USAID
FROM THE AMERICAN PEOPLE

PHOTO: ALEKSEY SERGEYCHIK-STOCK.ADOBE.COM

OPTIONS FOR LARGE-SCALE INSTALLATION OF INDIVIDUAL HEAT SUBSTATIONS BASED ON INTERNATIONAL BEST PRACTICES

Energy Security Project (ESP)

February 2021

This document is made possible by the support of the American people through the United States Agency for International Development (USAID). The contents of this document are the sole responsibility of Tetra Tech ES, Inc., and do not necessarily reflect the views of USAID or the United States Government. This document was prepared by Tetra Tech ES, Inc., USAID Contractor for the Energy Security Project (ESP), USAID contract 7201218C00003.

AUTHORS

PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL)

Molly Charles
Nazar Kholod
Meredydd Evans

ENERGY SECURITY PROJECT (ESP)

Ievgenii Cherviachenko
Artem Kuznetsov
Vladyslav Tsaruk
Yana Bugrimova
Ruslan Kalnytskiy
Sergii Pinchuk

CONTENTS

1. ACRONYMS AND ABBREVIATIONS

BCM	Billion Cubic Meters
CMU	Cabinet of Ministers of Ukraine
COVID-19	Coronavirus disease 2019
DH	District Heating
EBRD	European Bank for Reconstruction and Development
EEF	Energy Efficiency Fund
ESCO	Energy Service Company
ESP	USAID Energy Security Project
EU	European Union
GJ	Gigajoule
HCC	Housing Construction Cooperative
HIU	Heat Interface Units
HOA	Homeowner Association
HWS	Hot Water Supply
HWSS	Hot Water Supply Service
IFIs	International Financial Institutions
IHS	Individual Heat Substation
LSG	Local Self-Government
NEFCO	Nordic Environment Finance Corporation
NEURC	National Energy Utilities Regulatory Commission
NFEP	National Fund for Environmental Protection (Poland)
NGCA	Non-Government-Controlled Area
PNNL	Pacific Northwest National Laboratory
RSA	Regional State Administration
SCS	State Construction Standards
SECO	State Secretariat for Economic Affairs (Switzerland)
TP	Technical Permit
UAH	Ukrainian Hryvnia
UK	United Kingdom
URE	Energy Regulatory Authority of Poland (abbreviated from the Polish Urząd Regulacji Energetyki)
USAID	United States Agency for International Development
USD	United States Dollar
ZhEK	Ukrainian acronym that means Municipal Housing Maintenance Organization (an entity providing home maintenance services in which the homeowners have not decided on the form of managing them)

2. EXECUTIVE SUMMARY

Ukraine's developed district heating (DH) infrastructure is a critical resource for meeting heating needs in the country. However, underinvestment and poor management have made Ukraine's DH systems inefficient and unreflective of customer needs (a lot of buildings are under- or overheated and consumers cannot choose indoor temperature of multifamily buildings). DH policy in Ukraine is in need of structural reform to improve service quality, reduce dependence on subsidies, and avoid customer disconnections. Energy efficiency on the demand and supply side is a vital element of comprehensive reform to end the vicious circle of financial, technical, and operational problems and ensure long-term success of the DH sector.

The purpose of this report is to provide recommendations for implementing large-scale installation of individual heat substations (IHSs) as part of comprehensive DH sector reform. The report introduces the importance of IHS in the DH sector, then analyzes both the legal context and barriers to IHS installation in Ukraine. Further, it presents several case studies of approaches towards large-scale IHS installation in multi-family buildings that European countries have applied and successfully tested. Finally, the report proposes actions Ukraine could take to overcome the barriers in Ukraine and facilitate IHS deployment, based on lessons learned from international experience.

Installing IHSs in buildings connected to DH could greatly improve energy efficiency in the DH sector. IHSs allow for building-level temperature regulation and can significantly reduce heat consumption and overheating (if balancing of space heating networks and/or installation of thermostatic radiator valves accompany the IHS installation). IHSs are nearly universal in Western European countries with DH systems. Several European Union (EU) Member States in Central Europe have had success installing IHSs on a large scale as part of DH reforms, and generally found that these investments were cost-effective and improved service quality and energy efficiency.

To best provide insights into how Ukraine could approach IHS installation, the research team selected examples of Central and Eastern European countries that had to switch from old central heat substations to IHS, as well as one example from a Western European country to help highlight the role that IHSs play in new connections that can help grow DH. In Ukraine, large-scale IHS installation has proceeded much slower than in many other Central and Eastern European countries. Only 12% of multi-family buildings with DH in Kyiv are currently equipped with IHSs. There are several reasons for the slow pace in Ukraine, affecting the ability of both DH companies and building owners to invest in IHS. On the one hand, DH companies in Ukraine currently lack the clear legal authority to make investments into IHSs on their own and to have their respective capital and maintenance costs reimbursed through their heat tariffs. Specifically, lack of clarity in ownership laws also prevents DH companies from owning the IHS and gaining access to buildings. On the other hand, IHSs are needed to optimize consumption in multi-family buildings. At the same time, IHSs are relatively easy and fast to design, finance, and implement on a mass scale. Finally, IHSs reduce the amount of heat consumed, so a comprehensive approach to heat supply system modernization is required.

Based on the barriers that exist in Ukraine and international experiences, high-level recommendations to launch large-scale IHS installation in Ukraine include the following (see Section 7 for more details):

1. **Make Large-scale IHS Deployment Easy.** Deploying IHS on a large-scale requires finding viable financing and ownership models that can be replicated at scale. In Central Europe, this meant providing flexibility, but also allowing DH companies to invest in IHSs and recover their

costs. To kick-start the progress, most countries leveraged loans from international financial institutions (IFIs) and used national energy efficiency programs.

2. **Ensure that IHSs enables DH Customers Save Energy and Improve Service.** IHSs are a proven energy saving technology. Providing options to allow buildings to access IHS installations through savings or guarantees of reduced energy consumption can speed technology adoption. Likewise, it is essential to allow building owners to regulate temperatures to improve comfort and energy savings.

3. **Simplify Procedures and Build a Market to Support IHS Installation and Servicing.** Reducing bureaucracy and building a market for IHS Installation and servicing can help expand implementation with lower costs.

3. IMPORTANCE OF IHS FOR DISTRICT HEATING REFORM IN UKRAINE

Installing efficient IHSs with thermostatic controls, automated weather regulation and balancing of the space heating network can significantly improve DH efficiency and lower costs. A modern individual, or building-level, substation is made up of a heat exchanger and controls. These systems are low cost compared to other energy saving measures and, if a building is overheated or unbalanced, IHS can reduce energy use in the building by around 15-30%, so payback periods are short (according to IHS projects implemented in Ukraine).

IHSs make it possible for homeowners to regulate their heat consumption, which then allows other retrofit measures to result in actual energy and cost savings. So, IHS is a basis for achieving savings from other energy efficiency measures on the demand side. Unless IHS is installed, other energy efficiency measures will only lead to increase of indoor temperatures and not to reduction of heat bills for the homeowners.

IHSs give customers more power and strengthen homeowner rights, as they allow homeowners to regulate the temperature and heat consumption. Because of this, they help transform DH to become more customer-centric, which improves both the quality of the service and satisfaction with it. IHSs are the point of contact between the DH company and customers, so they are very important to building better customer service and a more trusting relationship. In Central Europe, IHSs were a critical part of keeping customers from switching to other heating sources. DH companies in Central Europe therefore became big proponents of the widespread switch to IHSs. IHSs also help DH companies better balance their loads, making system management easier.

> IHSs are a crucial part of implementing comprehensive reforms to improve the efficiency, service quality, financial situation, and environmental sustainability of DH systems. At the same time, large-scale IHS deployment must be integrated into broader reforms and legislative changes in the DH sector. Priority directions for reforms include implementing cost-reflective tariffs, increasing overall system efficiency, promoting building energy efficiency, and ensuring DH service quality and affordability, as outlined in the White Paper on Transforming District Heating in Ukraine. IHSs play an important role in facilitating these changes; they provide major benefits for both customers and DH companies by saving energy, lowering costs, and improving comfort and service quality. Without IHSs, it is very difficult to improve efficiency, implement tariff reform, improve customer relations and satisfaction, and reduce overall system cost.

Other benefits of installing IHSs include:

- Increasing energy independence of the country by saving energy and reducing the need for imports;
- Decreasing customer payments for heating;
- Improving the quality of services and the level of comfort for the population;
- Encourage homeowners to implement energy efficiency measures (as well as to apply to EEF and other programs).

IHS installation also affects the efficiency of DH companies. First, installing IHSs reduces consumption of water and electricity and some losses in heat supply and hot water supply due to the decommissioning of inefficient central heat substations. Because IHSs can reduce total demand, it is important to prioritize these investments with respect to investments in generation, transmission, and distribution capacity. Systematic forecasting of future demand must be considered when planning any investment, and prioritizing IHS installations before investments in system capacity can help DH companies and cities gain a better understanding of future demand. Second, improving the quality of services has a positive effect on consumer payment discipline, which helps improve the financial stability of DH companies.

Cities in Central and Eastern Europe installed IHSs primarily in the 1990s and early 2000s, soon after they began large-scale transformation of their systems. Some cities relied on donor investments to catalyze the initial change, but then moved to private financing for scale-up, and typically they were able to install the substations in a majority of buildings within a few years, given how cost effective they were. Despite the benefits of IHSs, only a small portion of buildings in Ukraine are equipped with individual heat substations. For example, in Kyiv, only 12% of residential buildings have them[1].

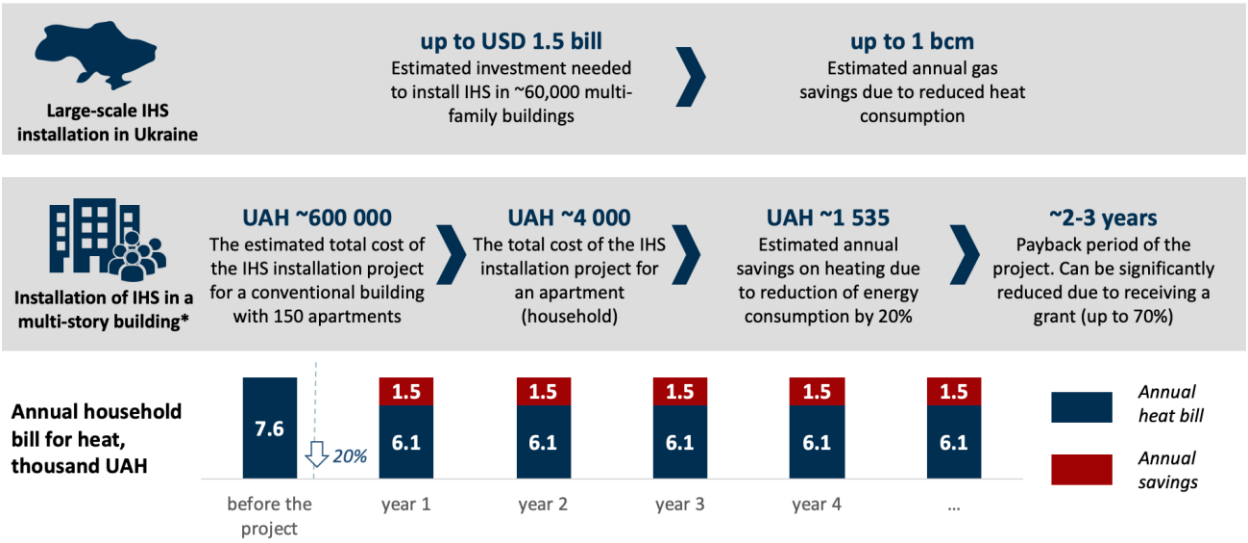
The project team performed a simplified cost and benefits assessment of mass installation of IHSs in Ukraine. This analysis shows that installing IHSs is cost-effective. The analysis is based on data from Ukraine, in particular examples of investments from the Energy Efficiency Fund.

In other words, for the vast majority of apartment buildings in Ukraine, installing IHSs is cost-effective because the measure reduces energy consumption in the building by 15-30%; this results in a typical payback period of 2-3 years (see Table 1 below).

It should be noted, that decrease in energy consumption (and heating bills) for households is achieved due to shaving of overheat and more careful determination of indoor temperature. It means that IHS may have the opposite effect if a building is under-heated (heat bills increase as well as temperature inside of the building becomes comfortable). Moreover, IHS installation should be accompanied with cleaning and balancing heat system in a building. Otherwise, effect of IHS installed is low and corresponding savings should not be expected. Other issues in the housing sector, such as chaotic disconnections of apartments from district heating, can also hinder the effectiveness of IHSs. At the same time, if IHS installation is accompanied by the measures described above, service quality is improved and this can help address the problem of disconnections from district heating.

[1] http://www.nerc.gov.ua/data/filearch/Catalog8//2017/Akt-Kiivenergo_03.05.2017-63.pdf

Table 1 Estimated simplified costs and benefits of IHS installation



**The calculation for a multi-story building is based on data for a building with 150 apartments and average heat energy tariff in Ukraine of 1,535 UAH.*

Source: Project team calculation based on Naftogaz, National Energy Utilities Regulatory Commission (NEURC) data, and other open sources

The figure above outlines potential costs and savings based on a typical 150-apartment building, energy saving level of 20%, and an average heat energy tariff in Ukraine of 1,535 UAH. Because IHSs typically save 15-30% of energy transmitted to a building, and costs scale based on the building size and the payback period are likely to be broadly representative of future projects across Ukraine. At the same time, the savings may slightly differ (as well as payback period) because of some parameters. First, most apartment buildings have fewer than 150 apartments, so the likely total cost nationwide will be smaller. In general, costs and benefits tend to scale, so larger, more expensive IHSs serve more apartments, which then save more energy. Second, the chart above assumes 20% savings from the IHS, which is on the low end of the range of what Ukrainian buildings have experienced, so savings are likely to be higher. Third, the IHS project costs or heat tariffs may be higher or lower due to market situations in future. Fourth, mass installation can and has driven down costs in most countries as competition grows for installation services. Also, policy changes can streamline the bureaucracy needed for installation, which can significantly reduce design and planning costs. On the other hand, the costs do not take into account possible changes in pipes outside of the building, which are required in some cases and would raise investment costs.

In addition to the savings that households gain from reduced energy consumption, wide-scale IHS installation can have several macroeconomic effects. First, reduced heat consumption will lower the demand for natural gas. Since Ukraine still imports significant volumes of gas, this improvement in the DH system will have a positive effect on the balance of payments. Any reduction in energy imports enhances the country's energy security. The savings will not necessarily be a direct impact on the state budget.

Second, investments in IHSs will create a multiplier effect. Ukraine will need about 1.5 billion USD to install IHSs in all multi-family buildings and most of this money will be spent on labor costs and IHS components manufactured in Ukraine.

From the perspective of companies, it is also important to note that mass installation of IHSs will save large amounts of energy, which also means that the volume of heat supplied will drop. Ideally, DH companies could coordinate investments in IHSs with investments in heat networks and supply. In practice, it is rare to perfectly synchronize such investments. Experience in Central Europe shows that typically it is best to install IHSs first, before major investments in other parts of the system, so that the network and supply investments can be adjusted to meet new demand levels. After IHSs are installed, it is helpful to upgrade other parts of the network soon because production and network losses will be higher on equipment operating at partial capacity. Likewise, it is important to revise tariffs to reflect actual operating costs so that DH companies do not suffer financial losses.

4. RESEARCH METHODOLOGY

To collect information on the process of IHS installation in other countries, the authors began with desk research to identify countries with systems and experience that could provide lessons to stakeholders in Ukraine. This included both Eastern and Central European countries that have gone through the process of large-scale replacement of central heat stations with IHS, and Western European countries with developed DH systems. From this, several countries were chosen for in-depth case studies. The research team identified experts from each of these countries to interview and asked a standardized interview protocol covering ownership, financing, legal issues, and technical specifications for substation upgrades and new connections.

To understand the Ukrainian situation and barriers to large-scale IHS installation, and to develop recommendations for Ukraine based on the international findings, the research team analyzed relevant Ukrainian legislation, interviewed experts in the district heating sector, and interviewed international donors with experience installing IHSs in Ukraine. The researchers then drew from both datasets to develop recommendations that considered the international best practices while also focusing on solutions to Ukraine's unique barriers, such as extensive bureaucratic hurdles to gain approval for IHS installation.

5. OVERVIEW OF UKRAINIAN FINANCING AND POLICY FRAMEWORKS FOR DEPLOYING AND SERVICING IHS

POLICY FRAMEWORK

Today in Ukraine there is no clearly defined, unified policy regarding the definition and process for IHS installation projects, which creates ambiguity and slows down project implementation. At best, specialists are guided by general construction and international standards.

There are no legal requirements for installing IHSs in existing multi-family buildings, which contrasts with the current legal requirements on equipping buildings with commercial metering units.

However, in new buildings, IHSs are mandatory. Specifically, State Construction Standards (SCS) "Heating, Ventilation, and Air Conditioning" requires developers to install IHSs with automatic controls in all new buildings, or to have apartment-level thermostatic controls so residents can regulate their apartment temperature. Another issue is that under current legislation, developers prefer autonomous boilers or individual heating in each apartment instead of district heating and installation of IHSs, even in cities with district heating. This approach, generally, prevents development of an efficient and cost-effective urban heating system. The problem is also exacerbated by the fact that developers need to pay the up-front cost of connecting to the DH network, which contrasts with many European countries, where these costs are folded into the tariff or spread out over several years.

The current laws of Ukraine do not contain a clear definition of "individual heat substation." At the same time, several by-laws reference IHS and the implicit definition used differs in each regulation (see Annex 3 Table 7).

NEURC has also written on the lack of a clear definition for IHS in Ukrainian regulations. Specifically, NEURC wrote a letter to the Verkhovna Rada Committee on State Building, Local Governance, Regional and Urban Development dated February 28, 2019, with the following information: "There is no clear definition of 'Individual Heating Substation' in the legislation (the latches and elevator unit at the entrance to the building also can be considered as IHS according to the current definition) and their classification (electrified, non-electrified, using dependent or independent scheme, etc.)."

The lack of a single definition may lead to legal barriers regarding some issues related to IHS and to some uncertainties within design of energy efficiency projects (e.g. project documentation may account IHS when it is not so). The legal question of what IHSs are and who should manage them will need to be clarified and consistently applied across all legislation.

Identified policy challenge(s): lack of clear IHS definition and lack of legal regulations for installing IHSs in existing multi-family buildings.

IHS OWNERSHIP

The issue of IHS ownership in Ukraine has not been resolved yet, so some legal contradictions remain. Thus, some legal uncertainties or even violations of the legislation may arise during IHS projects. One of the practical problems is not including IHS maintenance in the tariffs for DH companies that are NEURC licensees. This gap in the NEURC tariff methodology can also be a barrier for financing mass IHS installation.

