Sustainable Development Department
Europe and Central Asia Region

Modernization of the District Heating Systems in Ukraine: Heat Metering and Consumption-Based Billing

Yadviga Semikolenova
Lauren Pierce
Denzel Hankinson

Energy Sector Management Assistance Program

1818 H Street NW, MSN U11-1102
Washington DC 20433
Telephone: 202-458-7955
Fax: 202-522-2654

Website: http:// www.worldbank.org

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Acronyms and Abbreviations

CHP	Combined Heat and Power Plant
CTP	Group Heat Substation
IFI	International Financial Institution
ITP	Individual Heat Substation
DH	District Heating
HCA	Heat-Cost Allocator
HOA	Homeowners' Association
HOB	Heat-Only Boiler
NERC	National Electricity Regulatory Commission of Ukraine
NGO	Non-Governmental Organization
Ofgem	Office of Gas and Electricity Markets
O&M	Operation and Maintenance
TRV	Thermostatic Radiator Valve
Zhek	Municipally-Owned Building Management Company
TA	Tehnical Assistance
UAH	Ukraine Hryvnia
bcm	Billion Cubic Meters
tcm	Thousand Cubic Meters

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Executive Summary

Ukraine's district heating sector is in physical and financial crisis.

During the past 15 years, many of Ukraine's neighboring countries have upgraded District Heating (DH) systems making DH a financially sustainable way of providing good quality heat and hot water services at affordable prices. Ukraine has not made this transition.

It did not follow the sector reform path of most neighbors.

Countries in the region implemented policy reforms through effective changes to the legal and regulatory framework, enabling them to create independent regulators, raise tariffs to reflect full cost of service, involve the private sector and enable new investments. The introduction of heat metering at the building level was among the first steps in implementation of the investment programs.

Ukraine has kept regulation, ownership and operation of DH companies in the hands of local governments, and kept tariffs well below the levels needed to provide good quality service.

Heat metering and consumption-based billing are important steps toward improving service, lowering household costs…

Building-level heat metering and consumption-based billing are critical steps in meeting customer expectations for heating and hot water service. Public consultations with customers in two typical mid-sized cities in Ukraine, Lviv and Mykolaiv, confirm that customers want better quality service at affordable prices and that they do not trust the current system. Investing in building-level heat metering and implementing consumption-based billing can address these concerns in the following ways:

- **Better quality of service.** Building-level meters are typically installed along with a building-level substation package (ITP) which allows supply to be matched with demand through better temperature control at the building level.

- **Lower cost.** These investments reduce heating demand by roughly 15-25 percent, thereby, combined with consumption-based billing, decreasing average household expenditure on heating.

- **Improved transparency.** Consumption-based billing provides information about customers' heat consumption and how it relates to their bills as well as provides the incentive to balance heat supply and demand.

... and improving the financial viability of DH companies.

Heat meters with ITPs allow DH companies to:

- **Reduce the cost of supply.** Building-level metering helps optimizing the design of the heat supply system thus reducing costs further, particularly through controlling network losses.

- **Increase revenues.** Because meters with ITPs help improve the quality of service and transparency, they improve customers' trust and, hence, their willingness to pay. Additionally, improved quality of service can help improve collections from existing customers, attract new customers, and re-gain customers who had disconnected in favor of other heating solutions.

Quality DH services should be affordable.

There are obvious tensions between the objectives of improving quality of service for customers, while keeping DH affordable. Tariffs would need to more than double to reflect the economic costs of heat production. A one-off tariff hike of this magnitude would make DH services unaffordable for most Ukrainian households at current consumption levels. The proposed solution is to reduce heat consumption by 50 percent to compensate for a doubling of prices, coupled with a targeted social safety net to protect the poor. This can be done by:

- Assigning high priority to providing targeted subsidies to poor consumers to advance tariff increases;

- Installing ITPs with temperature controls (15-25 percent savings);

- Implementing energy efficiency measures to improve building envelops (20-25 percent savings);

- Installing heat-cost allocators (15-20 percent savings);

- Decreasing supply costs by reducing network losses and increased use of combined heat and power plants (10-20 percent savings).

Complementary reform measures are required.

A number of complementary institutional, legal and regulatory measures are required to support investments including:

- Complete de-politicization of the tariff regulation by passing responsibility to an independent sector regulator;
- Making DH companies clearly responsible for the financing, purchasing, installation, servicing of ITPs and meters as well as reading of meters;
- Standardizing heat supply contracts. Heat supply contracts vary substantially across Ukraine. The language is often confusing, excessively detailed and, in some cases, contradictory;
- Fostering the creation of homeowners' associations (HOAs). DH companies prefer to have contracts with HOAs because they are legal entities with an organized administration.

The financial support required includes:

- Targeted subsidies for poor customers. The Government could better serve poor customers by providing direct subsidies to the individual households, rather than to DH companies;
- Financing energy efficiency improvements. The Government could facilitate such investments through grant or concessional loan programs, funded or financed by donors.

The International Financial Institutions can help with financing and technical assistance.

The International Financial Institutions (IFIs) can help, as they have in other countries, with:

- Concessional financing for heat meters and ITPs. IFI financing could be on-lent to municipal governments to use for investment by municipally-owned DH companies;
- Technical assistance (TA). IFIs could fund TA for tariff-setting, affordability studies, setting-up a country-wide Building Certificates program; provide advisory services for the new utilities regulator; and assist with the design of targeted social safety nets;
- Funding for pilots. Given the potential for demand-side energy savings in Ukraine's buildings, IFIs could also assist with the design and funding of energy efficiency pilots in buildings.

1. Introduction

District heating (DH) plays a critical role in meeting basic heating needs in Ukraine, but the sector faces serious challenges that must be resolved to avoid collapse. For DH companies, the primary concern is financial sustainability. Companies lack the revenue to invest adequately in DH networks leading to lower quality of service and higher operating costs. For customers, the primary concern is quality of service and affordability. Artificially low prices have resulted in the continued deterioration of DH supply assets (and gas supply assets) resulting in lower heat supply quality. Low DH prices have provided little incentive for investment in energy efficiency. As a result, Ukraine is one of the highest energy intensive countries in the world.

Ukraine, together with other Former Soviet Union countries, did not follow the path chosen by their neighbors to modernize their DH sectors. Many countries of Eastern Europe enacted critical reforms in the 1990s to address problems related to affordability, quality of service, and financial sustainability similar to those now facing Ukraine. Evidence from these countries suggests that these challenges currently facing Ukraine, while difficult, are far from insurmountable.

Heat metering and consumption-based billing, as demonstrated by the success of neighboring countries, are critical steps on the path to sector reform. Implementing heat metering at the building level is also an attractive first step as it has the possibility of garnering widespread support from multiple stakeholders. Public consultations showed that many residential DH customers favor heat metering and consumption-based billing. Building level heat metering, coupled with technical solutions to improve efficiency of heat delivery to households, has demonstrated mutual benefits for customers, DH companies, and the Government. Installing equipment which allows heat supply to be matched with demand reduces final heat consumption. Consumption-based billing allows households to benefit from this decrease, as average household expenditure on heating goes down, making DH more affordable.

Heat metering and more efficient heat distribution helps DH companies to optimize the design of the supply system, thus improving quality of service and reducing cost of supply. Improved quality of service leads to better collections, which improves the financial viability of DH companies. High-quality, affordable and financially-sustainable DH services reduce the need for government transfers and explicit (and implicit) subsidies to sustain the DH system, thus decreasing fiscal deficit.

Yet, heat metering and consumption-based billing alone will not solve the problems facing the sector. Other important reforms, including energy efficiency improvements in buildings, efficiency improvements in DH networks, and regulatory reform will be needed to improve affordability and quality of service in the sector.

This study situates heat metering and consumption-based billing in the context of the various DH sector reforms needed in Ukraine. It builds on the work of previous studies including the recommendations of the 2010 ESMAP-funded study, prepared by the World Bank[1], that identified how to improve the DH sector in Kharkiv. That study outlined the potential for investments in DH systems in Kharkiv and other similar cities in Ukraine in both heat supply and demand side. It also recognized that policy changes needed to be initiated in order to create the enabling environment for this potential to be realized.

[1] Republic of Ukraine. Case Study: How to Improve the District Heating Sector in Kharkiv, May 2010, the World Bank

1.1 What makes district heating different in Ukraine?

With the fall of the Soviet Union, energy prices increased across Eastern Europe. In an effort to maintain the financial sustainability of the DH sector and ensure quality heat supply to customers, many of Eastern European countries took immediate steps to enact reforms that passed these costs on to customers while improving the overall efficiency of the DH network. Implementation of heat metering and consumption-based billing were critical steps in this process because they made customers' heating bills reflect the actual cost of providing service. Other reforms enacted included: the establishment of an independent regulatory regime, setting heating tariffs at economically justifiable levels, the involvement of the private sector in the ownership and management of DH companies, and the creation of heat supply contracts with customers requiring that DH companies provide an agreed upon level of service quality and that customers pay for the service.

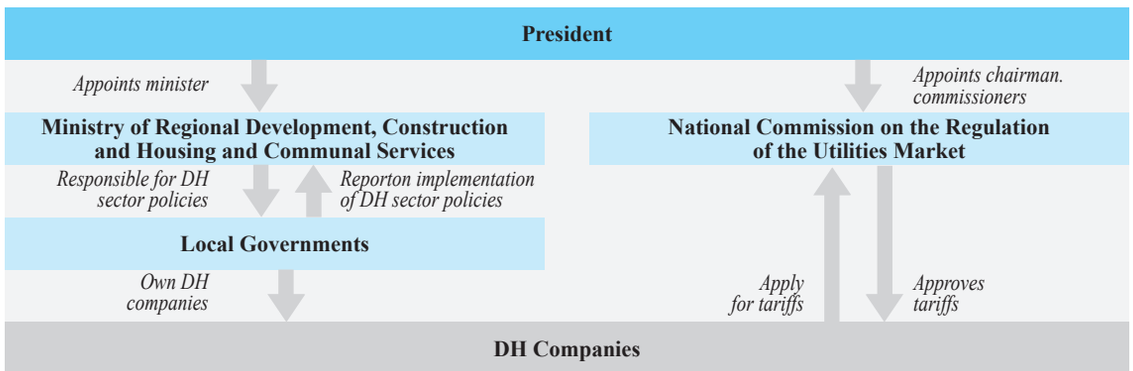
Ukraine, as well as other former Soviet Union counties, has not followed the path of DH reform taken by most other countries of the former Soviet Block to ensure the sustainability of the sector. In Ukraine, the drop in demand that followed the economic collapse in the 1990s allowed keeping prices low. Unlike in other countries where a strong, central government presence has championed DH sector reform with tariff hikes, local politicians in Ukraine have been responsible for setting DH tariffs. Knowing that existing assets would be adequate to meet demand for some time to come, oblasts and municipalities avoided including a significant capital component in energy prices.

Now, 20 years later, many of these assets are operating beyond their design life. Unlike in former Soviet Block countries where private sector involvement led to improved operations and management of the DH companies, Ukrainian DH companies have remained owned and managed by local governments. As a result of low tariffs and poor management of DH companies, financial sustainability and quality of service in the sector suffered. Low tariffs meant DH companies could not cover their costs, resulting in large debts owed to the natural gas sector and an inability to make needed investments. Protracted underinvestment has taken its toll on efficiency and quality of service. Roughly 60 percent of heat is lost in the network and during end-use. Most of the assets are close to or beyond the end of their design life resulting in low quality of service and higher operating costs. Poor service has caused dissatisfaction and distrust among customers.

Ukraine's DH network needs critical investment to avoid collapse, as occurred in the Alchevsk in 2006, where the system collapsed in the middle of winter and city residents had to be evacuated. The sector requires immediate reform in order to begin accumulating sufficient funds to make these urgent investments. Yet, years of underinvestment and customer distrust of DH services make the current situation in Ukraine different than what other countries confronted during the DH reforms of the mid-1990s. While there is no simple approach, Ukraine can learn from the successes of DH reforms in other countries. Ukraine has taken important steps in this direction recently by shifting the regulation of heat tariffs to the national level through the creation of the utilities market regulator[2]. Figure 1.1 shows the current structure of the DH sector in Ukraine, including the role of the newly created regulator.

[2] In July 2010, the Parliament of Ukraine passed a law on the National Commission for the Regulation of the Utilities Market in Ukraine. In July 2011, the President of Ukraine signed a decree creating the National Commission on the Regulation of the Utilities Market. The newly-created regulator approves tariffs for DH companies that operate boiler houses with total capacity of over 20 Gcal/hour, or about 200 DH companies that produce about 70 percent of total heat in Ukraine.

Figure 1.1: Structure of DH Sector in Ukraine



In many countries, the introduction of heat metering and consumption-based billing were also critical steps to help address larger problems in the sector. Box 1.1 describes the role heat metering and consumption-based billing played in shaping the DH sector in Estonia. Notably, there are no good examples of implementing consumption based billing in DH sectors of former Soviet Union countries, other than the Baltic States. This fact highlights the challenge of implementing heat metering and consumption-based billing among former Soviet Union countries.

Box 1.1: Heat metering and consumption-based billing in Estonia: legal, regulatory and institutional reforms

Estonia was a Soviet republic between 1940/1944 and 1991. In 1991, it inherited a centrally managed state housing sector and DH infrastructure, which for all practical purposes was identical to those of any other soviet republics.

Today, building-level DH metering covers virtually 100% of all buildings in Estonia. After the successful implementation and completion of real property reform in Estonia already some 10 years ago, this could not be otherwise: every heated building belongs to a separate actor of some kind: an enterprise, a housing association (korteriühistu), a municipality, or the state.

In the 1990's it was common that Estonian housing associations and enterprises installed heat meters on their own initiative. This had more to do with a certain attitude of suspicion vis-à-vis the integrity of the DH companies of the day, than actual lack of finances on the side of the heat providers.

The first attempt to introduce a modern EU-type regulatory regime in Estonia was done in The Energy Act of 1997. The Energy Act included unbundling, market opening, eligibility of customers, and an independent regulator. One of its leading ideas was to treat electricity, natural gas and district heat supply in an identical manner – something that did not work very well in practice. The Energy Act was repealed in its entirety in 2003 and replaced by sub-sectoral Electricity Market Act, Natural Gas and District Heating Act.

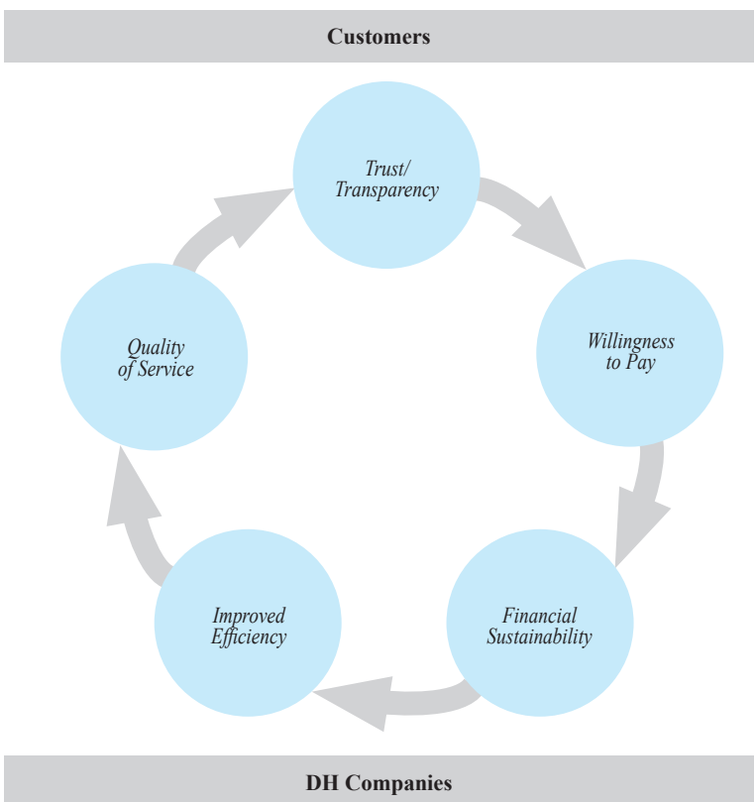
According to the District Heating Act, a DH company is responsible for the installation, maintenance, control and reading of the relevant meters – and that they are properly calibrated and function regularly. The Estonian Competition Authority (Konkurentsiamet) has the right to assess the appropriateness of the actions of DH companies. While the quantity of heat supplied to each building is metered by the DH company at the building's heat exchanger, the method of dividing the heat bill among the owners of the building is an "internal matter". In case of housing associations, it is usual that the owners of apartments pay for the heat they use on the basis of the living area they occupy. Although it would be possible to install heat meters for each apartment, this is not usual.

Source: Poyry Group. "Implementing Consumer-End Heat Metering in Ukraine. Activity 3: Institutional, legal and regulatory framework to introduce building-level heat metering in Ukraine." Report for the World Bank. 23 April 2011.

1.2 The role of heat metering and consumption-based billing

Heat metering and consumption-based billing alone will not solve the problems facing DH in Ukraine, but they are important steps towards improving governance and affordability in the sector. Consumption-based billing provides better **transparency** to customers thus increasing their confidence and **trust** in DH companies. With heat meters, customers' heating bills are based on the actual level of heat consumed as determined by the metering reading. This, in turn, provides incentives for consumers to conserve energy and implement apartment- and building-level energy efficiency measures. In general, customers are more **willing to pay** prices that better reflect the cost of heat services when they trust that the company is charging fairly for that service. In this way, willingness to pay directly impacts the **financial sustainability** of DH companies. Accurate data on demand provided by heat metering, allows financially viable DH companies to **improve efficiency** of heat production leading to decreased supply costs. Improved efficiency and the ability to adjust production to meet demand, provided by heat metering, improves **quality of service**. Improved quality of service increases consumer confidence and **trust** in DH companies further. As Figure 1.2 shows, these aspects taken together create a "win-win" cycle for both customers and DH companies.

Figure 1.2: Heat metering and consumption-based billing as a "win-win" cycle for customers and DH companies



Heat metering and consumption-based billing begins with installing building-level heat meters. Then heat consumption of each building is metered, divided and billed to each household residing in a building, usually on the basis of the area of their apartments. Apartment-level heat metering devises can be installed simultaneously with building-level heat meters or after the installation of building-level heat meters.

