Republic of Ukraine
Case Study: How to Improve the District Heating Sector in Kharkiv

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Contents

National Bank of Ukraine Exchange Rates used in this report

	Exchange rate:	
	as of 30 September 2008*)	**as of May 18 2010**
US$ 1.00	UAH 4.86	UAH 7.92
EUR 1.00	UAH 6.98	UAH 9.82

*) Used for currency conversions in this report

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1. Main Findings and Recommendations

Heat tariffs below cost-recovery level have undermined the financial position of the DH company, Kharhiv Heat Network (KHN) and resulted in chronic under-investment and asset deterioration, significantly reducing the efficiency of the DH system. This is unsustainable and requires urgent attention and commitment by the city authorities. ***The tariff level and rate structure need to be adjusted to enable the DH company to invest in modernization and improve supply efficiency. Metering and consumption-based billing should be implemented to incentivize demand side EE investments.*** Such a two-pronged approach, implemented over several years, will enable the DH company to achieve financial viability, reduce the costs of supply, and enhance the affordability of DH service to consumers.

Tariffs will need to be increased gradually but decisively so that they will reach a full-recovery level in a few years and well before the investments outlined in this paper have been completed as well as cross-subsidies must be eliminated. However, it may be difficult to achieve this at the local level due to the political nature of tariff-setting. Actions will need to be taken at the national level to **de-politicize tariff setting** by transferring tariff setting authority to a centralized body and to accompany this process with introduction of proper **social protection** mechanisms to compensate vulnerable groups.

At the City level, tariff setting needs to be seen as an integral part of a comprehensive 5-year restructuring and rehabilitation program that would also decrease the cost of supply and, hence, reduce the need for tariff increases.

The *first part* of such a program (years 1 and 2) should contain early steps to (i) **decreasing supply costs** through low-cost improvements of the efficiency of generation, transmission and distribution such as consolidation of small inefficient boiler plants, increasing supply share from cogeneration plants and introduction of efficient variable-speed pumps; (ii) **improving the financial performance of KHN including a payment plan for budget entities** that in a first phase makes sure that they are current on the flow of arrears and in a second phase gradually brings down the stock of arrears - complemented by a strict policy of cutting off non-paying entities unless they represent vital services; (iii) **consolidating sector entities** by merging KHN with one of the cogeneration plants that is also owned by the City government to decrease supply costs; and (iv) introducing a **pilot program** to demonstrate demand side energy savings potential including installation of building-level substations, consumption-based billing and individualization of heat control and metering complemented by an **outreach and communications program.**

The *second part* of the program (years 3 to 5) should include measures to:

- **Improve technical performance on the supply side** through (i) a move to high-efficiency condensing boilers, consolidation of small boiler stations into fewer, bigger and more efficient units, as well as the gradual introduction of small- and medium size CHPs to replace the heat-only boilers; (ii) replacement of the most dilapidated pipelines with modern pre-insulated pipe technology; and (iii) replacement of all block substations with building-level substations with temperature control and elimination of the separate hot tap water distribution systems.
- **Individualization of heat control and metering.** Consumption can be reduced by an additional 20-25% through introduction of thermostatic radiator valves and apartment level heat meters/allocators indicating a pay-back time of 3-4 years.
- **Demand side efficiency improvements**: (i) support to establishment of Home Owners Associations (HOAs); (ii) creation of a market for building maintenance services with the purpose of offering a choice of service providers to HOAs thereby providing incentives for

maintenance companies to improve their effectiveness; (iii) financial stimuli to efficiency improvements; and (iv) public awareness campaigns advocating benefits of EE measures in residential buildings.

On the national level the Government should consider: (i) improving the regulatory framework for heating and de-politicize the tariff setting through the establishment of an independent national regulator for heating services; (ii) revising tariff methodologies to allow for sustainable operation of heat utilities without the need for budget subsidies; (iii) improving homeowner association legislation by using international lessons learned; (iv) working with IFIs to put together attractive financial packages for municipal EE investment programs for residential buildings including contribution from carbon finance; and (v) improving the social support mechanisms for low-income households.

2. Kharkiv District Heating – Overview and Issues

This case study was launched with the objective of providing guidance to city and state level decision makers on how to deal with the heating sector challenges in a large city. The study addresses the supply and demand side efficiency measures as well as social protection mechanisms to ensure affordable heat supply. The Bank agreed with the Ministry of Housing and Communal Services (MHCS) to choose Kharkiv, Ukraine's second largest city, for the study after having confirmation from the Kharkiv City Administration that they welcomed this work and would support the consultants. The main findings and conclusions are presented below. More details can be found in the annexes: Annex 1 presents the country and energy sector background as well as the challenges faced by the district heating sector in Ukraine; and Annex 2 presents data on Kharkiv's district heating system.

Inefficient heat supply. The majority of Kharkiv's boiler houses are more than 35 years old and 75% of all transmission and distribution pipes are more than 15 years old nearing the end of their design life. Kharkiv has over 1600 km of double-pipe heat supply network. Virtually all of the existing pipelines are of the traditional, non-preinsulated type. Around 20% (i.e. around 320 km of double-pipe) is deemed to be so dilapidated that they need urgent replacement. However, in the recent five years, the KHN has only been replacing about 25 km of its heat networks annually, which corresponds to approximately 1.5% of the total length. In order to replace pipes by the end of their technical lifetime it would be necessary to replace 5-7% per year. The result is massive heat losses through leaking water. Because of the lack of meters it is impossible to get an accurate estimate of total network losses. Officially, the losses in the distribution network are estimated at 17% but may well be significantly higher. In a modern DH network of this size it is not unrealistic to expect losses to be less than 10%. Frequent breakdowns in the heating network constitute a serious problem. The annual breakdown rate is large and growing. Today, it exceeds 1.6 breakdowns per km of network in operation, which is about ten times higher than a well-maintained DH system in Western Europe.

Inefficient supply of hot tap water (HTW). HTW is produced at small boiler plants or at substations and piped in separate pipes from those used for space heating. This practice is wasteful since it leads to considerably higher distribution losses. Furthermore, in Kharkiv the recirculation systems for HTW have been allowed to deteriorate and go into disuse. This means that consumers have to let the hot tap run for several minutes before the water actually turns hot leading to great water and heat losses.