Given the historical ambiguity of approaches to the ownership of common property in multi-story buildings and the different options for who installs the IHS (homeowners, DH company, or Municipal Housing Maintenance Organization, e.g. ZhEK), clarifying issues around IHS ownership is essential for implementing projects.

With the adoption of the Law No. 417 "On Peculiarities of Exercising the Right of Ownership in Multi-family Buildings", which amended the Civil Code of Ukraine, the legislation clearly establishes the definitions and legal status of common property in multi-family buildings.

According to Article 382 of the Civil Code of Ukraine and Articles 1, 4, and 5 of Law No. 417, everyone who owns space in a multi-story building also owns a share of the common space in the buildings. The common property includes both the IHS and the premises in which they are located. Additionally, common property in a multi-story building includes mechanical, electrical, plumbing, and other equipment inside or outside the building; buildings and structures that are designed to meet the needs of all homeowners of multi-story building and located on the adjacent territory; and the right to land on which the multi-story building and its adjacent territory are located, in case of state registration of such rights.

Currently, there is no procedure or mechanism to clarify ownership of an IHS to a DH company when these organizations invest in an IHS. In other words, they can invest their money in an IHS, but it is not clear that they can own or reap financial benefit from the investment.

Due to the property issues described above, the procedure for disposing of common property in multi-family buildings become relevant. After all, the implementation of any IHS project, according to the legislation, requires a decision of the homeowners.

The order of disposal of the common property of multi-family buildings is established by Articles 5 and 10 of Law No. 417. Homeowners of multi-story building have responsibility for disposal of joint property in a multi-story building; establishing, changing, and abolishing restrictions on its use; adopting decisions on current and capital repairs, reconstruction, restoration, and technical re-equipment of the common property of a multi-story building and determining contractors for such work.

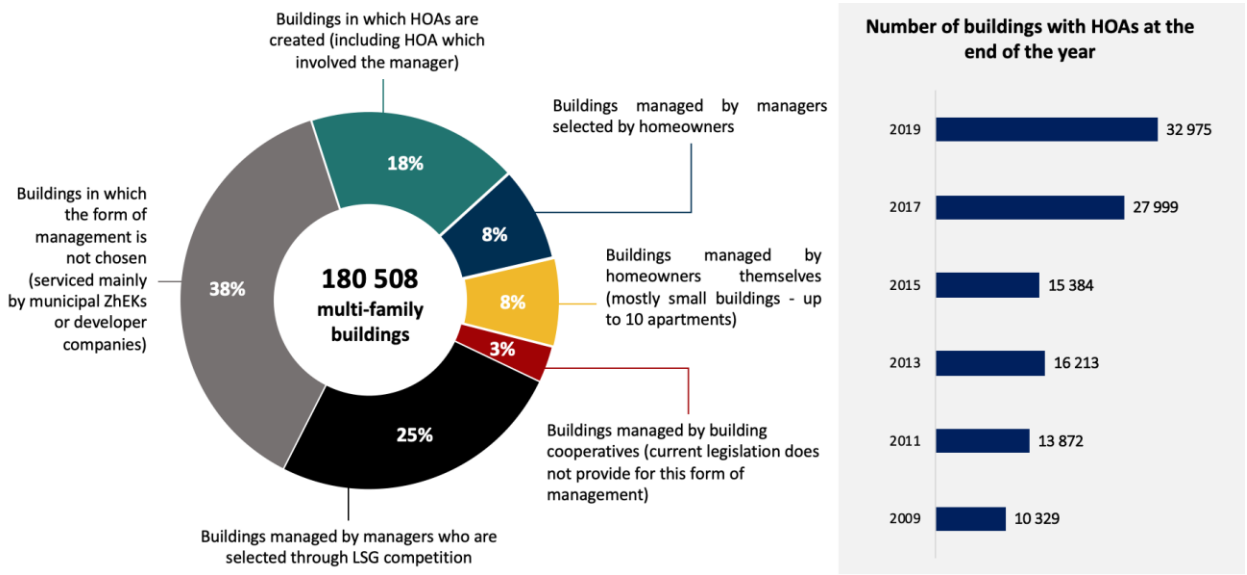
If a multi-story building is managed by an HOA, decisions on the use of common property are made by homeowners at the general HOA meeting, as the governing body of the HOA.

HOAs help with decision making in a few ways. First, the share of homeowners who need to agree to the investment is 2/3 compared to 75% when there is no HOA. Only 18% of multi-family buildings in Ukraine have an HOA.[2] Second, an HOA creates a forum for apartment owners to discuss common problems and needs, and HOAs have regular meetings and processes for deciding on building-level issues.

Actually, most multi-family building owners in Ukraine remain passive, which may be a barrier for IHS projects.

[2] The percentage of buildings with an HOA among buildings connected to DH may be somewhat higher, but precise data is not available.

Figure 1 Form of management in multi-family buildings as of the end of 2019



** Data after 2013 do not include the Autonomous Republic of Crimea and non-government-controlled areas (NGCAs) of Donetsk and Luhansk oblasts*

Source: Ministry of Regional Development of Ukraine and State Statistics Service of Ukraine data

In addition, the adoption of a decision procedure in multi-family buildings with a Housing Construction Cooperative (HCC) needs analysis. In Soviet times, creating an HCC was a common way for joint construction and operation of multi-family buildings. To date, due to certain historical reasons, maintenance of some multi-family buildings is carried out through HCC statutory bodies. At the same time, Law No. 417 does not have provisions for HCCs (by its statutory bodies) to make decisions on the reconstruction (modernization) of the common property of multi-story building by installation of IHS (such a decision must be made at a meeting of homeowners). For details on HCC legal status, see Annex 2.

Identified IHS ownership challenge(s): Ownership issue regarding IHS remains unresolved in current legislation. IHS installation requires a decision (at least 75%) of co-owners, who are mainly passive.

MECHANISMS OF THE INVESTMENT RECOVERY

There are no mechanisms of the IHS investment recovery by DH companies except tariffs. At the same time, the alternative mechanism may become an important component for mass IHS installation.

Moreover, in practice, Ukrainian tariffs rarely if ever include the costs of IHS installation, which is one of the largest barriers to widespread adoption, although in theory the rules do allow some of the costs to be included in the rate base. Looking at the regulations, the rules for determining tariffs are different for licensees of regional state administrations (RSAs) (CMU Resolution No. 869) and the NEURC (NEURC Resolution No. 1174). All DH companies can theoretically finance installation of IHSs through the investment component of the tariff (e.g., investment program costs) or as planned profit. Although there are no regulatory barriers to including investments for IHS in the tariffs, this practice is not common because of regulators' political decisions.

Servicing costs can be included in the tariff only if the DH company owns or uses the IHS and the company is an RSA licensee. Importantly, NEURC regulations do not allow its licensees to include IHS maintenance costs in the tariff, which is a clear barrier to company-owned IHSs.

The barriers to including IHS investment and maintenance costs in the tariff is also a reflection of broader system problems. Tariffs that do not reflect costs have made it difficult for DH companies to invest in modernization and routine maintenance, decreasing the quality and efficiency of DH services over time and raising costs. In the longer term, laws and regulatory practices can be changed. Reforming tariffs to allow for IHS investments can help bring down costs for customers and DH companies, opening the possibility of more systematic reform.

Table 2 Problems with including IHS costs in heat and hot water tariffs

	Investment component	Maintenance costs in a heat tariff	Maintenance costs in a hot water tariff
DH company - NEURC licensees *(rules for setting tariffs are regulated by NEURC Resolution No. 1174)*	Current legislation envisages the costs for IHS installation in the tariff. These costs may be included in the tariff as part of the investment component of the tariff (investment program costs) or as planned profit. However, the tariff price is closely controlled by regulators. Approving the full costs of IHS installation in the tariff is a rare practice because of socio-politicized impact.	IHS costs are not included in the tariff in accordance with NEURC Resolution No. 1174	Costs are included in the tariff in accordance with NEURC Resolution No. 1174
DH company - RSA licensees *(rules for setting tariffs are regulated by CMU Resolution No. 869)*		Costs are included in the tariff in accordance with CMU Resolution No. 869	Costs are included in the tariff in accordance with CMU Resolution No. 869
For both – NEURC and RSA licensees		The procedure for determining tariffs does not provide for the inclusion of costs for obtaining an easement or for renting the premises where the is IHS installed, which is considered an asset of the DH company, but most IHSs are in a basement plant room that the DH company does not own.	

** Cost sharing of IHS maintenance is between the tariffs for heat supply and hot water service carried out for RSA licensees in accordance with the volume of sales of the relevant services in the building. For more information on the general rules of tariff setting, see Annex 3.*

Source: Consultants' analysis of Cabinet of Ministers of Ukraine (CMU) Resolution No. 869 and the NEURC Resolution No. 1174

Identified IHS cost remuneration challenge(s): 1) There are no alternative mechanisms of the investment recovery by DH companies 2) Heat tariffs usually do not include IHS investment costs; 3) Heat tariffs do not always include IHS maintenance costs; 4) Heat and hot water tariffs do not envisage costs for obtaining an easement or for renting the premises for IHS installation by DH companies.

FINANCING OPTIONS

In Ukraine, there are about 80,000 multi-family buildings with district heating, the overwhelming majority of which can be equipped with IHS.

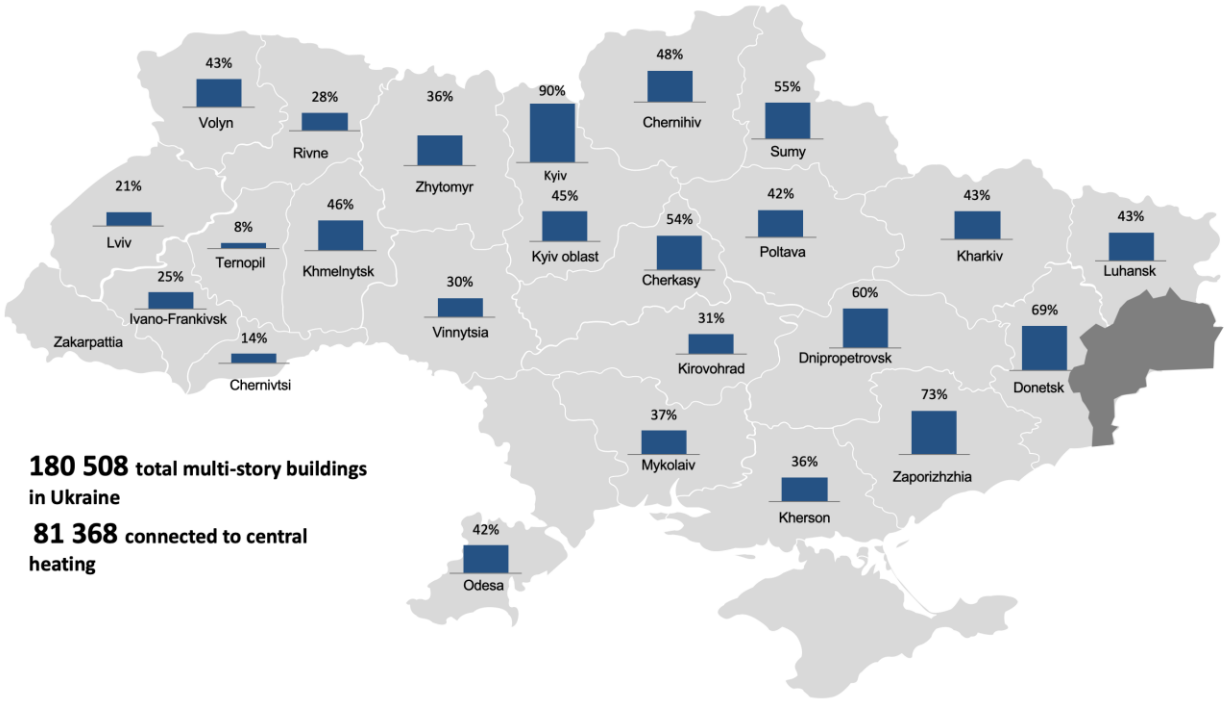
The most common problem is the need to attract a large amount of money, because the price of one IHS with installation work can cost 400,000-700,000 UAH. This poses a significant obstacle for both homeowners (who must pay up to 4,000 UAH, with an average monthly income of 9,500 UAH, according to statistics as of May 2020) and for DH (which, in practice, does not have the opportunity to envisage enough funds for the IHS installation in tariffs). The total investment needs for equipping all multi-family buildings in Ukraine (where it is relevant and possible) is almost $1.5 billion.

Currently, the main drivers for installing IHS are energy efficiency support programs.

- For consumers: HOAs and HCCs have the opportunity to receive compensation for installing IHSs under government programs such as "Warm Loans" and the Energy Efficiency Fund (EFF), although currently only HOAs can participate in the EEF program. Local authorities also create their own financial support programs for energy efficiency, both independent of state programs (for instance, in Kyiv) and as a supplement to state programs (for instance, in Rivne, Lutsk, Zhytomyr, Mariupol, and others).

- For DH companies (local government): Heat supply companies have the opportunity to attract soft loans from IFIs (usually under state or local guarantee), as well as receive a grant for up to 80% of the project cost.

Figure 2 Percentage of multi-family buildings in Ukraine with district heating



Source: Ministry of Regional Development of Ukraine data

However, regardless of whether a DH company finances IHS installation externally or with internal working capital, the mechanism of the investment recovery plays a pivotal role in the profitability and feasibility of the investment. In other words, for DH companies to invest in IHS installation, the mechanism of the investment recovery (as tariff or separate payment) must allow them to recover these costs. Guided by the general regulation set by the Procedures of the Formation of Heat Tariffs (both for RSA and NEURC licensees), such costs may be included in the tariff as part of the investment component of the tariff (investment program costs) or as planned profit. At the same time, the regulator closely controls these components of the tariffs, because the tariff issue is politicized and socially sensitive in Ukraine. Thus, such a tariff will not be politically approved. This means that DH companies seldom invest in IHSs, except in rare cases when a small share of the investment cost is covered by tariffs, typically linked to IFI investments.

The existing DH system in Ukraine was mainly designed and built during the Soviet era, when the approach to district heating was significantly different. In most case there was no reconstruction of heat supply systems. Mass IHS installation in a city (and any other energy efficiency measures) leads to a significant reduction in the amount of heat energy in the heating system. That is, mass installation of IHSs may require investments into the reconstruction of the city heating system. Central European countries found that when they installed IHSs on a large scale, they typically needed to change their heat production facilities to correctly size them to demand; this was also true of the heat networks in some cases, although heat network changes are typically made because of poor efficiency and losses, not sizing (see Annex 3 for more details on IHS technical impact).

It is, however, very important to ensure that IHS installations are closely coordinated with the DH company, and this is one reason that in Central and Eastern Europe, the majority of IHS investments were made by DH companies. Otherwise, significant reduction of heat energy in the heat supply system (caused by mass IHS installation) may lead to some risks, for instance:

- **Technical, coordination**: A central heat substation may not operate properly if some buildings switch to IHS. All the buildings connected to a central heat substation should switch at the same time, and again, this is easier to coordinate at the DH company level than through individual buildings;

- **Technical, planning**: Some neighboring buildings (adjacent to the building with IHS) may see a reduction in their heat quality if the project is implemented without an independent IHS scheme or automatic balancing valves. To prevent it, the DH company should take into account the actual situation for issuing technical permits or control project implementation, but without using this as an additional barrier, as is often the case in Ukraine;

- **Financial, tariff rearrangement**: Decreased sales and potential financial losses for DH companies (tariff setting is based on norms rather than realistic expected sales of thermal energy; shifting tariffs to more realistic demand projections will help improve many business and planning functions);

- **Technical, efficiency**: Increase in heat losses in the DH system during transition periods. This is also a reflection of the fact that many systems are oversized and have not been designed taking into account changing demand trends. Some outlying areas of the DH network may find that the lower demand leads to density of heat demand where it is not cost-effective to maintain district heating without new customers; such adjustments would also improve overall system efficiency.

Given that every major energy efficiency project or mass IHS installation requires investment in reconstructing the heat supply system and changes to heat supply schemes, it is advisable to consider a comprehensive approach to project implementation in order to save resources.

Identified IHS Investment financing challenge(s): Existing support programs for consumers as well as available financing options for DH companies cannot provide required investment needs for large-scale IHS installation in Ukraine.

APPROVALS NEEDED

OBTAINING TECHNICAL PERMIT

The key step is obtaining a technical permit (TP) to connect to heat networks. The rules and procedure for issuing TPs are regulated by CMU Resolution No. 1198 "On approval of the Rules for the use of heat energy" of 3 October 2007 (hereinafter the Rules for the use of heat energy), NEURC Resolution No. 1232 "On Rules for issuing and approving technical conditions for connection to heat networks" of 29 October 2009 (hereinafter the Rules for issuing TP) and NEURC Resolution No. 343 "On Rules for connection to heating networks" of 19 October 2012 (hereinafter the Rules for connection to heating networks).

According to these acts, unauthorized interference in the existing heat supply and heat consumption systems is prohibited. The TP is issued by the heat supply company on the basis of a request from the customer (homeowners). The Rules for the use of heat and the Rules for issuing TP directly clarify that DH companies must issue technical conditions for all customer applications that are in compliance of the rules.

However, the basis for Ukraine's building energy code, the Law "On energy efficiency of buildings" envisages that some projects do not need to obtain a TP. According to the Law "On energy efficiency of buildings", buildings do not require TPs for connection to heat networks, except in cases of increasing heat load or heat capacity of engineering systems of the building. The problem is to prove that the project can be attributed to thermal modernization and will provide appropriate energy efficiency class for the building (class C) when any procedure for that is not established. Also, provisions of the NEURC, CMU Resolutions, and the Law may contradict each other and lead to some legal uncertainness for energy efficiency projects, including IHS. (See Annex 3 for additional information on requirements to obtain technical permits.)

Identified IHS technical permit challenge(s): Legal basis for issuing technical permits acts as an obstacle to installing IHSs.

EXAMINATION OF PROJECT DOCUMENTATION

According to Article 31 of the Law "On Regulation of Urban Development", construction projects (except for projects with the lowest consequence class) are subject to examination by specialized expert organizations. Assignment of the object to a certain class of consequences (responsibility) is carried out by the project design organization in coordination with the real estate developer. According to Article 32 of the Law, multi-family buildings are required to examine project documentation.

Another barrier is the limited number of experienced IHS designers on the market, which can lead to poor project preparation. There are also almost no educational institutions training design

specialists. Large companies such as Danfoss (a manufacturer of heat generating and automated equipment) are mainly involved in training valuable staff. There is a need for increased capacity building among IHS designers to address this barrier and improve project design and preparation.

Identified IHS examination of project documentation challenge(s): The limited number of experienced IHS designers on the market.

DH COMPANIES' ACCESS TO PREMISES

When a DH company pays for IHS installation, it must get access (or user rights) to the building premises. According to Law No. 417, the only mechanism for access is to approve the decision at a homeowners or HOA meeting. The plant rooms are usually provided to DH companies by homeowners through a lease or easement, and the question arises from which sources a DH company will cover rental services or the cost of the easement, given that the tariff does not contain such a component. Other countries have made such easements free or minimal (e.g. 1 UAH).

