% and 26% of the heat supply to individual homes in Bishkek and Tokmok, respectively
- Electricity is used both as primary heating source and to supplement DH
- Electric heating is the main driver for the high residential electricity consumption – accounting for 60% of total consumption
- Widespread use of electricity for heating contributes to winter power shortages

40% of urban households rely on low efficiency coal stoves/boilers
- Solid fuel accounts for 57% and 66% of the heat supply to individual homes in Bishkek and Tokmok, respectively
- The low efficiency of stoves/boilers in use results in 20-30% higher coal consumption compared to more efficient models
- Inefficient technologies accentuate the negative impact of coal (health and environment)
Heat and electricity tariffs are below cost recovery levels

- Depending on the heating sources, residential tariffs cover 13-50% of the heat supply costs.
- The wholesale tariffs for heat from Bishkek CHP1 was 75-90% below the cost of heat production in 2007-2012.
- Tariffs cover only half the funds required to complete annual renovation and reconstruction of BTS’ rapidly depreciating heat supply network.
- The cash collected per kWh of electricity generated in the Kyrgyz Republic was 25-45% below the average cost of electricity generation in the country in 2008-2012.

Sector companies and assets are financially unsustainable

- Because tariffs are too low, heat and electric utilities operate at a loss and rely on subsidies to cover operating costs.
- However, subsidies are insufficient to cover the total cost of necessary maintenance and new investments.

The poor financial health of heating sector companies contributes to the further decay of heating infrastructure.


Challenge 2: Lack of Financial Viability
Low tariffs are a poorly targeted end-user subsidy that also contribute to the inefficient use of energy

Energy poverty rates are lower than in many other ECA countries…
- Energy expenditures account on average for 7.2% of total household expenditures
- The relatively low energy poverty rate is partially attributable to low tariffs for heat and electricity

…but the implicit subsidies delivered through low tariffs are regressive and distortionary
- Low DH tariffs predominantly benefit consumers with higher income levels (upper 50%)
- Low electricity and heat tariffs provide no financial incentive to consumers to invest in energy efficiency upgrades

Social safety nets are extensive but poorly targeted
- Public spending for social transfers account for about 2% of GDP (2013)
- Only one of the social assistance programs - the Monthly Benefit for Poor Families with Children - explicitly targets the poor but coverage is low (<1/3 of the poorest 20% of the population and only about 8% of their total consumption is subsidized)
- Other programs are aimed at certain social categories (e.g. households with widows or disabled children)

Source: Balancing Act, World Bank 2013
Source: Kyrgyz National Statistics Committee, KIHS, 2012
Source: Poverty and Social Impact Assessment, 2014
Heat losses in buildings are high and accentuate low comfort levels

Energy performance in residential and public buildings is poor
- The majority of buildings was constructed between 1960 and 1990
- Buildings are poorly insulated and maintained

Heat losses in buildings could be reduced by 30-50%
- Through basic energy efficiency measures such as window replacement, insulation, heating system upgrades

Individual houses account for more than half of the heat demand in Bishkek and Tokmok...
- ...but about 19% (Tokmok) and 27% (Bishkek) of the demand remains unmet due to the poor performance of buildings and heating infrastructure

Estimated heat demand-supply in individual houses

<table>
<thead>
<tr>
<th>Residence</th>
<th>Heat Demand</th>
<th>Heat Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bishkek</td>
<td>1,800,000</td>
<td>1,200,000</td>
</tr>
<tr>
<td>Tokmok</td>
<td>1,600,000</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

27% of heat demand in individual houses remains unmet in Bishkek and 19% in Tokmok

Potential demand reductions from EE investments in Bishkek and Tokmok

<table>
<thead>
<tr>
<th>Residence</th>
<th>Current demand/yr</th>
<th>Est. demand/yr after EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bishkek</td>
<td>1,000,000</td>
<td>330,000</td>
</tr>
<tr>
<td>Tokmok</td>
<td>800,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

Estimated Heat Demand Residential/Public Buildings, 2012

- Public buildings: 33%
- Multi-apartment buildings: 54%
- Individual houses: 67%
## Analysis and Recommendations