Inefficient end-use. With a specific heat consumption of 0.131 Gcal/m2 the average building in Kharkiv uses over 3 times more than what would be considered an acceptable standard in Western Europe at similar climatic conditions. With a specific HTW consumption of 157 liters per person per day consumers in Kharkiv use between 1.5 and 2 times more than consumers in Western Europe - HTW accounts for about one third of the total gas consumption. Many factors contribute to this inefficient end-use, the most important being: buildings were constructed with a level of insulation much lower than specified in today's building codes – the worst offenders are the concrete panel type buildings, mostly from the 70s and 80s, which constitutes 36% of all buildings.

Lack of end-user incentives to save. Heat consumers in Kharkiv have little options or incentives to change their behavior. Heat is predominantly sold based on m2 of floor area rather than actual consumption with only around 20% of all heat sold metered (normally at building level). Even if this were to change, the distribution system lacks technical options for individual consumers to regulate heat consumption. Thus any additional insulation or improved windows a house owner may chose to install in his apartment will only serve to raise the indoor temperature – and may therefore address the issue of under-heating, which is not uncommon – it will not, however, induce any energy savings to the DH system.

The DH Company, KHN, is in poor technical and financial condition with mounting debts and little hope of improvement. KHN fails to cover costs by revenues from heat sales due to a combination of low tariffs and a low collection rate (in 2007 around 87%)[1]. The estimated cost of supply in 2008 was around UAH 193/Gcal (US$39.7/Gcal) of which 71% was directly related to the cost of natural gas, i.e. covering the purchase of gas from Naftogaz, of heat from gas-fired cogeneration plants, and of electricity from the power company. In March 2010 the KHN owed UAH 550 million (US$ 69 million)[2] to Naftogas in unpaid gas bills. At the same time account receivables were at about UAH 385 million (US$49 million) 70% of which was owed by budget entities (municipal and state institutions).

Household heat tariff is inadequate to cover actual costs. The 2008 cost level of US$39.7/Gcal assumed a gas price at the point of consumption of UAH 571.67 per 1000 m3 (US$117.5 per 1000 m3) excl. VAT. For comparison, Russian gas is presently (March 2010) sold at around US$300 per 1000 m3 at the border to Ukraine to which the cost of transmission, distribution and delivery must be added – which could add an extra US$100 per 1000 m3. However, by March 2010 the approved heat tariff for households of UAH 265/Gcal is only equivalent to US$33/Gcal[3]. This means that due to the devaluation of the local currency and the lack of proper indexation mechanism to track fuel prices, the heating tariffs for households in Kharkiv today is lower in dollar terms than it was two years ago.

This household heat tariff level is very low compared to Western European tariffs and countries like Moldova and Bulgaria (see Table 1 below). If Kharkiv's household tariff were to reflect the real gas costs it would probably be around double the level it is at today, which would take it up to a level close to that of Helsinki, Finland. For budget entities and other non-household consumers the tariffs are close to cost recovery.

Table 1 - Comparison of heat tariffs of selected countries

Country/City	Households Local currency per Gcal	Commercial and Public Local currency per Gcal	Households US$ per Gcal	Commercial and Public US$ per Gcal
Kharkiv (2008)	189 UAH	320 UAH	$39	$66
Kharkiv (2010)	265 UAH	586 UAH	$33	$73
Moldova/Chisinau (2010)	699 MDL	699 MDL	$56	$56
Bulgaria/Sofia (2010)	70 BGN	70 BGN	$48	$48
Finland (Helsinki) (2010)	50 EUR	50 EUR	$67	$67
Denmark (2010)	550 DKK	550 DKK	$100[4]	$100

[1] This is the 2008 figure provided by KHN.
[2] However, when this debt was accumulated the exchange rate was different and if the debt to Naftogaz had been indexed to the US$ exchange rate then it would have been worth US$100 million today.
[3] at the March 2010 exchange rate of 7.98 UAH for 1 USD
[4] The heat tariff in Denmark varies greatly depending upon a specific municipality. Thus for instance in some municipalities heat tariffs of about US$50/Gcal and US$150/Gcal can be found. In addition, it is necessary to mention that the energy taxes in Denmark are, on average, higher compared to other EU countries.

The City Administration has so far been holding back on tariff increases (or drastic measures to enforce payment discipline) due to social considerations. Household tariffs are kept under cost-recovery level. The deficit created is compounded by the fact that collection rates are low. In the end this compounded deficit can only be dealt with through municipal subsidies or by accumulating debts to the gas supplier, Naftogaz[5].

Lack of supply-side EE investments. Kharkiv's DH is not only aging and suffering from under-investments, it is also suffering from an inefficient design. KHN's network rely on group substations to provide heating and HTW to ten, fifteen or more buildings from one centralized heat exchanger, which is a less efficient system than "intelligent" building-level substations that can provide individual pressure and temperature control to the building. Most of KHN's pumps are inefficient because they do not have variable speed technology that would enable them to optimize the differential pressure. A number of pipelines and pumps are over–dimensioned leading to heat losses and excessive pumping costs. The large majority of pipes use outdated piping technology[6], which is much less efficient due to less effective insulation and which render a much shorter technical lifespan (15 years) than pre-insulated pipe technology (30-50 years). Due to the lack of financial wherewithal necessary upgrades and system improvements are not taking place.

Lack of demand-side EE investments. There is a huge untapped potential for EE on the demand side: most houses[7] date back to a time when energy was cheap and thus there was little or no incentive to implement EE improving measures. As a result there is a lack of insulation and the internal piping systems are inefficient. In Denmark a newly constructed residential building will, as a maximum, have a heat consumption of 0.025 Gcal/m2: more than 5 times lower than the average heat consumption for buildings in Kharkiv. *International experience across the region[8] indicates that energy savings on the end-use side of 20-50% can be realized.*

The large unmet potential of EE improvements remains unrealized due to a number of barriers that are elaborated below:

- Lack of building-level sub-stations that will enable the system to respond to lower demand from the building. The centralized (block) substations will supply heat to a certain number of buildings based on uniform criteria related to ambient temperature. If one of these buildings demands less heat it would make no difference to the supply;
- lack of apartment-level controls (e.g. thermostatic valves) that would allow reduction of the amount of heat sent to each specific apartment. For vertically connected radiators installing individual control on a radiator requires a bypass to mitigate the potential impact on the hydraulic balance;
- Lack of metering. With only 20% of buildings metered it will be difficult to switch to consumption based billing, which is necessary to provide incentives for EE;
- The monopolistic status of the municipal building maintenance company (ZhKS). ZhKs has no interest in EE since they are paid irrespective of the efficiency of their service. The heat distribution systems inside residential buildings are the property of the ZhKS and generally have insufficient or no insulation and need replacement due to corrosion and build-up of calcification. It should be considered to privatize the ZhKs and transfer ownership of heat distribution systems to homeowner associations (also called