Identified IHS access to premises challenge(s): IHS installation project provided by DH companies requires getting access to premises usually through a lease or easement (which requires a decision of co-owners).

RESPONSIBILITY FOR MAINTENANCE

Responsibility for maintenance varies depending on who the owner is. When homeowners own the IHS, then according to Law No. 417, homeowners themselves provide for the maintenance, technical support and, if necessary, capital repairs (items 1.2 Part 1 of Article 7 of Law No. 417).

These legislative requirements are spelled out in the relevant bylaws, in particular:

1) The building owner must ensure that all indoor building systems are in proper working order, although the building owner can transfer this maintenance and repair obligation to a manager or other outside company in a contract[3] ;

2) When the building owner transfers maintenance obligations to an outside company, maintenance includes several tasks to ensure that the heating system in the building remains in good working order; inspections of specified equipment and parameters; and may also include repairs to ensure equipment operates properly. The service contract typically spells out the maintenance tasks, frequency, and emergency repairs.[4]

Alternatively, if the DH company owns the IHS, the DH company maintains and regulates the IHS. In this case, the DH company could also choose to hire a specialized company to service the IHS. This has been done by many DH companies in Europe. Having multiple mechanisms for IHS maintenance as well as installation can expand the market and reduce costs.

In spite of who is an owner of IHS, IHSs require quality maintenance that can be provided only by experienced professionals. There are a lot of cases when IHSs are damaged by people. In other words, durability of IHS much more depends on quality of maintenance, emergency support if

[3] Paragraph 12 of the Rules for the provision of heat supply services, approved by CMU Resolution No. 830 from August 21, 2019.
[4] Order of the Ministry of Energy "On maintenance of indoor heating, water supply, drainage and hot water supply systems" No. 219 from August 15.

needed and ensuring protection (eg. due to lockable doors) and not on payments for systematic visits by the maintenance companies. At the same time, the number of experienced IHS professionals are rather limited on the market. Developing a more robust service market can increase competition and lower costs.

The problem with IHS maintenance is mainly related to the possibility of a DH company including sufficient funds for maintenance in the tariff (as described above in the section on Integrating IHS costs).

Identified IHS maintenance challenge(s): There is no legal possibility to include maintenance costs in heat energy tariffs for NEURC licensees. Lack of experienced professionals specializing in IHSs.

The next chapter is dedicated to international experiences of mass IHS roll-out and focuses on the recent practice of four countries: Poland, Czechia, Latvia, and the United Kingdom (UK). Highlights of several other countries are provided. The policymaking experience and practical steps performed by the selected countries to achieve mass IHS installation may be sourced by Ukrainians for inspiration and lessons learned, however, adaptation and adjustment to local specifics needs to be ensured.

6. INTERNATIONAL FINANCING AND POLICY BEST PRACTICES FOR DEPLOYING AND SERVICING IHS

6.1. SUMMARY OF CASE STUDIES

This report covers four case studies, with brief information on several additional countries. The case studies were selected to cover a range of experiences with district heating reform and IHS installation. To best provide insights into how Ukraine could approach IHS installation, we selected examples of Eastern and Central European countries that had to switch from old, central heat substations to IHS, as well as one example from a Western European country to help highlight the role that IHSs play in new connections that can help grow DH. We considered several countries and selected these four based on the availability of data as well as the clarity and contrast of their examples. For example, Poland and Czechia both allow DH companies to own and operate IHSs, while Latvia requires ownership of the IHS eventually be transferred to building residents. Czechia had taken early steps to reduce cost by having buildings provide space to DH companies at low or no cost, but the approval times in Czechia tend to be long, as they are for all of building construction. The UK is working to expand district heating networks, which requires having a model to install IHS as part of the DH initial connection at a cost that will not be a barrier to connecting new customers.

6.2. POLAND [5]

OVERVIEW

Poland started reforming its district heating sector in the 1990s. After a sharp decline in DH sales in the 1990s, the share of DH among heating options stabilized in the 2000s. Since 2015, the share of DH has grown as DH replaces individual heating and new buildings are connected to DH. For example, in Wroclaw, DH provided heat to 62% of the buildings in the city in 2019, up from 45% ten years ago.[6] Krakow also had an extensive program to replace individual household coal furnaces with DH connections, which were partially subsidized. Most cities have concluded that developing DH combined with eliminating individual heat sources is one of the best ways to improve air quality.

Since 2000, DH companies have become the largest investors in IHSs. Poland introduced laws that give broad flexibility in IHS installation. Both DH companies and building owners can install, operate, and maintain IHSs; however, DH companies usually install, own, and maintain IHSs, and recover their costs through the tariff.

POLICY FRAMEWORK

The Energy Regulatory Authority of Poland (URE) has played a major role in the process of IHS installation. The URE developed guidelines to gradually eliminate central heat substations (also called group heat exchange stations) and replace them with building-level IHSs. Two important provisions in these guidelines are:

---

[5] We would like to thank Aleksander Golas, ESP expert and a former member of the Energy Regulatory Authority of Poland, and Andrzej Rajkiewicz, Vice President of the National Energy Conservation Agency of Poland, for providing information and helpful comments on this case study.

[6] https://www.wroclaw.pl/srodowisko/fortum-siec-cieplownicza-we-wroclawiu

- DH companies should modify their contracts with customers within three years so they can replace central heat substations with IHSs;

- The cost of installing IHSs is automatically included in tariffs; at the same time, there were near-automatic rejections of investment costs to maintain, rehabilitate, or establish central heat substations.

The Energy Law of 1997 also regulated the responsibilities and timelines for the transition, IHS ownership, and servicing of the IHSs and IHS rooms. In general, there was no problem meeting the deadlines established in the legislation for the transition, because virtually all HOAs[7] were interested in reducing their energy consumption.

IHS OWNERSHIP

In Poland, DH companies own most of the IHSs. For example, in Przemyśl, 93% of heat substations are owned and serviced by a local DH company.[8] Residents (such as the cooperative, administrator, housing community, or owner) can also own the IHS. According to the Building Law, all new and modernized buildings in Poland connected to the DH network must be equipped with building-level heat meters integrated in IHSs.

According to the Energy Law, the contractual responsibility usually ends at the building-level heat meter. The IHS is legally a part of the heat supply system and not part of the buildings' heating and domestic hot water installation.

MECHANISMS OF THE INVESTMENT RECOVERY

If the DH company owns the IHS, it recovers the cost of this IHS through the heat tariffs. Heat tariffs are calculated for five distinct groups: 1) customers without heat substations, 2) customers who receive heat from central heat stations, 3) customers who receive heat from IHSs owned by the DH companies; 4) customers who receive heat from IHSs not owned by the DH company; and 5) customers who receive heat from the heating network, in which heat is supplied from an external heat source.[9]

Calculation of particular heat tariffs is based on justified fixed and variable costs of heat production by different heat sources, and the cost of heat transmission and distribution is based on where the heat is delivered to.[10]

If the HOA owns the substation, the heat prices are lower than if the heat supplier owns the IHS in the building. If the IHS is installed at the customer's expense, the DH covers only cost on the construction of the heat network section to connect the IHS to the heat network.[11]

---

[7] https://www.ure.gov.pl/pl/konsumenci/faq-czesto-zadawane-py/cieplo/3813,Gdzie-znajduje-sie-miejsce-rozgraniczenia-wlasnosci-sieci-przedsiebiorstwa-ciepl.html?search=7853229202877; https://www.infor.pl/akt-prawny/DZU.2007.016.0000092,rozporzadzenie-ministra-gospodarki-w-sprawie-szczegolowych-warunkow-funkcjonowania-systemow-cieplowniczych.html

[8] https://mpec.przemysl.pl/plugins/filemanager/userfiles/images/2019/raport2018.pdf

[9] https://www.mpec.przemysl.pl/?taryfa-dla-ciepla

[10] http://www.inogate.org/documents/DH%20regulation_textbook_FINAL_eng.pdf

[11] Regulation on detailed rules for the formation and calculation of tariffs and billing for heat supply (Rozporządzenie w sprawie szczegółowych zasad kształtowania i kalkulacji taryf oraz rozliczeń z tytułu zaopatrzenia w ciepło).

The URE approves heat tariffs. The aim of the tariff approval process is to ensure that a company includes only justified costs of service in price calculations.

FINANCING OPTIONS

Until 1997, the heat price level did not depend on local conditions and heat supply costs. At the time, the Ministry of Finance set the official heat prices for the country-wide housing sector, according to the administrative map of Poland, cities, etc. DH companies used profit and depreciation allowances to cover their needs, which was not sufficient to finance the necessary investments. As a result, investments in the DH sector were financed mainly by state and local budgets.[12]

Since 1997, DH companies have financed the installation of most IHSs in Poland. The process of replacing old IHSs and installing new ones started in the early 1990s and finished in most cities by the mid-2000s.

DH companies have the option to cover all or only part of the IHS installation cost. For example, in Wroclaw, the DH company fully finances IHS installation in buildings that connect to its heat network.[13] OPEC, a DH company in Gdynia, covers 75% of the costs related to construction of new network sections to connect new customers to the heat network. Customers cover the remaining 25% of the network cost and pay for IHS design and construction.[14] Customers can install their own IHSs. There is no data available on how many IHSs customers have installed in Poland.

DH companies can finance IHS installations with their own working capital or through commercial bank loans. Since the payback period is short and this cost is nearly-automatically includable in the URE-approved tariffs, it is easy to get commercial loans for IHSs. In addition, HOAs[15] had access to cheap loan programs sponsored by IFIs, such as the World Bank and the European Bank for Reconstruction and development (EBRD), beginning soon after the fall of Communism, and from the mid-1990s, by the National Fund for Environmental Protection (NFEP).

Historically, IFIs and the EU provided initial funds to install IHSs. A DH system rehabilitation program financed by the World Bank started in 1992. The World Bank paid for IHSs in several cities, however, the DH companies had to pay for installation.[16] The $340 million project was implemented in Gdansk, Gdynia, Krakow, and Warsaw, covering all together about 20% of the Polish district heating market.[17]

---

[12] District Heating Sector. National Report, 2004.
[13] https://www.wroclaw.pl/srodowisko/fortum-siec-cieplownicza-we-wroclawiu
[14] https://opecgdy.com.pl/dla-klienta/podlacz-sie-do-sieci/koszty-przylaczenia-do-miejskiej-sieci-cieplowniczej/
[15] In this paper, we use the term "homeowners' association" as a generic term for HOAs, cooperatives, and other entities responsible for the maintenance of the buildings.
[16] https://www.mpec.krakow.pl/files/dokumenty/Monografia.pdf
[17] http://documents.banquemondiale.org/curated/fr/550781468146689071/pdf/multi-page.pdf

APPROVALS NEEDED

DH companies usually take care of all approvals to install IHSs for their customers.

When the DH company wants to install an IHS in a building, it needs to obtain a building permit from the city administration (usually the department for architecture and construction).[18] The maximum period to issue a permit is 60 days, but in practice, it can take longer in certain cases, such as for historic buildings, environmental issues, or fire protection. The building permit is valid for three years.

The DH company works directly with its customers. In Poland, 50% of HOA members are required for investment decisions. In housing cooperatives, in contrast, decisions are made by a majority of those present.

Box 1. Steps to connect to the heat network

1. DH customer submits the connection application and the DH company drafts connection conditions.
2. The customer and DH company agree on details such as construction date, approximate route of the heat pipeline, and room preparation for the IHS.
3. The DH company prepares and sends to the applicant a draft connection agreement.
4. The DH company prepares technical documentation, applies for a building permit, and then begins the project.
5. The DH company commissions the heat supply connection, including the IHS.g

DH companies are responsible for preparing the project design documentation for IHS installation. For new connections, DH companies usually include IHS provisions in the agreement to connect to the DH network.[19] The project design documentation is then reviewed by a municipality's building permitting department. The local government issues the operating permit, which allows the DH company to put the IHS into operation. The process to verify all the parameters takes 3-6 months. In total, the whole process, from the initial investment decision to the start of operation, typically takes 1.5-2 years. If building owners do the installation instead, they also need DH company approval.

Typically, the customers are responsible for preparing the utility room for the IHS according to guidelines and arrangements made with the DH company. While in most cases HOAs own IHS utility rooms, the DH companies maintain the rooms.

RESPONSIBILITY FOR MAINTENANCE

The IHS owner is responsible for maintenance. If the DH company owns the IHS, it can provide comprehensive maintenance and the IHS is served by the company's staff.

The HOA can also hire a specialized company to service the IHS. As part of a permanent service contract, service companies typically provide IHS maintenance once a month, along with round-the-clock readiness to address equipment failures or conduct inspections before and after the heating season. Examples of services provided by DH companies and service companies are presented in Annex 4.

[18] http://bip.piaseczno.pl/public/?id=88822#.; http://bip.um.szczecin.pl/files/F13F7457787846CCB691F18DF7F8C7A7/07_za%C5%82%20nr%207_decyzja.pdf
[19] https://www.mpec.krakow.pl/files/dokumenty/Umowa-o-przylaczenie-do-sieci-cieplowniczej-przyl_Zal_PS05_04A_wyd.10_NOWY.pdf

Table 3 Advantages and disadvantages of IHS ownership models in Poland

	DH COMPANY OWNS IHS	CUSTOMER OWNS IHS
Advantages for customers	• Significant reduction or even exemption from expenses related to the substation purchase. • IHS Service, regulation, operation, and maintenance is carried out by the DH company's qualified and experienced technical staff. • Security of heat supply is ensured and the time to addressing possible equipment failures is minimized.	• Lower heat bills.
	• Freedom in making decisions to turn the heat on and off	
Disadvantages for customers	• Higher heat bills compared to customer-owned IHSs since these services are included in heat tariffs.	• Up-front financial cost of purchasing and installing the IHS. • The need to service, regulate, operate, and maintain the IHS. • Risk of equipment failure and delay with its service. • HOA needs to pay for electricity used by the IHS.

Source: Based on information from the DH system in Przemysl[20]

The DH company supplies heat according to the agreement with the HOA. This agreement indicates the connected heat load for each heating season. If customers decide to change the connected heat load (for example, because of building renovations), they need to submit a written request to the DH company to amend the contract. The notification should indicate peak demand and it should be submitted before the start of the heating season. For example, a company in the town of Konin requires that the notification be submitted by the end of August for the next heating season.[21] The customers may amend their heat load only once a year, as it constitutes the basis for calculating fixed monthly capacity charges. The DH companies are not allowed to set a minimum amount of heat the customers have to purchase. At the same time, they are not obliged to provide any specific comfort temperature in the building. Instead, they should secure the availability of a certain hourly amount (and temperature) of the heat carrier, both calculated to reflect the requested capacity.

HOW QUICKLY THE MODEL CAN EXPAND IHS DEPLOYMENT

The Polish model gives DH companies and customers a great degree of flexibility in their decisions to install, service, and maintain IHSs. The URE developed guidelines to gradually eliminate central heat substations and replace them with building-level IHSs. The institutional and regulatory framework allows DH companies to quickly make investments and recover their costs through the tariff. At the same time, they and HOAs have access to preferential financing programs provided by the NFEP.[22] As a result, DH companies in Poland are interested in expanding their heat networks and heat sales and are willing to participate in at least a portion of the connection costs.

[20] https://mpec.przemysl.pl/?wezly-cieplne
[21] https://www.mpec.konin.pl/index.php/odpowiedzi-na-najczesciej-zadawane-pytania.html
[22] Except for large loans for major city DH companies, NFEP funding for individual HOAs, householders, and smaller DH companies does not usually take a direct form, but is channeled through a specialized, NFEP-owned commercial bank (Bank Ochrony Środowiska).

6.3. CZECHIA[23]

OVERVIEW

In the last 20 years, many central substations in Czechia have been replaced with IHSs in buildings. District heating companies, which are usually either owned by municipalities or have been privatized, typically made these investments as part of rehabilitation of district heating systems. In some cases, it was done by a service provider or company that purchases DH from the utility and serves as a supplier to end users.

POLICY FRAMEWORK

IHS installation was carried out in Czechia as part of larger DH reforms and privatization. Subsidies to DH companies were also phased out during this time. This caused heat tariffs to rise, but installing IHSs, which improved energy efficiency, was a key measure for avoiding rapidly increasing costs to customers. It was usually the DH company that made the investments into IHSs, which recovered the costs through heat tariffs. In some cases, municipalities required IHS installation in the lease of DH infrastructure to DH companies owned by municipalities. Requirements to create housing associations, as well as the common practice of setting aside space for the substation in residential buildings during housing privatization also helped facilitate the transition from central substations to IHSs.

IHS OWNERSHIP

In Czechia, the DH company usually owns the individual heat substation. It is possible for building owners to own the IHS, but this is rare.

In typical cases where the DH company owns the IHS, space in the building has to be provided for the substation plant room, and the DH company must reach a rental agreement with the building owners for unlimited use of the room. The DH company typically gets the substation plant room for free or pays a symbolic fee to lease it, since the space was set aside during building privatization in most cases through an easement. If the building owners do charge the DH company rent, it is usually not high because it is recognized that increasing it would raise the heat tariff and would create additional processing costs.[24]

MECHANISMS OF THE INVESTMENT RECOVERY

For the majority of IHSs that are owned by utilities, the cost of the IHS is recovered through the tariffs for end users. The DH company has tariffs with different levels: primary heat in large transmission pipes, a wholesale tariff for heat up to the IHS, and tariff for heat after the IHS.

Heat tariffs in Czechia are based on the cost-plus principle and include three types of costs: economically justified costs, a reasonable profit, and value added tax.[25] Economically justified costs are based on data in the utility's accounting and fall into two basic groups: variable costs (mainly fuel costs, as well as purchased thermal energy, electricity, process water, and charges for air pollution

---

[23] We would like to thank Jiří Zeman, international consultant, and Tomáš Voříšek, technical director of SEVEn, for providing information and helpful comments on this case study.
[24] http://www.eru.cz/teplo/casto-kladene-dotazy
[25] https://www.csas.cz/content/dam/cz/csas/www_csas_cz/dokumenty/analyzy/Tepl%C3%A1renstv%C3%AD%20v%20%C4%8CR_2018_10_public.pdf

or purchase of emission allowances) and fixed costs (including the cost of assets operated for the production and distribution of heat, repairs, depreciation, rent, overheads, wages, and statutory insurance).[26]

DH customers pay for the gigajoules (GJ) consumed and a fixed charge to the utility based on capacity, as well as hot water volume. The HOA or housing cooperative signs the DH service contract, so residents do not get a bill directly from the heating company; the housing association or a service company it hires does the billing breakout for residents.

FINANCING OPTION(S)

In most cases, the utility finances installation. There have been some pilot projects that co-financed installations, but the bulk are financed through utilities. Financing can be from the utility's own funds or commercial loans. DH utilities can easily get commercial financing because the projects have such short payback periods. It is possible for tenants to pay instead, in which case they would be charged the wholesale tariff instead of the IHS-based tariff, but this is less common. In the last five years, some projects have also been co-financed through an EU program that provides funding for replacement of old heat distribution infrastructure.