1.3 Structure of this report

The remainder of this report shows how building-level heat metering and consumption-based billing can benefit both customers and DH companies and begin the process of DH reform in Ukraine. The report is structured as follows:

- Section 2 describes the social issues and concerns, identified through public consultations carried out in two cities in Ukraine, which may pose a challenge to heat metering and consumption-based billing;
- Section 3 discusses the benefits of different options to introduce consumption-based billing to customers and identifies the most cost-effective alternative;
- Section 4 describes the benefits of heat metering and consumption-based billing to DH companies;
- Section 5 analyzes the role consumption-based billing can play in addressing two key challenges for DH reform – affordability and financial sustainability – and describes what other reforms will also be needed;
- Section 6 identifies next steps for implementing heat metering and consumption-based billing in Ukraine; and
- Section 7 discusses the role of International Financial Institutions in helping Ukraine implement consumption-based billing for the DH sector.

2. Main Issues and Concerns about Heat Metering and Consumption-Based Billing

Households are understandably strongly invested in the quality and cost of basic social services. This is particularly true for district heating, which covers roughly 60 percent of population in Ukraine and is a primary source of heat for many households, schools and hospitals. Gaining public approval is crucial to the success of DH reform as DH is only viable if demand is relatively high to justify the capital expenditures. To do this, policymakers must address: i) general social concerns about DH services and ii) social perceptions of how implementation of reforms, including the introduction of heat metering and consumption-based billing, may affect those services.

In order to better understand social concerns about district heating services and what social issues may arise from introducing heat metering and consumption-based billing in Ukraine, the World Bank conducted public consultations in two representative cities — Lviv and Mykolaiv[3]. Lviv and Mykolaiv represent typical medium-sized cities in Ukraine that rely on DH for heating needs[4]. One notable difference between the two cities is that residents in Lviv have more widespread experience with the installation of building-level heat meters than residents in Mykolaiv.

This section focuses on the main issues and concerns that came out of those public consultations. Section 2.1 looks at stakeholder concerns with DH services in general. Section 2.2 discusses what outcomes stakeholders expect from the introduction of heat metering and consumption-based billing. The remainder of this report demonstrates how heat metering and consumption based-billing are the first steps in beginning to address many of these concerns.

2.1 Concerns about existing DH services

Participants in public consultations expressed a number of concerns regarding the existing DH services in Ukraine. Often consumers do not have a direct interaction with a DH company: instead, residents must deal with Zheks, municipally-owned building management companies. Zheks are usually considered to be underfunded and have reputation of providing poor quality services. It is not surprising, therefore, that respondents generally do not trust DH companies and Zheks to provide good quality services and to bill them fairly for those services. Affordability also emerged as a primary concern, with many residents identifying alternative heating strategies that help them cope with higher DH heating costs. The following subsections look at these trust and affordability concerns in further detail.

Lack of trust

Participants of public consultations expressed a general mistrust of DH companies and Zheks — the two institutions primarily responsible for providing and billing for DH services. This lack of trust stems from:

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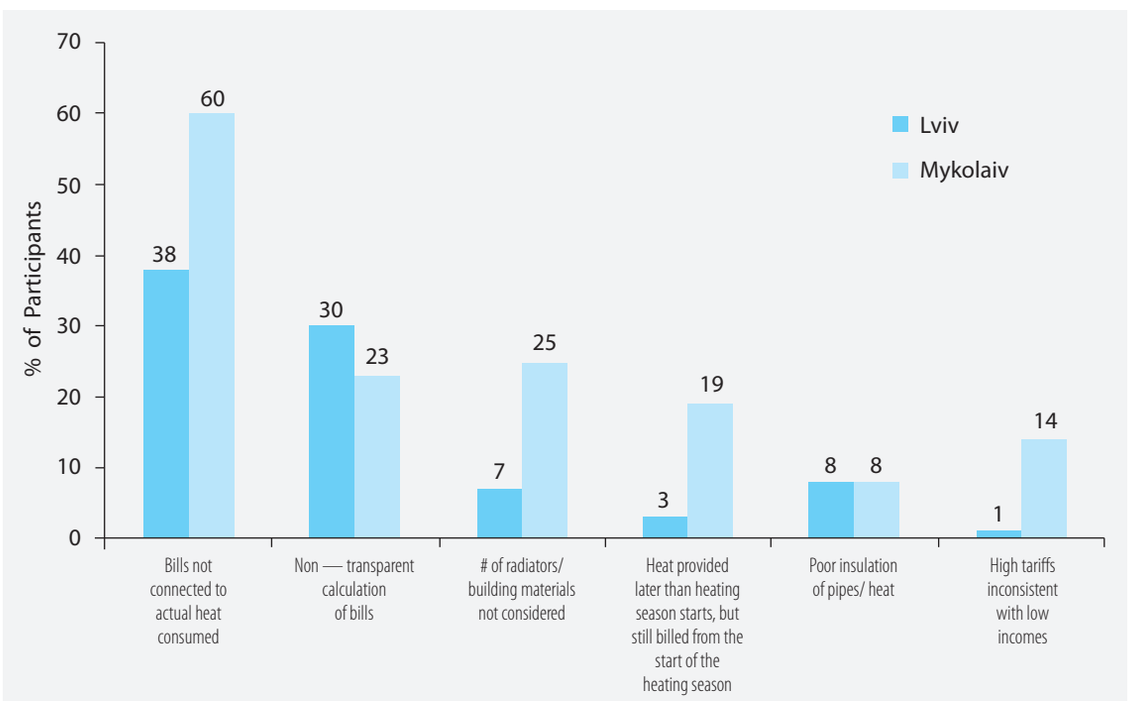
[3] See Appendix A for further information on how public consultations were carried out, including: the reason for selecting these two cities, the method for selecting respondents, and the format of the consultations. Public consultations were conducted by Center of Social Expertise of the Institute of Sociology of the National Academy of Sciences of Ukraine (CSEP) under supervision and guidance of the World Bank. The full report on the results of public consultations is available upon request.

[4] In 2009, heat consumption in Lviv was 1.9 million Gcal (Residential: 1.2 million Gcal, or 70%). 2009 heat consumption in Mykolaiv was 0.8 million Gcal (residential: 0.5 million Gcal, or 60%). The difference in heat consumption between the cities is mainly due to difference in their size and geographical location. See Annex A for more details.

- **Unfair and non-transparent billing.** Most participants of public consultations believe that current bills are not fair or transparent. They believe bills to be unfair because the amount charged is not tied to the actual quantity of heat consumed or the quality of services provides. For example, in Mykolaiv, a significant portion of participants noted that billing for heat is unfair because it does not take into consideration the number of radiators in each apartment, and construction materials of the building. Public consultations also found concerns about transparency because residents do not know the equation used to calculate heat tariff. As a result, they have no way of knowing whether heat price increases are caused by increased natural gas prices, which is seen as a justifiable expense, or by increases to other cost components, such as salaries of the DH companies' employees, which are not seen as justified. Figure 2.1 summarizes reasons why participants of public consultations believed billing to be unfair.

- **Poor quality of service.** Some residents are not satisfied with the level of service quality provided by DH companies. For example, consultations participants noted that DH companies start the heating season later than the established start date and stop heat supply prior to the established end date, but still charge as if they were providing heat for the whole heating season. Other participants noted dissatisfaction with the service, including the lack of routine maintenance, provided by Zheks. For example, customers mentioned usually having to pay extra money to hire heat engineers or plumbers for services which technically have already been paid for through a residential rental payment (kvartplata).

Figure 2.1: Why do participants of public consultations think heat bills are unfair in Ukraine?



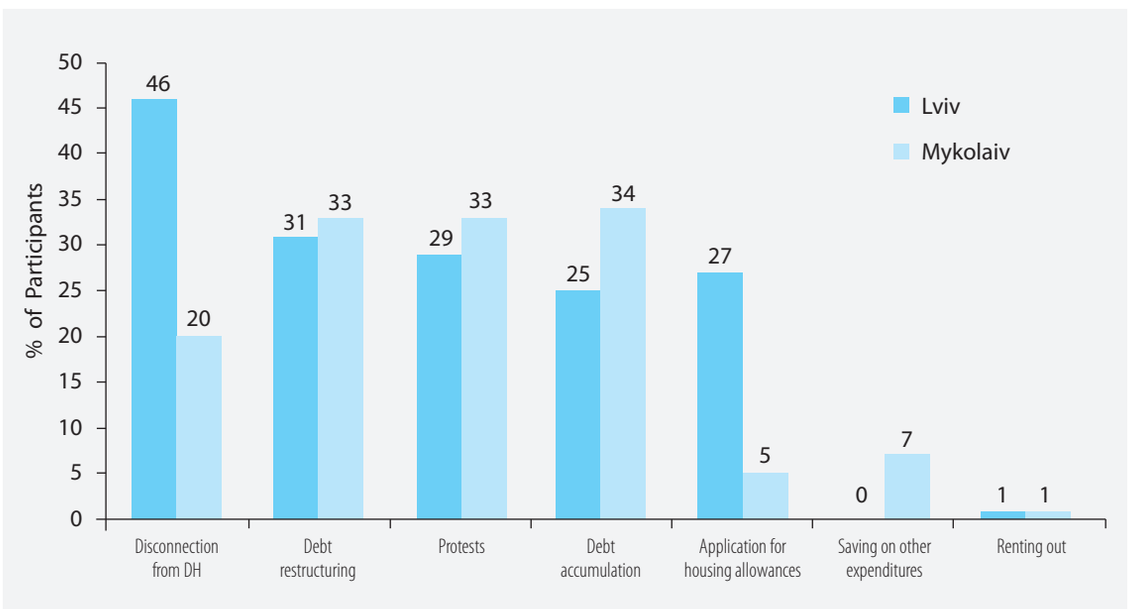
Affordability

Affordability of heating services is one of the main concerns for many residents. Participants of public consultations are keenly aware of any changes to the amount billed for heat services. For example, 83 percent of participants recognized that heating bills increased over the past year. Participants in Lviv attributed the increase in heating bills to high fuel prices (e.g., gas) whereas

participants in Mykolaiv believed heating bill increases resulted from outdated infrastructure and heat loss in the system.

Public consultations participants in both cities identified a number of possible strategies to cope with the rise in heating costs. While the majority noted the ability to disconnect from the DH network, this strategy is not realistic as it would require a large upfront investment in an alternative heating source[5]. Similarly, participants also noted protests as important strategy even though previous research in Ukraine shows that few people are willing to protest publicly against high heating costs. The three most common credible coping strategies are debt restructuring, debt accumulation and application for housing allowances. Figure 2.2 summarizes coping strategies that could be employed by respondents in response to high heating bills.

Figure 2.2: How could households cope with high heating bills?



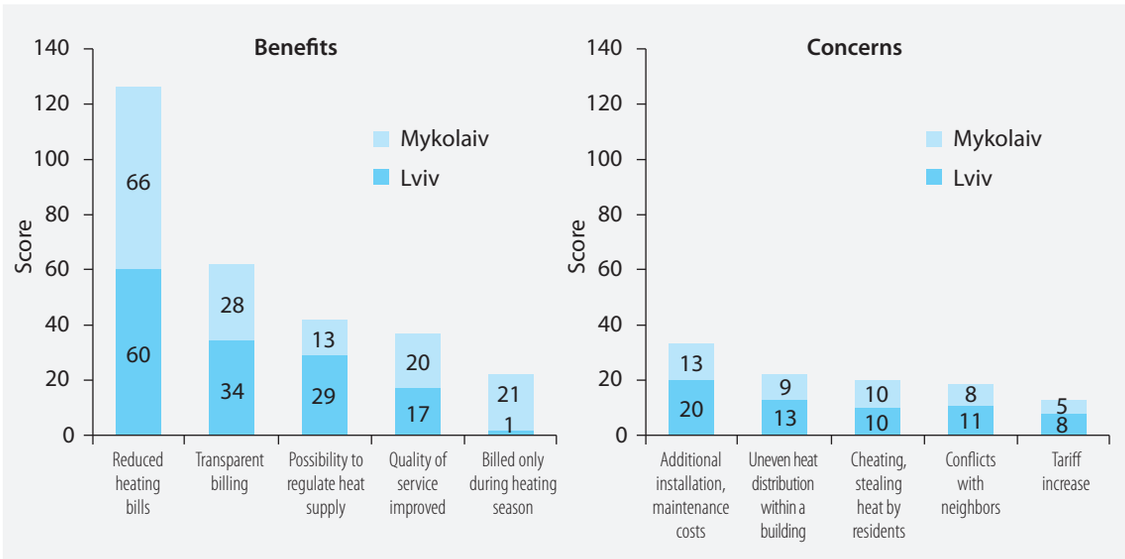
2.2 Expected outcomes of heat metering and consumption-based billing

Overall participants of public consultations believed that the positive outcomes from heat metering and consumption-based billing outweighed the negative consequences with lower heating bills. Also, they cited increased transparency most frequently as one of possible benefits. However, respondents noted a number of concerns regarding installation of heat meters and provision of service.

Figure 2.3 shows how participants of public consultations ranked the perceived benefits and concerns of heat metering and consumption-based billing. Outcomes were ranked out of a possible score of 130. High scores assigned to expected benefits signify that all participants perceived the outcome of heat metering as highly important. Notably, maintenance costs, which were the highest rank of negative consequences, only scored 35. This demonstrates consensus among public consultations participants in the perception that the benefits of heat metering and consumption-based billing outweigh the costs. This section looks in further detail at these benefits, consequences and concerns.

[5] Additionally, municipal authorities do not favor this option as it is generally leads to problems with DH system and could be more dangerous if not properly installed and maintained.

Figure 2.3: Expected benefits and concerns of heat metering and consumption-based billing



Benefits

Participants in both cities generally believed that installation of heat meters yielded benefits to customers. Responses varied slightly between residents that currently have heat meters versus those that do not. Overall, the benefits identified most frequently included:

- **Lowered heating bills.** Almost all participants of public consultations believe that meters and consumption-based billing will reduce their heating bills, at least in the short-term.

- **Transparency**. Many participants in both cities expect that consumption-based billing would lead to improved transparency because they would gain a better understanding of what they are actually paying for, and would be able to compare prices paid for the services performed. Participants also believed that meters would also help identify who was responsible for poor quality of service, thus improving transparency in the sector further.

- **Quality of service.** Participants in both cities noted that metering and consumption-based billing would contribute to improved quality of service. Some participants, primarily in Lviv, believed that service quality would be improved through the ability to regulate temperature. Participants in Mykolaiv who have experience with meters without temperature controls were less likely to cite this as a benefit of heat metering. However, a small number of Mykolaiv participants valued the potential opportunity to pay for heat only during the heating season.

Concerns

Participants in both cities expressed very few concerns about the installation of building-level heat meters and introduction of consumption-based billing. Some failed to identify any negative consequences of metering and over half of the participants were only able to identify one or two potential problems. Nevertheless, the concerns cited most frequently included:

- **Higher costs**. Public consultations participants in both cities ranked the buying, installing and maintaining meters by customers as the primary negative outcome of installing meters and introducing consumption-based billing. Currently, residents must organize amongst themselves in order to buy, install and maintain a heat meter in their building. As a result, residents have to pay for the meter upfront as well as collect money for maintenance when needed.

- **Transparency and fairness within buildings**. Participants expressed concerns about unfair distribution of heat and, therefore, heating costs among building residents as well concerns that some residents might install additional radiators in order to get more heat at the expense of their neighbors. For example, customers perceived it as unfair that building heating bills would be split on the basis of the living area among apartments even though some apartments are not as well heated. While heat metering does not directly address heat distribution issues, it is worth noting that they appear to become more visible after installation of building-level meters.

Concerns about implementation

Participants of public consultations expressed a number of concerns related to meter installation and servicing. They identified the main concerns related to each group that would play a role in heat metering and consumption-based billing implementation. These include:

- **DH companies.** In general, participants believe that DH companies would resist installation of building-level meters and introduction of consumption-based billing because it would lead to a decline in sales. However, discussions with representatives of DH companies did not reveal strong opposition to heat metering. The top concerns expressed by participants about DH companies included lack of transparency in servicing and reading meters and possible increased heating bills. Despite these concerns, most participants would still prefer that DH companies carry out installation and management of heat meters. Additionally, it is worth noting that respondents that currently have building-level heat meters expressed far fewer concerns about transparency of DH companies suggesting that installation of heat meters and introduction of consumption-based billing may help improve trust in the sector.

- **Zheks.** The main challenges expected from Zheks include poor quality of service, lack of qualified staff and potential misuse of resources. As noted in Section 2.1, residents generally do not trust Zheks because they believe that Zheks do not perform services for which they are paid. As one young man in Mykolaiv described, *"Zheks can solve everything but you have to pay them extra. ...in order to get a Zhek mechanic to come, you have to start calling him very early in the morning, before he gets drunk."*

- **Residents.** Participants also expressed a number of concerns related to collective organization. Currently, residents must organize amongst themselves in order to install a heat meter in their building. The challenges of collective organization most frequently mentioned by participants included: finding volunteers to form a committee to spearhead the process, obtaining approval from all residents in a building and collecting payments from all residents. Participants also noted difficulty fundraising as a main obstacle to meter installation.

3. Options to Introduce Consumption-Based Billing and Their Benefits to Customers[6]

Customers want a heating solution that best meets their service quality requirements at a reasonable price and is billed in a transparent manner. Currently, for most residential consumers in Ukraine connected to DH, heat consumption is not measured, but estimated based on a number of normative indicators[7]. Building-level heat meters are installed in about 30 percent of residential buildings that use district heat, but not all of those buildings use meters for consumption-based billing.

Given the current situation with heat metering in Ukraine, one option to introduce consumption-based billing would be to install building-level heat meters in all of the Ukrainian buildings connected to DH and enforce using them for consumption-based billing. In this case, the building-level heating bill would be divided among apartments based on the living area each apartment occupies. This would improve transparency of billing and give consumers a better understanding of what they are paying for, thus addressing one of the major customer concerns highlighted in Chapter 2. However, this would not affect the quality of service – another concern shown in Chapter 2 to matter to customers.

In order to improve quality of DH services, building-level heat meters should be installed with temperature controls. Temperature controls would allow DH companies to better match heat supply to actual heat demand, thus improving efficiency of heat consumption as well as production. Temperature controls could be at group substations, or centralized heat substations (CTPs)[8], which control temperature for a group of buildings. In this case, the supply of heat to each building would depend on the average demand of the buildings connected to a CTP. The efficiency gains of this option would be quite modest, about 1-3 percent per building.