[5] By March 29, 2010 Kharkiv had consumed 515 MCM of gas since January 1, for which it was only able to pay UAH 107 million out of the UAH 618 million bill from Naftogaz – this corresponds to only 17% of the billed amount
[6] Steel pipes in concrete ducts
[7] Two thirds of all residential buildings are more than 40 years old and 10% were built before 1917.
[8] E.g. from World Bank supported projects in Lithuania, Poland and Bulgaria

condominium organizations) with clear and robust rules for decision making on investments that relate to the whole condominium;

- Lack of awareness of the technical options and potential for EE among all the different stakeholders, including the homeowners; and
- Limited access to financing for individuals or HOAs, who would wish to invest in EE improvements.

3. Lessons Learned of Relevance to Kharkiv

World Bank funded district heating project in Sofia. In Bulgaria the Government implemented a DH strategy that resulted in the following actions and results for the DH system in Sofia (with a population of 1.4 million people – comparable to the size of Kharkiv):

- Obligatory heat metering in all district heated buildings, which was introduced by end 2001;
- Apartment owners to install demand side measures (DSM) at apartment level, including installation of heat cost allocators and thermostatic radiator valves. This step was successfully completed by 2003 with about 95% of apartments having DSM installed.
- In Sofia the DH Company replaced around 10,000 (out of about 15,000) old heat substations by modern and automated building-level substations.
- Consumption based billing at apartment level in Sofia reduced the heat consumption of buildings by 20 -30%, on average about 25%.

The apartment level billing system based on heat cost allocators was introduced and operated by private "heat accounting companies". These companies made agreements between apartment owners and the DH company for arranging the heat accounting in a building. Their services included:

(i) Installation of electronic heat cost allocators and thermostatic valves for each radiator,
(ii) Providing the service of heat cost allocation based on standard formula (approved by the state energy regulator),
(iii) Providing the results of the heat cost allocation to the DH Company in electronic form. The reading of cost allocators is typically done before the heating season and after the heating season; and
(iv) The services also include maintenance of the equipment

Lessons learned from the Sofia project include: (i) the heat accounting companies should be licensed by authorities before they are allowed to start their activities in order to have qualified firms doing the heat cost allocation, (ii) public information to tenants about efficient use of energy with the new equipment should be provided by the heat accounting companies/DH Company and (iii) maintenance services should be bid out competitively.

World Bank/GEF Vilnius Heat Demand Management Project[9]**.** The Vilnius project showed that introduction of apartment-level cost allocation and control as well as consumption-based billing can save 20-30% of the heat bill; a similar level of savings as that obtained in other projects[10]. However, the project also showed the difficulty of rolling out programs for heat savings in apartment buildings due to a number of mostly institutional barriers. Only 79 out of the targeted 550

[9] World Bank, Implementation Completion and Results Report for Vilnius Heat Demand Management Project, June 2009.
[10] E.g. from World Bank supported projects in Lithuania, Poland and Bulgaria

buildings were retrofitted despite the availability of state and municipal subsidies, attractive financing and ample technical assistance at the end of the five years of project duration. It is therefore important that any plans to address demand side energy efficiency in Kharkiv take a realistic view on the timeframe within which savings can be achieved and address the barriers early on.

The lessons learned include (i) the need to involve local financial institutions as intermediaries; (ii) the need to provide pro-active support to the establishment and operation of homeowners and condominium associations, (iii) the need to provide cost-neutral propositions to consumers through a combination of subsidies and vendor and utility financing of the equipment and its installation; (iv) to make long-term financing available to homeowners for building envelope improvements, and (v) to accompany the program with a vigorous public awareness raising campaign.

4. Short-Term Recommendations for Kharkiv DH

In the *short term* (next 1-2 years) it will be necessary to deal with some of the root problems for the heating sector: depoliticizing of tariff setting and raising tariffs to cost recovery level; thereby putting the heating company on a path of long-term sustainability; and ensure adequate social protection for vulnerable groups to cope with rising heat prices.

Tariff setting needs to be depoliticized. Social protection should not be provided through low tariffs for low-income households as both the rich and the poor benefit from this approach.

Tariffs must be brought up to cost recovery level. According to KHN around 30% of the present unpaid UAH 550 million gas bill to Naftogaz is due to tariff shortfalls. Tariffs should be gradually increased so as to ensure that the providers of heat services may cover not only production and distribution costs but also capital costs related to necessary investments in upgrading and rehabilitation. The price increases associated with capital costs should be kept to a minimum by carefully structuring financial packages. The price increase should be implemented in parallel with a strengthening of the social protection mechanisms[11] so as to compensate for the impact on the most vulnerable groups and an EE program to facilitate decreased consumption.

Decreasing supply costs. KHN should prepare an ***Investment Program*** which identifies and prioritizes short-term (1-2 years) and medium-term (3-5 years) investments that will serve to improving the efficiency of generation, transmission and distribution. Over the short term, capital constraints will hamper investments but KHN should still seek efficiencies that can be achieved with low capital demands such as consolidation of small inefficient boiler plants, increasing supply share from combined heat and power plants (as opposed to from heat-only-boilers) and introducing variable speed pumps. Short-term priority investments should also include introduction of building-level substations with group meters, allowing for consumption based billing, and changing the distribution system to operate with variable flow instead of fixed flow. Such investments are more capital demanding but as a first step it could be considered to install building-level substations in the 563 buildings that have 9 and more floors - making up about 12% of the total number of the residential buildings. The total cost is estimated to be about US$23.3 million and the savings would be about 20% of heat consumption of the buildings in question[12] (this is *before* individual metering is introduced).

[11] To a certain extend this will require changes to the social protection system on a the national level.

[12] While the system is still in transition from a centrally controlled fixed flow system to a demand-driven variable flow system some of the savings obtained in an individual building may result in overheating in another building, which will partially offset the achieved savings leading to lower system savings in the transitional period.