In new buildings, it is more common to have a gas-fired boiler for the building rather than district heating, and building owners usually pay for and own their own boiler. However, they also have the option to own and operate an IHS and pay a lower tariff that reflects this. Alternatively, they can have the utility pay for the IHS and recover the cost through the heat tariff.

APPROVALS NEEDED

IHS installation requires approval from homeowners, since it impacts the cost of the service. A critical factor enabling this is to have an organized housing association. In Czechia, it was mandatory to create an HOA or cooperative before the building could be privatized. For new buildings, the developer creates the HOA legally before people move in, and people who purchase apartments become members.

The quorum of members required for making investment decisions impacts how easily IHSs can be installed. In Czechia, the percent of HOA members required for investment decisions has decreased over time and is now under 80%. This makes it easier for an HOA to make decisions, especially compared to some other countries where 100% of members must be present to meet quorum. In housing cooperatives, in contrast, decisions are made by a majority of those present. This means that decisions can be made by a minority of homeowners, if people do not participate in cooperative meetings, but also makes it easier to facilitate renovations and investments.

The DH company handles installation and approvals. It is responsible for project design documentation for IHS installation, which is typically done by either the DH company's own engineers or in collaboration with an outside engineering company. The project design documentation is then reviewed by the municipality's building permit department. Since it typically involves replacing piping as well as electrical and telecommunications connections, the DH company must get approval from the electricity distributor, running water distributor, and telecommunications company. Once it has received statements from all of the necessary entities, the building permit is approved. This part of the process can take about 6-12 months. After obtaining

[26] http://www.eru.cz/cs/teplo/casto-kladene-dotazy#6

the building permit, the DH company will install the equipment and apply for an official inspection. Next, the local government issues the operating permit, which allows the DH company to put the IHS into operation. The process to verify all the parameters takes 3-6 months. In total, the whole process, from the initial investment decision to the start of operation, typically takes 1.5-2 years. Through the construction permitting process, the DH company demonstrates that the installation meets standard safety and fire requirements. If building owners do the installation instead, they also need DH company approval in addition to the other requirements mentioned above.

RESPONSIBILITY FOR MAINTENANCE

The IHS owner, usually the utility or service provider, is responsible for maintenance. In some cases, it hires a third-party service company to do the maintenance, but the IHS owner pays for this service. If owned by the DH company, maintenance costs are factored into the regulated heat tariff; the end user does not see this cost broken out.

HOW QUICKLY THE MODEL CAN EXPAND IHS DEPLOYMENT

Because IHSs are very cost-effective, utilities were able to upgrade many central substations by financing installation and owning the IHSs. Utilities could get commercial financing for these investments because IHS installations could generally be repaid in less than four years. IHS installations also made it easier to balance the whole system and improve service quality. Expenses for DH consumers have grown as subsidies were gradually reduced, but improved efficiency meant that expenses did not increase as much as they would have otherwise. Problems with overheating were reduced, as IHSs allow the temperature to be automatically regulated based on the outside temperature. The HOA or building owners could decide what temperature they wanted, which improved satisfaction with district heating and helped retain customers. In addition, metering along with better controls and reducing overheating lowered bills for customers. Since IHS installation was associated with better service, pushback from homeowners was not a major problem. For example, there was a project three years ago in which a DH company owned by the municipality replaced about 20 central substations; 90% of the heating customers viewed the project positively because it helped increase the service level and lowered the price of hot water.

At first, DH utilities were resistant to installing IHSs in buildings. However, many customers, in some cases entire buildings, were disconnecting from DH, leading utilities to realize that they had to provide high quality service to compete with individual heating systems. In addition, many old pipes needed to be renovated anyway, and installing IHSs, which moved hot water preparation inside each building, and renovating two pipes rather than four was less expensive for companies. Some utilities did have challenges with excess capacity in central DH stations, which had to be reconstructed if supply dropped too much. However, the utilities were reimbursed for the IHS investment costs through heat tariffs, and customer satisfaction improved. This was another enabling factor for large-scale IHS deployment.

6.4. LATVIA[27]

OVERVIEW

Latvia inherited a Soviet-style DH system and rebuilt it in the 1990s. The national government and municipalities have played an essential role in modernizing the DH systems. Cities owned most DH companies and required them to install IHSs using grants and loans from commercial banks. DH companies leased the IHSs at fixed prices to residents before turning them over. Customers signed separate agreements with DH companies to service IHSs. The quality of equipment was sometimes questionable.[28]

Most of the DH consumers are located in Riga (representing about 50% of the customers in the country) and most of the remaining customers are in the eight other largest Latvian cities and towns.[29] This case study is mostly built on the example of Rigas Siltums, the DH company in the capital of Latvia.

POLICY FRAMEWORK

With large-scale property privatization in Latvia in the 1990s, homeowners became responsible for their property. They had to invest in reconstructing the buildings, including installing IHSs. However, residents did not have enough money to pay and banks were initially reluctant to lend to HOAs to invest in IHSs. However, banks were willing to cooperate with municipalities or DH companies. In this situation, the government of Latvia adopted the *State Investment Program* in 1995 to replace old central heat substations with IHSs, which was the first step in Latvia's large-scale deployment of IHSs.

Municipalities that owned DH companies implemented DH modernization projects in two phases. During the first phase (1997-2001), DH companies installed heat meters and IHSs and replaced old heat pipes using government grants and loans from commercial banks and IFIs. In the second phase, DH companies modernized the heat production process by replacing old fossil fuel heat-only boilers and installing the next generation, automated IHSs using EU funds. DH companies introduced smart meters for wireless remote automatic reading of heat consumption data.

In Riga, the City Council adopted the *Concept of Riga Heat Supply Development*[30] in 1997 and developed the *Riga District Heating Rehabilitation Project*[31] in 1999. The goal of the project was to replace all central heat substations with IHSs in all multi-family buildings connected to the heat network. The Riga City Council issued regulations for the installation and modernization of IHSs in 1999.[32]

---

[27] We would like to thank Dr. Valdis Vītoliņš, CEO of Jurmala District Heating Company, for providing information and helpful comments on this case study.

[28] Energy Charter Secretariat, 2008. Energy Efficiency Policies and Programmes of Latvia: In-depth Review, p. 24. https://www.energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Latvia_2008_en.pdf

[29] https://www.euroheat.org/knowledge-hub/district-energy-latvia/

[30] Riga City Council. Decision No. 5438 "On the Concept of Riga Heat Supply Development" (Par Rīgas siltumapgādes attīstības koncepciju), December 23, 1997.

[31] Riga City Council. Decision No. 6981 "On the Riga District Heating Rehabilitation Project" (Par Rīgas centralizētās siltumapgādes rehabilitācijas projektu), January 26, 1999.

[32] Riga City Council Regulation No. 41. "Regulation for installation and modernization of individual heating units" (Individuālo siltummezglu ierīkošanas un modernizācijas noteikumi), December 28, 1999. https://likumi.lv/ta/id/102-individualo-siltummezglu-ierikosanas-un-modernizacijas-noteikumi

IHS OWNERSHIP

In the mid-1990s, DH companies obtained commercial loans to procure and install IHSs, while cities provided municipal guarantees. DH companies owned the IHSs for the first several years, while customers made lease payments to cover the initial investments and interest. In Riga, the DH company was not allowed to own the IHS long-term, despite its initial investment.[33] Now IHSs are owned by building owners[34] and only in rare cases can they be owned by DH companies. Most buildings in Latvia are equipped with IHSs today.

In Riga, the City Council obligated Rigas Siltums to "organize and ensure planned installation or modernization of individual heating units in buildings." Customers also had an option to hire independent contractors to install IHSs. [35]

Rigas Siltums removed 185 central heat stations and installed over 3,000 IHSs from 1997 to 2001.[36] The City Council approved the *Riga Heat Supply Development Concept for 2006–2016*[37], which stipulated that all buildings connected to the DH network should be equipped with IHSs. All public buildings were equipped with IHSs by 2005, and in total the company installed about 8,000 IHSs in the city by 2008. In parallel, the company also eliminated the pipes for hot water supply, since IHSs supply the hot water more cost-effectively.

MECHANISMS OF THE INVESTMENT RECOVERY

During the first stage of DH modernization reform, DH companies owned the IHSs and leased them to building owners. In 2000, the Riga City Council issued a regulation to define the method for building owners to pay back the DH companies for investments made in internal building systems. The DH company and the building owners signed a separate agreement to recover the IHS cost. The residents paid \$0.05/m^2 per month for up to ten years (the maximum term according to the Riga regulation); these lease payments allowed residents to repay the cost of the IHSs, so that Rigas Siltums could then transfer ownership to residents without losses.[38]

Rigas Siltums procured IHSs in bulk to reduce the unit price. The price tag for one IHS was \$8,000-\$10,000, including construction costs. There is some evidence that the quality of IHSs installed by the DH companies was inadequate[39], and cheap water pumps and leaky heat exchangers were two key problems.[40] This made the IHSs less durable and efficient than in other countries we assessed. To improve the efficiency of the search for leaks, the company started coloring the water since 2010

---

[33] Riga City Council Regulation No. 41. "Regulation for installation and modernization of individual heating units" (Individuālo siltummezglu ierīkošanas un modernizācijas noteikumi), December 28, 1999. https://likumi.lv/ta/id/102-individualo-siltummezglu-ierikosanas-un-modernizacijas-noteikumi

[34] In accordance with Paragraph 3.3 of Cabinet of Ministers Regulation No. 169 of May 06, 1997 "Procedure for Calculating Apartment Rent" (Dzīvokļa īres maksas aprēķināšanas kārtība).

[35] Riga City Council Regulation No. 41. "Regulation for installation and modernization of individual heating units" (Individuālo siltummezglu ierīkošanas un modernizācijas noteikumi), December 28, 1999. https://likumi.lv/ta/id/102-individualo-siltummezglu-ierikosanas-un-modernizacijas-noteikumi

[36] Rigas Siltums annual report, 2001.

[37] Riga Heat Supply Development Concept for 2006–2016 (Rīgas siltumapgādes attīstības koncepcija 2006.–2016.gadam). http://www.rea.riga.lv/files/Rigas%20Siltumapgades%20Attistibas%20Koncepcija%202006.-2016.%20gadam.pdf

[36] Riga City Council Regulation No. 41. "Regulation for installation and modernization of individual heating units" (Individuālo siltummezglu ierīkošanas un modernizācijas noteikumi), December 28, 1999. https://likumi.lv/ta/id/102-individualo-siltummezglu-ierikosanas-un-modernizacijas-noteikumi

[39] Energy Efficiency Policies and Programmes of Latvia 2007: In-depth Review, https://www.energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Latvia_2008_en.pdf

[40] https://www.rosteplo.ru/Tech_stat/stat_shablon.php?id=650

to quickly identify damaged heat exchangers in IHSs. Similarly, in Jūrmala, heat exchangers, water pumps, and electronic controllers have been repeatedly replaced after initial installation in the 2000s, however, the replaced equipment has not always been chosen to ensure optimal heat consumption.[41]

FINANCING OPTIONS

DH companies financed the vast majority of IHS installations. Rigas Siltums financed the replacement of the central heat stations using its own money and commercial loans. The Swedish government financed conversion of the first five central heat stations. IFIs, such as the World Bank, EBRD, and Nordic Investment Fund, also financed the modernization of the DH systems, including IHS installations. There is a requirement in Latvia to install IHSs in new buildings as part of the internal engineering system. Development companies install IHSs in new buildings as part of the construction cost.

APPROVALS NEEDED

DH companies have set the individual technical requirements on connecting buildings to the DH grid and the technical parameters that need to be met. IHSs are designed by certified designers in accordance with technical requirements issued by DH companies.

Box 2. Procedure for installing or upgrading IHSs in Riga (under the 1999-2005 program)

1. The DH company coordinated with customers on its intention to install an IHS.
2. The DH company installed or modernized an IHS in accordance with the requirements of the regulatory, design, installation, and operation regulatory documents.
3. The local government provided permits to perform the work.
4. The DH company sent a written notice to the building owner six months before the commencement of the intended work.
5. The owner of the building provided building inventory data, examined technical documentation, and prepared a room for the IHS.

Source: Riga City Council Regulation No. 41, 1999.

RESPONSIBILITY FOR MAINTENANCE

Riga Siltums has agreements with most of its customers to maintain their IHSs. The service package includes the following:

- Once a year: maintenance and repair of heating systems and hot water supply; maintenance of automatic systems; checking pressure gauges and thermometers; flushing the heating system; chemical flushing of heat exchangers; hydraulic tests.
- Once a month: filter cleaning.
- Once a week: visual checks; filter check; control of IHS parameters.

[41] http://news.lv/Jurmalas-Avize/2017/03/24/jurmalas-siltums-aicina-rupeties-par-energoefektivitati

Rigas Siltums charges $0.03/m^2 of apartment area per month for IHS maintenance. Maintenance also includes adjustment of IHS settings. An HOA could choose a servicing company for IHS maintenance, but usually, Rigas Siltums provided maintenance of the IHSs.

HOW QUICKLY THE MODEL CAN EXPAND IHS DEPLOYMENT

Latvia made rapid progress in replacing central heat stations with IHSs in the 1990s and the early 2000s. In Riga, the City Council recommended installing or modernizing IHSs in buildings that was mostly done from 1999 to 2005. In Riga, for example, 90% of IHSs were installed during the first six years of reform.

There was some lack of interest from the DH companies to install IHS so cities forced DH companies to invest in IHSs. However, DH companies only installed the IHSs and leased them to the customers. As a result, DH companies may not have been interested in the final results, and the quality of the equipment sometimes was questionable. This model showed some early success in the deployment of IHSs, but lack of choice and competition often led to results different from expected.

6.5. UNITED KINGDOM[42]

OVERVIEW

Most district heating networks in the UK are relatively new, so there has not been a process of replacing central substations with individual heat substations in the UK, unlike the Central and Eastern European countries discussed in the previous case studies. Instead, IHSs are typically installed in new or existing buildings at the time of connection to the DH network. There are different arrangements possible for financing the cost of the IHS, but often these investments are made by the DH company and costs are recovered through heat tariffs and connection charges.

POLICY FRAMEWORK

District heating systems have been expanding in the UK in recent years. Although DH has existed for many decades in the UK, many DH systems were discontinued in the 1970s and 80s as individual gas boiler heating systems grew in popularity. However, the government recently set a target of 17% of UK heating needs to be met through heat networks by 2030,[43] and the UK government is dedicating significant funding to build heat networks. Expanding district heating systems is a central part of the UK's strategy to achieve decarbonization targets.

IHSs are not required by national regulations but are almost universal in buildings connected to DH. IHSs include heat exchangers, meters, and control valves, and are installed to protect both the building and heat network by creating hydraulic balance within the building and ensuring that they deliver back the correct temperatures. IHSs are also necessary because most DH companies charge a high penalty if the return temperature to the energy center is too low.

---

[42] We would like to thank Soulla Paphitis, business development manager at Danfoss, for providing information and helpful comments on this case study.
[43] https://www.euroheat.org/knowledge-hub/district-energy-united-kingdom/

IHS OWNERSHIP

Regulations in the UK allow for flexible ownership arrangements. A common approach is for the heat supplier or network operator[44] to own the substation.[45] Network operators can be local government authorities or private energy service companies (ESCOs), and are usually separate from the energy supplier.[46] The substation often marks the ownership boundary between the DH company and its customers; however, an alternate arrangement is for the DH company to own and be responsible for all piping and installations within a residential building, including heat interface units (HIUs)[47] and meters serving individual apartments. It is also possible for a building owner to own all installations within the building, including the substation.

Under the EU's Energy Efficiency Directive requirements, heat meters are required to be installed at each building supplied by a heat network. In addition, the DH company should install individual heat meters for each customer or dwelling supplied, unless it can be shown that this is not cost-effective or technically feasible. When this is the case, heat cost allocators must be installed, unless they are also shown to be not cost effective.[48]

In typical cases where the DH company owns and operates the substation, the building developer or owner is responsible for ensuring that the substation plant room is suitable for the IHS before installation begins, and also needs to provide the DH company with access to the plant room for installation and regular maintenance. This usually involves a separate contract to agree on property access and easements. A standard arrangement is for the substation plant room to be leased long term to the DH company at a nominal rent.[49] If the building owner instead owns the substation, the DH company would not need to be given access rights to customers' premises.

MECHANISMS OF THE INVESTMENT RECOVERY

When the DH company installs and owns the IHS, it will typically recover the investment cost through payments from the building owner and heat customers. The heat provider will typically charge an initial fee for connecting to the heat network, which is usually paid by the building developer or landlord, not customers. The heat tariff is made up of a standing, or fixed, charge, (which covers regularly recurring operation and maintenance costs and is normally paid by the landlord of rented residential premises), and the unit charge (the price per unit of heat supplied, normally paid by the customers).[50]

Because there are several possible contract structures, the heat tariffs can be set in different ways. They can be set specifically to recover construction and operating costs (cost-based pricing), set initially by the heat provider through competitive tender and then index-linked, or set to match the opportunity cost of using the heat network (avoided cost pricing). The avoided cost approach is often used to set the heat tariff, especially when an ESCO serves as the DH company. This uses the cost of gas-fired central heating as a benchmark to set heat prices, as gas heating is the most cost-

---

[44] Although there are different kinds of companies that can own and operate DH networks, for consistency in nomenclature, we will use the term DH company instead of network operator throughout the rest of this case study.
[45] https://www.energyservicebristol.co.uk/wp-content/pdf/Heat_Network_Developer_Pack_Part2_Aug18.pdf, https://www.arup.com/-/media/arup/files/publications/h/strategic_comm_hn_guide_issue_1_22072016.pdf
[46] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf
[47] HIUs are installed in individual dwellings to deliver and record heat consumption. They incorporate many of the same elements as individual heat substations (heat exchangers, metering, controls) but on a smaller scale. https://www.arup.com/-/media/arup/files/publications/h/strategic_comm_hn_guide_issue_1_22072016.pdf
[48] https://www.london.gov.uk/sites/default/files/osd44_draft-heat-networks-code-of-practice-for-the-uk.pdf
[49] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf
[50] https://www.energyservicebristol.co.uk/wp-content/pdf/Heat_Network_Developer_Pack_Part1_Aug18.pdf

effective alternative form of heating and hot water for most residential customers (for developments where this is not the case, an alternative benchmark can be used).

FINANCING OPTIONS

Typically, the DH company pays for the IHS and is responsible for arranging financing, either through its own funds or commercial loans. The government also provides grants for implementing heat networks. The DH company recovers the investment cost through charges for connecting buildings to district heat and the heat tariff.

If the substation is instead owned by the building owner, then they are responsible for arranging financing for the installation. For example, under certain contract types, a building landlord or developer could pay for and own the substation, and also be responsible for setting the price of heat and selling it to customers. It is also possible to have a contract where an ESCO operates the substation and other equipment over a certain contract term, but ownership remains with the building owner.