- Identify main supply-and demand-side options and related investment measures
- Conduct economic and technical screening of the long-listed measures
- Develop a short list of 20 investment measures
- Assess the economic viability of short-listed investment measures
- Evaluate non-economic pros and cons of each measure
- Identify the most viable heating options for each customer segment
- Develop an action plan with recommended investments and implementation steps
The short list includes 20 measures that were economically and technically viable.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transmission/Distribution</th>
<th>End-Use</th>
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<tbody>
<tr>
<td></td>
<td><strong>Option: DH (CHP and large HOBs)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rehabilitation of CHPs</td>
<td>• Replacement of transmission pipelines</td>
</tr>
<tr>
<td></td>
<td>• Rehabilitation of large HOBs</td>
<td>• Replacement of distribution pipelines</td>
</tr>
<tr>
<td></td>
<td>• Construction of new large HOBs</td>
<td>• Re-insulation of over-ground distribution pipelines</td>
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<tr>
<td></td>
<td>• Installation of heat meters at the outlet of heat generation units</td>
<td>• Construction of new transmission and distribution pipelines</td>
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<td></td>
<td>• Solar heat production for DH</td>
<td>• Installation of variable speed drive pumps</td>
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<tr>
<td></td>
<td><strong>Option: Autonomous Heating (small HOBs)</strong></td>
<td>• Insulation of valves and related pipeline equipment</td>
</tr>
<tr>
<td></td>
<td>• Construction of new and replacement of existing small HOBs</td>
<td>• Processing of feed-water and circulating water in the DH system</td>
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<td></td>
<td><strong>Options: Individual heating systems (various options)</strong></td>
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<tr>
<td></td>
<td>• Installation of efficient individual coal-fired heat boilers</td>
<td>n/a</td>
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<tr>
<td></td>
<td>• Installation of individual gas boilers</td>
<td></td>
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<tr>
<td></td>
<td>• Installation of individual efficient coal-fired heat stoves</td>
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<tr>
<td></td>
<td>• Installation of individual gas heaters</td>
<td>n/a</td>
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<tr>
<td></td>
<td>• Installation of heat pump systems</td>
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<tr>
<td></td>
<td>• Installation of solar water heaters</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>• Installation of electric oil radiators</td>
<td>n/a</td>
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<td></td>
<td><strong>Option: Energy Efficiency</strong></td>
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<td>n/a</td>
<td>n/a</td>
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</table>

Measures highlighted in orange were short-listed based on the initial economic and technical screening.
The economically most viable heating options are DH (CHP), individual heating solutions and small HOBs in Bishkek.

Results of the levelized cost assessment for Bishkek

- **CHP (coal)**
- **Indiv. house stove (coal)**
- **Small HOB (coal)**
- **Small HOB (gas)**
- **Indiv. house stove (gas)**
- **EE - Panel building**
- **EE - Public**
- **Indiv. house boiler (coal)**
- **Indiv. house boiler (gas)**
- **Indiv. heat pumps**
- **Large HOBs (coal)**
- **Large HOBs (gas)**
- **EE - Brick building**
- **Indiv. radiator (elec.)**
- **Small HOB (elec.)**

![Bar chart showing costs for different heating options in Bishkek.](chart)

**Assumptions for the levelized cost assessment**
- **CHP costs:** excludes CAPEX for CHP plant (sunk cost); includes replacement of T&D pipelines older than 20 years, re-insulation of 50% of the over-ground pipelines, installation of VSD at pumping stations (baseload pumps) and installation of building-level substations in all multi-apartment and public buildings.
- **Large HOB costs:** includes boiler replacement and the same investment measures as for CHP.
- **Fuel price:** Coal: US$52.41/t for CHP; US$57.6/t for large HOBs; US$61.23/t for small HOBs; Gas: US$330/thousand m³; Electricity: US$0.14/kWh.