Financial performance of KHN must be improved. Over the next one or two years KHN will need to come back to financial health. KHN must ask the regulator for tariffs that will cover the capital costs of the Investment Plan for improvement of the heat supply. New tariffs should also eliminate the cross-subsidy from non-household sectors to households inherent in the present tariff structure. Furthermore, KHN will need to address the large payment arrears. The problem needs to be separated into stock and flow of arrears. Through improved collection, especially among budget entities, KHN should become current on the flow of arrears and then, together with the City of Kharkiv, they will need to find solutions to bring down the stock of arrears. A debt restructuring and payment plan will need to be agreed with the involved budget entities (who are responsible for 70% of the arrears) and the City administration has to be actively involved in its implementation. Finally, KHN should be prepared for private participation, which would lead to efficiency improvements and access to finance for needed investments. This could include bidding out upgrades from heat-only boilers to small CHP plants on a BOT model.

Consolidation of sector entities. The City of Kharkiv should consider a merger of KHN and CHP-5 with a view of decreasing operating costs of heat and power production. Over time this should lead to increased use of CHP technologies instead of heat-only-boilers.

Ensure social protection for the vulnerable population. The tariff increases that will be necessary for a sustainable operation of KHN could result in a doubling of a family's heating costs over quite short time unless measures are taken to reduce heat demand in the residential buildings. This transition will have significant impact on the vulnerable groups and requires that the social safety net is able to compensate for some of this price shock. However, since the social protection system is nationally regulated this cannot be fully solved on the local level. In the short term Kharkiv City can provide additional budget funds for existing subsidy programs, but these are poorly targeted and some vulnerable groups may not be covered.

Pilot program to demonstrate demand side energy savings potential. In order to try out different models to address the substantial barriers for implementation of demand side measures a pilot program should be established for 10-20 buildings in a first phase. The pilot program should include (i) installation of building-level substations and switching to consumption-based billing; (ii) individualization of heat control and metering (explained in more detail below); (iii) homeowner associations taking over ownership of internal piping and consumer installations from ZhKS; and (iv) trying out models for private sector participation in maintenance of buildings and financing of energy efficiency measures including the so-called ESCO[13] model.

Outreach and communications program. The pilot program will generate valuable experience when the same elements are being rolled out over a city-wide scale over the medium term (see next Section). The pilots will need to be complemented with an outreach and communications program that is meant to raise awareness and change attitudes toward energy use in residential buildings. Lessons learned from World Bank projects in Poland, Lithuania and Bulgaria indicate the need to accompany a program for energy efficiency improvements in residential buildings with a vigorous public information and awareness raising campaign.

5. Medium-Term Recommendations for Kharkiv DH

Over the *medium term* (3-5 years) the Investment Program should continue the improvements of supply side efficiency, including a finalization of the decentralization of substations, replacement of obsolete distribution pipelines, increased cogeneration and rehabilitation/consolidation of old

[13] An ESCO will finance EE improvements against taking a share of the savings to pay back its investment. It may also provide a performance guarantee, meaning that it will have to accept a lower pay-back if the EE measures prove to be ineffective thus guaranteeing the customer that he will not be worse off after the measures are implemented.

boilers. On the demand side efficiency improvement should be pursued through "individualization" (i.e. introduction of apartment-level radiator valves and heat allocators) and support to end-user investments in building envelope improvements.

On the **generation side,** KHN should gradually phase out all low-efficiency boilers (i.e. those that are more than 30 years old) and either move to cogeneration or high-efficiency condensing boilers. KHN will also need to make an assessment of whether portions of the DH network should be decentralized (served by local boiler plants) to provide more efficient delivery of heat.

In the **transmission network** the pace at which old, leaking pipes are replaced with modern pre-insulated pipe technology needs to be accelerated. From the present replacement ratio of 1.5% (25 km) per year, the ratio needs to be raised to 7-10% per year in order to achieve a rapid substitution of the roughly 30% of the pipes, which KHN have labeled "severely dilapidated", meaning that they have substantial heat losses due to leakages and missing or insufficient insulation.

The substitution of block substations with **building-level substations** should be finalized during the first one or two years of the medium-term program. Following the introduction of sub-stations with local temperature control and metering in each building all consumers should be switched to **consumption based billing**, which is a vital step to achieve savings related to behaviour changes and to motivate end-user to improve the heat efficiency of the building envelope.

Conversion from constant to variable flow operation of the DH network will gradually take place in section by section of the DH network as more and more building-level substations and variable-speed pumps are introduced. This will contribute to energy savings since it enables the network to operate at lower temperature levels and reduces the consumption of electricity for pumping.

Elimination of the separate HTW distribution systems. As substations are decentralized the existing HTW systems should be eliminated and HTW be supplied through heat exchangers in the building-level substation. This will serve to eliminate a very substantial source of heat losses: (i) the small distribution pipes for HTW that run from the existing block substations to each building and (ii) the wasteful behaviour of running the hot water tap for several minute before use in order to get the temperature high enough.

Individualization of heat control and metering. End-use consumption can be reduced substantially through installation automatic radiator valves and heat allocators[14] on apartment level - and introduction of *individualized* consumption-based billing. Initially, with only a building-level meter, the building's consumption will have to be shared among the apartments based on a m2-based distribution key. However, subsequently heat allocators should be introduced in each apartment since this individualization of the billing provides consumers with an even stronger incentive to save energy and the automatic radiator valves allows for individual choice of heat settings and thereby comfort level. The cost of individual heat allocators and automatic radiator valves for all consumers in Kharkiv is estimated at US$132 million[15]. It is expected that this would lead to savings of 20-30% of the end-use consumptions as evidenced by the lessons learned presented in Section 3 and that pay-back times for an average apartment would range from four to six years at the present heat prices.

[14] Heat allocators are not meters per se but they provide information of *relative* heat consumption from each radiator enabling the allocation of the total heat bill to an individual apartment. The allocation is done using a formula that compensate apartment with exposed positions (such as the top floor and end units with more "cold" walls)

[15] Thermostatic valves and heat allocator installation will cost US$250-400 per flat depending on the number of radiators and the need to install by-passes in the case of single-string systems

The apartment-level billing systems should be introduced and operated by private operators, licensed by the City authorities and contracted based on competitive bidding. The example of Sofia, described in Section 3, can serve as an inspiration.