In some cases, the building developer or owner may take on responsibility for financing some of the construction activity and then transfer the assets to the ESCO or network operator for an agreed fee (which may not exactly match the construction cost). Most commonly this approach is taken for the secondary heat network inside the building and apartment-level heat interface units, but on some occasions has been extended to include the IHS.[51]

APPROVALS NEEDED

If an existing building is connecting to DH, the tenants need to agree to any work being done. Often this involves a consultation period, where the building owner sends out a notice of planned works and residents have a certain period (for example, 30 or 60 days) to comment or raise objections. If there are no objections, then plans for the work can move forward. If there are objections, the building owner must address those and have another consultation period.

The local government responsible for a particular area also needs to approve new connections to DH. Since new connections to a network involves putting in new piping, approval is also required from the highways agency to dig up roads and lay the pipes. There are standard policies and procedures required for the products used for the network equipment.

The technical specifications for IHSs are determined by the DH company. The design consultancy (which designs the network, components, products, and mechanical system) works within those specifications, and the design must be approved by the DH company. If the connection is for an existing building, then the building maintenance crew must also advise the process.

Substations must be tested before being put into operation. The main component of this is pressure testing, or PED testing. Under the EU directive for pressure equipment, any component within the heating system must be tested at 1.5 times the pressure that it is designed to work at. Once the substation has been built, a pressure test certificate is provided with the equipment to certify that it has been pressure tested and has passed all requirements. For domestic hot water systems, water regulations advisory scheme approval from the Water Board is also required. Some customers may

[51] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf

ask for additional certification on the welding of the pipework, which involves taking infrared readings of pipe welds, and is normally done at an additional cost.

RESPONSIBILITY FOR MAINTENANCE

The owner of the substation, typically the DH company, is responsible for operating and maintaining the substation. The cost of maintenance for the primary heat network, which includes the substation, is included in the heat price.[52]

In cases where the building owner owns the substation, they will typically pay a building maintenance company or other contractor to perform maintenance. Under contracts where an ESCO operates but does not own the substation, the ESCO provides maintenance. In this case, there may not be an incentive for the ESCO to maintain the equipment in good condition, so the contract will typically contain detailed provisions for operation and maintenance standards.[53]

HOW QUICKLY THE MODEL CAN EXPAND IHS DEPLOYMENT

Since IHSs in the UK are typically installed as part of the process of connecting buildings to district heating networks, the scale at which the model can expand IHS deployment depends on how quickly it can expand DH systems and connect buildings to the network. Since most IHSs are financed by the utility with the costs recovered through the tariff and connection charges, this is similar to other counties in Central Europe that rapidly retrofitted their connections, so the model appears to have potential for expanding IHS deployment.

There are some methods used in the UK to improve incentives for extending heat networks. One example is zoning that requires new developments to connect to an existing heat network if they are within a certain distance of the network. Another is to require the DH company to connect new customers on standard terms on premises within a certain distance of the network, to spread the additional cost of new connections over all existing customers. Finally, national or local government funds can provide refundable finance for the cost of a new connection. Public sector debt or equity may be available as part of a local authority's policy package for development of a heat network, and can be partly or fully funded through borrowing from the Public Works Loan Board.[54]

6.6. MODELS IN OTHER COUNTRIES

The following table provides brief summaries of the models for IHS installation used in other countries besides the detailed case studies above.

Table 4 Summary of findings in additional countries.

COUNTRY	KEY FINDINGS	NOTES
Finland	The building owner owns the IHS, pays for the IHS and installation, and is responsible for maintenance.	Finland and other Scandinavian countries were not considered in detail for case studies because in these countries, DH tariffs are not regulated and DH competes on the market with other types of space heating. This would likely impact how IHSs

[52] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf
[53] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf
[54] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf

COUNTRY	KEY FINDINGS	NOTES
		are installed and limit the extent to which lessons can be applied to Ukraine.
France	Either the DH company or building owner can own the IHS, but most commonly the DH company owns it and recovers the cost through the tariff.[55]	DH in France uses a lot of steam, reducing efficiency, and has tariffs that are lower for public entities.
Italy	The building owner pays upfront to connect to a DH system, which includes the cost of an IHS. The building owner owns the IHS and is responsible for maintenance.[56]	The charges for connecting to DH are high, so expansion of DH systems has been limited.
Lithuania	Large-scale replacement of central substations with IHS was completed in 2004 and was mainly done by DH companies, which used to own the IHSs, used to service IHSs, and used to recover the cost through the tariff (differentiated tariff). After reform in 2011, ownership and servicing of IHSs was transferred by law to homeowners.	Some pilot projects were also financed through an energy efficiency program that provided funding to HOAs. In these cases, the HOAs owned the substation and repaid financing.[57] Replacement of central substations with IHSs saved about 15% of heat, and also significantly reduced pipeline maintenance costs and increased service quality.[58]

6.7. KEY FINDINGS FROM INTERNATIONAL CASE STUDIES

In most countries considered here, regulations permit DH companies to make investments into IHSs and own the equipment. In Central and Eastern European countries where there was replacement of central substations with IHSs, this generally catalyzed the process of large-scale substation upgrades as building residents had limited ability to finance the investments themselves. In general, countries with more flexibility in ownership arrangements appear to have better outcomes.

In Poland, DH companies own and service most of the IHSs in the country. Since they invest in the IHSs and operate them during an extended period of time, DH companies are interested in high quality equipment. Poland also has a developed service market where the competition between DH and servicing companies improves the quality of customer services. DH companies include the cost of IHSs in heat tariffs. The DH companies are not allowed to set a minimum amount of heat the customers have to purchase, and the customers can change this amount before every heating season. The Polish model gives the DH companies and customers a high degree of flexibility in their decisions to install, service, and maintain IHS.

---

[55] http://cpcu.castor-dev.com/wp-content/uploads/2019/07/Tarifs-de-vente-CPCU-Janvier-2019.pdf

[56] http://swww.a2acaloreservizi.eu/home/cms/a2a_caloreservizi/area_clienti/documenti/Prezzi-TLR-Prestazioni-01_apr_2020.pdf, https://www.alperia.eu/public/downloads/calore/criteri_di_determinazione_dei_corrispettivi_di_allacciamento_per_zona_bolzano.pdf

[57] http://documents.worldbank.org/curated/en/270421468187730327/pdf/98691-WP-Box393176B-PUBLIC-WB-IFC-Private-Sector-web.pdf, https://www.ase.org/sites/ase.org/files/residential_ee_study_final.pdf, http://documents.worldbank.org/curated/en/785701468757001491/pdf/multi0page.pdf, https://www.lsta.lt/files/Leidiniai/LSTA10metu_anglu.pdf

[58] https://www.euroheat.org/news/district-energy-in-the-news/lithuanian-district-heating-celebrates-80th-anniversary/?hilite=%22heat+substations%22

Czechia's practice of setting aside space for the substation plant room and allowing the DH company to use the space for free (or a small rental charge) provides an example of the benefits of reducing steps needed for IHS installation. Since charging the DH company for leasing the space would be reflected in a higher tariff anyway, allowing free use of the space reduces paperwork and approvals with no significant impact on the costs paid by heat customers. However, IHS installation in Czechia appears to move slowly due to lengthy approval requirements in other stages of the process.

In Latvia, DH companies installed the majority of IHSs in the country and transferred them to the customers. Customers now own IHSs, and DH companies own them only in rare cases. This model provided some quick progress in the deployment of IHSs in the country. However, the quality of IHSs sometimes was questionable, and the customers had to invest again to modernize them.

In the UK, there is a wide range of possible ownership and financing arrangements for the IHS and connecting a building to district heating. While this creates flexibility and can allow buildings to connect to DH under terms that will meet their needs, it can also complicate the process of connecting to DH by requiring complex negotiations. Different contract structures can also provide different incentives for the DH company to maintain good condition of equipment like the IHS.[59] Heat customers have reported varying levels of satisfaction with DH service quality and price.[60] However, this is a somewhat different case study from the others, as DH is relatively new in the UK. Unlike in Ukraine, the main challenge for the UK is growing DH networks and connecting new customers, rather than upgrading existing networks and equipment.

[59] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf

Table 5 Summary of international practices

Experience	Poland	Czechia	Latvia	United Kingdom
Essential national policy decision to kick-start the massive IHSs installation	The Energy Regulatory Authority developed guidelines to gradually eliminate central heat substations and replace them with building-level IHSs (DH companies should modify their contracts with customers and the cost of installing IHSs is automatically included in tariffs).	IHS installation was carried out as part of larger DH reforms and privatization (when DH subsidies were phased out). In some cases, municipalities required IHS installation in the lease of DH infrastructure. Requirements to create housing associations also helped facilitate IHS installation.	The government adopted the State Investment Program in 1995 to replace old central heat substations with IHSs. Some municipalities adopted the Concept of Heat Supply Development.	IHSs are not required by national regulations but are almost universal in buildings connected to DH. IHSs are also necessary because most DH companies charge a high penalty if the return temperature to the energy center is too low.
Ownership of IHS	DH companies own most of the IHSs (which are legally a part of the heat supply system), but homeowners can also own it.	DH company usually owns the IHS.	Now IHSs are owned by building owners and only in rare cases they can be owned by DH companies.	A common approach is owning IHS by heat supplier or network operator. It is also possible for a building owner to own the IHS.
Approvals needed	DH company needs: 1. to require approval from homeowners. 2. to obtain a construction permit from the city administration to install IHS.	DH company must get approval from homeowners, from the electricity distributor, running water distributor, and telecommunications company. After, the local government issues the operating permit.	DH company coordinated with customers on its intention to install an IHS The local government provided permits to perform the work	The tenants need to agree to any work being done with DH companies. The local government responsible for a particular area also needs to approve new connections to DH companies.
Financing options	DH companies can finance IHS installations with their own working capital or through commercial bank loans The World Bank paid for IHSs in several cities	The utility finances the installation either with its own working capital or through commercial loans. It is possible for tenants to pay instead, if they will own the IHS. It is also possible for homeowners to get loans.	Financed by: 1. DHs 2. IFIs 3. the developer in new buildings, as a part of the construction cost	The DH company recovers the investment cost through charges for connecting buildings to district heat and the heat tariff. If the IHS is instead is owned by the building owner, then the building owner is responsible for arranging financing for the installation
Integration of the IHS installation cost	If the DH companies owns the IHS, it recovers the cost of this IHS through the heat tariffs If the HOA owns the substation, the heat prices are lower than if the heat supplier owns the IHS	For the majority of IHSs, the cost of the IHS is recovered through the tariffs for end users.	Firstly, DH companies owned the IHSs and leased them to building owners. Since 2000 in Riga, the DH company and the building owners signed a separate agreement to recover the IHS cost The residents paid \$0.05/m^2 per month for up to ten years	When the DHC installs and owns the IHS, they will typically recover the investment cost through payments from the building owner and heat customers
Responsibility for maintenance	DH company owner - it can provide maintenance and the IHS is served by the company's staff. HOA owner - it can also hire a specialized company to service the his. There is a robust private service market.	The responsible for maintenance. Is the utility or service provider. If owned by the DH company, maintenance costs are factored into the regulated heat tariff; the end user does not see this cost broken out. There is a robust private service market.	Riga Siltums (DH company) has agreements with most of its customers to maintain their IHSs (\$0.03 per m^2 of apartment area/month)	DH companies, is responsible for operating and maintaining the IHS. The cost of maintenance is included in the heat price. In cases where the building owner owns the substation, they will typically pay a building maintenance company or other contractor to perform maintenance

7. DETAILED RECOMMENDATIONS FOR UKRAINE

1. **Make Large-scale IHS Deployment Easy.** Deploying IHS on a large-scale requires finding viable financing and ownership models that can be replicated at scale. In Central Europe, this meant providing flexibility, but also allowing DH companies to invest in IHSs and recover their costs through the mechanisms of the investment recovery. To kick-start progress, most countries leveraged loans from IFIs and used national energy efficiency programs.

POSSIBLE MEASURES	COMMENT	IMPLEMENTATION TOOLS
Establish a legal framework to provide the possibility to install IHS and recovery such investments by DH companies.	This approach can ensure the rapid development of mass IHS installation.	Resolve IHS ownership issues, including IHS maintenance costs in the tariff and creating a mechanism that will provide for the procedure of initiation, access to premises, financing the purchase and maintenance of IHS, and implementation of such projects (taking into account legal aspects and passivity of homeowners).
Establish the mechanism of the IHS investment recovery and secure of investment funds. Payments of homeowners should be differentiated depending on presence or absence of the IHS installed by DH companies.	It is important to analyze the alternative approaches for investment recovery (through the tariffs or a separate payment)	Depending on the selected approach for the investment recovery, either provide amendments to tariffs legislation or develop a new mechanism based on the separate payments.
Set up initial financing mechanisms for capital costs to help encourage DH companies to make these investments.	Low-cost financing can help speed the introduction of IHSs and allow for technical support with initial installations.	This could include some IFI loans targeting IHS and possibly some government support mechanisms.
Address the issue of IHS ownership that may arise after IHS installation by DH companies on their initiative and at their expense.	Ensuring an unambiguous interpretation of legal norms and a legitimate mechanism is a necessary condition for dissemination of IHS projects in Ukraine.	Changes in legislative and regulatory legal acts

2. **Ensure that IHSs Help DH Customers Save Energy and Improve Service.** IHSs are a proven energy saving technology. Providing options to allow buildings to access IHS installations through savings or guarantees of reduced energy consumption can speed technology adoption. Likewise, it is essential to allow building owners to regulate temperatures to improve comfort and energy savings.

POSSIBLE MEASURES	COMMENT	IMPLEMENTATION TOOLS
Support the EEF to continue working with buildings so that the savings could pay for the cost of the IHS.	Based on the international experience, using two approaches simultaneously (via DH companies and energy efficiency programs) can provide more progress in IHS installation and implementing other energy efficiency measures.	Disseminate information on the benefits and advantages of energy efficiency measures (including IHS installation) and energy efficiency programs (eg. EEF).

POSSIBLE MEASURES	COMMENT	IMPLEMENTATION TOOLS
Clarify regulations to guarantee HOAs and building owners the right to choose the indoor temperature regime.	Today, DH companies may set IHSs so that they save no energy and offer poor comfort. They are trying to protect their sales, but in fact, they are alienating their customers.	Establish a clear mechanism to regulate relations between DH companies and customers regarding all DH issues. This could be through amendments to current legislation in housing and communal services.
Ensure that technical specifications enable IHSs to control the temperature of return water.	Low temperature of return water improves the efficiency of the entire DH system in several ways, including but not limited to reduced fuel consumption for generation and reduced pipe diameters for transport.	In the legal framework, provide a set of mandatory technical requirements applicable to IHSs; requirements must ensure optimal IHS technical performance and utilization of all opportunities IHSs can offer for increased efficiency.

3. Simplify Procedures and Build a Market to Support IHS Installation and Servicing

POSSIBLE MEASURES	COMMENT	IMPLEMENTATION TOOLS
Provide simplified access to financial resources through loans from IFIs under state and local guarantees.	IFIs and state and local guarantees can help stimulate projects, but project approvals are complicated. This recommendation will streamline them.	Simplify the project implementation procedures for projects financed by IFIs using a local or state guarantee (CMU Resolution No. 541 and No. 110).
Strengthen building codes to more clearly outline the regulations for IHS installation.	Building codes in Ukraine today have little helpful guidance on installing IHS. Clear guidance and incentives for the efficiency gains would help smooth the path to large-scale IHS installation.	Improve current legislation relating to construction.
Facilitate access to finance through energy efficiency programs for residential customers.	It is an important condition for the development of mass installation of IHS by the population.	Encourage and support residential customers to establish HOA and participate in the EEF, increase budgets for local programs and the state program "Warm Loans", and stimulate HOA establishment.
Encourage creation of an IHS service market (both for IHS installation and maintenance) through financing programs (including EEF and IFI loans).	Ukraine today has few market players that can install and maintain IHSs. This drives costs up. Leveraging public investments can help grow this market.	Ensure that publicly funded programs that support IHS installation create opportunities for new companies to access this market.
Develop educational programs for DH companies and increase their awareness, including providing them with templates of approval processes. Provide DH companies with models for using easements for the IHS plant room to lower transaction costs.	Providing templates of approval processes, along with changes in tariffs, can help DH companies more rapidly accept IHSs. DH companies are the major source of bureaucratic delays today, and it is important to recognize the need for change in the tariff models to change this. Regarding easements, this is a best practice from Central Europe to reduce overall cost, since paid lease agreements with buildings will incur overhead and processing charges that can be avoided with good policy design.	Preparation of District Heating Handbook, including technical solutions, requirements, connection schemes etc. Establish centers that train experienced designers who are able to develop quality IHS projects, building upon existing structures such as universities or trade schools. Existing associations may be used to scale up building of know-how. Prepare typical but voluntary templates for project documentation and feasibility studies, which may be subsequently used by DH companies in the process of IHS installation.

POSSIBLE MEASURES	COMMENT	IMPLEMENTATION TOOLS
Help municipalities to develop this market through public information and awareness building campaign to promote IHS installation.	Municipalities can play a large role in expanding the deployment of IHSs. They also have great access to local customers, tradespeople, and DH companies to help communicate the importance.	Provide assistance to municipalities to launch communication campaigns with local customers and tradespeople in order to grow the market.

Ukraine has a significant opportunity to reduce energy use, improve energy security, and revitalize the district heating sector by launching large-scale IHS installation. The benefits are clear, and the costs are relatively moderate. Based on the experience in Europe, it is possible to achieve a large-scale roll-out in a short period, and, in fact, doing so is also an essential piece of rebuilding customer trust in DH. The recommendations in this report describe three key areas of improvement that can drive this change to make IHS deployment pay for itself.

8. ANNEX 1. ANALYSIS OF UKRAINIAN OPERATIONAL CYCLE OF IHS INSTALLATION AND MAINTENANCE (PROJECT OWNED BY HOMEOWNERS)

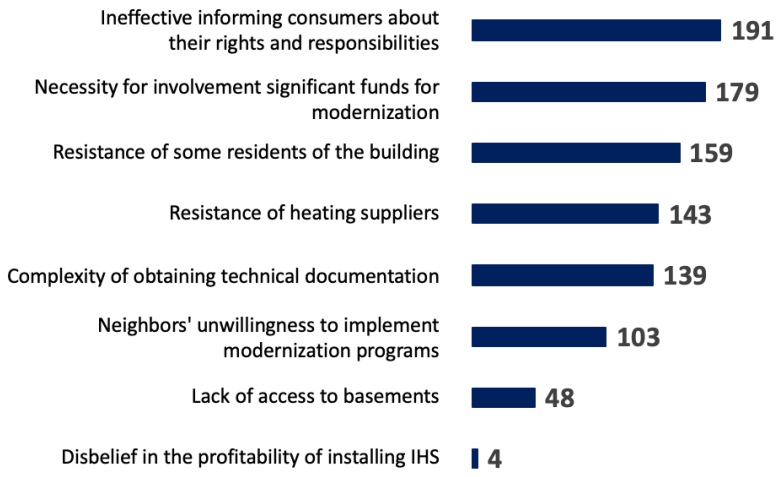
IHS installation is gaining popularity among customers in multi-family buildings because it provides opportunities to save money and improve the quality of heat supply. However, the pace of project implementation remains rather slow across the country.