Temperature controls could also be introduced at the building level by installing individual heat substations (ITPs). ITPs control temperature for an individual building, allowing DH companies to deliver energy to each building according to its individual demand. This option would significantly improve heat supply efficiency and result in a decrease of building-level heat consumption by about 15-25 percent.

In order to introduce individual, apartment-level temperature controls in a building, ITPs and building-level heat meters would need to be installed together with thermostatic radiator valves (TRVs) and heat-cost allocators (HCAs) on all radiators in each apartment. TRVs would allow households to regulate temperature according to their needs, and HCAs would "measure" heat emitted by each individual heat radiator. In this case, the total cost of heat consumption of the building, metered by a building-level heat meter, would be allocated to the individual apartments partially according to the floor area and partially based on the readings of the HCAs. This option would further improve heat supply efficiency and would result in up to a 30-35 percent reduction in heat consumption due to better targeted consumption-based billing incentives.

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[6] This Section is based on two reports prepared by independent consultants from District Heating and Cooling Division of Poyry Group, Finland. For the analysis, the consultants used detailed technical and financial data for 35 Ukrainian DH companies, provided by National Electricity Regulatory Commission of Ukraine (NERC), as well as information collected during field visits to 5 companies included in the dataset. The reports are available upon request.

[7] (i) Connected capacity of the customers set in technical documentation; (ii) normative outside temperature for the heating season in a particular region; and (iii) normative length of heating season.

[8] In a 4-pipe system, a CTP/group substation, to which a number of buildings are connected, divides the water circulation of the primary side to separate the space heating and the domestic hot water DHW circuits of the secondary side. For more details, see Appendix B.

Most commonly, DH companies are responsible for installation and maintenance of CTPs, ITPs and building-level heat meters since they are a part of a DH network. TRVs and HCAs are usually installed by the households.

As an alternative to DH, a single apartment could disconnect from the DH system, install an individual gas heater and meter heat consumption at the apartment level. This would also allow for full individualization of heat consumption: a household would be able to regulate apartment-level temperature. The potential average savings of this option is about 30-35 percent.

The purpose of this section is to show how the above options to introduce heat metering and consumption-based billing compare in terms of costs and quality of service—the criteria stressed in Chapter 2 as important to most customers. Among DH options, we discuss only those options for which DH companies are responsible. We also look at individual gas heaters as an alternative to DH. The analyzed options include:

- **Option 1.** Most common current situation, in which buildings are connected to DH network without metering. As a result, building level heat consumption is estimated;
- **Option 2.** DH with building-level heat meters, but no temperature controls;
- **Option 3.** DH with building-level heat meters and rehabilitated CTPs, which control temperature for a group of buildings;
- **Option 4.** DH with building-level heat meters and ITPs of Ukrainian configuration[9], which control temperature for an individual building;
- **Option 5.** DH with building-level heat meters and ITPs of European configuration;
- **Option 6.** Apartment disconnects from DH system and installs apartment-level individual gas heater.

3.1 Cost

The following subsections show which option to introduce heat metering and consumption-based billing is the lowest cost option when considering the current and full cost of providing DH service.

Current cost

Currently, the actual cost of heat production in Ukraine is much lower than what DH companies should be spending to provide service. In 2009, the average production cost of a typical Ukrainian

[9] The configuration of ITPs in the EU-countries and Ukraine is different. Although there is no unified EU standard for ITP configuration and national standards and rules pertaining to ITPs differ, most of the times ITP configuration is similar in EU countries and complies with a number of EU directives. In Ukraine, ITP design standards were heavily influenced by a former GOST system, which mandated backing-up of major technological components. Such design practices significantly increase capital cost of an ITP. For more detailed explanation, see footnote 16 in Appendix B.

DH company[10] was estimated to be €21 per Gcal (UAH 235/Gcal)[11], or over 50 percent lower than the estimated average cost of production when accounting for full costs[12]. Box 3.1 describes why the actual cost of heat production is so low.

Box 3.1: Why are actual heat production costs low in Ukraine?

Actual heat production costs in Ukraine are low for several reasons:

- **Low gas prices.** DH companies pay very low prices for the gas used to produce residential heat: In 2009, DH companies paid only €66 (730 UAH) per thousand cubic meters (tcm) of gas used to produce residential heat, or roughly one fourth of estimated cost of gas supply, when including full cost of transmission and distribution. Appendix C discusses full economic cost of Ukrainian gas in detail.
- **Under-maintenance.** Operation and maintenance investments are well below the level necessary to sustain proper operations of DH networks.
- **Underinvestment in the network.** Historically, DH companies have not invested enough in DH infrastructure assets to maintain a reasonable quality of service. The book value of DH companies' assets is based on historic book value. The consequent depreciation charges in the total costs of DH companies are much lower than necessary to maintain a given level and quality of service for customers, about 3 percent on average.

Because of the underinvestment and poor maintenance, the investment cost of the analyzed options are higher than in the case of the efficiently run company: additionally, installing CTPs and ITPs would require partial replacement of distribution pipes.

Table 3.1 looks at the costs and benefits of the various options to introduce heat metering and consumption-based billing for a household living in a typical two-room apartment with three residents in an older, panel multi-apartment building in Ukraine. In terms of costs, all of the alternative options increase the cost of providing service per unit of energy. The increase in costs results from the additional investment costs and costs of purchasing, installing, operating, and servicing the equipment for each of these options. Additionally, investments costs for heat meters with CTPs and ITPs include significant upgrading of distribution network. In terms of benefits, most of the alternative options reduce annual average heat consumption per apartment. For example, CTPs and ITPs provide the ability to supply heat according to specific demand of a group of buildings or an individual building, respectively. This leads to more efficient heat supply and reduces building-level heat consumption.

[10] Operational profile of a typical Ukrainian heat producer was developed based on analysis of detailed technical and financial data for 35 Ukrainian DH companies and information collected from field visits to 5 of those. A typical Ukrainian DH company uses gas-fired heat only boilers to produce heat, sells at least 80% of their total heat production to households and the rest to other consumers. For companies that sell a bigger part of their heat production to non-residential consumers, average production cost is higher because of the higher price DH companies pay for gas they used to produce heat for on-residential consumers. See Appendix B for more details.

[11] As of June 2011, the average production cost of a typical Ukrainian DH company is €26 per Gcal. The increase reflects the recent rise in domestic gas prices and thus does not affect the argument.

[12] The estimated average production cost of heat of a typical Ukrainian heat producer, when accounting for full costs, is €45/Gcal. See next subsection and Appendix B for more details.

Table 3.1: Costs and benefits of various options to introduce consumption-based billing, current cost of service, per average apartment per year

		District Heating					Disconnected from DH
		Current Heat Consumption, No Metering	*Heat Meter*	*Heat Meter + temp. controls @ CTP*	*Heat Meter + temp. controls @ITP/UA*	*Heat Meter + temp. controls @ ITP/EU*	*Individual Gas Heaters*
Annual consumption	*(Gcal/apt)*	9.16	9.16	8.97	7.32	7.32	6.41
	Gains (%)	---	0%	2%	20%	20%	30%
Average cost of heat	*(€/Gcal)*	21.3	21.5	23.0	24.4	23.7	40.2
Annual total cost of heat, including:	*(€/apt)*	195	197	206	178	174	258
	% of current total cost	100%	101%	106%	91%	89%	132%
Heat	*(€/apt)*	195	195	191	156	156	56
Investment	*(€/apt)*	---	1.5	12.5	18.0	14.8	160.5
O&M	*(€/apt)*	---	0.5	2.5	4.0	3.2	41.5

As Table 3.1 shows, ITPs of European configuration provide the lowest cost solution to introduce consumption-based billing for Ukrainian households. The annual cost of heat for an average apartment under both ITP options is roughly 10 percent lower than the situation with current heat consumption and with no metering. This is because the cost savings from reduced building heat consumption under the heat metering with ITP options offset the additional cost of installing, operating and maintaining ITP equipment. Both ITP technologies improve efficiency equally; however, those of Western European design are at least 30 percent cheaper than those of Ukrainian configuration. As a result, annual heating cost of an apartment is cheaper with ITPs of European configuration than with ITPs of Ukrainian configuration.

It is also worth noting that heating an apartment with individual gas heaters is the most expensive option compared to all DH options considered, including the current situation with no consumption-based billing. Although individual gas heaters improve heating efficiency by 30 percent, average annual heating costs would be roughly 30 percent greater than under the current situation. This is primarily because the reduced apartment-level consumption afforded by individual gas heaters does not offset their high investment cost — about €2,000 per apartment.

Full cost of service

Heating costs for a typical DH company in Ukraine are well below what would be needed for an efficiently-run DH company to cover the full cost of providing service. In this section, we look at how implementing the various options to introduce heat metering and consumption-based billing described above would affect the average cost of heat production and affordability concerns when taking into account the full cost of service. The full cost of service assumes that the DH company spends an appropriate amount on the following to ensure sustainable operation of the DH network and good service quality, as experienced in EU countries:

- Capital expenditures, such as rehabilitation and replacement;
- Operation and maintenance;
- Fuel expenditures, at the full, unsubsidized price[13].

Table 3.2 shows the costs and benefits of each option to introduce consumption-based billing when considering the full cost of heat production in Ukraine. As the table shows, the cost savings of improved efficiency are amplified when compared to actual cost of service scenario. In other words, DH companies have more to gain from making investments in new technologies which reduce costs when the full cost of service is taken into account. Additionally, investments costs for building-level heat meters with ITPs are lower for an efficient company because they do not need to replace a part of distribution network[14]. Under this scenario, ITPs of European design still emerge as the lowest cost option because of high investment cost of gas heaters and the high cost of gas delivered to households.

Table 3.2: Costs and benefits of various options to introduce consumption-based billing, full cost of service, per average apartment per year

		District Heating					Disconnected from DH
		Current heat consumption, no metering	*Heat Meter*	*Heat Meter + temp. controls @ CTP*	*Heat Meter + temp. controls @ ITP/UA*	*Heat Meter + temp. controls @ ITP/EU*	*Individual Gas Heaters*
Annual Consumption	*(Gcal/apt)*	9.16	9.16	8.97	7.32	7.32	6.41
	Efficiency Gains (%)	---	0%	2%	20%	20%	30%
Average Cost of Heat	*(€/Gcal)*	44.8	45.0	45.9	47.1	46.4	75.9
Annual total cost of heat, including:	*(€/apt)*	410	412	412	345	340	486
	% of current total cost	100%	100%	100%	84%	83%	119%
Heat	*(€/apt)*	410	410	402	328	328	284
Investment	*(€/apt)*	---	1.5	7.5	13.0	8.8	160.5
O&M	*(€/apt)*	---	0.5	2.5	4.0	3.2	41.5

[13] An efficiently-run DH company would have consumer connections based on ITPs with automatic temperature regulation based on outside weather conditions. The estimated average full production cost of heat at such company, if it has an operational profile similar to a typical Ukrainian heat producer, is €47/Gcal. However, in order to analyze the impact of different options to introduce consumption based billing, we compare a typical Ukrainian heat producer to an efficiently-run DH company that does not have ITPs; the estimated average full production cost of heat at such company is €45/Gcal. The estimated average cost of an efficiently-run heat producer with ITPs is higher because of: (1) higher cost of capital; and (2) higher fixed costs component per Gcal due to the fact that with ITPs, an efficiently-run heat producer would generate 15-25 percent less heat to meet demand. Appendix B shows how the full cost of service compares to the actual cost of service for DH companies in Ukraine; Appendix C discusses the full economic cost of Ukrainian gas to final consumers.

[14] We assume that an efficient company has already made necessary investments in distribution rehabilitation. For an efficient company, the cost of heat in Table 3.2 includes the cost of these previous investments.

3.2 Quality of service

The ability to regulate heat supply with temperature controls, while leading to improved efficiency as described above, also improves comfort levels within a building. This, in turn, leads customers to perceive an improved quality of service. Table 3.3 describes how each of the options also improves customer comfort levels compared to the current situation with almost no heat metering and consumption-based billing.

Table 3.3: Customer comfort level under different heat metering and consumption-based billing options

Option	How does this option affect a customer's comfort level?
Heat meter, no temperature controls	Does not improve customer's comfort level over current situation
Heat meter + temp. controls @CTP	Comfort improves slightly because of ability to regulate heat supply according to the average demand of all buildings connected to the CTP Differences in demand among buildings connected to CTP may lead to building-level temperature variations
Heat meter + temp. controls @ITP/UA	Provides ability to regulate heat supply according to demand of an individual building When ITPs are properly calibrated, they improve distribution of heat within the building, in other words there are no colder or warmer apartments Same comfort levels regardless of UA or EU configuration
Heat meter + temp. controls @ITP/EU	
Individual gas heaters	Allows for temperature control of individual apartments, which maximizes customer's comfort level

3.3 Transparency and allocation of responsibilities

In general, consumption-based billing can improve transparency in the DH sector. Consumption-based billing provides more transparency primarily for the reasons identified during the public consultations, namely:

- Customers would gain a better understanding of what they are actually paying for;
- Customer would be able to compare prices paid for the services performed.

Currently in Ukraine, individuals, contractors or DH companies can purchase and install heat meters. However, if they are purchased by individuals or contractors they must be transferred to DH companies for servicing and meter reading. As public consultations showed, most respondents trusted DH companies more than other entities, including themselves or Zheks, to install and manage building-level heat meters due to their technical expertise. Also, when a DH company installs building-level meters, along with other equipment, their costs could be amortized, allowing customers to pay off the cost of equipment over time.

3.4 Which option to introduce consumption-based billing benefits customers most?

Installing building-level heat meters along with Western European design ITPs is the most attractive option to introduce consumption-based billing for residential consumers. Building-level heat meters with European ITPs consistently address the issues identified as most important during public consultations, including:

- **Lower costs.** ITPs are the cheapest option for residential customers. By improving the efficiency of heat supply, ITPs reduce building-level heat consumption and the cost of heating each apartment;
- **Improved quality of service.** ITPs allow heat to be distributed evenly between apartments in the building resulting in increased comfort levels for customers;
- **Improved transparency and allocation of responsibilities.** Like all options, installing building-level heat meters together with ITPs improve the transparency of customer billing. Furthermore, DH companies install and maintain meters and ITPs, which alleviates customers concerns about collective organization and fundraising for installation.

Table 3.4 shows, even though several other options to introduce consumption-based billing provide some of the benefits described above, only installing building-level heat metes together with European ITPs provide all of these benefits at the lowest cost.

Table 3.4: Which option to introduce consumption-based billing provides the most benefits to customers?

	Lower costs	Improved quality of service	Improved transparency
Heat meter, no temperature controls			✓
Heat meter + temp. controls @CTP			✓
Heat meter + temp. controls @ITP/UA	✓	✓	✓
Heat meter + temp. controls @ITP/EU	✓✓	✓	✓
Individual gas heater		✓✓	✓

✓ = Better than benchmark

✓✓ = Best option

4. Benefits of Heat Metering and Consumption-Based Billing to DH Companies

In addition to benefiting customers in several ways, installing ITPs with heat meters and temperature controls is an important first step in improving the efficiency of heat supply and the financial sustainability of DH companies. In general terms, financial sustainability improves when customers' affordability concerns are met and DH companies can reduce costs and increase revenues. ITPs with heat meters help reduce costs by improving efficiency of heat production, and can increase revenues by improving quality of service and building consumer trust in DH companies, thereby increasing customers' willingness to pay. Sections 4.1 and 4.2 describe in further detail how ITPs are a first step to reducing costs and increasing revenues.

4.1 Improving efficiency and reducing the cost of heat supply

ITPs with heat meters help DH companies reduce the cost of heat supply by improving efficiency. This is the case either for an efficiently-run company, or a less efficiently-run company. As mentioned in Section 3, ITPs improve efficiency by:

- Introducing building-level temperature controls. These controls allow the DH company to produce heat to meet the specific demand of each building as opposed to meeting the average demand of the entire system;

- Replacing part of the distribution network. Installing ITPs requires replacing part of the distribution network, which in turn leads to reduced distribution losses.

The ability to meet the actual demand of each building coupled with rehabilitation of the distribution network reduces building-level heat consumption by 15-25 percent. The benefits of reduced consumption that result from ITPs with heat meters outweigh the investment costs to DH companies because they lead to:

- Reduced maintenance costs. The ongoing cost of maintaining new distribution pipelines will be significantly lower than the cost of maintaining deteriorated assets;

- Reduced fuel costs. In general, the drop in building-level heat consumption reduces gas consumption of the DH companies. The benefits of reduced fuel costs will likely be shared between DH companies and customers. For example, the benefits of reduced costs that occur as a result of reduced building-level demand will likely accrue to customers. However, some of the reduction in gas consumption occurs as a result of reduced distribution losses. These benefits could be allowed to accrue, at least in the short-term, to DH companies to incentivize their investment in measures, such as ITPs, which improve efficiency;

- Optimized heat supply. Building-level metering also helps optimizing the design of the heat supply system thus reducing costs even further.

4.2 Increasing revenues

ITPs with heat meters are a first step to increasing revenues by increasing customers' willingness to pay. Many customers in Ukraine are no longer willing to pay for the low quality of service provided by DH companies. Among residential customers, this generally leads to the accumulation of debts to the DH companies. For example, roughly one-third of respondents in public consulta-

tions suggested they would simply stop paying for heat and accumulate debts to DH companies if tariffs increased, but quality of service remained unchanged. Non-residential customers, particularly commercial customers, simply disconnect from the heating network altogether. Similarly, new buildings, including new residential buildings, generally do not connect to the DH network, but instead install building-level gas boilers to serve heating needs. The loss of customers forces DH companies to spread costs out over a shrinking customer base, which leads to further increases in customer heating costs without demonstrating any improvements in service.

As public consultations in Section 2 showed, customers in Ukraine draw a clear link between quality of service and the cost of their heating bills. Roughly 68 percent of public consultations participants identified outdated infrastructure and heating losses for the increases to their heating bills. Additionally, much of their concern relates to issues of trust. As one respondent described, *"…they [DH companies] charge us money for this [modernization the infrastructure] but we can see that no works have been done,*" (young man, Mykolaiv).

ITPs with heat meters help to break this cycle by:

- Improving quality of service. As discussed in Section 3, ITPs increase customers' comfort levels by distributing heat evenly within the building;

- Improving customer trust in DH companies. Heat meters help improve customer trust by improving the fairness and transparency of heat billing.