Organization of homeowners. Most important with regard to the institutional and organizational changes is the set-up of homeowner's organizations (HOAs) capable of entering into negotiations and concluding agreements with public authorities, housing maintenance companies, heat suppliers and commercial banks. Under current Ukrainian legislation, only such organizations are authorized to manage the common property in multi-flat buildings. Thus, the absence of owner's organizations hinders the possibility to apply any comprehensive solution to the issues related to funding and implementation of energy efficiency measures in residential buildings. Only a limited number of buildings in Kharkiv City have HOAs. They account for only 4% of all multi-flat buildings in the city. Nevertheless, it is possible to build upon lessons learned by these, when promoting the set-up of further HOAs. When functioning HOAs are established they should take over ownership of the internal piping and consumer installations from ZhKS.

Market for building maintenance services. It will be necessary to break the monopoly of the ZhKS in order to create a real market for building maintenance services including individual heat billing/heat accounting. In Sofia (see Setion 3) the introduction of market players to deal with HOAs created the dynamics that led the HOAs to push for savings. ZhKS should be broken up into bits that can be privatized separately so as to create a competitive marketplace.

Financing of demand side measures. It will be necessary to set-up a financing mechanism for investments in demand side efficiency measures by HOAs. This could be credit lines through local financial intermediaries – maybe combined with a municipally and/or state funded support mechanism to help buy down the costs of the investments. An example here is the Polish Thermo-Modernization Program (TMP) that has been very successful as a mechanism to finance HOA-led building envelope improvements by offering credits to HOAs at market rates with a 25% matching grant through a network of local banks. The TMP is financed through annual budget allocations into a TMP account in the state-owned National Economy Bank (BGK)[16]. BGK has signed framework agreements with a network of private banks that allow these to offer loans to finance of EE improvements to HOAs where the HOAs only have to pay back 75% of the principal. Since its start in 1999 the TMP has supported EE upgrades for more than 10,000 HOAs and facilitated investments worth more than US$1 billion in building envelope improvements for multi-family buildings.

Alongside such a support mechanism the City should also support a model that attracts private sector capital to EE investments based on Energy Performance Contracts (EPC) with ESCOs. In such a model, the ESCO finances the investment and in return signs an EPC with the HOA for repayment based on the savings. The contract fixes future payments for heating on a level corresponding to the pre-renovation energy consumption and allows the ESCO to be paid back over the following years

However, it is unrealistic to expect a rapid roll-out of a city-wide program for building envelope upgrades in multi-family buildings. A number of barriers exist, including:

- the absence of functional HOAs as well as financial and legal constraints for HOAs (see above);
- the comparatively large portion of the house owners under or near the poverty threshold who will be unable to finance a down payment for any common investment project

[16] Polish name: Bank Gospodarstwa Krajowego

- the lack of experience with energy saving renovations in Ukraine, particularly in the residential sector; and
- the lack of skilled energy auditors, workers and supervisors.

It is recommended to prepare a focused study of these barriers and to have all the financial and legal questions fully worked out before moving to a scale-up phase of the Pilot Program mentioned under the short-term measures. This study should also look into the option of providing an income-adjusted subsidy for the down-payment.

Public awareness and outreach. The public information and awareness raising campaigns that were started up during the short-term program will need to continue throughout the medium-term program. As success stories regarding lowered heat costs and increased property values develop they need to be publicized in order to motivate more homeowners to embark on building envelope improvements. The outreach program should stress that the benefits to flat-owners of building envelope upgrades go beyond lower heating bills and also include: conservation of their property, lower maintenance and emergency repair costs, better comfort levels, higher property value, and major visual improvements

6. General Recommendations

It is clear from the study findings that a single municipality will be unable to address all of its heating sector challenges on its own: actions will need to be taken on a national level as well. The following recommendations can be derived from the study regarding any new heating project in the country:

On the national level the Government should consider:

(a) Improving the regulatory framework for heating through establishment of a central regulatory body for heating services. This will help to de-politicize the tariff setting and should lead to tariffs being raised to cost recovery level. The regulatory body must be independent and shielded from political interference;

(b) A transparent and predictable price-setting process should be established to support investments in system rehabilitation and efficiency improvements;

(c) Allowing homeowner associations (HOAs) to take over ownership of the communal assets in buildings and to tender out building maintenance services to private maintenance companies after having privatized the ZhKS; and

(d) Working with local banks to put together attractive financial packages for municipal EE investment programs for residential buildings including contribution from carbon finance and sale of AAUs[17]. Several carbon finance models could be considered and should be seen as complementary to more traditional financing support mechanisms.

On the municipal level the heating utilities should devise Rehabilitation Programs that comprise measures on the supply side as well as the often over-looked demand side. The supply-side assets currently have a problem as a result of being oversized. Getting demand right early in the Rehabilitation Program is essential to avoid this problem. A public outreach/communications program will be needed to change consumer behavior so as to achieve sufficient market penetration of efficient end-use measures.

[17] Assigned Amount Units: Under emissions trading of the Kyoto Protocol, an Annex I Party may transfer some of the emissions under its assigned amount, known as assigned amount units (AAUs), to another Annex I Party that finds it relatively more difficult to meet its emissions target.

Annex 1 – Country and energy sector background

Primary energy use in Ukraine is divided among Industry (25%), Electricity (22%), Residential Sector (17%), Transport (9%), District Heating (3%), Agriculture (1%), and Commercial and Public Services (2%)[18]. Ukraine inherited a large component of heavy industry as it was an important source of heavy equipment in the former Soviet Union. Nearly 20 years later, most of these assets are using the same technology as they were then and even then most of it was out of date, resulting in a labor and energy intensive sector, fueled by low cost energy and labor. Similarly, district heating was designed based on low-cost energy, inefficient, but reliable, boilers and limited temperature controls in the supply system and none at the consumer end. With no controls and costing based on the size of consumer apartments, there was no incentive to avoid wasting energy at the consumer end.

The 1990s saw an economic collapse that had considerable impacts on the energy sector. Prices were kept low, knowing that the existing assets would be adequate to meet demand for some time to come, thus avoiding a significant capital component to energy pricing. The drop in demand was convenient during the 1990s because it meant that virtually no new assets needed to be built, keeping the cost of supply low at a time when customers' ability to pay was limited by the collapse in their income. However, nearly 20 years has passed and many of these assets are operating beyond their expected life, requiring significant investment in asset replacement. Financing such investments will be challenging, coming off the financial/economic collapse of 2008/9.