Barriers to homeowners deciding to install an IHS are the need to attract a large amount of funding and the disorganization of homeowners.

Project preparation procedures (difficulty of fulfilling access conditions, project preparation, etc.) are a barrier for HOAs during IHS installation due to lack of relevant knowledge and experience.

Eventually, after IHS installation, there is often a problem with improper maintenance, partly due to the limited number of specialized companies in the market, and partly due to homeowners' passivity. As a result, IHSs work inefficiently and do not provide adequate savings.

Figure 3 The main barriers for installing and using IHS (rate of responses)



**The survey was conducted among 398 local residents of Ternopil of different age groups, genders, marital status, and, mostly, with below average income. Each respondent had the opportunity to provide several answers.*

Source: Analytical report of the UDHEEP project based on the results of a household survey on IHS installation in Ternopil (2018).[61]

STEP 1. MAKING A DECISION ON IHS INSTALLATION BY HOMEOWNERS

To initiate IHS installation, the homeowners of a multi-story building must make a decision at a general meeting on:

- use of common property (premises, the building's existing equipment);
- reconstruction or technical re-equipment of the common property of the building equipment;
- establishing the amount and procedure for payment of contributions to finance the costs of installing the IHS;

[61] https://www.minregion.gov.ua/wp-content/uploads/2019/04/UDHEEP_Ternopil_consumers.pdf

- authorizing a person to sign relevant agreements.

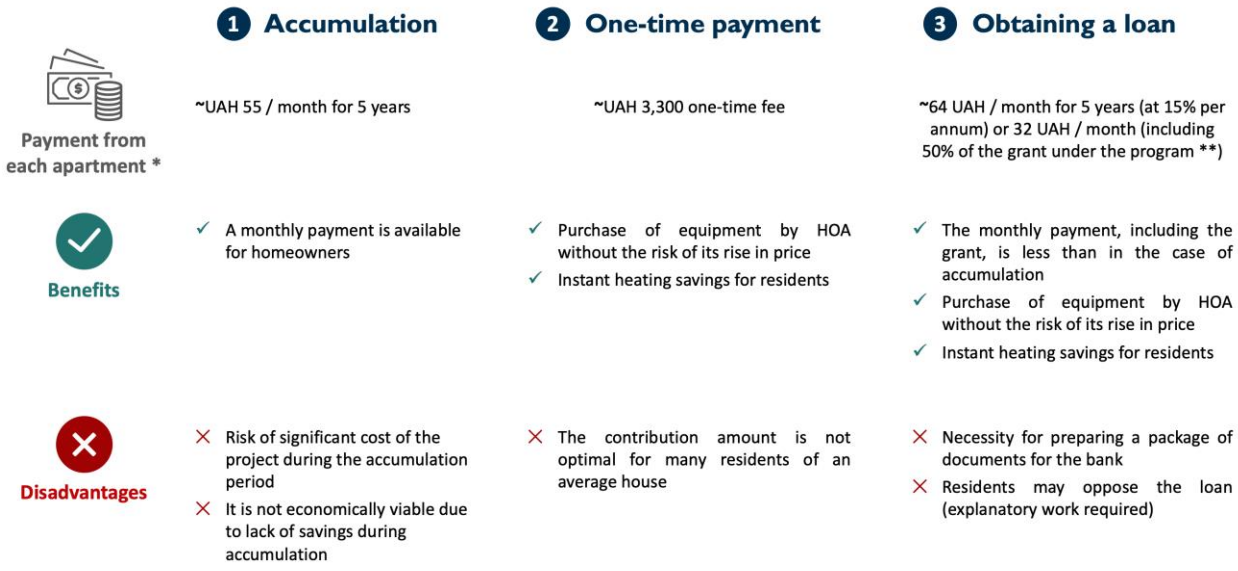
Resistance from homeowners often becomes a barrier in decision-making; 159 of 400 respondents (40%) noted it (see Figure 3). The reason for this is people's indifference and the lack of explaining the advantages and profitability of installing an IHS.

There are examples of successful implementation of IHS projects in multi-family buildings with unorganized homeowners when ZhEK independently takes the appropriate decision and, after the project, becomes the asset holder of the IHS (for instance, under the Comprehensive Target Program for Energy Efficiency and Housing Infrastructure of Kyiv for 2016-2020). This practice is logical, from the point of view of the need to improve the quality of services and provide savings for multi-family buildings that have not chosen a form of management, but, as noted above, can lead to legal uncertainties and inconsistencies with the law.

STEP 2. FINANCING IHS INSTALLATION

A significant barrier is the need to raise a large amount of funds, because the price of IHS, taking into account the installation work, can cost 3,000-5,000 UAH per apartment. There are three main options for financing IHS installation: monthly payments from homeowners, a lump-sum contribution from homeowners, or a loan.

Figure 4 Review of IHS financing options by homeowners of multi-story building



** At a cost of IHS installation of 500,000 UAH for multi-story building with 150 families*

*** EEF EnergoDim is an example of grant size*

Source: Authors' analysis

The problem of raising a large amount of funds is partially solved by energy efficiency co-financing programs, which offer up to 70% compensation for project costs. The most common programs in Ukraine are the state programs "Warm Loans", the EEF's EnergoDim, and local programs supported by local authorities (for instance, in Kyiv, Rivne, Vinnytsia, and other cities).

At the same time, energy efficiency support programs face two common barriers to scaling up: 1) limited budgets of some supporting programs (e.g., Warm Loans); and 2) disorganization of homeowners (as a rule, only HOAs can be participants in such programs).

Figure 5 Review of energy efficiency programs in Ukraine

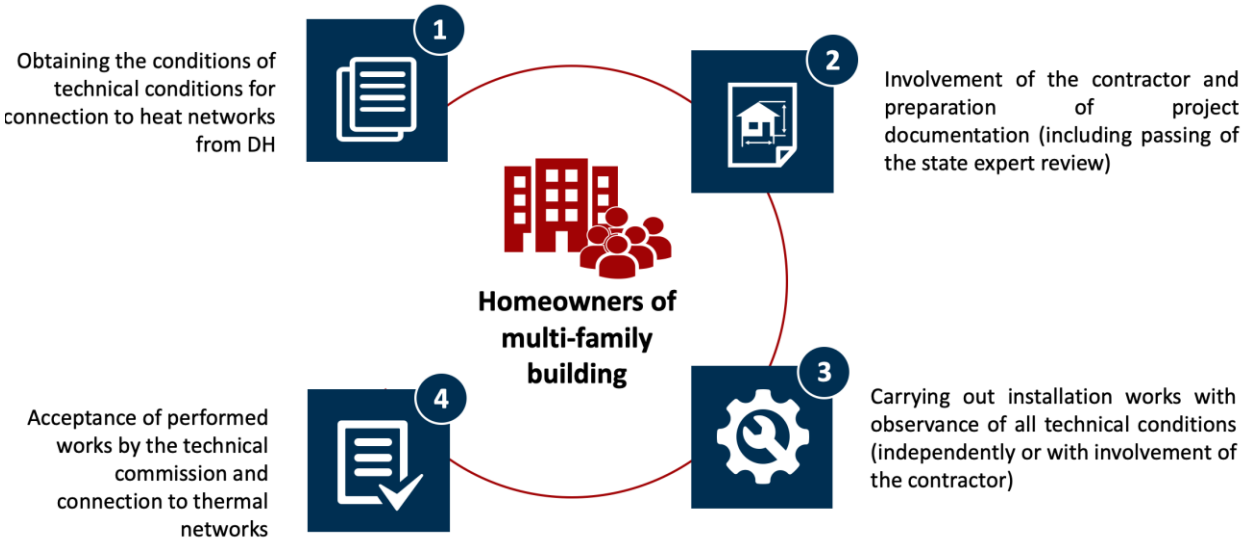
	"Warm loans"	Local initiatives on the example of the Kyiv 70/30 program	Energodim Program
About program	**40%** loan compensation for an energy efficiency project for HOA (including the installation of IHS). A comprehensive project is not required. Mandatory loan attraction.	**70%** compensation for condominiums, HCC and houses managed by ZhEKs. Participants must choose at least 2 types of work, one of which is carried out at the expense of the participant (its cost is not less than 30%), and the other at the expense of the local budget (any of the measures may be the establishment of IHS). No loan is required.	**Up to 70%** compensation for HOA. The IHS can only be part of a comprehensive project. Borrowing is not required.
Benefits	✓ Relatively simple mechanism for participation in the program	✓ Relatively simple mechanism for participation in the program	✓ The budget of the program (over 5 bill UAH) allows everyone to meet the requirements
Disadvantages	✗ The limited budget does not allow everyone to meet the requirements ✗ There is no proper audit and monitoring of projects	✗ The limited budget does not allow everyone to meet the requirements ✗ There is no proper audit and monitoring of projects	✗ The program does not cover buildings without HOA (~46 000 multistory buildings with DH as of the end 2020)

Source: Authors' analysis based on open sources.

STEP 3. OBTAINING A TECHNICAL PERMIT (TP)

Obtaining a TP is the first step in IHS installation by homeowners.

Figure 6 IHS installation procedure by homeowners in multi-family buildings



Source: Authors' analysis

However, considering a DH company's possible lack of interest in installing an IHS due to reduced sales of heat energy, a DH company may use certain tools to slow down this process, for instance, deliberately delaying issuance of technical conditions (given that the law does not provide for liability for violating deadlines) or inclusion of excessive requirements to the Specification.

There are also cases when the TP contains conditions calculated on the basis of outdated parameters of the heat supply system and the use of which is already irrational. For instance, according to the TP, an IHS should be developed based on the heat schedule of 115°C, when the actual temperature of the coolant is 80°C. This leads to the fact that the designed IHS will either be impossible to put into operation (if it does not meet the TP) or the IHS will not work effectively (if the TP condition is met).

STEP 4. PROJECT DESIGN

After receiving the TP for connection to the heating network, the homeowners select and sign a contract with a project designer, whereupon the project documentation is developed according to the TP.

The project is developed on the basis of SCS A.2.2-3-2014 "Composition and content of project documentation for construction", as well as specialized SCS and construction norms, principally SCS B.2.5-67: 2013 "Heating, ventilation, and air conditioning."

In accordance with the Ministry of Energy Order No. 71 "On approval of the Rules for technical operation of heating installations and networks" of 14 February 2007 (hereinafter the Rules for technical operation of heating installations and networks), all heating installations, networks, and other heating equipment of the economic entity must be provided with a set of documentation, including the heat supply project design (IHS installation, internal system, installation of heat metering units) (item 5.5.1.). According to item 5.8.4. of the Rules for technical operation of heating installations and networks, heating installations and networks that are executed without a project design, or out of the project design with violation of the operating regulatory documents, are not allowed to operate.

STEP 5. INSTALLATION WORK

During a heat supply modernization project, the constructor must comply with all relevant SCSs, instructions, guidelines for installing heating equipment, and legislation on health and safety.

CMU Resolution No. 406 stipulates that IHS installation projects do not require documents entitling their implementation (notification of the start of construction work, permission for construction work), and after completing the facility, it is not an object put into operation by state agencies and urban planning services.

STEP 6. ACCEPTANCE FOR OPERATION

After installation and before starting the heat supply, the modernized heating system must be accepted for operation by a special technical commission. According to the Rules for technical operation of heating installations and networks, accepting constructed heating units and networks for operation is carried out on the basis of the certificate of conformity of the constructed heating units and networks to the project design documentation, requirements of national standards, and state building norms and rules. Operation is prohibited if heating installations and networks do not comply with the design documentation, SCS, and national standards and regulations.

According to the Rules for connection to heating networks, consent for connection of the heat-generating unit is carried out on the basis of the act of readiness of the heat generating unit for operation, which must be signed by representatives of the technical commission. Prior to convening the technical commission, a working commission is established in accordance with the proper procedure, which includes customer and network owner representatives. The technical commission accepts the heat-generating unit for operation only after the elimination of all shortcomings and violations identified by the working commission.

The plan of connecting the heat-generating unit to the heating network, indicating the basic parameters of the heating network and equipment, is attached to the act of readiness.

The Rules for connection to heating networks stipulate that in case of technical feasibility and fulfillment of such Rules by the customer, the network owner is obliged to connect the customer's object to its heating network in accordance with the relevant heat supply plan.

The customer (homeowners) must also pay a connection fee. According to the Rules for technical operation of heating installations and networks, the fee for connection of completed, reconstructed, technically re-equipped heating installations to heating networks is determined by the cost of work specified in the project design documentation in proportion to the ordered capacity.

After project completion, the homeowners should become the owner of the IHS. However, in practice, there are cases when HOAs or ZhEKs (mainly in unorganized buildings) become the owner or asset holder, which carries the risk of legal uncertainties due to the norms of Law No. 417.

STEP 7. IHS MAINTENANCE AND REGULATION

For the effective operation of the IHS, it is necessary to set it up and provide periodic maintenance. IHS maintenance during the heating period costs up to 400 UAH per month (which is less than 4 UAH per family for multi-floor buildings with 100 families, although there are cases of only 20 families in multi-floor buildings). However, companies are not motivated to provide ongoing services due to such a small fee, and homeowners are usually not willing to pay more. This leads to difficulties with the availability of companies and specialists (performers) on the market. In large cities, there are usually at least 1-2 companies and a few individual specialists, but in small cities the problem is more acute. As a result, the IHS is not maintained, which leads to inefficient use and the risk of accidents.

Theoretically, an HOA can apply to the DH company to sign an individual contract for heat supply services, which includes maintenance of indoor systems (including IHS). However, in practice, there may be difficulties determining the contract price and including IHS maintenance costs in the heat supply tariff (for more details, see Section 3.5 on the inclusion of IHS maintenance in the heat energy and hot water supply services tariff).

A similar problem concerns adjustment of the IHS. Although this service costs about 3,000-5,000 UAH from each apartment, the adjustment is carried out only after installing or as needed. In addition, there are cases when homeowners are not willing to pay that much money, even if it leads to savings. According to experts, there are not sufficient incentives to develop this area of their activities.

Most IHSs, in practice, are regulated manually, which does not allow for obtaining the declared savings and may lead to different quality of services in apartments of the same building.

9. ANNEX 2. ANALYSIS OF UKRAINIAN OPERATIONAL CYCLE OF IHS INSTALLATION AND MAINTENANCE (PROJECT OWNED BY DH COMPANIES)

In some cities, DH companies can become the driving force for IHS installation projects. This is especially true in cities and regions where there is a high level of unorganized homeowners. For instance, 79% of apartment buildings in Kyiv and 74% in Kharkiv have not chosen a form of management, yet DH companies were considerably involved in the IHS installation programs in those cities.

Some DH companies are already actively implementing IHS projects with the support of IFIs and local authorities. However, in order to effectively implement projects and programs in accordance with the law, it is necessary to address a number of barriers on the way, such as:

- provide investment and access to programs (current program budgets are quite limited nationwide);
- resolve legal conflicts arising with the right of IHS ownership;
- optimize procedures for project preparation and implementation.

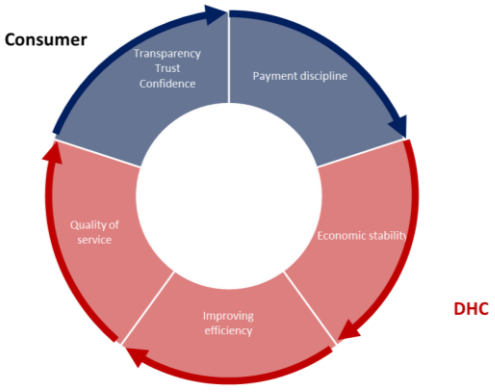
STEP 1. DECIDING ON IHS INSTALLATION

Legally, DH companies do not have limitations on project initiation for IHS installation (most barriers arise during and after installation). The key factors considered by DH companies are the effectiveness of the integrated project (most commonly, an IHS is only one of the components of a complex project) and the funding source.

IHS installation affects the efficiency of supply and quality of services to customers:

- IHS installation reduces losses in the heat and hot water supplies due to the decommissioning of inefficient DH and/or replacement of pipelines.
- Improving the quality of services has a positive effect on customer payment discipline, which is the basis for DH companies' financial stability.

Figure 7 Advantages for DH companies and customers from IHS installation



Source: Making district heating happen: empowering users through fair metering. Policy paper on infrastructure (EBRD, 2018).

On the other hand, IHS installation provides reduction of the heat supplied by DH companies and they may be not interested in IHS installation, if their tariffs are not increased because of socio-political considerations. At the time, increased tariffs for population are compensated by lower consumption.

IFIs and donor organizations that provide soft loans or grants to finance energy efficiency projects play the most important role in initiating projects to install IHSs. IHS installation, in many cases, an

integral component of energy efficiency projects. Thus, DH companies choose between IHS installation (as one of the components) or not to attract investment at all.

STEP 2. FINANCING IHS INSTALLATION

There are cases of IHS funding from the local budget. For instance, more than 200 apartment buildings in Kyiv were equipped with IHS during 2014-2017. In some cities (for instance, Kharkiv), the local IHS installation program only covers municipal buildings with outdated equipment.

The most significant and important source of IHS funding (usually as a component of an investment project) for most cities are IFIs and donor programs, such as World Bank, EBRD, State Secretariat for Economic Affairs of Switzerland (SECO), Nordic Environment Finance Corporation (NEFCO), and others.

Figure 8 Review of programs to support utilities in implementing energy efficiency

NEFCO

NEFCO projects and DemoUkrainaDH program - providing loans to municipalities to modernize energy production up to 500,000 euros at 6% per annum (additionally, the grant from Sweden and E5P are provided. Grants reach up to 60% from the total project costs).

Achievements:

157 IHS are installed and 254 IHS are rehabilitated in 5 cities of Ukraine under the NEFCO projects.

166 IHS are installed in 9 cities of Ukraine under the DemoUkrainaDH program.

European Bank for Reconstruction and Development

European Bank for Reconstruction and Development - providing loans to utilities under state and local guarantees for up to 20 years and up to 6% per annum (additional grant from E5P up to 40% may be provided).

Example:

Installation of about 400 IHS in Lviv in 2019-2020

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Cooperation Office - co-financing of energy efficiency projects in the amount of 80% of the project.

Example:

More than 200 IHS were installed during 2013-2019 in the city of Vinnytsia

WORLD BANK GROUP

World Bank - providing loans to the state budget or utilities under a state guarantee for up to 20 years and up to 3% per annum.