Experience in Ukraine and elsewhere shows a clear link between quality of service, trust, and willingness to pay: customers are less willing to pay higher tariffs for poor quality heat service. Conversely, customers are more willing to pay higher tariffs when they believe that the tariff fairly reflects the quality of service provided. Additionally, improved quality of service and trust will help DH companies retain customers, attract disconnected customers back to the DH network, and eventually attract new customers. This, in turn, improves affordability, and therefore willingness to pay, because it allows the DH company to spread the fixed costs of its assets over a larger customer base.

5. Financial Sustainability and Affordability of District Heating

Heat metering and consumption-based billing are important steps towards improving the financial sustainability of the DH sector. However, there are a number of other issues that need to be addressed in order to maintain the long-term viability of the DH sector. Addressing these issues inevitably involves raising tariffs to: i) eliminate subsidies that take needed funds away from other things including the gas, the O&M and return on investment of DH companies; and ii) cover the return on investment needed to rehabilitate the system. However, raising tariffs has social constraints as many people in Ukraine cannot afford to pay a full-cost recovery heating tariff given the current costs and consumption levels of DH in Ukraine.

This section focuses on what, in addition to heat metering and consumption-based billing, needs to be addressed in order to revitalize the DH sector in Ukraine. Section 5.1 first looks in more detail at the problems facing DH companies currently and what needs to be done in order to improve the financial sustainability of DH companies. Section 5.2 discusses ways to mitigate affordability concerns that arise when tariffs are raised to full-cost recovery levels.

5.1 Financial sustainability

As described in Box 3.1 in Section 3, the production costs for a typical DH company are artificially low. These artificially low costs create a vicious cycle in which companies do not have enough money to maintain their assets or invest in rehabilitation and modernization of the system. The deterioration of DH infrastructure, in turn, leads to a decline in quality of service. As a result, willingness to pay drops, and some customers, particularly non-residential customers, completely disconnect from the DH system, leading to decreased revenues that do not even cover the already low costs of DH companies. It is important to break this cycle.

The following describes how costs have been kept low for DH companies and why this practice is unsustainable:

- **Implicit and explicit subsidies for natural gas burden local budgets and the gas sector**. Until recently, local governments regulated the price of DH services. These governments set heating price below the level needed to cover the DH companies' cost of providing service. Local governments were supposed to provide subsidies from the oblast and municipal budgets to help DH companies cover these costs. However, often local governments provided subsidies late or did not provide them at all. As a result, DH companies have not been able to pay their bills, particularly gas, creating financial sustainability problems in the gas sector as well.

  Additionally, the gas price for residential use, including heat, does not reflect the full cost of gas. Instead, entities purchasing gas for residential purposes only pay a price that covers the cost of gas supply from local gas fields, even though these fields cannot meet residential gas demand. As a result, gas used to meet the marginal residential needs must be imported at much higher border price. Moreover, since price of gas for residential consumers also does not cover transmission and distribution costs, the Ukrainian gas sector ends up carrying the burden of roughly €2 billion of implicit subsidy annually.

- **DH companies do not spend enough on maintenance leading to early depreciation of DH assets**. DH companies lack revenues to allocate sufficient funding to maintenance. Protracted under-maintenance leads to decreased asset reliability and means larger expenditures on DH infrastructure rehabilitation and replacement.

- **DH companies do not invest sufficiently in rehabilitation and replacement.** As noted in Section 3.1, depreciation in the cost structure of Ukraine's DH companies is currently only about 3 percent of their total costs which is about 5-8 times less than what is needed to maintain good service quality for customers. This is primarily because assets are undervalued. An efficiently run DH company, in contrast, invests 15-25 percent of its revenues in capital improvements and new assets[15]. As a result of underinvestment, many DH assets across Ukraine are beyond the end of their design lives. The lack of investment has led to high technical losses and a deterioration in the quality of service

In order to break this vicious cycle, tariffs need to increase to allow production costs to reflect the full cost of providing service. Specifically, increasing tariffs will make possible to eliminate gas subsidies and allow DH companies to allocate sufficient funding to maintenance and investment in the DH network as well as pay their bills. As a result, quality of service would improve leading to increased willingness to pay and customer retention would improve leading to higher revenues for DH companies.

5.2 Affordability

Raising tariffs is a difficult process and should be done in conjunction with measures to ensure affordability in order to gain widespread support. To illustrate, if just gas prices were increased to cover the full cost of gas, the average production cost of a typical Ukrainian DH company would increase from €21 per Gcal (UAH 235/Gcal) to €48 per Gcal (525 UAH/Gcal). At the household levels, this means that average heating costs for a typical two-room apartment would increase from €195 per year to €450 per year (or from 2,145 UAH to 4,930 UAH per year).

Simply raising tariffs in such a manner would face substantial opposition. Currently, roughly 80 percent of the population in Ukraine can afford to pay actual financial cost of DH services[16]. A one-off tariff hike of this magnitude would make DH services unaffordable for nearly all Ukrainian households. Gaining trust and support of residential consumers would require ensuring that the process of reforming tariffs is consistent with the ability to address affordability concerns, transparent, and accompanied by energy efficiency measures to counteract the effect of tariff hikes for poor customers.

In order to foster affordability, increases in tariffs need to be accompanied by measures that reduce the overall consumption of heat by DH customers, coupled with a targeted social safety net to protect the poor. If affordability constraints are taken into account when designing energy prices, it may take as long as 5-10 years to reach full cost recovery to enable a building-level energy efficiency program to be implemented in tandem. Additional measures to improve affordability and decrease heat consumption include:

- **Heat meters and ITPs.** Installing building-level heat meters with ITPs is a first step to mitigate the sharp increase in heating costs that would occur from increasing gas prices to cover the full cost of DH service. Heat meters with ITPs decrease heat consumption by 15-25 percent and reduce heating costs approximately 10-15 percent compared to the current situation;

[15] Capital improvements are distinguished from other types of capital expenditure in that they are focused on extending the useful life, or improving the productivity of existing assets rather than replacing existing assets, or extending the network to serve higher levels of demand.

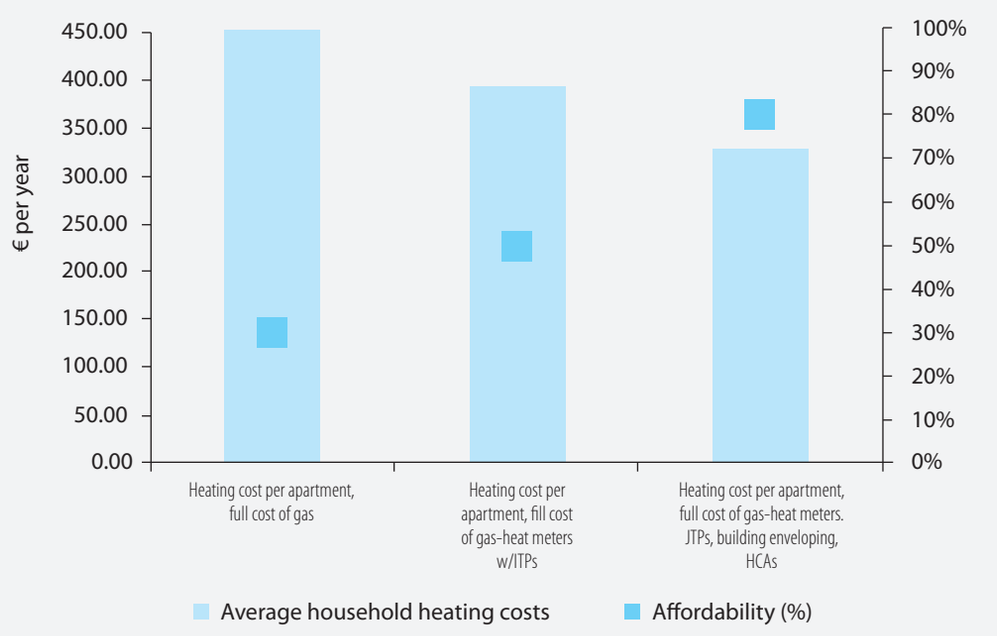
[16] DH service is considered affordable if DH bills comprise no more than 10 percent of a household's consumption.

- **Demand side management**. Energy consumption of buildings in Ukraine is estimated to be about 250-275 kWh/m^2, 2-2.5 times worse than in Western Europe, where it is about 120 kWh/m^2. Implementing energy efficiency in residential buildings could substantially reduce DH costs in Ukraine. Customers could help reduce heat consumption by: replacing windows and exterior doors, installing more efficient insulation in roofs and external walls, glazing balconies, and installing heat-cost allocators (HCAs). Such energy efficiency measure could lead to a 40 percent reduction in end-use energy consumption. Heat metering and consumption-based billing provides an additional incentive for customers to pursue these initiatives because they would reap the cost savings of improved efficiency;

- **Production efficiency measures.** DH companies could increase the efficiency of heat production by: installing more efficient heat-only boilers and using more CHPs (combined heat and power plants) in heat production: efficient Western European companies use waste heat from CHPs for about 80 percent of heat energy needs. DH companies could further reduce transmission and distribution losses, improving efficiency of electricity use — particularly for pumping, and carefully reviewing staffing needs and adjusting employment accordingly;

- **Targeted social safety nets.** Targeted subsidies need to be provided to the poorest who cannot afford heat.

Figure 5.1: Impact of implementing energy efficiency measures on annual heating cost of a household, full cost of gas over 10 years[17]



Strong, de-politicized leadership at the national level can help champion tariff reform in the DH sector. Sections 6 and 7 below describe how measures like public awareness campaigns, energy efficiency improvements, and an enhanced role of the national regulator can help raise tariffs in a sustainable manner while ensuring affordability for DH customers.

[17] See Appendix D for more details.

6. What Needs to Happen Next?

Heat metering with ITPs is not widespread in Ukraine even though, as Sections 3 and 4 showed, both customers and DH companies could benefit from it. At current tariff levels, DH companies have little incentive to invest in building-level heat meters and ITPs. Although heat metering with ITPs could provide cost savings to consumers at current tariff levels, organizational and funding challenges deter most DH customers from taking the initiative to install heat meters in their buildings, and most of them are not aware about ITPs and their benefits.

This section discusses what needs to happen next to foster implementation of heat metering and consumption-based billing as first steps towards improving the financial sustainability of the DH sector. Section 6.1 describes the role of the independent regulator in helping to raise tariffs to cover the full cost of DH services. Section 6.2 describes why DH companies are best placed to take on many of the tasks that must be carried out in implementing heat metering. Section 6.3 discusses the role of the Government in helping to further improve the financial sustainability and affordability of DH services. Finally, Section 6.4 explains how changes to laws and regulations could support heat metering and consumption-based billing implementation.

6.1 Role of the independent regulator

Creating an independent regulator is an important step to improving the financial sustainability of the DH sector while maintaining affordability for customers. An independent regulator could help gradually increase tariffs to cover the full, unsubsidized cost of providing DH services while promoting cost saving measures. For example, including meter installation as a requirement in the licenses of DH companies can help keep heating bills affordable for households. The independence of the regulator is key to this process. By maintaining an arms-length relationship with regulated DH companies, consumers, and political authorities, an independent regulator could make decisions that although politically difficult, have long-term benefits for both DH companies and customers.

Proper tariff setting serves as the regulator's most effective tool to protect customers while ensuring the financial sustainability of the sector. Proper tariff setting should induce cost saving incentives for DH companies and customers alike. Heat meters in conjunction with a good tariff methodology play an important role in helping create these regulatory incentives. Specifically:

- For the regulator, heat meters provide accurate data on actual consumption at the building level. This allows regulators to accurately set volumetric tariffs and create benchmarks for efficiency improvements for heat suppliers;

- For district heating suppliers, metering will indicate how big actual network losses are and provide incentives to reduce them through targeted investments in networks. Moreover, heat metering and consumption-based billing will be the first steps for the companies to improve their image and regain trust of the customers;

- For customers, heat meters along with tariff methodologies that allow customers to pay for heat based on actual consumption as determined by meter readings provide incentives to reduce heating bills through energy efficiency improvements.

Once incentives are properly aligned, an independent regulator is well-placed to help share costs and benefits equitably between customers and DH companies. To do this, the regulator could eventually consider implementing incentive-based regulation (for example, price-cap or revenue-

cap) with clear service quality targets in order to give the DH companies an incentive to cut costs while maintaining required levels of services.

The Government of Ukraine recently began the process of developing an independent regulator. In 2010, the Government transferred responsibility for tariff setting from local authorities to a newly created independent regulator. In July 2010, the Parliament of Ukraine passed a law on the National Commission for the Regulation of the Utilities Market in Ukraine. While the Commission was being formed, the National Electricity Regulatory Commission served as the DH sector regulator. In July 2011, the President of Ukraine signed a decree creating the National Commission on the Regulation of the Utilities Market.

6.2 Role of DH companies

DH companies are best placed to carry out the tasks of financing, installing, owning, servicing of building-level heat meters and ITPS, as well as reading heat meters. Worldwide experience shows that DH companies are normally responsible for installing and owning ITPs and building-level heat meters. International best practice should resonate with customers in Ukraine since, as public consultations showed, most respondents trust DH companies to install and manage building-level heat meters due to their technical expertise. Assigning these responsibilities to DH companies has a number of additional benefits as well. Table 6.1 describes the main responsibilities in implementing heat metering and explains how and why DH companies should be responsible for them.

Table 6.1: The role of DH companies in implementing heat metering

Main responsibilities	Who should be responsible and what is the best approach?	Why is this the best approach?
Who installs and owns the ITPs and building-level heat meters?	ITPs and building-level heat meters should be installed and owned by a DH company that owns the network Existing building-level heat meters not owned by DH companies should be transferred to their ownership and responsibility (e.g. through purchase)	Avoids problems of collective organization and fundraising as customers would not need to organize and fundraise for the purchase and installation of heat meters Lowers price for equipment as DH companies would be able to obtain a lower price for ITPs and heat meters by purchasing assets in bulk to install in a number of buildings Improves quality as DH companies already have expertise to install meters effectively
Who is in charge and pays for calibrating the meters?	DH companies should be responsible for calibrating and service of the heat meters They should be allowed to include cost of calibration in the tariff	DH companies have the technical expertise to calibrate, maintain and repair heat meters This responsibility naturally falls on the owners of heat meters
Who reads the meters?	The DH company should be responsible for reading meters Residents should have access to meters in order to verify meter readings	DH companies have to read meters in order to process customers' heating bills
Who should pay for the ITPs and meters?	DH companies should pay for ITPs and meters through a mix of equity and debt financing The ITPs and meters should then be included in the company's asset base with a reasonable return on assets included in the tariff	This gives customers the ability to pay for equipment over time. As a result, they would not have to cover the high upfront cost of the investments. Instead, the investment cost as well as the operation and maintenance costs of the ITPs and meters would be included in heat tariffs[18]

[18] On average the cost of financing and maintaining ITPs/EU and heat meters is equal to roughly €1.5 per household per month. This assumes an investment cost of €22,000 per building, with 108 households per building, a 20 year asset life for the meters and ITPs, and a 5% discount rate.

6.3 Role of the Government

The Government should play an important role in governance by helping to promote heat metering and consumption-based billing as well as improve the financial sustainability and affordability of DH services. The Government can do this by gradually eliminating gas subsidies to DH companies while simultaneously promoting initiatives that help reduce heating costs to households. Timing these efforts will be key; a phased approach in which gas subsidies are eliminated over a medium term can help ensure that customers and DH companies have time to implement necessary cost saving measures. Moreover, the Government can support initiatives that reduce costs — and improve affordability — in the DH sector by:

- Financing energy efficiency improvements. In addition to heat metering, investments in production efficiency and consumer-end energy efficiency can reduce the cost of heat production. The Government can help finance these investments for DH companies and for consumers. For example, the Government could obtain concessional financing for DH sector energy efficiency improvements. This could, in turn, be on-lent to municipally-owned DH companies, thereby reducing financing costs for investments in rehabilitation and replacement. Or, the Government could develop a program to help fund energy efficiency capital improvements in residential buildings. Unlike existing subsidies to DH companies, which simply offset costs that would otherwise be incurred by customers, Government support for energy efficiency helps reduce costs;

- Supporting public awareness campaigns about the benefits of metering. Public consultations clearly showed that customers believed heat metering would reduce their heating bills. However, they also showed that customers did not think of implementing heat metering as a way to cope with higher heating costs. As tariffs for DH services begin to increase, the Government can support public awareness campaigns that help customers see heat metering and demand-side energy efficiency investments and behavior as a viable solution to reducing heating bills;

- Providing incentives for demand-side management. Annual energy consumption of a typical household in Ukraine averages roughly 250-275 kWh/m^2. By comparison, a typical household in the European Union consumes approximately 120 kWh/m^2 annually. Additionally, the EU aims to reduce average household energy consumption to 60 kWh/m^2 by 2020. Achieving current EU consumption levels by 2020 and the 60 kWh/m^2 consumption target by 2030 could be a realistic goal for Ukraine. The Government could help reach this goal through measures, such as implementing building codes and EE standards, loan guarantees or tax relief for EE investments in residential buildings;

- Providing targeted support to poor customers. Some customers may still not be able to afford DH services even after a reduction in costs through efficiency improvements. The Government could better serve these customers by providing direct subsidies to the individual households. Subsidies to DH companies effectively subsidize all customers – even those that can afford DH services. Eliminating these subsidies frees up funds, which could be more effectively targeted towards the poorest households.

6.4 Laws and regulations

When assessing the main issues related to heat metering and consumption-based billing, the following questions should be raised, discussed and answered from the point of view of legislation:

- Who installs, pays for and owns the meters?
- Who is in charge and pays for calibrating the meters?

- Who reads the meters?
- Where should the financing needed for the meters come from?

The legal and regulatory framework for DH in Ukraine does not sufficiently address these issues. Responsibilities for financing, installation, and ongoing maintenance of heat meters are not clearly defined and many building owners lack an incentive to implement heat metering. Having a clear and consistent legal and regulatory framework would improve the ease and transparency of implementing heat metering and consumption-based billing across Ukraine. The following describe changes to the legal and regulatory framework that could help promote heat metering[19].