Small HOBs, individual heating solutions and energy efficiency in Tokmok

Results of the levelized cost assessment for Tokmok

- **Indiv. house stove (coal)**
- **Small HOB (coal)**
- **Indiv. house boiler (coal)**
- **Indiv. house stove (gas)**
- **EE - Public**
- **Small HOB (gas)**
- **Indiv. house boiler (gas)**
- **Indiv. heat pumps**
- **Large HOBs (coal)**
- **Large HOBs (gas)**
- **EE - Brick building**
- **Indiv. radiator (elec.)**
- **Small HOB (elec.)**

![Bar chart showing costs for different heating options in Tokmok.](chart)

**Assumptions for the levelized cost assessment**
- **Large HOB costs:** includes boiler replacement and the same investment measures as for CHP.
- **Fuel price:** Same as in Bishkek.
A multi-criteria assessment of economic and non-economic benefits related to each heating option was used to select priority and fallback recommendations for each customer segment:

- Assessment criteria included technical, institutional, environmental, health, social and economic advantages and disadvantages.
- Heating options were customized to different consumer segments, taking into account their current primary heat supply infrastructure, while avoiding the switch to inferior heating solutions in terms of health and environmental impacts (e.g. switching from electricity to coal).

### Current heat source by consumer segment

<table>
<thead>
<tr>
<th>Consumer Segment</th>
<th>Current Heat Source</th>
<th>Priority Option</th>
<th>Fallback Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiv. houses</td>
<td>Stoves/boilers (coal)</td>
<td>Heater/boilers (gas)</td>
<td>Stoves/boilers (coal)</td>
</tr>
<tr>
<td></td>
<td>Indiv. electric</td>
<td>Heater/boilers (gas)</td>
<td>Heat pumps (electric)</td>
</tr>
<tr>
<td>Multi-apartment bldgs.</td>
<td>CHP</td>
<td>CHP (Bishkek only)</td>
<td>Heater/boilers (gas)</td>
</tr>
<tr>
<td></td>
<td>Large HOBs*</td>
<td>Small HOBs (gas)</td>
<td>Heater/boilers (gas)</td>
</tr>
<tr>
<td></td>
<td>Small HOBs</td>
<td>Small HOBs (gas)</td>
<td>Heat pumps (electric)</td>
</tr>
<tr>
<td></td>
<td>Indiv. electric</td>
<td>Heater/boilers (gas)</td>
<td>Heaters/boilers (gas)</td>
</tr>
<tr>
<td>Public bldgs.</td>
<td>CHP</td>
<td>CHP (Bishkek only)</td>
<td>Heater/boilers (gas)</td>
</tr>
<tr>
<td></td>
<td>Large HOBs*</td>
<td>Small HOBs (gas)</td>
<td>Heaters/boilers (gas)</td>
</tr>
<tr>
<td></td>
<td>Small HOBs</td>
<td>Small HOBs (gas)</td>
<td>Heaters/boilers (gas)</td>
</tr>
</tbody>
</table>

* Priority and fallback options for large HOBs would need to be determined based on the results of feasibility studies and depend on the specific operational condition of each boiler house.
Improving the Performance of the Heating Infrastructure

through:
1. Enhancing the reliability and efficiency of the DH system
2. Implementing a program targeting the use of efficient individual heating solutions
3. Replacing and/or constructing small HOBs
4. Assessing the viability of large HOBs
Investing in the DH network will be critical to improve service quality, reduce losses and harness the benefits of the CHP modernization

**Potential scope:** DH networks operated by BTS, BTE, Tokmok KZhK and Zhululuk servicing more than 140,000 residential and public customers

**Recommendation:** Implement package of priority reliability and efficiency investments, focusing in a first step on the network operated by BTS to complement ongoing modernization of the CHP1 and ensure sustainability of (ongoing and future) investments

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**Efficient building-level flow control and metering**

- Modern substations with heat exchangers in all multi-apartment and public buildings
- Building-level heat meters and apartment-level hot water meters
- Consumption-based billing for all multi-apartment and public buildings

**Replacement/re-insulation of priority T&D pipelines**

- Replace priority T&D with pre-insulated and accurately dimensioned pipes
- Re-insulate over-ground pipelines

**Variable speed drives (VSD) at pumping stations**

- Replace old pumps with modern, efficient VSD pumps
- Modern SCADA system for controlling and monitoring DH system

**Benefits:**

- Increase heat delivery and service quality for end-consumers
- Improve water quality, safer operation, less corrosion
- Enable customers to control energy use and bills
- Create incentives for EE
- Reduce service interruptions and improve reliability
- Reduce network losses
- Reduce electricity consumption by pumping stations and improve flow control