Ukraine is among the most energy intensive economies in the world: Ukraine's energy use per unit of purchasing power parity adjusted GDP exceeds German figures by a factor of 3.6 (0.47 kg of oil equivalent in Ukraine vs. 0.13 kg in Germany[19]). The energy intensity of Ukraine is higher than that of energy-rich Russia. While Ukraine's energy efficiency has improved at a rate of 4-6 percent per year, from 1 kg of oil equivalent per unit of purchasing power parity adjusted GDP in 1999 to 0.47 kg in 2006[20], it remains at a level similar to that of Poland in the early 1990s.

The heating needs in buildings in Ukraine are expected to be a considerable source of energy savings with most buildings using several times as much energy for heating than in Western Europe. The demand-side issues are exacerbated by supply-side energy losses as well, with pipeline losses nearly double that of Western European practices and inefficient boiler technologies. Heating prices fail to reflect costs and price setting is politicized. District heating systems have not been modernized and suffer from a lack of metering and controls, particularly at the customer end. The legal status of condominium associations makes it impossible for commercial banks to lend for building upgrades. Building standards, construction practices and inspection requirements need to be addressed so that new buildings will be energy efficient.

The Government of Ukraine (GoU) has long recognized the need to reduce Ukraine's energy use and energy intensity as well as improve energy efficiency. In 1996, the GoU developed an Energy Efficiency Program, where it outlined its strategy of decreasing energy consumption in industrial, energy and housing sectors by using rehabilitation measures and updating old technologies. In the "Energy Strategy till 2030" from 2006, the GoU set a target to improving Ukraine's energy intensity by 50% by 2030. In 2005, the Government's policy on energy efficiency has been delegated to a specialized agency, National Agency of Ukraine for the Effective Use of Energy Resources (NAER)[21]. In 2009, NAER developed a new Energy Efficiency Program, where it sets a target of decreasing the energy intensity of Ukraine's economy by 20% by year

[18] Coal transformation constitutes 7%; non-energy use is 6%; distribution losses are 5% (IEA, 2010)
[19] Ibid
[20] Energy Information Administration, http://tonto.eia.doe.gov/country/country_time_series.cfm?fips=UP#prim
[21] Presidential Decree on Establishment of National Agency of Ukraine for the Effective Use of Energy Resources #1900/2005 dated December 31, 2005.

2014. However, so far none of the programs or strategies has been accompanied by an enforceable action plan supported by realistic financing sources, making it doubtful whether the targets will be achieved.

Regulatory responsibility for the heating sector, with the exception of CHP co-generation, lies primarily with local governments. However, the Ministry of Housing and Communal Services (MCS) has begun playing an increasing role in regulating district heating. In particular, MCS issues licenses for production, transport and supply of heat as well as sets tariff criteria and processes. Household heat tariffs do not cover heat production cost of district heating companies. As a result of inefficient energy pricing, district heating companies are virtually bankrupt and only pay about 60% of their gas bill. Low tariffs enable only limited replacement and upgrading to the district heating networks.

The investment needs of the energy sector are considerable due to the lack of investment over the past 20 years. Annual energy efficiency investment needs are estimated to be somewhere between $1-5 billion per year for the next five years. The Energy Strategy to 2030[22] estimates the total investment requirements on the supply side of the energy sector at more than UAH 1 trillion (USD 200 billion) for 2005-30, which implies a substantial higher rate of investment than occurred in the last 15 years. The gas sector needs about $2 billion per year over the next 5 years to modernize compressors, replace aging pipelines and gas storage assets as well as upgrade its instrumentation and controls. District heating networks, boilers, CHP plants and TPPs rehabilitation also requires at least $1.5 billion per year. The coal sector needs investment of about $1.8 billion per to address mine safety and to expand supply to meet growing needs. The power sector (including hydropower rehabilitation, power networks, nuclear and renewable sectors) investment requirements exceed $2.6 billion per year to modernize the existing assets and to replace the aging capital stock.

The challenges of the DH sector in Ukraine

District heating (DH) supplies approximately 60% of heating needs in the residential, commercial and public sectors. The country has as many as 7000 heat-only boiler plants as well as 250 combined heat and power plants (CHP). Most of the plants use natural gas as their primary fuel. These plants are organized into some 900 companies (Teplokomunenergo), the overwhelming majority of which are owned by the municipalities in which they are doing business[23]. A few of the plants are privately owned and operated. In Ukrainian cities most district heating systems are natural monopolies, and a competitive heat market – in the conventional meaning of the word – does not really exist. Competition between heat sources in not prohibited and a variety of heating options are available, especially for new buildings. These options include large district heating systems, roof boilers, heat pumps or individual apartment heaters that operate on gas or electricity. However, in practice, district heating consumers do not often switch to other heat options for economic, financial and technical reasons.

DH infrastructure is deteriorating and losses are high. Heat production, transmission and distribution facilities are inefficient and need urgent replacement and modernization due to a protracted lack of investment in municipal heating systems. The exact losses are not known because of a lack of metering equipment, but it is estimated that up to 60% of energy is wasted within the municipal heating chain, on its way from production to distribution and consumption – and that the largest losses occur at end-user facilities. Even though firm numbers are lacking to back this up a

[22] Cabinet of Ministers, 2006

[23] Figures cited in "Regulation of Ukrainian District Heating Sector"' a July 17, 2008 report prepared by Dr. Valdas Lukosevicius for USAID

reasonable estimate is that about half of these losses are due to leaking pipes and valves in the transmission and distribution networks.

Metering and end-user controls are essential for improving efficiency and transparency of energy markets operations. However, metering of heat consumption still remains an issue. Very little residential heat in Ukraine is metered. In Kyiv only 3% of residential buildings are equipped with heat meters, and only 1.8% have hot water meters[24]. The GoU recognizes that without meters and regulation devices, consumers cannot control their heat use and companies have little incentive to reduce the tremendous network losses. In the absence of metering, it is impossible to know the exact heat losses, which makes improvements challenging. In 1995, the Cabinet of Ministers approved a national program that aims to install heat and water regulation devices and meters in the housing sector. Because of difficulties in implementing it, the Cabinet has extended the program's timeframe on several occasions. However, implementation continues to be much slower than planned.

Poor end-use efficiency. The main reasons for poor efficiency in the residential heat consumption are: ***(i)*** Billing is based on square meters of living space rather than heat and hot water consumption thereby providing no incentive to consumers to conserve heat; ***(ii)*** Inability to individually control the amount of heat supplied to each apartment - control is mainly exercised through opening and closing of windows; ***(iii)*** Poor heat integrity of the building envelope with insufficient wall and roof insulation, old and cracked windows, cold staircases etc.; and ***(iv)*** Centralized heat substations fail to allocate heat to individual buildings based on their actual consumption resulting in over- or under-heating.