Clearly defining the responsibilities of DH companies in the Law

The issue of installing heat meters appears to be mostly regulated by Cabinet of Ministers Resolution No. 630, of 21 July 2005, which sets forth the rules applicable to the provision of housing and communal services. Further, the Government issued a number of other acts, rules and norms relevant to the installation of heat meters. Yet the approach seems to be piecemeal at best, with over thirty pieces of legislation affecting heat and hot water metering. Box 6.1 describes several of the different laws that govern heat metering in Ukraine. These laws and regulations contradict one another and do not clearly identify which stakeholders – DH companies, individual customers, Zheks, or municipalities – are responsible for each task that must be carried out in order to implement building level heat meters.

Box. 6.1: Selected Ukrainian legislation concerning installation and financing of heat meters

- Government Resolution No. 483, of 3 July 1995: prohibits putting into operation buildings which lack heat and water meters.
- Government Resolution, No. 947 of 27 November 1995: requires that heat meters are installed by specially licensed organizations, and only on the basis of standard technical documents.
- State Building Norm B.2.2-9-99 of 1999: requires installation of building-level heat meters in all new public buildings connected to DH network.
- Resolution of the Cabinet of Ministers of Ukraine No. 955, dated 10 July 2006: establishes the procedure for tariff setting for the production, transport and supply of district heat and hot water. The cost of calibration, maintenance and repair of building-level meters may be included in the heat tariff, provided that the meters are owned by the heat supplier – and only for customers living in houses that actually have meters. Customers have the right to demand the installation of heat meters – and presumably do the installation themselves – but it is not an obligation.
- Rules for Central Heating, Cold and Hot Water Supply and Sanitation Services Provision; Rules for Use of Heat Energy adopted by Resolution of the Cabinet of Ministers of Ukraine No. 1198, dated 3 October 2007: prohibit to commission a new or reconstructed heat supply system without commercial meters.
- License Conditions for Performing Economic Activity on Heat Energy Supply (Common Order of the State Committee of Regulatory Policy and Entrepreneurship and Ministry of Housing and Communal Services of Ukraine No. 169/419 dated 30 December 2008): obliges heat suppliers to provide meters which are duly calibrated.

[19] See Appendix E for more detail.

The Government can improve the clarity and consistency of the legal and regulatory framework by clearly defining the responsibilities of DH companies in the Law. Clearly assigning the tasks of financing, purchasing, installing, servicing, and reading meters to DH companies improves transparency and accountability in the sector. These responsibilities should be clearly defined in the Law. Any norms in other legislation which contradicts the Law should be repealed when the norm takes effect.

Standardizing heat supply contracts

Heat supply contracts vary substantially across Ukraine. The language is often confusing, too detailed and, in some cases, contradictory. Heat supply contracts are signed with a range of different parties serving as the customer. According to the Law on Heat Supply, heat shall be supplied to the customer through a party which holds the title to the building (*balansoutrymuvach*). The title-holder must enter into two heat supply contracts: with the end user and with the DH company. In practice, the title holder could be the Zhek, housing association or another body. Housing associations still do not exist in Ukraine in sufficient numbers, and most buildings are of mixed ownership: apartments are owned by residents, but common areas – by municipalities. On behalf of municipalities, Zheks are responsible for maintenance of the common areas, including DH infrastructure inside the building. As a result, the common contracts are between a DH company and a Zhek.

In some municipalities, however, DH companies must sign contracts directly with individual apartment owners. It appears that the issue of choosing either a Zhek or an individual apartment owner as a contractual party mostly depends on local circumstances. It is usually not a decision of a DH company, but of the local municipal authority. This type of contractual relationship usually causes complications, since a DH company must conclude and enforce the contract with the owner of each apartment.

Furthermore, the rules laid out in heat supply contracts vary across the country. The Cabinet of Ministers developed a model heat supply agreement, but local authorities tend to use this as a template only, adapting it to meet the individual needs of their municipality. With such a variety of contracts with inconsistent, vague, and confusing language, heat supply contracts are an additional obstacle to heat metering implementation.

Developing and implementing simple, standardized contracts could help address this issue. Specifically, standardized contracts could: i) provide additional clarity about the rights and responsibilities of each party to the contract; and ii) ensure that laws and regulations about heat metering are applied consistently across Ukraine.

Creating effective homeowners' associations

It is particularly important that every building has a clearly defined organized owner. From a legal standpoint, a DH company can enter into contracts with Zheks, homeowners' associations (HOAs), or individual apartment owners. From the perspective of the DH company, an HOA is the best customer because it is a legal person with an organized administration, which simplifies the companies' customer relations. Best practice shows that making HOAs mandatory can help support their development. For example, more than 60 percent of the population in Estonia now lives in buildings with HOAs as a result of a law requiring the creating of HOAs in multi-family apartment buildings. In Ukraine, country level legislation does not make condominium associations mandatory. As a result, secondary regulations and bylaws have not been established. The

Government should build on lessons learned from other countries in the region and establish laws and regulations that ensure that every building has a clearly defined ownership and management structure.

Harmonization with EU Law

The Government has a major incentive to address heat metering because it is a necessary component of Government efforts to harmonize Ukrainian laws with EU laws. Specifically, Ukraine must make heat metering compulsory in order to comply with EU law.

Ukraine signed its Accession Protocol to join the Energy Community (EnC) on 24 September 2010, ratified the Protocol on 15 December 2010, and is exercising its full membership powers as of January 14 2011. On December 2009, the Ministerial Council of the EnC decided to include the Energy End-Use Efficiency and Energy Services Directive 2006/32/EC, of 5 April 2006 in the acquis mandatory under the Treaty. As a member of the EnC, Ukraine is required to enforce this Directive. Article 13 (1) of this Directive requires Member States to "ensure... that final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters".

In order to harmonize Ukraine norms and standards with EU law, the Law in Ukraine should clearly require that every building, or group of adjoining or related buildings belonging to the same owner, which are connected to a DH network have building level heat and domestic hot water meter. The law should be enforced step by step and supported by a clear action plan. Table 6.2 shows an example of such an action plan.

Table 6.2: Recommended action plan for introducing heat metering and consumption-based billing in Ukraine

Type of building	What must be accomplished?	Required date of completion
New buildings	Enforce existing state norm which requires that all new building level heat meters Enforce consumption-based billing in all new buildings that already have building-level meters	Deadline 1
Existing buildings with heat meters not owned by DH companies	Transfer ownership of existing heat meters to DH companies	Deadline 2
All buildings capitally renovated	Require building level heat meters in all building capitally renovated after Deadline 3	Deadline 3
All existing building without building-level heat meters	Require building-level meters in all existing buildings by Deadline 4	Deadline 4

7. What Can the International Financial Institutions Do to Help?

Ukraine can take the following steps to begin to improve the financial sustainability of the DH sector while maintaining affordability to customers:

- Financing and implementing heat metering and consumption-based billing with ITPs/EU;
- Financing energy efficiency measures along heat supply chain;
- Technical assistance to the newly established regulator;
- Technical assistance for the design of targeted social safety nets.

The International Financial Intuitions (IFIs) can help the Government of Ukraine begin to address these issues through a combination of loans for physical infrastructure and technical assistance for pilot studies, public outreach and regulatory support. The following subsections describe these possible areas for support in further detail.

7.1 Loans for heat meters, ITPs and other energy efficiency measures to improve efficiency of heat supply

DH companies are best placed to purchase, finance, and install building-level heat meters. However, most DH companies lack the financial resource to undertake this type of capital investment without additional resources. Furthermore, commercial banks in Ukraine are unwilling to lend to most DH companies because of their poor credit-worthiness. Unfortunately, the current poor financial condition of DH companies coupled with the difficulty of raising tariffs before customers perceive benefits means DH companies will struggle to attract financing for heat meters and related investments that will lead to improved financial performance in the longer term.

The IFIs can help break this cycle by providing low cost financing. Providing a loan for heat metering with ITPs can most effectively break this cycle because heat meters with ITPs and other energy efficiency measures:

- Improve comfort and reduce costs for customers, allowing the regulator to more easily justify necessary tariff increases;

- Help DH companies identify areas in the network with highest losses allowing them to better prioritize investments in rehabilitation and modernization. Reduction of network losses and better use of CHPs could reduce the cost of supply could by roughly 10 percent, thus improving affordability of DH services.

Box 7.1 below describes how the World Bank support helped to implement similar actions in Poland.

Box. 7.1: Heat metering — a first-step to DH sector reform in Poland

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

World Bank financing played an important role in helping the Government tackle the problems facing the DH sector. From 1991 to 2000, the World Bank provided US$340 million for the Heat Supply Restructuring and Conservation Project in Poland. The project included support for: i) energy sector restructuring, commercialization of restructured enterprises, introduction of a transparent regulatory framework, and pricing policy reform, ii) rehabilitation and modernization to extend DH infrastructure asset life, and iii) energy conservation and pollution reduction through investments in energy efficiency improvements.

The Government's dual effort — supporting investments in energy efficiency and conservation along with pricing policies that led to gradual increases in residential tariffs in conjunction with reductions in budget layouts for energy subsidies — was key to the project's success. Energy efficiency measures carried out by DH companies achieved a 50 percent reduction in heat transmission and distribution losses, which led to 22 percent energy savings, equivalent to roughly US$55 million per year.

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

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

7.2 Technical assistance for sustainable tariff setting

DH companies cannot make the investments in rehabilitation and modernization needed to improve efficiency and reduce costs unless tariffs increase. Yet, as Section 5 showed, nearly all of Ukrainian households will not be able to afford DH services if tariffs are raised to cover the full, unsubsidized cost of service. The newly established, independent regulator faces the difficult task of setting tariffs that balance the principles of:

- Ensuring affordability for customers;
- Improving, and eventually maintaining, the financial sustainability of DH companies.

Given their breadth of knowledge on the practices and principles of good tariff setting and their past experience helping clients in other countries address similar challenges, the IFIs are well-suited to support the independent regulator navigate the process of tariff reform in Ukraine. Specifically, the IFIs could provide regulatory support in the form of:

- Technical assistance for affordability studies. As public consultations demonstrated, affordability is a key concern for many households in Ukraine. Yet, most households do not have a viable strategy for mitigating the cost of large heating bills, with some suggesting they would simply not pay their bills. Preliminary analysis shows that many households could not afford to pay full cost-recovery tariffs. As a result, the risk of non-payment at higher tariffs is a credible threat. Given these realistic concerns, the IFIs might consider providing funds for more detailed affordability studies, which would equip the independent regulator with a better understanding of affordability among different customer groups and income deciles;

- Technical assistance for tariff studies. The regulator will need to determine how to most effectively distribute costs between customer groups. The IFIs could provide support by funding tariff study that builds on the results of the affordability study;

- Advisory services for the regulator. The IFIs might also consider supporting institutional capacity building for the newly created regulator by providing training on the application of good regulatory practices and principles applicable to the current situation in Ukraine.

7.3 Pilots for improving demand-side energy efficiency in residential buildings

Evidence from energy efficiency programs elsewhere in Eastern Europe suggest that the lowest cost measures can save as much as 20-30 percent on energy consumption for heating use, and higher cost measures can save as much as 40-60 percent of energy consumption for heating use. Table 7.1 shows the savings from energy efficiency investments made in buildings in Bulgaria, Lithuania and Poland.

Table 7.1: Evidence on savings from energy efficiency measures in Eastern Europe

Project location	Efficiency Measures	Energy Savings (percent of savings on consumption)	Cost Savings (percent of savings on bills or overall cost savings in USD)
Pleven, Bulgaria	Weatherization, TRVs & HCAs, Radiator shields	26%	23 %
Sofia, Bulgaria	New roof Insulation (walls, attic, basement) New windows & exterior doors Weatherization Insulation & upgrading interior heating system	60%	US$ 350 per household per year
Vilnius, Lithuania	Weatherization Insulation (walls, attic, basement)	50%	
Warsaw, Poland	Insulation (walls, attic) TRVs & HCAs New boiler for building	52 %	45 %

Source: Municipal Network for Energy Efficiency Program (USAID).

Pilots could be used to assess, by way of comparison, which technical interventions are most effective in Ukraine. For example, building enveloping could be used in one building (or cluster of buildings), and heat-cost allocators in another, to assess which investments yield the highest energy savings. Box 7.2 describes how the World Bank supported pilots for energy efficiency improvements in multi-apartment buildings in Lithuania.

Box. 7.2: Energy efficiency pilots in multi-apartment buildings in Lithuania

The World Bank launched the Lithuania Energy Efficiency Housing Pilot Project in 1996 to finance energy efficiency improvements in residential buildings through a credit line for homeowners and Homeowner Associations (HOAs). The project accomplished energy efficiency and weatherization retrofits in 229 residential buildings. Projects initially focused on renovating building heating systems, particularly district heating substations in building basements, but eventually expanded to include window replacements, wall insulation, and roof renovations.

The Lithuania Energy Efficiency Housing Pilot Project was quite innovative in its focus on energy efficiency investments in multifamily buildings managed by HOAs, and in its approach to finance the project by on-lending funds through a domestic commercial bank to HOAs and individual homeowners. Loans were administered with an 11 percent fixed interest rate, a minimum 10 percent down payment, no mortgage requirements for HOAs, and a maximum loan maturity of 10 years. Loans averaged close to US$1,000 per apartment and US$31,500 per building. In 1999, the Lithuanian Government began offering a matching grant of 30 percent of the loan principal not to exceed US$12.50 per square meter, and a partial VAT exemption for loan participants. Loan repayments were shared between homeowners according to an agreement made in the HOA general meeting. The program also focused heavily on training, public awareness, and educational outreach activities.

On average, homeowners registered energy savings of 17 percent per year leading to a roughly 13 percent reduction in heating costs per household. Based on a survey, 56 percent of homeowners reported a decrease in their heating bill and 48 percent reported improvement in housing quality. The average loan payback period was 17 years, and was reduced to 12 years when the Government grant and VAT exemption were implemented. After the World Bank's pilot program ended, the Lithuanian Government continued and expanded the program, eventually transforming it into an overall residential building renovation program utilizing commercial loans and credit insurance mechanisms.

Source: Taylor, Robert P. et. al. Financing Energy Efficiency: Lessons from Brazil, China, India, and Beyond. The World Bank: 2008. 206-109.

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Appendix A: Public Consultations in Lviv and Mykolaiv

Public consultations were conducted in two cities – Lviv and Mykolaiv – to investigate possible social constraints against the introduction of building-level heat metering in Ukraine. This appendix describes the purpose of the public consultations, the rationale for selecting the two cities, the structure of the focus groups, and the methodology for the consultations.

A.1 Why were public consultations carried out?

The success of public sector reform relies on anticipating and addressing possible social constraints during the development and implementation of the reform process. This is especially true for reforms targeting the District Heating (DH) sector in Ukraine, which covers about 60 percent of Ukrainian population and more than 65 percent of all buildings in Ukraine. In 2009, households consumed over 60 percent of total heat delivered by DH companies[20].

The World Bank carried out public consultations that consisted of focus group discussions, in-depth interviews and case-studies in order to discern the public's primary concerns, attitudes, and hesitancies related to the DH sector. The results of these consultations serve as an important tool to help determine the parts of the reform that must be better targeted and advertised to the public in order to ensure its success.

A.2 How were the two cities selected?

Public consultations were carried out in Lviv and Mykolaiv because, although they are similar in many ways, the DH market in each city differs in critical ways that could influence customers' opinions about DH services, their trust in DH companies, and in their perception of the benefits of heat metering and consumption-based billing. The cities are both oblast centers and are similar in terms of population size, household income and the structure of the DH market. However, aspects of the DH sector in each city differ in the following important ways:

- Installation of heat meters. Building-level heat meters are significantly more common in Lviv than Mykolaiv, primarily because residents have taken initiative to install them;

- Length and intensity of the heating season. The length and intensity of the heating season differs between the two cities because of their geographic location. Lviv is located in Western Ukraine, whereas Mykolaiv is Southern Ukraine. As a result, Lviv experiences a more prolonged and intense heating season than Mykolaiv. The average annual temperature in Lviv is 7.2°C, with its coldest period in January (4.6°C below zero) and warmest in July (17.3°C above zero). In Mykolaiv, the average annual temperature is 10.0°C, with its coldest period in January (3.1°C below zero) and warmest in July (22.3°C);

- Contractual relationships within the DH supply chain. In Mykolaiv, residents contract directly with the DH company for DH services. In contrast, in Lviv, customers contract for DH services through municipal building management companies, Zheks;

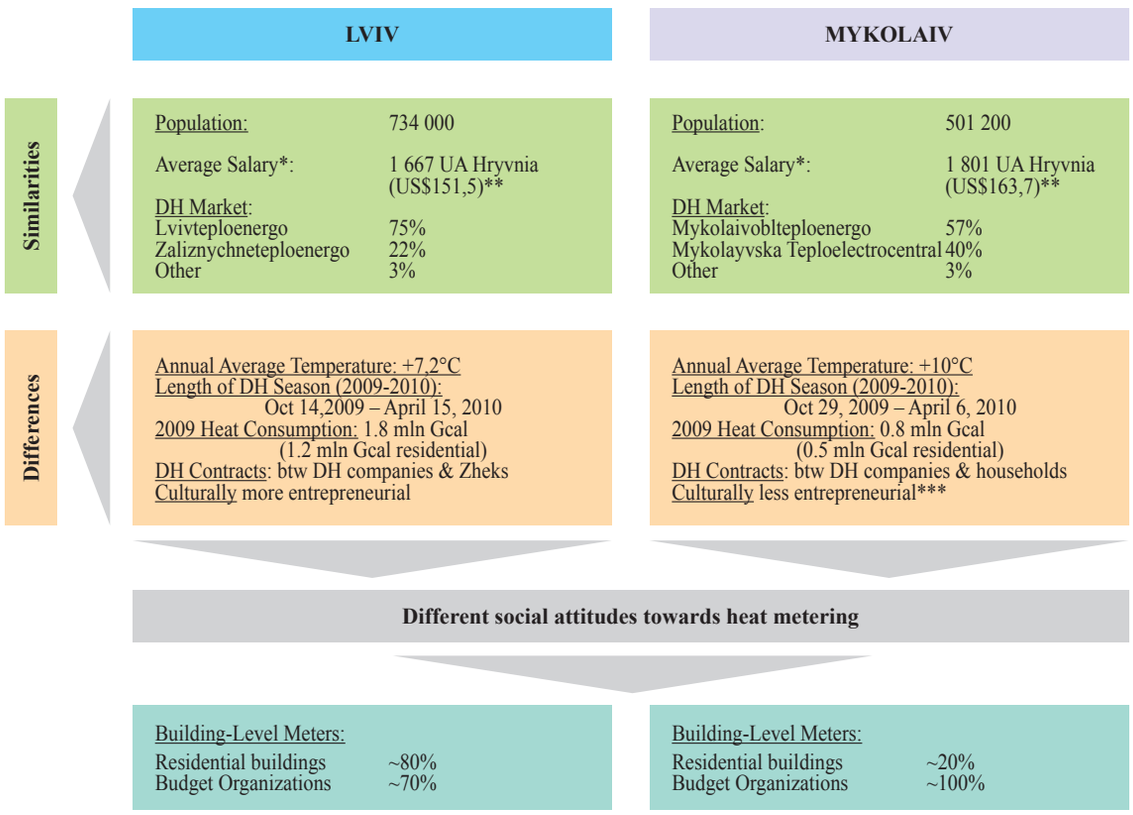
- Social attitudes. Residents of Lviv are considered to be very entrepreneurial and pro-business. These and other cultural differences between the two cities could help to explain the difference

[20] State Statistics Committee of Ukraine, 2010.

in attitudes towards the DH sector in general and towards heat metering and consumption-based billing in particular. Different social attitudes may also explain, at least in part, why residents in Lviv have been more pro-active in installing building-level heat meters.