Example:

92 IHS in Mykolaiv in 2019 are established

Source: NEFCO data, Authors' analysis based on open sources

Local budgets and IFIs programs are unable to guarantee the full investment needs of more than $1.5 billion, but can provide a demonstration effect for the population. The problem of limited funding from local budget programs and IFIs goes beyond the study of IHS.

Operational barriers that arise in the financing of IHS projects (both from the local budget and from IFIs and donors) mostly apply to all investment projects implemented with the participation of DH companies. For instance, the low institutional capacity of the authorities and DH companies to prepare quality project and tender documents, frequent changes of project managers, and the inconsistency of Ukrainian construction legislation with the procedures for implementing projects with IFIs.

An important issue noted by the interviewed experts involved in IFI projects is the rules for accepting construction work. In accordance with SCS Rules for defining the cost of construction, acceptance of construction work for projects involving budget funds is carried out on the basis of

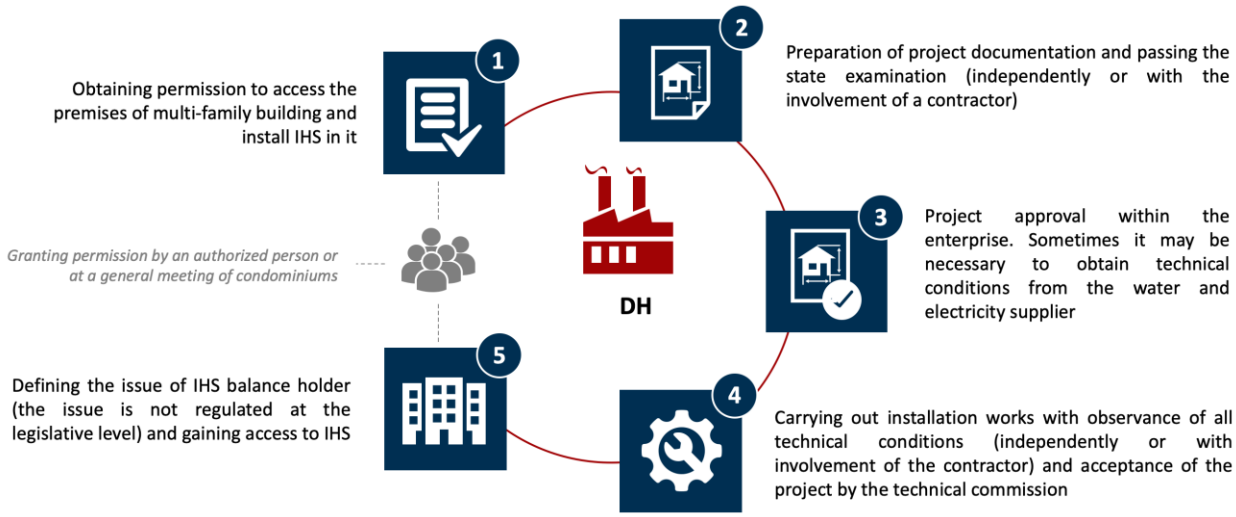
the act and certificate forms KB-2v and KB-3. At the same time, completing these forms requires compliance with the pricing rules regulated by law. This means that after the tenders (at the proposed prices of contractors), estimates must be formed at state prices. This will allow forms KB-2v and KB-3 to be properly completed after the completion of the work and to complete the project in accordance with the requirements of national legislation. This procedure can lead to significant delays in project implementation. Projects involving a state-guaranteed loan are exempt from this requirement. For such projects, acceptance of works is carried out in accordance with price lists.

Some delays arise purely due to the project implementation conditions of IFIs and donors. These barriers are not directly related to IHS issues, and their solution requires a revision of the procedures for implementing investment projects. For instance, for projects implemented in cooperation with SECO, the equipment supplier must be registered in Switzerland. This meant that IHS had to be imported into Ukraine, and to exempt suppliers from paying state duty and VAT, the project had to be registered with the Ministry for Development of Economy, Trade, and Agriculture of Ukraine.

STEP 3. OBTAINING PERMISSION TO ACCESS APARTMENTS OF A MULTI-STORY BUILDING

The procedure for IHS installation by heat supply companies is similar to the procedure for HOAs. The main differences are the need to obtain HOA permission and the lack of need to obtain TP (the DH company coordinates on this issue within the company between the relevant departments).

Figure 9 Procedure for installing IHS by DH companies

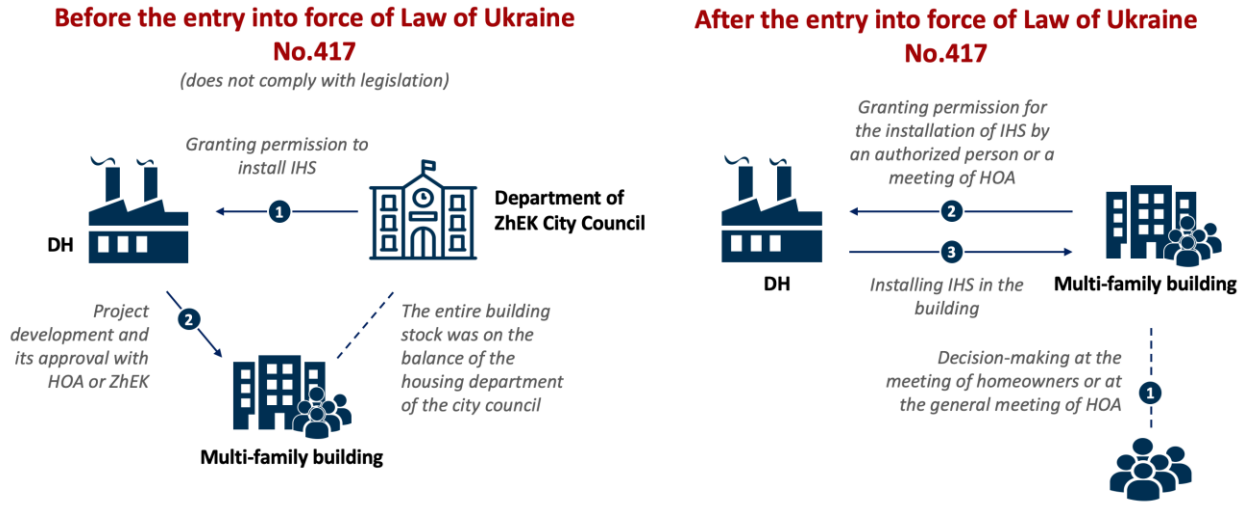


Source: Authors' analysis from interviews with experts, legislation, and open sources

When installing IHS at the expense of DH companies, the DH company must obtain access (or user rights) to the premises of an apartment building to install the IHS. According to Law No. 417, if an IHS is managed by homeowners, the only mechanism for access is the decision of the homeowners at a meeting (if an HOA is not created) or at the general meeting of the HOA (see Figure 1). These premises are usually provided to DH companies by homeowners via a lease or easement, and the question arises from which sources DH companies will cover rental services or the cost of easement, given that the tariff does not contain such a component.

However, in practice, there are cases when DH companies receive permits from management companies (including housing and utility services), and the latter inform residents about IHS establishment. This practice violates Law No. 417.

Figure 10 Obtaining permission for DH companies to install IHS in an apartment building



Source: Authors' analysis based on interviews with DH companies and Law No. 417

STEP 4. PROJECT DESIGN

After obtaining permission for IHS installation, the heat supply company must develop project documentation, independently or with the project engineer. If the project is funded by IFIs, the DH company usually receives technical or advisory support, but must comply with additional IFI project-related requirements.

During project preparation, it could become necessary to obtain technical conditions from the regional energy company and the water supplier. From the legislative point of view, water suppliers and regional energy companies cannot refuse to issue technical conditions, but may include in them measures that require additional investments (for instance, replacement of water supply networks). Funding for these activities is usually impossible or difficult. According to the Law "On regulation of urban planning activities", project documentation requires expertise.

STEP 5. INSTALLATION WORK AND ACCEPTANCE FOR OPERATION

According to CMU Resolution No. 406, it is not required to obtain permits for construction and operation from state agencies and urban planning services for IHS installation projects if technical re-equipment (IHS installation) occurs in accordance with SCS. The only necessary condition is to check the project for TP compliance and technical commission acceptance.

Once the IHS is installed by the DH company (regardless of the source of funding), in practice, it remains on the DH company's balance, although this carries the risk of non-compliance with Law No. 417. For instance, Kyivteploenergo (DH company in Kyiv) has more than 1,300 IHSs on its balance sheet, including both IHSs installed before and after adoption of Law No. 417.

STEP 6. IHS MAINTENANCE AND REGULATION

Unlike the requirements of CMU Resolution No. 869 (for regional state administration licensees), NEURC Resolution No. 1174 "On the Procedure for setting tariffs for heat energy, its production, transportation, and supply" of 25 June 2019 (hereinafter NEURC Resolution No. 1174), does not

contain direct norms on including in the tariff the supply of the heat energy part of IHS costs, which are owned or used by the NEURC licensee.

As a result, even though the DH company has the opportunity to justify including in the tariff the heat supply of part of the IHS cost as "depreciation of fixed assets, other non-current tangible and intangible assets for production purposes involved in the supply of heat" (item 3 item 5.2 of NEURC Resolution No. 1174), part of the expenses for IHS maintenance from the NEURC licensees remains unaccounted for in the tariff, that is, they are not compensated by customers, as a result of which the DH company makes losses.

This situation is unreasonable and requires proper regulatory regulation (in particular, by analogy with the regulation contained in CMU Resolution No. 869 for RSA licensees).

As for including in the hot water supply tariff the costs of servicing IHS by NEURC licensees, the costs can be included for the engineering and technical personnel who are on the balance sheet (owned) or used by the service provider, provided for by NEURC Resolution No. 767 "On the Procedure for setting tariffs for the hot water supply service" of 4 August 2020 (hereinafter NEURC Resolution No. 767).

A separate problem should be noted that according to the Law "On housing and utility services" (part 5 of article 22), tariffs for communal services to supply hot water are set with the help of engineering personnel, formed and set separately for each apartment building. Although the Law applies to both NEURC and RSA licensees, in practice, this problem only concerns RSA licensees because implementation of this provision is provided for in CMU Resolution No. 869 (paragraph 64).

For instance, about 1,500 apartment buildings in Kyiv are equipped with IHS. The DH company must calculate more than 1,500 individual tariffs with engineering personnel and the Kyiv City State Administration must check that calculations are correct for each tariff and approve them. It should be noted that each hot water supply service (HWSS) tariff must be reflected in at least four annexes, printed, signed, and submitted in two copies - 12,000 pages (and more, in the case of other applications). The procedure also requires printing tariffs in the newspaper of local government bodies. This approach is not rational from the point of view of the DH company and authorities' resource expenditure.

The Parliament of Ukraine is in charge of preparing for another read-through draft Law No. 2458 "On the introduction of changes to the laws of Ukraine as well as the regulation of food from the sphere of supplying housing and utility services" (given) of 20 May 2020. Among other provisions, this draft proposes to introduce a refusal to establish HWSS tariffs for each building with an IHS, but to take into account the costs of IHS maintenance as part of a separate tariff for all buildings with IHS.

According to the Law "On housing and utility services" (Section VI item 4) apartment building homeowners are required to decide on a model of contractual relations with the service provider (except for electricity and natural gas) for each type of utility service (including heating and hot water supply), and the utility providers must make an agreement with the homeowners in accordance with the model chosen by the homeowners. Application of the new contractual models should take place no later than within five months from the date of completion of the quarantine declared by the CMU to prevent the occurrence and spread of the coronavirus disease 2019 (COVID-19).

The Law "On housing and utility services" (Article 14 Part 1) envisages three models for homeowner selection: individual agreement, joint agreement, and agreement with a joint customer (the latter is possible if the building is formed by condominiums that are parties to this agreement).

Under the terms of an individual agreement, homeowners pay a fee to the relevant utility service for maintenance and repair of the apartment building's indoor systems, the amount of which is contractual (not regulated by the state) and determined by the agreement between the homeowners and the utility service provider (Article 14 Part 3).

Under the terms of a collective agreement, agreement with the collective customer, as well as a "special" individual agreement (which will be concluded by law, if the homeowners do not determine the appropriate contractual model within the time allotted by law), the maintenance fee and fee for indoor repairs of apartment buildings should not be paid as these networks are serviced either by the manager or independently by the homeowners or another person chosen by them (Article 14 parts 4 and 7 and Section VI item 5).

As previously noted, individual heating is a part of an apartment building's indoor systems, providing heat supply and hot water services (Article 1 item 3 part 1). In the case of an individual agreement, the heating supply company's service fee to the homeowners includes current repairs of the apartment building's indoor systems and the fee for maintenance and current repairs of the individual heating as an integral part of the indoor system.

In these circumstances, after concluding new agreements to provide heating and hot water, there are no proper grounds for including the service cost of individual heating into the provider's tariffs, as this will lead to double payment by homeowners. In particular, homeowners would have to pay maintenance costs for individual heating points as part of the cost of heat energy and hot water services (paid to the energy provider), as well as part of the contractual fee for maintenance of indoor systems (paid to the energy provider or manager, depending on the contract). This discrepancy requires appropriate regulation.

10. ANNEX 3. OTHER ASPECTS OF IHS INSTALLATION IN UKRAINE

Table 6 Definition of IHS in various regulations

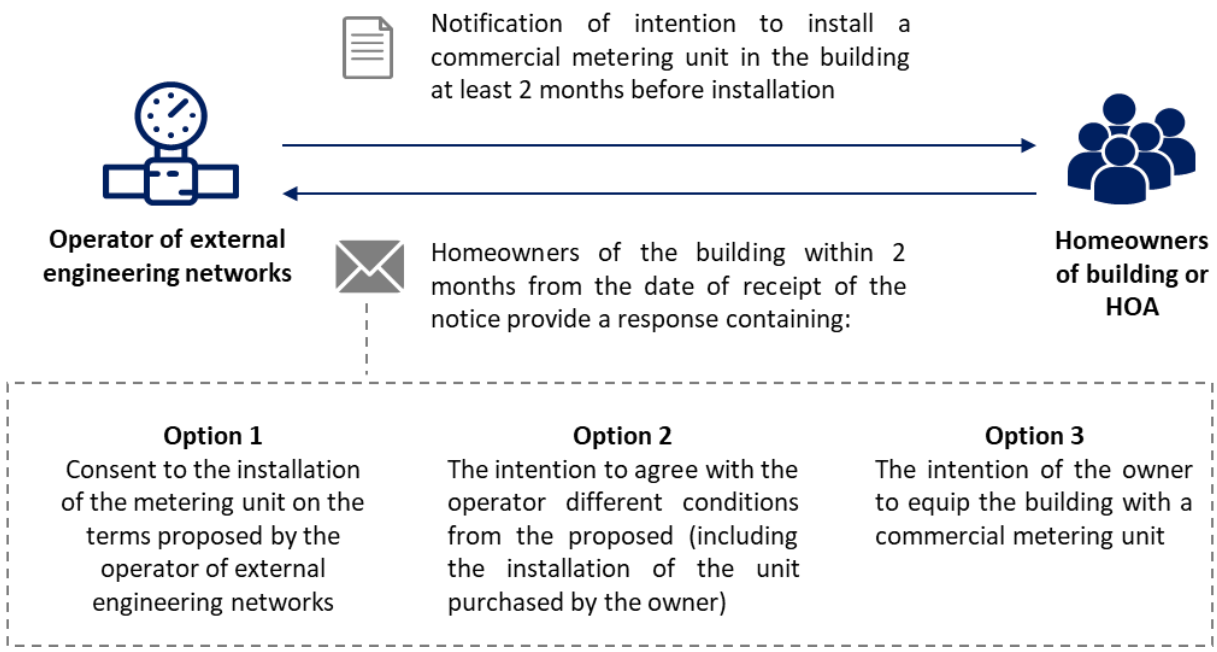
CMU Resolution No. 869 Procedure for setting tariffs for heat, its production, transportation and supply, services for the supply of heat energy and hot water supply (2011)	An IHS is a heat substation from which heat supply and control of the heat consumption system of one building (structure) or its part is carried out (item 7, item 6).
NEURC Resolution No. 767 Procedure for setting tariffs for hot water supply services (2020)	An IHS is a heating substation that provides heat supply and control of the heat consumption system (heating system, hot water supply, ventilation or technological processes) of a separate building (structure) or its part, and is an integral part of the indoor systems in a multi-story building.
CMU Resolution No. 830 Rules for providing heat supply services (2019)	An IHS is a set of devices and equipment that help regulate the temperature of the heat transmitted, taking into account weather conditions and control of the heat consumption system, of one building (structure) or its part (item 2).
Ministry of Energy Order No. 71 Rules for the technical operation of heat installations (2007)	IHSs are intended for connecting heating systems, ventilation, and hot water supply in one building or part of one building, and also separate technological installations using heat energy.
SCS B.2.5-39:2008. Engineering equipment of buildings and structures. External networks and structures (2009)	"A set of equipment or devices that is located in separate premises and provides connection of such devices to the main heat network and (if necessary) to the network of cold water supply, controls modes of heat consumption, controls transformation of heat energy, regulates heat parameters, distributes heat energy by the types of consumption to distribution networks (of hot water supply), and protects these distribution networks from an emergency increase of the coolant parameters. It is used to service one consumer (a building or its parts)."

Sources: CMU Resolutions No. 869 and No. 830, NEURC Resolution No. 767, Ministry of Energy Order No. 71

THE PROCESS OF INSTALLING METERS IN ACCORDANCE WITH THE LAW "ON COMMERCIAL METERING OF HEAT ENERGY AND WATER SUPPLY"

Note: The Law of Ukraine #2458, that changes the process of meters installation, is approved by VRU (03.12.2020), but is not entered into force as of preparation of this Annex.

Figure 11 Simplified review of the procedure for installing commercial metering units in multi-family buildings



Source: The Law "On commercial accounting of heat energy and water supply"

The operator equips the building with a node if, during the two months from the date of receipt of the operator's notification, the building owner did not inform the operator of their intention to agree with the proposed node installation or their intention to independently equip the building with commercial metering units, as well as if the owner announced their intention to agree to a different proposal to install commercial metering units or about the intention to independently equip the building with commercial metering units, but did not do this within four months from the date of receipt of the operator's notification.

Equipping buildings with commercial metering units and engineering systems equipment to ensure accounting is carried out in accordance with the design documentation in compliance with construction norms and rules, taking into account the Law of Ukraine "On commercial accounting of heat and water supply", and does not require technical conditions and other requirements, commercial accounting, or coordination with state bodies, local governments, their officials, operators of external engineering networks, and utilities.