**17% heat and hot water savings**

**23% reduction in heat losses and 25% reduction in water leakages**

**33% electricity savings**
Mobilizing sufficient financing will remain challenging despite the strong business case for efficiency improvements

Implementation issues

- Poor financial condition of heating companies
- Tariff increases enacted, but remain well below cost recovery

Attracting commercial financing will be challenging for DH companies and will put additional pressure on tariffs

Need to demonstrate that tariff increases result in improved service quality

Potential solutions

- Mobilize different sources of (concessional) financing
- Tariff reforms
- Develop a prioritized investment and implementation plan to improve the service quality of DH companies and ensure the technical sustainability of investments
- Introduce regulatory changes to monitor the performance of heating companies
- Conduct extensive information and public outreach campaigns to inform consumers about benefits of planned improvements

World Bank Technical Assistance: The World Bank initiated a ESMAP- and CAWEDP-supported technical assistance activity to support BTS in developing an investment and implementation plan for BTS to identify priority investment measures targeting reliability and efficiency improvements of the DH network and to complement the ongoing modernization of the CHP1.
Switching to efficient individual heating solutions can generate energy savings, reduce pollution and improve comfort levels.

**Potential scope:** Residential customers relying on polluting small coal stoves/boilers and inefficient electric radiators as their primary heating sources (including 95,000 households in Bishkek and Tokmok).

**Recommendation:** Implementation of a scalable program to replace inefficient individual heating solutions with more efficient technologies.

<table>
<thead>
<tr>
<th>Households using polluting coal stoves/boilers</th>
<th>Households using inefficient electric heaters</th>
</tr>
</thead>
<tbody>
<tr>
<td>No access to gas or centralized heat in the mid-term</td>
<td>(planned) access to gas in the next 2-3 years</td>
</tr>
<tr>
<td>No access to gas or centralized heat in the mid-term</td>
<td></td>
</tr>
</tbody>
</table>

### Efficient coal stoves/boilers
- Improve efficiency of coal heating
- Reduce indoor pollution
- Relevant for urban and rural areas
  - Continued use of coal

### Efficient gas heaters/boilers
- Clean and efficient
- Reduce winter power shortages if replacing electric heaters
- Reduce pollution if replacing coal

### Efficient heat pumps
- Improve efficiency of electric heating and help reduce loads
  - Efficiency decreases with low ambient air temperature
  - Sensitive to frequency and voltage fluctuations
  - Relatively high upfront investment costs

**Benefits:**
- Reduce coal consumption (up to 35%)
- Reduce electricity consumption (up to 70%)
- Increase comfort levels and decrease pollution
Individual heating programs are institutionally complex and require careful design of financing and delivery mechanisms

Examples: Clean Stove Initiative in Mongolia and Efficient Gas Stove Program in Armenia

The clean stove program in Mongolia supported deployment of 98,000 low-emission stoves in Ulaanbaatar in 2011-2012 by offering micro-loans to low income households and providing targeted subsidies after installation of the stoves. In Armenia, more than 8,000 low income households in urban areas were supported to get connected to gas service and/or receive an individual gas heater, installed by the gas company and based on an output-based financing scheme.
Small gas-fired HOBs are a cost-effective solution to help improving efficiency, reducing pollution and mitigating winter power shortages

Potential scope: All public buildings without access to DH, multi-apartment buildings served by large or small HOBs (i.e. with a building-internal system) and new buildings constructed in the future without access to DH

Recommendation:

- Gradual replacement of dilapidated small HOBs (incl. 48 small HOBs operated by BTE and 136 public/private owned HOBs in Bishkek)
- Efficient gas-fired small HOBs
- Extension of the DH network supplied by CHP, if viable
- Construction of new small HOBs
- New public and multi-apartment buildings to be constructed and without access to DH
- To be considered for buildings served by large HOBs in need of extensive repair or buildings located at the outskirts of the service area supplied by large HOBs (especially for Tokmok)

Benefits

- Can generate **20-50% fuel savings** compared to old and inefficient models
- Reduce pollution in urban areas
- Help mitigating winter power shortages (e.g. more than 1,000 electricity-based small HOBs owned by public institutions)

Implementation Issues

- Requires increase in access to gas
- Poor condition of building-internal heating infrastructure needs to be taken into account
- Collective decision-making process in multi-apartment buildings
- Challenge of securing sufficient financing
The future of large HOBs should be determined based on the results and findings of detailed feasibility studies