Figure A.1 below provides further detail on these similarities and differences between Lviv and Mykolaiv and shows how they could explain the difference in metering penetration in the two cities.

Figure A.1: Public consultations: cities and hypothesis



* Per employee, oblast level (State Statistics Committee of Ukraine, 2010)
** 1 Euro = 11 UAH
*** Compared to Lviv

A.3 Structure of public consultations

Participants in the focus groups discussions included residents of buildings that received heating services from DH companies (as opposed to those with individual heating solutions). Twenty-six focus group discussions were carried out in total, thirteen in each of the two cities. Each focus group had 10 participants, for a total number of 260 respondents. All participants were middle- and low-income apartment building residents, and each focus group had a roughly equal proportion of male and female respondents.

Focus groups were structured so as to reflect potential differences in consumer views along the following lines:

- Age of buildings. Fifteen groups included people who live buildings built before 1980 and eleven included people who lived in buildings built after 1980;

- Type of building management. Twenty focus group discussions represented residents living in Zhek-managed buildings and six represented residents living in cooperatively-managed buildings[21];

- Installation of building-level heat meters. Twelve focus groups represented residents of buildings with building–level meters and fourteen represented residents of buildings that did not have meters.

A series of 20 in-depth interviews was carried out with a variety of DH sector stakeholders in order to follow up on issues identified during the focus groups. Ten in-depth interviews were carried out in each city with the representatives of DH companies, Zheks, municipal authorities, and representatives of building management boards/initiative groups. Additionally, eight case studies were conducted — four in each city — that documented the experiences of residents, business-owners, servicing companies, and an NGO with heating services and building-level heat metering.

Table A.1 contains the detailed distribution of focus group discussion respondents according to the characteristics mentioned above. Table A.2 contains the list of participants in the in-depth interviews and case studies.

Table A.1: Distribution of focus group discussion respondents by recruiting criteria

Target groups	Pre 1980 buildings				Post 1980 buildings			
	With meters		*Without meters*		*With meters*		*Without meters*	
	Lviv	**Mykolaiv**	**Lviv**	**Mykolaiv**	**Lviv**	**Mykolaiv**	**Lviv**	**Mykolaiv**
	Zheks							
Youth	1	1	1	1			1	1
Middle aged	1	1	1	1	1	1		
Senior			1	1	1	1	1	1
Senior Single							1	1
Total for Zhek managed building	2	2	3	3	2	2	3	3
	Cooperative							
Youth								
Middle aged		1	1					
Senior	1	1						1
Senior Single	1							
Total for cooperative	2	2	1					
TOTAL	**8**		**7**		**4**		**7**	

[21] In cooperatives, apartments are privately owned, but common areas (e.g., basement, staircases, roof, etc) belong to all the residents equally. Residents pay maintenance fees for the common areas in a cooperative. An elected cooperative management board is responsible for common area maintenance. In Zhek-managed buildings, the apartments may be privately owned, but common areas are municipally-owned and managed by Zheks. Residents pay maintenance fees to Zheks.

Table A.2: List of respondents in case studies and in-depth interviews

№	Representative	Position / duties
	Lviv	
1	Local authorities	First Deputy Mayor of Lviv
2	Representative of DH company	Deputy director
3	Zhek	Energy manager of state Zhek
4	Zhek	Deputy director of Zhek, biggest in the city district
5	Service company	Chief engineer of the inner building communications maintenance service (Individual heat sub-stations)
6	Service company	Branch of the foreign company – heating equipment producer
7	Private entrepreneur	The owner of the premises (hotel and restaurant)
8	Representative of building council (cooperative)	Chief Accountant of housing cooperative
9	Representative of building council (coperative)	Chairman of the residents' association
10	Zhek	Active member of the house management board
11	Case – study	Case of installing in-house boiler
12	Case – study	Case of installing meter in an institute building
13	Case – study	Public organization of residents aimed at assisting with resolving housing problems, including heat supply issues
14	Case – study	Bad experience of a meter installation
	Mykolaiv	
1	Local authorities	Deputy Mayor on housing issues
2	Representative of DH company	Deputy head
3	Representative of DH company	Director of Production and Technical Department
4	Zhek	Director
5	Private company	Heat meters installation firm Director
6	Service company	Director
7	Representative of building council (cooperative)	Chairman of association of co – owners
8	Representative of building council (cooperative)	Chairman of association of co – owners
9	Zhek	Senior in the house
10	Representative of a private company	Head of administrative and economic office center
11	Case – study	Bad experience of a meter installation
12	Case – study	Case of business establishment (meter installation company)
13	Case – study	Case of a meter installation in an HOA
14	Case – study	Case of a meter installation in a Zhek managed building and further refusal to use it

A.4 Methodology for consultations

Discussions with residents were structured around four main topics: (i) perceived institutional challenges and trust issues regarding meters installation and management; (ii) perceived positive and negative consequences of building-level heat metering and consumption-based billing; (iv) capacity for collective organization in order to install a building-level heat meter; and (v) awareness about heat bill increases and possible coping strategies with rising heating costs.

Focus group participants were asked to identify possible problems in each of the four main discussion topics. Respondents were then asked to select the five most important problems or concerns related to that issue. Lastly, respondents were asked to rank the problems from the most significant to the least significant.

The most significant concern was assigned the highest score of 5 and the least significant problem of the five most important concerns was assigned the lowest score of 1. If all 26 focus groups ranked the same problem as the most significant, it received a score of 26*5=130 points. Hence, the highest possible score that an issue could receive was 130 (or a maximum of 65 for each city), and the lowest possible score an issue could receive was 1. Results varied, in some cases, as focus groups were not always able to propose a total of 5 problems for each issue, and sometimes assigned less than 5 points of concern for a given issue.

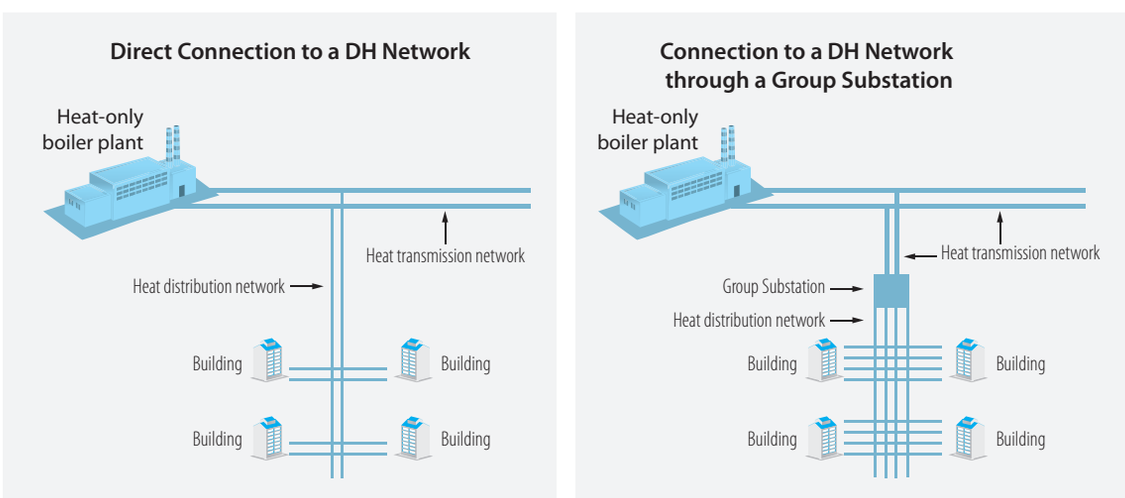
Appendix B: Estimating the Impact of Different Options to Introduce Consumption-Based Billing

This appendix supports the analysis carried out in Section 3 which compared the benefits to customers of various options to introduce consumption-based billing. Appendix B.1 provides a more detailed description of the various options considered. Appendix B.2 describes the assumptions about residential buildings, existing heat producers, and a hypothetical efficient heat producer, which were used to carry out the analysis.

B.1 Options to introduce heat metering and consumption-based billing

Currently, most of residential buildings in Ukraine are heated either through a direct connection to a DH system and have a building-level hydro-elevator[22]; or through group substations/4 pipes (CTPs)[23], as demonstrated in Figure B.1. DH systems operate in production-driven mode (constant flow), where the quantity of heat delivered to consumers is controlled by supply temperature from the heat source. This system cannot fulfill the individual demand of each building separately, since it supplies heat according to the average heat demand of the whole system. This is one of the primary reasons why some DH system customers are under-heated at the same time that other costumers are overheated.

Figure B.1: Methods for connecting to a DH network



Given that customers are already connected to DH systems, there are several options of introducing heat metering and consumption-based billing. Some of these options would not just allow trans-

[22] A hydro-elevator has a shell heat exchanger for domestic hot water (DHW) only. The hydro-elevator mixes the DH supply water with the return water of the space heating (SH) circuit in a constant ratio in order to get the SH supply water temperature to an allowed level. Since the driving force in the pressure of the DH supply pipe, it also reduces the pressure level more tolerable to SH network. There is no hydraulic separation between transmission (primary) and distribution (secondary) networks

[23] In a 4-pipe system, a CTP/group substation, to which a number of buildings are connected, divides the water circulation of the primary side to separate the space heating and the domestic hot water DHW circuits of the secondary side. The DHW supply is isolated from the primary network with heat exchangers, whereas the space heating may be connected directly, without heat exchanger, or indirectly, with a heat exchanger.

parency of billing and give consumers a better understanding of what they are paying for, but also improve connection quality and customer satisfaction with the DH service. The options include:

- **Option 1.** Current situation, in which buildings are connected to DH network without metering. As a result, building level heat consumption is estimated;

- **Option 2.** DH with building-level heat meters, but no temperature controls. The easiest option to introduce heat metering and consumption-based billing is to install heat meters without temperature controls in buildings and enforce using them for consumption-based billing. These meters measure the heat consumption of each building, which provides better billing and service transparency and better information regarding the heating demand of each building. In this case, the building-level heating bill would be divided among apartments based on the living area each apartment occupies. However, this option does not improve the overall efficiency of heat supply, since a DH system with these meters could still only operate in constant flow mode;

- **Option 3.** DH with building-level heat meters and rehabilitated group substations, or CTPs, with temperature controls at a CTP. This option involves installing building-level heat meters such as those described above, and simultaneously installing new CTPs or rehabilitating existing CTPs. The temperature controls and new pumps in CTPs can improve the supply efficiency of heat and domestic hot water (DHW) to buildings because CTPs enable a DH system to operate on a variable-flow mode, providing a different supply of heat as needed to each group of buildings connected to a CTP (as on Figure B.1b). The supply of heat to each building group would be determined according to the average heat demand of all the buildings connected to a new or rehabilitated CTP. Since heat supply would depend on the average demand of several buildings, however, energy savings of this option would be quite modest, amounting only to about 1-3 percent energy savings per building;

- **Option 4.** DH with building-level heat meters and individual heat substations (ITPs) of Ukrainian configuration, which control temperature for an individual building. This option involves installing a heat meter in each building and individual heat substations (ITPs) with heat exchangers for both DHW and space heating (SH) in each building. In this method, energy would be delivered to each building according to its individual demand. This option would significantly improve heat supply efficiency, and result in a decrease of building-level heat consumption by about 15-25 percent;

- **Option 5.** DH with building-level heat meters and ITPs of European configuration. There are two ITP installation options available to Ukrainian buildings: ITPs of European configuration and ITPs of Ukrainian configuration. An ITP of Ukrainian configuration (Option 4) is at least 30 percent more expensive than an ITP of European configuration. The main reason for the price difference is in the design standards and requirements of each ITP. There is no technical reason why European configured ITPs cannot be used in Ukraine[24];

[24] The configuration of ITPs in the EU-countries and Ukraine is different. Although there is no unified EU standard for ITP configuration and national standards and rules pertaining to ITPs differ, most of the times ITP configuration is similar in EU countries and complies with a number of EU directives, e.g. Pressure Equipment Directive (97/23/EC), Measuring Instruments Directive (2004/22/EC), Energy Services Directive (2006/32/EC), etc. In Ukraine, ITP design standards and rules were heavily influenced by a former GOST system, which mandated backing-up of major technological components (which at the time was justified by low availability factor of local equipment). This led to the current ITP design practice in Ukraine, where major parts of ITPs, such as pumps (including hot water supply circulation, space heating and ventilation system circulation pumps) and safety equipment (including safety valves for hot water supply, space heating and ventilation systems, and shut-off valves) are backed-up (e.g. instead of one pump, two pumps are installed, etc). Such design practices significantly increase capital cost of an ITP. In addition, poorly estimated heat loads of buildings often lead to over-sizing of heat exchangers, which in turn further contribute to increased costs of an ITP.

- **Option 5.1.** DH with building-level heat meters, ITPs, which control temperature for an individual building, and thermostatic radiator valves (TRVs) and heat-cost allocators (HCAs) in each apartment. In addition to metering the heat consumption of the entire building, the heat emitted by each individual heat radiator in an apartment is "measured" with evaporative or electronic devices, HCAs. Since most of the high-rise buildings in Ukraine use vertical piping to distribute heat and water[25], there is no other affordable technical option for apartment-level heat metering. The total cost of the heat consumption of the building (including the billings costs) is allocated to the individual apartments partially according to the floor area (to account for heating of common areas) and partially based on the readings of HCAs. TRVs allow maintaining the selected room temperature automatically. The valve closes when heat gains heat up the room and opens when temperature drops. Households can usually lower the indoor temperature with TRVs but not increase them without violating the pre-set adjustments of the valves. This option allows for "individualization" of heating services in buildings, connected to DH. The efficiency gains of this option is up to 30-35 percent;

- **Option 6.** Apartment disconnects from DH system and installs apartment-level individual gas heater. This option involves apartments disconnecting from the DH system completely and switching to an alternative source of heat. In this case, consumers pay for heat according to gas meters installed in their apartments. Some consumers in Ukraine choose this method and install apartment-level gas heaters for SH and DHW heating. Most city administrations do not promote the disconnection option because it can be unsafe, especially if gas heaters inside apartment buildings are installed and maintained unprofessionally. Disconnections also lead to problems with existing DH systems. Current gas tariffs for residential consumers in Ukraine are very low (about 20 percent of full economic cost of gas)[26], so some apartment owners still choose to disconnect. The potential average saving in heat consumption of this option is about 30-35 percent.

Most commonly, DH companies are responsible for installation and maintenance of CTPs, ITPs and building-level heat meters since they are a part of a DH network. TRVs and HCAs as well as individual gas heaters are usually installed by the households. Among DH options, we discuss only those options for which DH companies are responsible (Options 1, 2, 3, 4 and 5). We also look at individual gas heaters as an alternative to DH (Option 6).

Each of the analyzed options to introduce heat metering and consumption-based billing have different investment, operation and maintenance costs as well as efficiency implications. As a result, each option has a different impact on the cost of heat supply and apartment-level heating service quality. The type of investment needed to implement each option, the potential energy savings and the additional operation and maintenance costs of each option are presented in Table B.1 below.

[25] In a lot of countries of the former Soviet Block, basically all existing buildings have a hot water network with single pipes in vertical strings, and each radiator in an apartment is thus supplied from a different string. In Western and Northern Europe horizontal two-pipe systems with only one point of entry into the apartment and one exit are more common.

[26] The reason for the low price of gas used to produce residential heat in Ukraine is quite unique. Ukraine produces about 20 bcm of gas per year, which amounts to about 1/3 of its total annual gas demand. It is assumed that indigenous gas is used for households needs, including heat. Gas prices to households have been designed to cover the marginal cost of gas supply from local gas fields: about 40 Euro per tcm. This price does not include transmission and distribution charges which could significantly increase the cost of gas supply to households based on experience elsewhere. See Appendix C for discussion of true economic cost of Ukrainian gas to final consumers.

Table B.1: Investment needs, additional costs and efficiency gains, by option

	Description	Investments	Investment Cost per Building/ Apt	Annual Energy Savings	Additional Annual Costs
Current Heat Consumption, No Metering	Hydro-elevator (injector-pump, pipe and shell heat exchanger for DHW). No building-level heat controlling possibilities. No heat meters	-----	-----	-----	-----
Heat Meter, No Temperature Control	Base-case + heat meter	* Building-level heat meter	* € 2000/ bld	-----	€ 40 for O&M/ bld
Heat Meter + New CTP/ 4 Pipes + Temperature Controls @CTP	Typical CTP configuration (DH temperature controls with mixing valve and circulation pumps; pipe and shell heat exchanger for DHW; 4-pipe heat and hot water distribution system) + heat meter	* Plate heat exchanger for DHW, new control valve and pumps * All pipes between CTP and a building replaced * Building-level heat meter	* € 7,500/ bld * *€ 5,000/ bld * € 2,000/ bld	2%/ bld	€ 290 for O&M/ bld
Heat Meter + ITP/2 Pipes + Temperature Controls	ITP (plate heat exchangers for both SH and DHW, individual temperature controls) + heat meter	* ITP * Pipes from the distribution network to the building-level heat meter * Building-level heat meter	* € 10,000/ bld (European) * € 15,000/ bld (Ukrainian) * € 10,000/ bld * € 2000/ bld	20%/ bld	€ 340 for O&M/ bld
Gas Heating, Apartment Level	Individual gas heater for space and domestic hot water heating	* Gas piping to the apartment * Gas heater with flue gas equipment	* € 2000/ apt	30% / apt	* 0.1 MWh/ year additional electricity/ apt * € 40 Euro for O&M/ apt

B.2 Assumptions

This appendix describes the assumptions made regarding a typical residential building in Ukraine heated by a DH company, a typical DH company that is currently operating and providing heat in Ukraine, and a hypothetical DH company in Ukraine that is operating efficiently and recovering the full cost of its services. These assumptions served as basis for the analysis carried out in Section 3. The specific assumptions about each of these groups are described in further detail below.