District heating tariffs are below costs. The domestic gas price does not cover the cost of production, and residential gas consumers as well as gas-fired heat producers pay a preferential gas price that does not reflect the economic value of gas. Despite this subsidy, heating tariffs do not even cover the short term marginal costs of producing heating. Heating tariffs are kept low for reasons that belong in the domain of the political economy but the rationale cited by politicians and regulators is normally related to energy poverty and poor purchasing power[25]. However, the result is that DH companies and end-users fail to get the correct price signals that may lead to more energy efficient supply and consumption. The total gas subsidy to district heating is about $2.4 billion per year. District Heating prices, set by municipalities are roughly 50% below prices set in efficient DH companies in Western Europe. As a result, DH companies are unable to fully pay for the gas consumed: non-payments to Naftogaz are about 60%. This nonpayment underestimates the size of the total subsidy to DH as the selling price at about US$107/tcm is about US$200/tcm less than the cost of importing gas from Russia.

Heating utilities are on the brink of bankruptcy. The low household tariffs combined with high incidence of non-payments have led to a situation where most DH companies are in financial trouble[26]. Since tariffs do not reflect the replacement cost of the capital stock the majority of DH companies have not been able to make significant capital investments for decades leading on one hand to high risk for outages and technical failures and on the other hand to quality problems as perceived by consumers (e.g. insufficient temperatures in homes and institutions). Significant accounts receivable are being built up, especially by budget entities that often are asked to pay almost double the heat price of households without being given the budget funds to meet their payment obligations. Efforts to attract investments continue to be constrained by poor creditworthiness of the DH companies and municipalities, and the need to restructure significant gas debts. Furthermore, legal and financial barriers have hampered private capital.

[24] Dubovyk et al., 2005

[25] A recent attempt by the regulator to raise the ceiling prices as of 1st of October 2009 by 25% for natural gas for DH companies failed

[26] It is estimated that on average DH companies only pay about 60% of their gas bills to the gas supplier, Naftogaz.

Fiscal deficits. The physical and economic inefficiencies of the DH systems have given rise to significant fiscal deficits due to governmental transfers and subsidies, whether from the state and/or municipal level, especially during the recent period of significant increasing natural gas prices[27]. At the municipal level this puts a great strain on the limited amount of budget funds raised from local revenues that can be used for discretionary purposes (under 5%).

[27] In 2008 in Kharkiv, a city with 1.4 million inhabitants and a city budget of US$415.6 million (not including budget transferes), the deficit caused by the poor financial performance of the heat utilities was equivalent to US$32.9 million or 8% of total budget.

Annex 2 – Data on Kharkiv Heat Supply

Heat Supply to Residential Buildings in Kharkiv. Kharkiv Heating Networks (KHN) provides DH services to residential consumers living in 5,639 residential buildings. The overwhelming majority of these buildings (4,822 or 85.5%) are registered by the Housing and Communal Services Municipal Company (ZhKS) as so-called *communal* residential buildings[28]. 64% of the residential buildings in Kharkiv are built of brick with some insulation features while the rest, 35.5%, are concrete panel buildings with very poor insulation. Two thirds of all residential buildings are more than 40 years old and 10% were built before 1917. Buildings constructed after year 2000 make up only about 1% of the total number of residential buildings.

Heat Production. (KHN) is the main heat supplier in the city and presently supplies 90% of the residential consumers in the city with the balance made up by consumers directly supplied from one of the two large combined heat and power plants (CHP3 and CHP5). In 2007, the total volume of heat energy (produced and purchased) made up 6,616,500 Gcal with the produced energy of 4,181,300 Gcal (or 63.2%) and purchased energy of 2,435,200 Gcal (36.8%). A heat balance for 2007 is presented in Figure 1 at the end of this annex.

KHN has 272 boiler houses with a total installed capacity of 3,053 Gcal/h. All boiler houses are working on natural gas. In 2007 the heating companies of Kharkiv used 657,000 tons of equivalent fuel (566.4 million m^3 of natural gas) and 94.0 million kWh of electric power. The main KHN heat energy sources include four large (district-level) boiler houses:

- Boiler House No. 4 Dzerzhynska - 300 Gcal/h;
- Boiler House No. 5 Moskovska - 780 Gcal/h;
- Boiler House No. 6 Kominternivska - 400 Gcal/h;
- CHP-4 - 660 Gcal/h.

The smaller boiler houses ranges from 0.1 Gcal/h to 50 Gcal/h. In total the installed capacity is 912 Gcal/h. Most of KHN's boiler houses were constructed in the 1960es and 1970es in accordance with typical designs adopted at that time. As they are reaching their technical lifetime, they require constant rehabilitation and upgrade.

Heat Energy Transportation and Distribution. The KHN has 1605 km of double-pipe heat supply network (including 410 km of backbone transmission pipes). About 75% of the pipes have been used for more than 15 years and KHN estimates that of this around 515 km of double pipes are severely dilapidated (32.1%) and 48 km (3%) require urgent replacement due to leakages. KHN hopes to carry out a gradual replacement of the existing pipes by efficient pre-insulated pipes with internal anticorrosion coverage and deploy such pipes at the same time as introducing new technologies, including automation and installation of meters

Generation and Distribution Efficiency. KHN claims that *generation efficiency* is 89.7%, however this number is average for all units including both heat-only boilers and cogeneration units. *Efficiency of heat distribution* is mainly defined by the losses in heat networks. According to KHN, the actual losses of heat energy through transportation and distribution make up 15.8% of the total heat supplied to the network (including the purchased heat). The 2008 network test, however, has revealed that the *real* heat losses are 4-6% higher than the actual ones and make up 16.4 – 16.7%.

Heat Consumption. KHN provides heat energy for heating and HTW supply to residential buildings, public houses and other consumers. Altogether, 6,046 buildings are heated with 5,639 of

[28] This is approximately the same as condominiums. The remaining buildings (817 or 14.5%) are owned by various legal entities.

them being residential houses (including 4,822 buildings registered on the balance of the ZhKS as the municipal residential facilities). The total heated space of KHN consumers has the area of 27,184,064,000 m^2. In 2007, the actual consumption of heat for residential and public buildings and HTW supply was 5.5 million Gcal. Residential consumers use the biggest share of heat energy (85.6% in 2007). 9.1% of heat was sold to budget organizations and 5.3% to other consumers. 64% of energy for residential consumers is used to generate and distribute *heat* and the remaining 36% is used for HTW.