**Potential scope:** 9 large HOBs in Bishkek supplying around 580 public and residential buildings and 3 large HOBs in Tokmok servicing about 415 buildings

**Recommendation:** Conduct a feasibility study to determine whether it is economically and technically preferable to continue operating large HOBs or replace them with efficient centralized or individual gas-fired heating options

- Large HOBs in poor operational condition and need of major rehabilitation
  - Rehabilitate boilers
  - Optimize service area esp. in Tokmok

- Large HOBs in good operational condition
  - Implement priority reliability and efficiency improvements
  - Replace by efficient centralized or individual gas-fired heating options (small HOBs or gas heaters), e.g. depending on condition of building-internal network

partial
Improving the Financial Viability of the Heating Sector

through:

5. Implementation of Tariff Reforms
**Recommendations**

- Consistent implementation of electricity and heat tariff revisions in line with the approved MTTP
- Adoption of a clear and transparent tariff-setting methodology for heating sector companies and non-residential consumers
- Transition to consumption-based billing (short-term: building-level for heat and apartment-level for hot water)
- Consolidation of social assistance system by topping-up programs targeting the poor and promoting energy efficiency, while phasing-out non-targeted programs

**Benefits**

- Increase funding for heating companies to invest in supply-side improvements and enhance service quality over time
- Predictability of heating costs for end-user
- Improved transparency of revenue allocation between heating companies
- Predictability of revenues for heating companies
- Simplification of tariff setting for non-residential consumers and reduction of regulatory burden
- Enables consumers to control consumption and adjust it according to affordability limits and desired comfort levels
- Can generated savings of up to 25-30% of the heat consumed
- Increase pressure on heating companies to improve service quality and reduce losses
- Ensure that a basic level of heat consumption remains affordable to the poor
- Protecting the poor without increasing fiscal costs
- Mitigating the impact of tariff increases on the poor by reducing their heat losses

Note: it is critical that electricity tariff reform is pursued in parallel with heat tariff reform in order to prevent fuel switching from central heating to electricity.
Improving the Energy Efficiency of Buildings through:

6. Implementation of a national Energy Efficiency Program
Energy efficiency in buildings can generate energy (cost) savings, improve comfort levels and mitigate impact of tariff increases.

**Potential Scope:** Public and/or residential buildings (in urban areas, there are 224,410 multi-apartment building, 320,800 individual houses and about 2,000 public buildings).

**Recommendation:** Implement an energy efficiency (EE) program targeting either public or residential buildings supported by scalable financing and implementation schemes.

**Benefits:**

- **Substantial energy savings** achievable through basic EE improvements
  → 480,000 MWh (Bishkek and Tokmok)
- **EE can help to economically reduce heat/electricity supply bottlenecks**
  → Growing energy intensity has driven the increase in residential consumption: number of residential customer increased by 5% in 2007-2011, but consumption grew by 26%
- **Reduce energy cost expenditures** for households and public institution
  → help mitigating impacts of tariff increases for households and free public resources for other development needs, respectively
- **Improve comfort levels in buildings by reducing losses and reduce local/global air pollution**

**Percentage Reduction in Energy Poverty for Poor Households Following the Introduction of an EE Program**

The use of targeted financing and implementation mechanism can help to incentivize and scale-up energy efficiency investments.

**Implementation issues:** There are a number of technical, institutional, financial, regulatory and policy barriers in the Kyrgyz Republic impeding energy efficiency:

1. **Low financial viability and lack of incentives**
2. **Lack of access to affordable financing**
3. **Split incentives/weak homeowner associations**
4. **Low technical capacity**

**Financing Ladder for Energy Efficiency**

- **1. Need for targeted financing and implementation schemes**
  - Select a target segment (public or residential)
  - Design simple financing schemes reflecting market maturity, including incentives and phasing-in of more sustainable models

- **2. Continue implementing pricing and billing reforms**
  - Transition to cost-reflective heat and electricity prices
  - Implement metering and consumption-based billing to enable energy cost savings

- **3. Conduct capacity building and public outreach campaigns**
  - Training and capacity building activities (e.g. energy auditors, construction companies, equipment suppliers, commercial banks, municipalities, etc.)
  - Awareness raising and public outreach campaigns

- **4. Develop policy/program enhancements**
  - Strengthening of homeowner associations/professional management companies
  - Adopt and enforce standards for appliances/equipment, construction materials, buildings, etc.