B.2.1 Typical residential building

The common residential building type in Ukraine is a multi-story, multi-apartment structure, and so this report defined a typical Ukrainian residential building as a 9-story multi-apartment building, with 18 one-room apartments, 45 two-room apartments and 45 three-room apartments. The average apartment in a typical building was a two-room apartment with three residents. The characteristics of the typical residential building used in the report's analysis are presented in Table B.2.

Table B.2: Assumptions for a typical residential building

Year of Construction	1989
Floors	9
Sections	3
Number of Apartments	108
Total Number of Tenants	324
Design Outdoor Temperature, °C	-22
Total Annual Heat Consumption, Gcal	989
SH, Annual Consumption, Gcal	512
DHW, Annual Consumption, Gcal	477
Average Annual Heat Consumption of a Typical Apartment, Gcal	9.16

B.2.2 Typical heat producer

The typical heat producer in Ukraine[27] currently operates well below the full cost of production. This section describes assumptions made about a typical heat producer in Ukraine.

A typical heat producer in Ukraine was defined as a DH company that uses gas-fired heat-only boilers (HOBs) to produce heat, sells 80 percent of its heat to residential consumers, and serves 385 residential buildings that are connected to the DH system directly (as in Figure B.1a) with hydro-elevators and DHW exchangers. The analysis also accounted for heat supply to budget organizations, including schools and hospitals, and to commercial consumers.

A typical DH company has an installed capacity of 265 Gcal/hr, producing heat with medium-size HOBs (50-60 Gcal/hr per boiler). The DH company was estimated to have a heat production efficiency of 85 percent, and to lose about 20 percent of heat in the network.

In terms of operational costs, it was assumed that the DH company buys gas to produce residential heat at about 33 percent of the price it pays for gas that is used to produce heat for its other consumers. The company has a cost structure similar to Ukrainian DH companies that have HOBs only and sell at least 80 percent of their heat to households: 50 percent fuel costs; 12 percent purchased energy; 22 percent payroll; 3 percent depreciation; 3 percent operation and maintenance; and 10 percent other costs. The company's actual average financial cost of heat production is 235 UAH (€21) per Gcal. Table B.3 summarizes the assumptions about a typical DH company.

[27] Operational profile of a typical Ukrainian heat producer was developed based on analysis of detailed technical and financial data for 35 Ukrainian DH companies and information collected from field visits to 5 of those.

Table B.3: Assumptions for a typical Ukrainian DH company

Installed capacity, Gcal/hr	**265**
Network, km (dual pipe)	88
Transmission, km	45
Distribution, km	43
Efficiency of heat production, %	85
Efficiency of transmission, %	90
Efficiency of distribution, %	92
Typical buildings served	385
Total heat produced, Gcal/ year	500,000
Heat sold to residential consumers, Gcal/year	380,000
Heat sold to other consumers, Gcal/year	34,000
Transmission and distribution losses, Gcal/year	86,000
Price for gas used to produce residential heat	730 UAH (€66)
Price for gas used to produce other heat	2200 UAH (€200)
Average Financial Cost	235 UAH/Gcal (€21/Gcal)

B.2.3 Efficient heat producer

This section describes assumptions made about an efficient heat producer in Ukraine that accounts for the full cost of providing heating services.

The heat production efficiency of a well-run DH company is approximately 95 percent, with roughly 5-8 percent network losses. This implies that an efficiently run DH company would satisfy the demand of 385 typical residential buildings by producing about 10 percent less heat than a typical Ukrainian DH producer would have to produce to meet the same heating demand. Less production combined with lower network losses would result in a savings of approximately 20 percent of gas needs for production. The cost structure of an efficiently run company would reflect the full cost of its gas needs.

An efficiently operated DH company would have consumer connections based on ITPs with automatic temperature regulation based on outside weather conditions; ITPs would include heat exchangers for SH and DWH generation. ITPs would reduce heat demand of 385 typical buildings by about 15-25 percent and further decrease production and gas needs of an efficient company compared with a typical Ukrainian heat producer.

An efficiently operated DH company would allocate the appropriate amount of funds towards capital expenditure, operation, and maintenance activities in order to sustain proper quality of service. For example, if a DH company initially invested in efficient boilers and pre-insulated pipes, then it will not need to replace more than 3 percent of its boiler capacity or 4-5 percent of its network per year. Initial investment in efficient capital components keeps operation and maintenance costs low (including the cost of electricity for pumping), and allows the company to operate with fewer staff as well.

Under these conditions, an efficiently run DH company has the following cost structure: 69 percent fuel costs; 2 percent purchased energy; 6 percent payroll; 19 percent capital component,

3 percent operation and maintenance costs and 1 percent other costs. This cost structure is similar to the cost structure of a typical Finnish DH company. The fuel costs may seem high. However, this is because DH companies in Ukraine supply heat primarily to the type of residential building described above, which are highly inefficient. Improving efficiency of consumption, would decrease heat demand and reduce gas production needs further, thereby decreasing the share of fuel costs relative to other cost components.

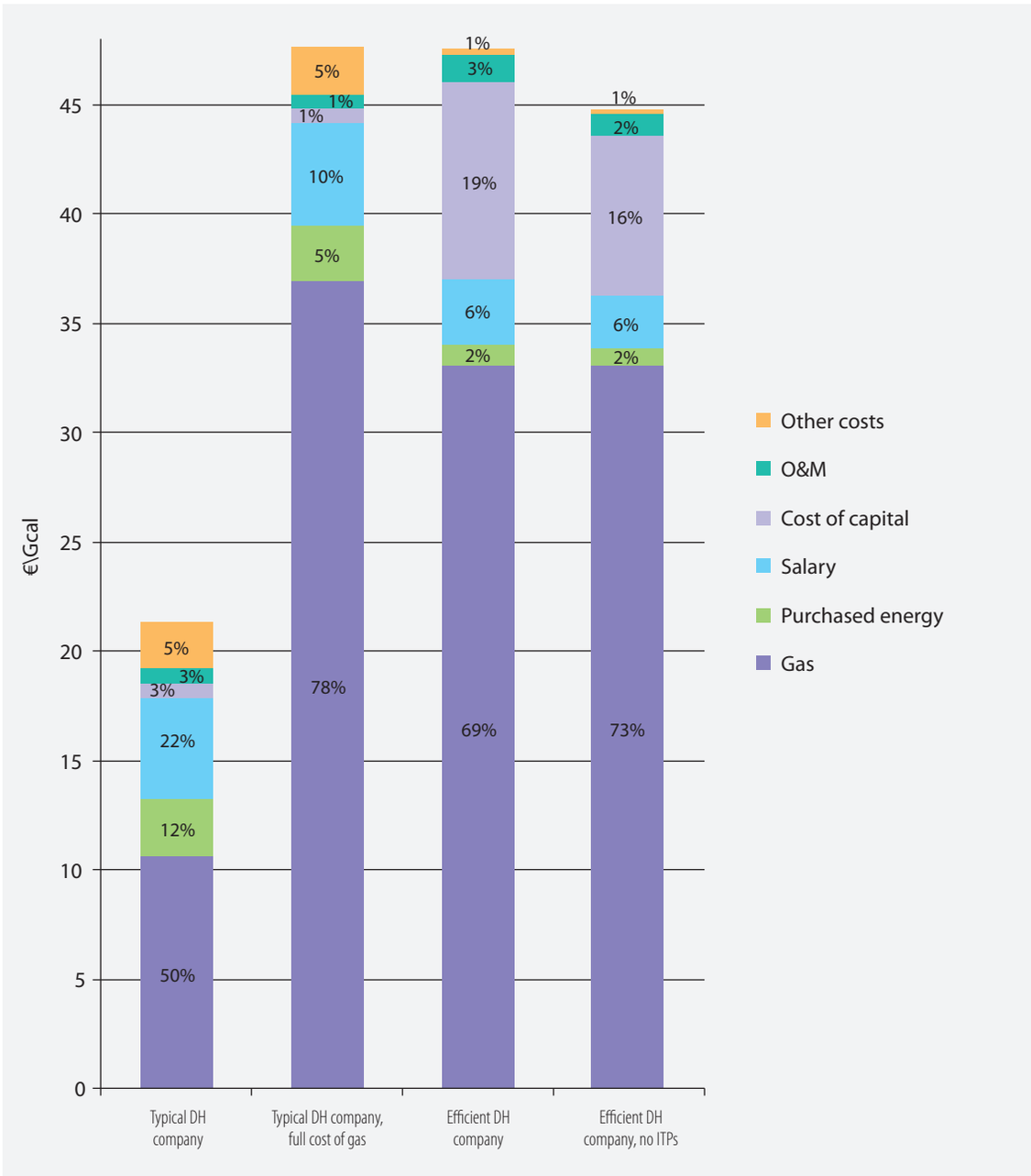
Given the above assumptions, the average full production cost of heat at an efficiently run DH company would equal €47 (UAH 522) per Gcal. This amount is more than twice the current average actual heat production cost of a typical DH company in Ukraine. Table B.4 summarizes the differences between a typical heat producer in Ukraine today and a similar heat provider that is efficiently run and recoups the full cost of production. Figure B.2 compares average production costs of an efficient DH company and a typical heat producer in Ukraine, including production cost of a typical Ukrainian producer, when the full cost of gas is covered.

Table B.4: Typical heat producer versus efficient heat producer

	Typical	Typical, full Cost of Gas	Efficient with ITPs	Efficient without ITPs[28]
Installed capacity, Gcal/hr	265			
Network, km (dual pipe)	88			
Transmission, km	45			
Distribution, km	43			
Efficiency of heat production, %	85		95	
Efficiency of transmission, %	90		97	
Efficiency of distribution, %	92		95	
Typical buildings served	385			
Total heat produced, Gcal/year	500,000		375,000	459,000
Heat sold to residential consumers, Gcal/year	380,000		304,000	380,000
Heat sold to other consumers, Gcal/year	34,000		34,000	34,000
Transmission and distribution losses, Gcal/year	86,000		37,000	45,000
Price for gas used to produce residential heat	730 UAH (€66)	3,000 UAH (€270)	3,000 UAH (€270)	
Price for gas used to produce other heat	2,200 UAH (€200)	3,000 UAH (€270)	3,000 UAH (€270)	
Average Financial Cost	235 UAH/ Gcal (€21 /Gcal)	525 UAH/Gcal (€48 /Gcal)	522 UAH/Gcal (€47 /Gcal)	493 UAH/Gcal (€45 /Gcal)

[28] This company is used as a benchmark for the analysis of implementing different consumption-based billing options under full cost of service assumption in Section 3. The estimated average cost of an efficiently-run heat producer with ITPs is higher because of: (1) higher cost of capital; and (2) higher fixed costs component per Gcal due to the fact that with ITPs, an efficiently-run heat producer would generate 20 percent less heat to meet demand.

Figure B.2: Average production costs of a typical heat producer versus efficient heat producer

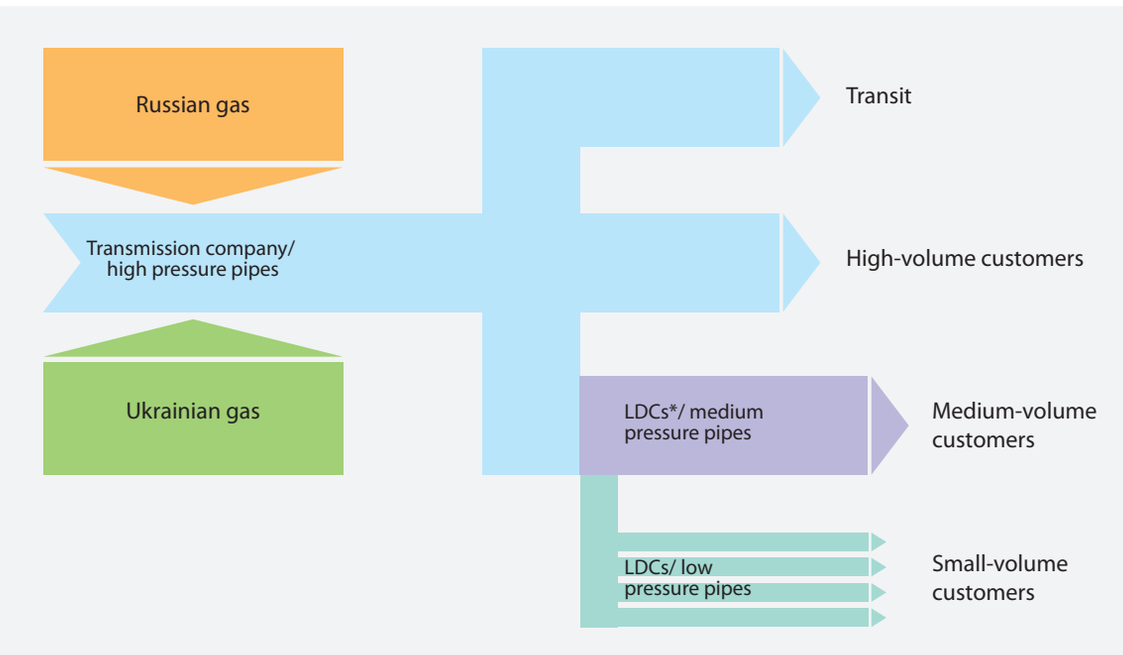


Appendix C: Economic Cost of Gas to District Heating Companies and Households in Ukraine

C.1 Pricing natural gas

Consumer prices for natural gas are determined by commodity costs and transmission and distribution costs, depending on the off-take pressure. While large industrial consumers and large power plants typically receive natural gas directly from transmission network, most other users receive natural gas from their local gas distribution company. Figure C.1 below shows delivery chain of natural gas to final consumers in Ukraine.

Figure C.1: Delivery chain of natural gas to final consumers in Ukraine



* *LDC:* local distribution company.

Commodity costs of gas should be driven by the market value of the marginal supply source of natural gas as any changes in volume would be impacted directly by this cost of supply. Transmission and distribution are natural monopolies, hence transmission and distribution tariffs are usually regulated. Most commonly, policy makers use rate of return on the asset base or shareholder equity. Benchmarking is used as a tool by regulators to help determine prices, especially if incentive-based regulation is employed to create an incentive for cost reduction. Distribution costs typically make up a big part of natural gas costs for households and small volume customers because of their low volumes of consumption. Transportation infrastructure required to move natural gas to many diverse customers across a reasonably wide geographic area are costly.

C.2 Commodity cost of gas in Ukraine

As it is seen from Figure C.1, gas supply in Ukraine consists of Russian gas and indigenous Ukrainian gas. Ukrainian gas production has been relatively constant over the past eight years, at about 20 billion cubic meters (bcm) annually, about 35 percent of total domestic gas consumption. Current indigenous gas production cannot fully meet demand, making Russia the marginal supplier of gas. Hence, the economic value of gas in Ukraine for the medium-term is equal to the commodity cost of Russian gas. Hence, **the true financial commodity cost of gas in Ukraine should be the border price Ukraine pays for Russian gas. During 2008-2009 heating season, it was Euros 250/ thousand cubic meters (tcm).** The difference between local gas supply costs and the economic value of gas should be addressed through taxes that can be used to subsidize the poor[29].

However, recent Government policies are leading towards a possible shift in the gas market that would facilitate competition. The Government hopes that domestic gas production will increase from 20 bcm/year now to 24 bcm/year by 2015 and 30 bcm/year by 2020. Coupling increased gas supply with energy efficiency gains and inter-fuel substitution (presumably another 10-20 bcm/year) and possible gas supply from other sources (LNG or shale gas) could enable the establishment of a competitive market for gas supply, considerably driving down the prices.

C.3 Benchmarking transmission and distribution costs of gas in Ukraine

In order to benchmark the true economic cost of delivering gas to final consumers in Ukraine, we would look at transmission and distribution costs of an efficiently run, regulated gas transport system as a benchmark. For that, we analyze transmission and distribution costs of the UK gas transport network.

The UK gas market is fully unbundled and the network is centrally regulated. The UK transmission network is owned and operated by National Grid; there are eight local distribution companies. The supply of natural gas in the UK is competitive as consumers can choose their gas supplier. UK transmission, distribution and metering businesses are regulated by the Office of Gas and Electricity Markets (Ofgem). Ofgem has established price control mechanisms that restrict the amount of revenue that can be earned by regulated businesses – currently a 4.3-4.4 percent post-tax real rate of return on regulatory asset value, depending on the regulated company.

Transmission costs

In the UK, firm transmission charges comprise of capacity and commodity charges (Table C.1). Charges for entry capacity are not fixed but are determined by auctions which apply to all system entry points. All entry capacity is offered on a pence per kWh per day basis, where the quantity is measured in terms of an end of the day entitlement. The reserve prices for the auctions are estimated using an approved methodology.

Exit capacity charges reflect the estimated long run marginal cost of developing the system to meet a sustained increase in demand and are determined by the exit zone to which a particular off-take point belongs. Exit capacity charges apply to customers supplied through the existing network system off-takes.

[29] Since marginal production cost of gas in Ukraine is about Euros 40/tcm, competitive pricing could be achieved through an efficient tax on gas producers to retain the resource rents for the country, or through competition, as it is done in the US. These approaches best preserve the signal of the economic price to the sets of buyers and sellers along the chain.

Operation and maintenance costs of the system are covered by commodity charges. It is a uniform charge independent of entry and exit points, and is levied on both entry and exit flows.

In September 2010-September 2011[30], UK transmission system handled 95 bcm of natural gas (equivalent of 1,046 TWh).[31] Given the charges in Table C.1, the average MINIMUM transmission cost for the period was 6.6 GBP per tcm (€ 7.6, or 83.6 UAH per tcm)[32]: since reserve prices are used in the calculation, not the actual auction prices for entry capacity, this estimate represents the lower bound of the transmission cost in the UK.