Metering. As of 01.01.2008, only 4,053 of building meters were used to settle accounts with consumers, including 2,912 heat meters and 1,141 HTW meters. The meters register one fifth (20.4%) of the total volume of heat energy used for the needs of consumers. Municipal budget organisations and other consumers meter about 70% of the consumed heat energy. *Residential* building heat meters register 19.4% of the total volume of heat energy consumed by the population for heating purposes, while apartment and building HTW meters measure 14.9% of the total HTW used by the population.

KHN Financial Status. The main business of KHN – provision of DH heat and HTW supply services – is *loss-making.* The long-term and current liabilities are almost 5 times higher than the company's own funds. This is mainly due to the fact that: (i) *the heat tariffs do not fully reflect the costs of the key resources* (natural gas, electricity, purchased heat, salaries). In 2006, the coverage of actual expenses from the heat supply revenues was only 79.8%; and (ii) *residential consumers have accumulated significant arrears.* The company's financial resources allow it to fund only small projects (mainly current repairs), which does not meet its real investment needs and cannot ensure reliable functioning of the city's DH system. It will need to improve its financial stability in order to be able to mobilise any additional funding sources for its investment plans.

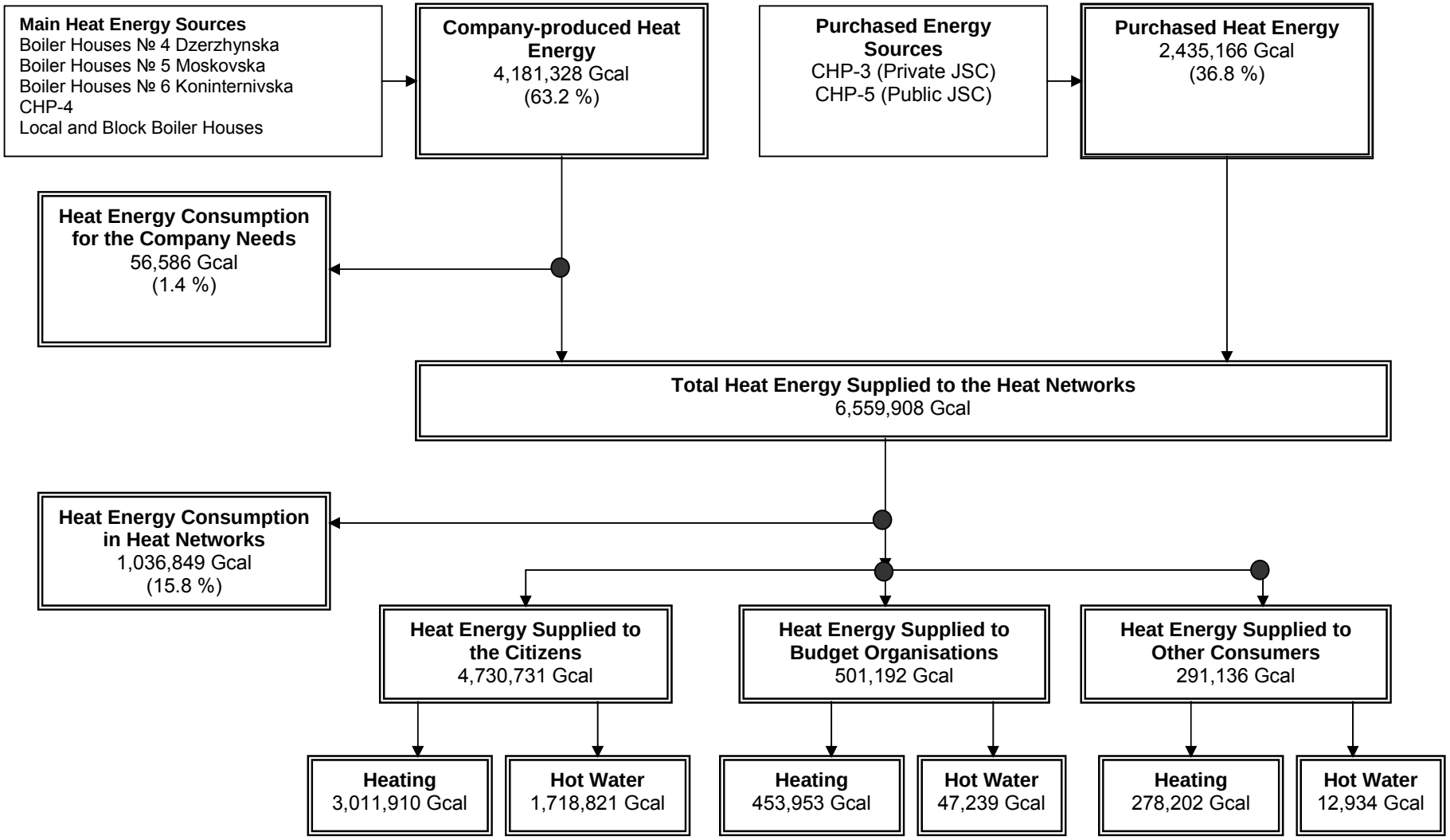
Since October 2006 the tariff has included an 8% capital charge (the so-called "investment component"). However, in 2007 the tariff only managed to cover 97.9% of the variable costs (assuming 100% of consumers pay up), and in reality only 87.4% of that amount was collected. The break-down of expenses for heat production, distribution, and supply of DH and HTW services is roughly:

- 40% for natural gas;
- 26% for the purchased heat energy also dependent on the gas price; and
- 5% for electricity.
- 29% all other costs

Low payment discipline is a considerable problem for KHN. Practically half of all consumers (226,500 or 48.2%) are running arrears and on an aggregated basis the arrears correspond to more than three months of billing. More than half of the debtors (121,300 or 53.6%) are estimated to be sufficiently well-to-do people who purposefully avoid or postpone paying for the services consumed. This category of consumers owes 62.3% of the total private consumers' debt with the average liabilities per subscriber being UAH 1,218 (US$251).

In March 2010 the debt to Naftogaz was UAH 550 million (US$ 69 million).

Figure 1. Heat Energy Balance for Kharkiv Heat Networks (2007)



Source: KHN