* Also used to finance residential energy efficiency
The investments required to improve the heating sectors in Bishkek and Tokmok are substantial.

<table>
<thead>
<tr>
<th>Recommended measures</th>
<th>Investment cost (US$ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short-term</td>
</tr>
<tr>
<td><strong>DH reliability and efficiency measures</strong></td>
<td></td>
</tr>
<tr>
<td>Install building-level substations</td>
<td>37</td>
</tr>
<tr>
<td>Metering, temperature regulation, consumption-based billing</td>
<td>77</td>
</tr>
<tr>
<td>Replacement and reinsulation of network pipelines</td>
<td>40</td>
</tr>
<tr>
<td>Variable speed drive pumps</td>
<td>3</td>
</tr>
<tr>
<td><strong>Program for efficient individual heating systems</strong></td>
<td></td>
</tr>
<tr>
<td>Efficient small coal stoves and boilers</td>
<td>17</td>
</tr>
<tr>
<td>Gas-fired stoves and boilers</td>
<td>46</td>
</tr>
<tr>
<td>Efficient heat pumps</td>
<td>10</td>
</tr>
<tr>
<td><strong>Replacement of all small HOBs with gas-fired small HOBs</strong></td>
<td>30</td>
</tr>
<tr>
<td><strong>Replacement of large HOBs with gas-fired large HOBs</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Energy efficiency program</strong></td>
<td></td>
</tr>
<tr>
<td>Residential buildings</td>
<td>-</td>
</tr>
<tr>
<td>Public buildings</td>
<td>42</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>225</td>
</tr>
</tbody>
</table>
## Roadmap for the heating sector

<table>
<thead>
<tr>
<th>Short-term (next 24 month)</th>
<th>Mid-term</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expansion of the natural gas infrastructure</strong></td>
<td>• Complete upgrading of infrastructure with potential increase in coverage</td>
</tr>
<tr>
<td>▪ Adopt a time-bound gasification plan and oversee upgrading of related natural gas infrastructure</td>
<td></td>
</tr>
<tr>
<td><strong>Reliability and efficiency improvements of the DH network</strong></td>
<td>• Complete implementation of priority investments for the DH network supplied by CHP1</td>
</tr>
<tr>
<td>▪ Adopt detailed investment and implementation plan for the DH network supplied by CHP1, mobilize funding and start implementation of the investment plan</td>
<td>• Develop and adopt detailed investment and implementation plans for BTE and KZhk</td>
</tr>
<tr>
<td><strong>Program for efficient individual heating solutions</strong></td>
<td>• Implement full-scale program for small efficient heating technologies in urban and rural areas</td>
</tr>
<tr>
<td>▪ Develop a scalable program to replace polluting and inefficient individual heating solutions by efficient models</td>
<td></td>
</tr>
<tr>
<td>▪ Mobilize funding and implement pilot phase along with public outreach campaigns</td>
<td></td>
</tr>
<tr>
<td><strong>Construction and replacement of small HOBs</strong></td>
<td>• Complete replacement/rehabilitation of small HOBs</td>
</tr>
<tr>
<td>▪ Develop and adopt prioritized investment and implementation plan for gradual replacement/construction of small HOBs</td>
<td></td>
</tr>
<tr>
<td>▪ Mobilize funding and start implementation based on identified priorities</td>
<td></td>
</tr>
<tr>
<td><strong>Rehabilitation or replacement of large HOBs</strong></td>
<td>• Mobilize funding and start decommissioning or rehabilitating large HOBs</td>
</tr>
<tr>
<td>▪ Conduct detailed feasibility studies for all large HOBs to determine most viable options, adopt investment and implementation plan</td>
<td></td>
</tr>
<tr>
<td><strong>Implement energy efficiency program in buildings</strong></td>
<td>• Continue and scale-up implementation</td>
</tr>
<tr>
<td>▪ Develop a scalable energy efficiency program, mobilize funding and start implementation in selected target segment (residential or public buildings)</td>
<td></td>
</tr>
</tbody>
</table>