Table C.1: Average transmission charges and costs, UK

Average reserve entry capacity charge	Average exit capacity charge	Commodity charge	Total Gas Transmitted	MIN Average Transmission Cost	
€ cent per kWh per day	*€ cent per peak day kWh per day*	*€ cent per kWh*	*bcm*	*€ /tcm*	*UAH/tcm*
0.009	0.012	0.022	95	7.6	83.6

Distribution costs

Firm distribution charges in the UK comprise local distribution zone (LDZ) capacity and commodity charges plus LDZ customer charges (Table C.2). For medium-volume customers, the LDZ charges are based on equations shown in Table C.2. These functions use the maximum daily consumption at a supply point (or Supply point Off-take Quantity (SOQ)[33]) in the determination of the charges.

In September 2010-September 2011[34], the UK distribution system handled 52 bcm of gas (equivalent of 572 TWh); the average load factor was 35% for small-volume customers and 52% for medium-volume customers. Given the charges presented in the table below, the average distribution cost to a small-volume customer for the period was 71 GBP per tcm (€ 83, or 902 UAH per tcm)[35]. For a medium-volume customer with an annual consumption of 50 million cubic meters of gas (equivalent of 0.55 TWh), the average distribution cost was 9.6 GBP per tcm (€ 11, or 105.6 UAH per tcm)[36].

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30 Since September 2010, National Grid reports how much gas has been delivered to local distribution zones off-take points.

31 1 bcm = 11 x 10^9 kWh

32 Assuming 80% capacity load factor,
TOTAL Transmission Charge =$(95 \times 11 \times 10^9)$kWh x (0.009) / 100
+ [$(95 \times 11 \times 10^9)$kWh / (0.8)] x (0.012) / 100
+ $(95 \times 11 \times 10^9)$kWh x (0.022) x 2 / 100 = € 690 mln
AVE Transmission Charge (per tcm) = € 690 mln / 95 bcm

33 SOQ for a non-daily metered customer = Annual Consumption / (365 x load factor).

34 Since September 2010, National Grid reports how much gas has been delivered to local distribution zones off-take points.

35 Assuming that all gas handled by the distribution system went to small-volume consumers,
TOTAL Distribution Charge to Small-Volume Consumers = $[(52 \times 11 \times 10^9)$kWh/(0.35)] x (0.17) / 100
+ $(52 \times 11 \times 10^9)$kWh x (0.03) / 100
+ [$(52 \times 11 \times 10^9)$kWh / (0.35)] x (0.09) / 100 = € 4,254 mln
AVE Distribution Charge to Small Volume Consumers (per tcm) = € 4,254 mln / 52 bcm

36 TOTAL Distribution Charge to a Medium Volume Consumer=
= $[(50 \times 11 \times 10^6)$kWh / (0.52)] x (0.7) x $[(50 \times 11 \times 10^6)$kWh / $(0.52 \times 365)]^{(-0.18)}$ / 100
+ $(50 \times 11 \times 10^6)$kWh x (0.14) x $[(50 \times 11 \times 10^6)$kWh / $(0.52 \times 365)]^{(-0.21)}$ / 100
+ $[(50 \times 11 \times 10^6)$kWh / (0.52)] x (0.07) x $[(50 \times 11 \times 10^6)$kWh / $(0.52 \times 365)]^{(-0.21)}$ / 100 = € 0.57 mln
AVE Distribution Charge to a Medium Volume Consumer (per tcm) = € 0.57 mln/50 mcm x 1000

Table C.2: Average distribution charges and costs, UK

	Average firm capacity charge	Commodity charge	Average customer charge	Average Distribution Cost	
	€ cent per peak day kWh per day	*€ cent per kWh*	*€ cent per peak day kWh per day*	*€/tcm*	*UAH/tcm*
Small-volume customers (<72 MWh/year)	0.17	0.03	0.09	82.1	902
Medium-volume customers (~550 GWh/year)	$0.70 \times SOQ^{(-0.18)}$	$0.14 \times SOQ^{(-0.21)}$	$0.07 \times SOQ^{(-0.21)}$	11	105.6

The estimated distribution cost for a medium-volume customers is a lower bound of what DH companies in Ukraine would pay: the load factor for heat only boilers in Ukraine is typically lower than 52%.

C.4 Estimated economic cost of natural gas to big utilities, DH companies and households in Ukraine

The estimates of transmission and distribution costs presented in tables C.1 and C.2 provide a benchmark of transmission and distribution charges would be in an efficiently run, regulated gas transport system. Given the border price of gas of €250 Euros/tcm, **the price of natural gas in Ukraine would be at least €250 + €7 = €257 to big utilities, at least €250 + €7 + €11 = €268 Euros to DH companies and at least €250 + €7 + €83 = €340 Euros to households**.

Appendix D: Eliminating Gas Subsidy and Affordability of DH[37]

This appendix supports analysis carried out in Section 5 and discusses affordability of DH to households when heat tariffs reflect the full cost of gas to DH companies. This appendix looks at impact of gradual increase of price that DH companies pay for gas when the gas price reform is coupled with energy efficiency measures that mitigate the impact of increased heating costs.

Gas prices for DH companies are assumed to increase from €66 (730 UAH) for gas used to produce residential heat and €200 (2,200 UAH) for gas used to produce other heat to €270 (3,000 UAH) over the period of 10 years. Households' incomes are assumed to increase annually at expected real GDP growth rate, 5 percent per year. If gas price increase is not mitigated, elimination of gas subsidy would gradually raise annual heating costs of an average apartment from €195 to €450.

Table D.1 shows what impact this change would have on affordability of DH to Ukrainian households. DH service is considered affordable if DH bills comprise no more than 10 percent of a household's consumption. As it is seen, when DH costs start reflecting full financial cost of gas in year 10, DH is affordable to only 30 percent of all households.

Table D.1: Impact of increased gas prices on annual households' heating costs

Decile	Average annual heating cost per apartment, €										
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
	195	**221**	**247**	**273**	**298**	**324**	**350**	**376**	**402**	**427**	**450**
	% of household's annual consumption spent on heat										
1	14%	15%	16%	17%	17%	18%	18%	19%	19%	19%	20%
2	11%	12%	13%	13%	14%	14%	15%	15%	15%	15%	16%
3	10%	10%	11%	12%	12%	13%	13%	13%	13%	14%	14%
4	9%	10%	11%	11%	12%	12%	12%	13%	13%	13%	13%
5	9%	9%	10%	10%	11%	11%	12%	12%	12%	12%	12%
6	8%	9%	9%	10%	10%	10%	11%	11%	11%	11%	11%
7	7%	8%	9%	9%	9%	10%	10%	10%	10%	11%	11%
8	7%	8%	8%	9%	9%	9%	10%	10%	10%	10%	10%
9	6%	7%	8%	8%	8%	9%	9%	9%	9%	9%	9%
10	6%	6%	6%	7%	7%	7%	8%	8%	8%	8%	8%

Table D.2 shows what impact gradual increase of gas price would have on affordability of DH to Ukrainian households, when this reform is coupled with installation of ITPs and heat meters in buildings. In this case, heat consumption of an average apartment would fall by 20 percent; cost of heat of an average apartment would increase from €195 to €395. The investment cost would add €18 to annual household's heating bill, but decrease in consumption induced by ITPs would still be significant to decrease total apartment heating cost. As a result, DH would become affordable to 50 percent of households.

[37] This Appendix benefited from input of Victor Sulla.

Table D.2: Impact of increased gas prices and installation of ITPs on annual households' heating costs

Decile	Average annual heating cost per apartment, €										
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
	195	**196**	**218**	**240**	**263**	**286**	**307**	**329**	**351**	**373**	**395**
	% of household's annual consumption spent on heat										
1	14%	13%	14%	15%	15%	16%	16%	16%	17%	17%	17%
2	11%	10%	11%	12%	12%	12%	13%	13%	13%	13%	14%
3	10%	9%	10%	10%	11%	11%	11%	12%	12%	12%	12%
4	9%	9%	9%	10%	10%	11%	11%	11%	11%	11%	11%
5	9%	8%	9%	9%	10%	10%	10%	10%	11%	11%	11%
6	8%	8%	8%	8%	9%	9%	9%	10%	6%	10%	10%
7	7%	7%	8%	8%	8%	9%	9%	9%	5%	9%	9%
8	7%	7%	7%	8%	8%	8%	9%	9%	5%	9%	9%
9	6%	6%	7%	7%	7%	7%	8%	8%	5%	8%	8%
10	6%	5%	6%	6%	6%	6%	7%	7%	4%	7%	7%

Table D.3 shows the impact of gradual increase of gas price, when simultaneously ITPs and heat meters are installed, building envelopes are improved and heat-cost allocators are installed. These additional investments would decrease heat consumption of an average apartment by about 50 percent. Improving building envelope and installing heat-cost allocators would cost about € 100,000 per building; together with installing ITPs and heat meters, these investments would add additional €70 to annual heating bill of an average household, but the cost of heat of an average apartment would increase from €195 to €329 per year. DH would become affordable to 80 percent of households.

Table D.3: Impact of increased gas prices, installation of ITPs, improving building envelope and installing heat cost allocators on annual households' heating costs

Decile	Average annual heating cost per apartment, €										
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
	195	**182**	**197**	**213**	**229**	**245**	**261**	**277**	**294**	**312**	**329**
	% of household's annual consumption spent on heat										
1	14%	12%	13%	13%	13%	14%	14%	14%	14%	14%	14%
2	11%	10%	10%	10%	11%	11%	11%	11%	11%	11%	11%
3	10%	9%	9%	9%	9%	10%	10%	10%	10%	10%	10%
4	9%	8%	8%	9%	9%	9%	9%	9%	9%	9%	10%
5	9%	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%
6	8%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%
7	7%	7%	7%	7%	7%	7%	7%	8%	8%	8%	8%
8	7%	6%	7%	7%	7%	7%	7%	7%	7%	7%	8%
9	6%	6%	6%	6%	6%	6%	7%	7%	7%	7%	7%
10	6%	5%	5%	5%	5%	6%	6%	6%	6%	6%	6%

Apartment-level costs could be reduced further by decreasing cost of heat supply by the DH companies. This could be achieved by further increase the efficiency of heat production by installing more efficient heat-only boilers, using more CHPs (combined heat and power plants) in heat production, further reducing transmission and distribution losses, improving efficiency of electricity use—particularly for pumping, and carefully reviewing staffing needs and adjusting employment accordingly. The analysis of how these additional measures would impact apartment-level costs is not done here because the impact of increased capital costs on average cost of heat needs to be address on case-by-case basis.

Appendix E: Legal, Regulatory and Institutional Issues[38]

E.1 Existing primary and secondary legislation

When assessing the main issues related to heat metering, the following questions should be raised, discussed and answered from the point of view of legislation:

- Who installs, pays for and owns the meters?
- Who is in charge and pays for calibrating the meters?
- Who reads the meters?
- Where should the financing needed for the meters come from?

In Ukraine, there are over 30 pieces of legislation supposedly affecting heat and hot water metering. For a country struggling with burden of a heavy bureaucratic tradition, the existence of such a large number of legislative and regulatory acts seems to aggravate the problem. The norms are unclear, available with difficulty and often appear to be contradictory. Moreover, the questions stated above still need the final answer.

The main pieces of legislation affecting district heating are:

- Law of Ukraine On Heat Supply, of 2.6.2005, No. 2633-IV;
- Law of Ukraine On Housing and Communal Services, of 24.6.2004, No. 1875-IV.

These laws have been amended several times, most recently in 2010.

The Law on Heat Supply provides the legal framework heat supply – essentially district heat and supply of hot water. It establishes the installation of heat meters and heat regulators as one of the main objectives of government policy in the sector. Despite this declared goal, the Law does not make heat meters compulsory at house or apartment level.

The two above Laws establish the customer's right to pay for heat according to a meter, if there is one. If no meters exist, customers pay in accordance with heat consumption norms (i.e. estimated nominal heat-per-m^2 consumption), which are established locally. The Laws also give the right of access to the meters to heat suppliers' inspectors. However, there is no clarity on who installs, owns and calibrates these meters.

The issue of installing heat meters is for the most part regulated by Cabinet of Ministers Resolution No. 630, of 21 July 2005, which sets forth the rules applicable to the provision of housing and communal services. Further, the Government issued a number of other acts, rules and norms relevant to the installation of heat meters. Yet again, these documents fail to establish the party that is exactly obliged to install heat meters and pay for them.

In general, the installation of metering equipment of heat energy is carried out in accordance with designs approved by a DH company. The company must approve any type of heat meter which is officially approved in Ukraine for the purpose of commercial metering of district heat. While some companies quote "bad experience" with certain types or manufactures of meters, they must approve the meter if it is officially approved and required by the customer. The DH company may reject the premises where the installation is proposed, and provide justification for this, but usually the premises are not an issue.

[38] This Appendix is based on a report prepared by Poyry Group. The report benefited from detailed inputs from the Ministry of Regional Development, Construction and Housing and Communal services. The report is available upon request.

There are several legislative acts that address the financing the installation of heat meters. However, they do not identify concrete sources of funds and, hence, remain "programmatic", without much anchoring in reality. The cost of calibration, maintenance and repair of house meters may be included in the heat tariff, provided that the meters are owned by the heat supplier – and only for customers living in houses that actually have meters. However, it seems that this provision has not been used in practice.

In practice, local authorities are usually in charge of the implementation of legislative acts regarding DH. Many issues are addressed in local bylaws, rules and other legislative acts which differ from municipality to municipality. As a result, it is difficult to evaluate how effectively the adopted legislative acts have been implemented and enforced.

In general, Ukraine has had a piecemeal approach towards metering. There are some 30 pieces of legislation supposedly affecting heat metering. However, none of these makes heat meters compulsory. Current Ukrainian legislation is unclear and incomplete. It allows heat meters to be financed, installed, and owned by practically anybody in the supply chain – from heat supply companies to contractors to the residents of buildings.

E.2 Heat supply contracts

As in most other countries, the supply of heat and domestic hot water is made available to Ukrainian customers on the basis of a contract. The situation in Ukraine, however, is complicated by the existence of a large number of different types of contracts between DH companies and their customers.

According to the Law on Heat Supply, heat shall be supplied to the customer through a party which holds the title to the building (balansoutrymuvach). It could be Zhek, housing association or another body. The title-holder must enter into two heat supply contracts: with the end user and with the DH company. Housing associations still do not exist in Ukraine in sufficient numbers, and most of buildings are of mixed ownership: apartments are owned by residents, but common areas – by municipalities. On behalf of municipalities, Zheks are responsible for maintenance of the common areas, including DH infrastructure inside the building. As a result, the common contracts are between a DH company and a Zhek.

However, another practice is that each single apartment is the contractual client of a DH company. It appears that the issue of choosing either a Zhek or an individual apartment owner as a contractual party mostly depends on local circumstances. It is usually not a decision of a DH company, but of the local municipal authority. This type of contractual relationship usually causes complications, since a DH company must conclude and enforce the contract with the owner of each apartment.

Another complication is that DH contracts are quite different. All of the contracts are essentially based on the model agreement[39]. However, the published text of the model agreement is not binding but rather a template which may be complemented by the local authorities. As a result, there appears to be an element of random selection in the texts, which is usually based on practical experience gained over the years by the company and the lawyers who advise it. The differences in details usually have no or limited legal or practical significance.

The standard heat supply contract is long and rather heavy in details. With regard to heat metering, the contacts usually specify that if meters exist, payments shall be made on the basis of meter readings, and in such case, a "metered tariff" (per Gcal) shall be applied – as opposed

[39] The model heat agreement is provided by the Cabinet of Ministers Resolution No. 630, of July 21, 2005.

to "calculated tariff" based on heated area (per m2) for heat, and the number of residents for domestic hot water.

The main rule in standard contracts seems to be that the customer has the right to install – at his own cost – heat and/or domestic hot water meters, provided that they are technically acceptable, and have them registered by the heat supplier. If the meter is owned by the customer, it is the customer who pays for both calibration and maintenance. If the district heating company owns the meter, the customer cannot be requested to pay the cost calibration and maintenance separately, but the cost will be – indeed must be – included in the tariff.

Since housing associations are legal persons with independent decision-making powers and bodies elected to exercise these powers, the distribution of the cost of heat is based on decisions adopted by these bodies, within the framework established by the Law On Housing Associations. If the house is incorporated as a housing association, the rules are established by the municipal authorities and the Zhek.

E.3 Harmonization with EU Law

The basic document regulating the harmonization of Ukrainian law with EU law is Law of Ukraine On National Program for Adapting Ukraine's Legislation to European Union Legislation, 18.03.2004, No. 1629-IV (last amended on 23.12.2010), which establishes the principles and methods for harmonizing Ukraine's legal system with EU acquis communautaire, generally based on criteria established by the EU for candidate countries. One of the priority areas for harmonization is norms and standards.

Ukraine signed its Accession Protocol to join the Energy Community (EnC) on 24 September 2010, ratified the Protocol on 15 December 2010, and is exercising its full membership powers as of January 14 2011.On December 18 2009, the Ministerial Council of the EnC decided to include Directive 2006/32/EC of April 5 2006 on energy end-use efficiency and energy services ("Energy End-use Efficiency and Energy Services Directive") Directives in the acquis mandatory under the Treaty.

With regard to metering, Article 13 (1) of the Energy End-use Efficiency and Energy Services Directive requires the Member States to "ensure... that final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters". However, this requirement is conditional: providing individual meters is required "in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings." For situations where an existing meter is replaced Article 13 (2), part 2, of the Energy End-use Efficiency and Energy Services Directive requires that individual meters always be provided. Again, the main rule does not apply if the installation of individual meters is "technically impossible or not cost-effective in relation to the estimated potential savings in the long term." Finally, for cases where a new connection is made in a new building or a building undergoes major renovations, individual meters shall always be provided.

It should be noted that the Energy End-use Efficiency and Energy Services Directive does not directly address the question concerning the party who pays for the meters, and indeed practices vary between Member States and from energy sub-sector to sub-sector. Further, Article 11 (19) allows Member States to "establish a fund or funds to subsidize the delivery of energy efficiency improvement programs and other energy efficiency improvement measures..." including, "where appropriate, improved metering and informative billing." Consequently, public funds may be allocated either to energy companies or to customers to improve metering and financing new meters.