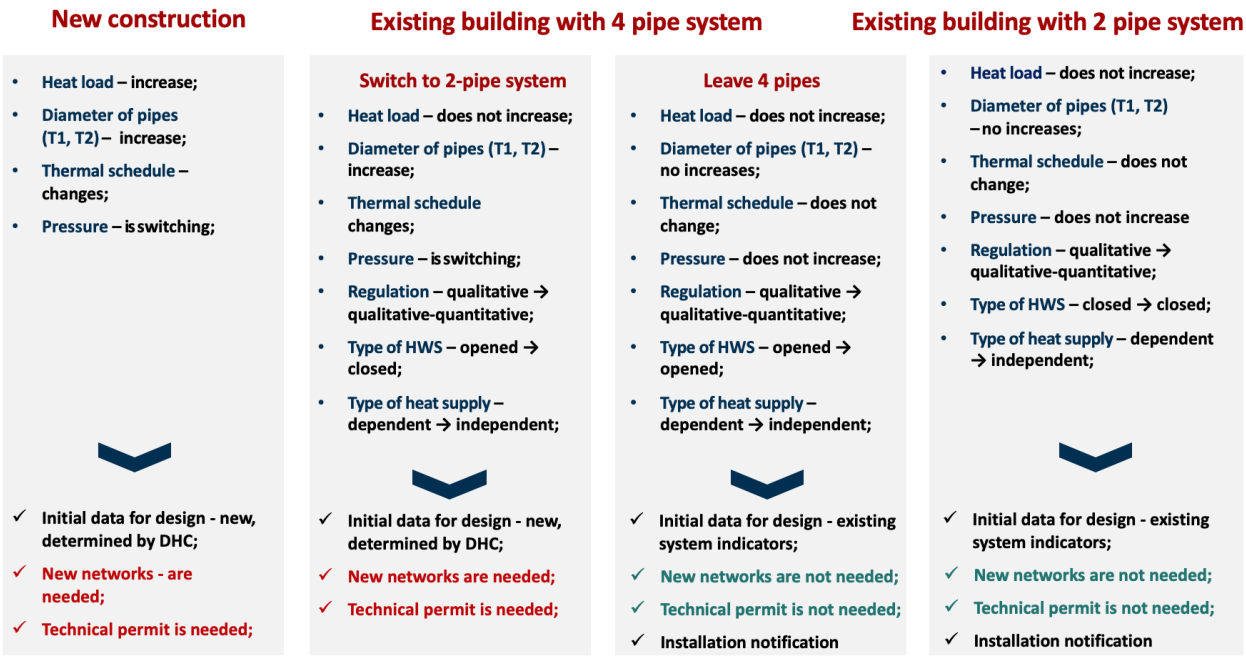
The costs of equipping the building with commercial metering units that are incurred by the operator are reimbursed by the consumers of the relevant utilities and owners (homeowners) of the premises equipped with individual heating and/or hot water supply in a building by paying a quarterly fee for commercial metering units, which is paid to the executor of the relevant service.

ANALYSIS OF TECHNICAL IMPACT OF IHS INSTALLATION

Mass installation of IHSs in a city leads to a significant reduction in the amount of heat energy in a heating system, which why mass installation of IHSs may require investments in reconstructing a city's heating system. Heat network changes are typically made because of poor efficiency and losses, not sizing. In some cases, IHS installation does not require obtaining technical conditions from DH companies.

The figure below briefly describes when an IHS installation project envisages technical changes to heat system operation and requires obtaining technical permits.

Figure 12 Analysis of technical impacts of IHS installation



Source: Ministry of Regional Development Reform Support Team

Based on the table above, there is no requirements to obtain technical permits and replace networks if thermal schedule and pressure is not changed in the system.

LEGAL STATUS OF HOUSING CONSTRUCTION COOPERATIVES

In Soviet times, the HCC was a widespread method for joint construction and operation of residential buildings. To this day, for certain historical reasons, the maintenance of individual apartment buildings is carried out through HCC statutory bodies.

Law No. 417 established an exclusive list of forms of apartment building management, among which there is no building management through HCCs. That is, HCCs are not included in the list of entities that can manage multi-story building.

An HCC is a legal entity formed by individuals and/or legal entities that have voluntarily pooled their property shares to participate in the construction or reconstruction of a residential building (buildings) and subsequent operation(s).

The purpose for establishing an HCC is defined in the Model Statute of a housing construction cooperative, which was approved by a resolution of the Council of Ministers of the USSR on April 30, 1985. The charter states that an HCC is created to provide its members (and members of their families) with housing through the construction of the building (buildings), its (their) further operation and management.

In accordance with Article 384 Part 1 of the Civil Code of Ukraine, a building is the property of the HCC that constructed or received it. That is, according to current legislation, the HCC manages the multi-story building as the sole proprietor.

However, in accordance with Article 384 Part 2 of the Civil Code of Ukraine, in case of purchase of the apartment, the HCC member becomes the owner. If at least one HCC member bought their apartment, the HCC loses the status of sole owner of the apartment building. In fact, several homeowners appear in the building: the person who bought their apartment, and the HCC of the unpurchased apartments.

In some apartment buildings, despite consisting of 100% purchased apartments, HCCs still perform the functions of actual management, although there are no legal grounds for this.

The current legislation has effective mechanisms to bring the legal status of HCC buildings in line with modern realities. Law No. 417 gives the right to choose one of the forms of building management: make joint decisions at a general meeting of homeowners, establish an HOA, or involve a manager. Article 5 of the Law "On HOAs" also gives the right to reorganize (by transforming) an HCC into an HOA.

It should be noted that a significant number of HCCs have been reorganized into condominiums in recent years. According to the Ministry of Regional Development, the number of apartment buildings serviced by HCCs has decreased by almost 1,000 since 2016.

Figure 13 Number of buildings serviced by HCCs

Source: Ministry of Regional Development data

GENERAL RULES FOR THE FORMATION OF TARIFFS FOR DH COMPANIES

FOR DH COMPANIES - RSA LICENSEES

The procedure for setting tariffs for heat energy, its production, transportation and supply, and services for the supply of heat energy and hot water supply, approved by CMU Resolution No. 869 of 1 June 2011, provides for the following basic rules for IHSs:

- Possibility to include in the structure of regulated tariffs for DH company services the costs of servicing only those IHSs that are owned by the DH company and/or are in its use;
- Separation of costs between the tariff for the supply of heat energy and the tariff for the service of hot water supply (HWS). The distribution of costs for IHS maintenance (service) in a particular building equipped with IHS is carried out in accordance with the volume of sales of relevant services in the building (paragraph 64 of CMU Resolution No. 869);
- The need to set a tariff for HWS for each multi-story building equipped with IHS that is owned by the DH company and/or is in use (paragraph 64 of CMU Resolution No. 869).

FOR DH COMPANIES - NEURC LICENSEES

The procedure for setting tariffs for heat energy, its production, transportation and supply, approved by the NEURC Resolution No. 1174 of 25 June 2019, does not contain direct rules on including in the tariff for heat supply part of the costs of the IHS owned by the NEURC licensee or in its use.

With regard to NEURC licensees including IHS maintenance costs in the HWS tariff, these costs may be included for IHSs that are owned or used by the service provider, as provided by the Procedure for setting tariffs for hot water supply approved by NEURC Resolution No. 767 of 4 August 2020. In particular, NEURC Resolution No. 767 stipulates that:

- Tariffs for the HWS service are formed separately for customers who receive the service with and without the use of IHS;
- Tariffs for HWS service produced with IHS use are formed and set separately for each multi-story building in terms of customer categories, taking into account the cost of production of the services and the profitability of the business entity conducting the activities.

The full planned cost of HWSS includes the cost of depreciation, repairs, and other improvements to fixed assets that are part of the IHS.

DH companies generate financial losses because NEURC licensees' heat tariffs do not include IHS maintenance costs.

11. ANNEX 4. DETAILS ON INTERNATIONAL EXPERIENCES

POLAND

DEFINITION OF IHS IN POLISH LEGISLATION

The Minister of Industry Order of 16 September 1988 on detailed rules for the operation of heating networks contains the first Polish definition of heat substation: "heating nodes, i.e. devices connecting sections of heating networks with customer installations, together with fittings, accessories, support structures, auxiliary devices, control and measurement and regulation equipment and other equipment."[62] Minister of Economy[63] and Ministry of Climate[64] regulations define heat substations as "connected devices or installations used to change the type or parameters of the heat carrier supplied from the connection and to regulate the amount of heat supplied to receiving installations." The substation is part of the distribution network from a legal perspective.[65]

APPROVALS AND SPECIFICATIONS NEEDED

DH companies provide guidance on IHS design in a document called the Technical Conditions for Connection. The IHS design should correspond with following documents' requirements:

1. PN-B-02423: 1999 Heating and heat engineering. Heating nodes. Requirements and acceptance tests.
2. PN-B-02421: 2000 Heating and heat engineering. Thermal insulation of wires, fittings and devices. Requirements and acceptance tests.
3. PN-B-02419: 1999 Heating and heat engineering - Security of water heating installations and closed water heating systems.
4. PN-91 / B-10405 Heating - District heating networks - Requirements and acceptance tests.
5. PN-77 / B-10420 Hot water devices in buildings - Requirements and acceptance tests.
6. PN-76 / B-02440 Protection of utility hot water devices - Requirements.
7. PN-92 / B-01706 Plumbing installations. Requirements in designing.
8. PN-92 / M-34031 Steam and hot water pipelines. General requirements and tests.

---

[62] Minister of Industry Order of 16 September 1988 on detailed rules for the operation of heat networks (Zarządzenie Ministra Przemysłu z dnia 16 września 1988 r. w sprawie szczegółowych zasad eksploatacji sieci cieplnych) http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WMP19880290261

[63] Minister of Economy Regulation of 17 September 2010 on detailed principles for setting and calculating tariffs and settlements for heat supply (Rozporządzenie Ministra Gospodarki z dnia 17 września 2010 r.w sprawie szczegółowych zasad kształtowania i kalkulacji taryf oraz rozliczeń z tytułu zaopatrzenia w ciepło). https://www.infor.pl/akt-prawny/DZU.2010.194.0001291,rozporzadzenie-ministra-gospodarki-w-sprawie-szczegolowych-zasad-ksztaltowania-i-kalkulacji-taryf-oraz-rozliczen-z-tytulu-zaopatrzenia-w-cieplo.html

[64] Climate Minister Regulation of 7 April 2020 on detailed principles for the setting and calculation of tariffs and settlements for heat supply (Rozporządzenie w sprawie szczegółowych zasad kształtowania i kalkulacji taryf oraz rozliczeń z tytułu zaopatrzenia w ciepło).

[65] https://www.prawo.pl/biznes/czy-wezel-cieplny-zasilany-z-sieci-cieplnej-jest-elementem-instalacji-centralnego-ogrzewania-w-budynku,153327.html

9. PN-82 / M-74101 Industrial fittings. Safety valves. Requirements and tests.

In accordance with the provisions in force in Poland, the devices offered must have the following attestations, certificates, approvals and decisions[66]:

1. All devices, elements, and materials appearing in the substation should have the required certificates, technical approvals, or other documents allowing use in construction in accordance with applicable regulations.

2. Pressure equipment must meet the requirements of Directive 97/23/EC, the equipment should have a CE marking according to the Minister for Development and Finance Regulation of 27 September 2017 amending the Minister of Development Regulation of 11 July 2016 on the requirements for pressure equipment and pressure equipment assemblies.

3. A hygienic certificate for domestic hot water pumps and exchangers.

The IHS design documentation depends on conditions and needs and should contain the following:

- Technical conditions;
- Technical description;
- Calculations necessary to design the substation;
- List of the substation devices and components;
- List of attachments and drawings;
- Situational plan with object designation and location of the IHS;
- Schematic drawing of the technology and installation of the substation with an indication of all the necessary connections and terminals.

Design documentation should contain all data necessary to complete the investment, both in the formal and legal aspect (terms of delivery, arrangements, and permits) as well as technical and organizational details.

The substation plant room should meet the fire safety requirements listed in the Minister of Infrastructure Ordinance of 12 April 2020.[67]

RESPONSIBILITY FOR MAINTENANCE

Both DH companies and specialized servicing companies can provide IHS maintenance. Usually, they offer the same list of services, though servicing companies tend to advertise their work more. Poland

[66] Any imported equipment meeting the standards of any of the EU countries is assumed to automatically meet the Polish standards, so no additional certification in Poland is needed.
[67] https://www.piib.org.pl/budownictwo-aktyprawne-61/przepisy-i-warunki-techniczno-budowlane-aktyprawne-180/593-rozporzidzenie-ministra-infrastruktury-z-dnia-12-kwietnia-2002-r-w-sprawie-warunkechnicznych-jakim-powinny-odpowiadaudynki-i-ich-usytuowanie-cz-1

has a developed servicing market and many companies compete for customers. Below are two examples of services provided by a DH company and a specialized servicing company.

If the DH company owns the IHS, it usually carries out all maintenance work such as[68]:

- Cleaning substation equipment;
- Flushing heat exchangers;
- Fixing the internal installation;
- Removal of minor defects, repair or replacement of worn substation devices and selected devices of internal installations.

If residents own the IHS, they can also hire a servicing company, which is responsible for IHS maintenance and typically performs one full maintenance inspection before the start of the heating season.

During ongoing maintenance or a one-time inspection, the specialized company performs the following actions[69]:

- Check circulation pumps in automatic and manual mode;
- Check the shut-off and control valves in open and closed positions;
- Check the operation of valve drives by manual control from the regulator;
- Check the operation of the heat meter;
- Check the operation of the electrical installation in the substation;
- Electrical switchboard maintenance;
- Tighten screw connections of the electric wires;
- Check the operation of thermometric and manometric detectors;
- Regulation of network water flows in the heating node;
- Vent the technological system;
- Top up damaged thermal insulation;
- Local painting of damaged piping coating;
- Eliminate of small leaks;
- Correct weather regulator settings depending on user requirements;

---

[68] Veolia https://energiadlalodzi.pl/oferta/nasza-oferta/uslugi-dla-budynkow/
[69] Alfarex https://www.alfarex.pl/str/23/konserwacje-wezlow-cieplnych

- Check the patency of the open/closed safety valves;
- Clean all filters;
- Check the operation of the supply and exhaust installation of the substation;
- Switch off after the heating season and start the heating system before the heating season;
- Keep a substation maintenance book;
- Check if IHS equipment needs any renovation or replacement;
- 24-hour availability to address failures and faults.

UNITED KINGDOM

IHS technical specifications are set by the DH company. For example, the Enfield borough in London, which set up its own DH network and locally-controlled network operator, provides the following specifications for IHSs in buildings connecting to the network.[70]

"The Primary Heating Network should be hydraulically separate from the Secondary Heating Network through a Substation in a building within the Development. Heat transfer across the Substation will be achieved by means of a 2-port control valve which will modulate to maintain a constant Secondary Heating Network flow temperature in a +/- 5°C margin around its nominal value under all normal load conditions.

The Substation should be located in a Substation Plantroom within a building within the Development.

Each Substation should include the following equipment:

- Isolating valves
- Filter
- Heat exchanger(s)
- Motorised regulation valve(s)
- Energy meter
- Temperature sensors
- Control panel
- Hydraulic connections
- Power and instrumentation (fibre) connections

[70] https://governance.enfield.gov.uk/documents/s51104/Appendix%201%20-%20DEN%20Technical%20SPD%202.pdf

Each Substation should contain two heat exchangers for resilience.

All Heat exchangers should be fitted with removable insulation jackets complying with the following specification as a minimum:

- Silicone coated glass fabric coated on one side with a water resistant flexible coating
- Insulation - 50 mm mineral fibre foil coated
- Fastenings - Fire retardant Velcro of a type which can be repeatedly removed and replaced to enable the entire jacket to be removed or replaced within 2 minutes by a maintenance operative
- Maximum Operating Temperature - 220°C
- Thermal Conductivity - 0.033 W/mK
- Non-flammable conforming to BS 476. All heat exchangers should be fitted with local isolation valves to enable removal of the heat exchanger without compromising or affecting the operation of the system where a duty exchanger has been installed in accordance with the system design or this specification. Braised units should not be used.

A Network Meter should be installed on the primary side of the Substation to record flow volumes and energy delivered by the Primary Heating Network. The Network Meter will comply with the European Standard EN 1434. The meter will comprise:

- an electromagnetic or ultrasonic flow meter (measuring tube)
- temperature sensors
- a heat calculator with display
- electrical supply and a 15-year battery.

Pre-commissioning, commissioning and testing should be in accordance with the relevant CIBSE Commissioning Codes, BSRIA Guides and this Specification. All records of commissioning and testing activities should be kept. All plant, equipment and system components should be installed, adjusted and set in accordance with the manufacturer's instructions.

All packaged plant and equipment should have a label fitted by the manufacturer describing key information, including:

- Manufacturer
- Location of manufacture
- Date of manufacture
- Key performance data
- Model reference
- Serial number.

A Substation Plantroom(s) should be provided within the Development in which the Substation(s) will be installed. The Substation Plantroom must be located so that the Energy Company has free and safe access to it, that equipment (including the Substation) can be operated and maintained, and if necessary replaced in its entirety without the need for removing any structure or walls. The Substation Plantroom location should be on the ground floor of the Development or in the basement if step free access can be provided. The Energy Company will require permanent access to the Substation Plantroom and the Primary Heating Network routed to the Substation Plantroom."

Table 7 Example of UK technical requirements for substation plant room

ITEM	PROVISION
Maintenance Space	No less than 1.2 m clear space around the Substation
Maintenance Electrical Socket	230 V Ac to earth / 32 A – Commando Wall Socket 230 V Ac to earth / 13 A – Wall Socket
Electrical Supply For Control Panel	230 V, 50 hz - fused switch spur or distribution board – supplied by dedicated radial circuit with MCB 16A Type C
Lighting	Minimum of 150 lux
Water Supply	Temporary: DN 50 (for flushing) Permanent: DN 25, with quick release coupling (used for maintenance only, and suitable for use of a WRC approved pressure water jet)
Water Drainage	Provide floor gully connected to foul drain for waste water removal
Concrete Plinths	Provide concrete plinths for heat exchangers and control panel (100 mm high)
Ventilation	Provide mechanical or natural ventilation, with a minimum of three air changes per hour, or greater so as to limit the air temperature with the Substation Plantroom to below 35°C at all times
Health & Safety	The Substation Plantroom should not have elements that introduce risk to health and safety, e.g. sharp metallic objects, holes in roof or floor without protection. Plan showing evacuation route in case of fire, located in a visible place. Fire extinguishers CO_2 and Foam. A floor plan of the installation identifying all valves that should be isolated in case of emergency.
Anti-Slip Floor Finish	Surface roughness required to provide a low risk environment. Minimum surface roughness required is 26 microns (painted or sealed slab finish)
Signal from The Secondary Heating Network	The Development is required to provide a signal showing the operational status of the Secondary Heating Network for use in the control systems associated with the primary side of the Substation. A 24 V DC signal to the control panel via a volt free contact in the Development's control system. When the Development's contact is closed the system is "enabled". When the Development's contact is open the system is "disabled"
Door Locks	Single key for Substation Plantroom, but with a master key for multiple locks or multiple substations within a Development
Trench/Pit Covers	GRP egg crate for Primary Heating Network and any other floor trenches

ITEM	PROVISION
Building/Substation Plantroom	The Substation Plantroom must be water tight and any penetrations sealed
Protection of the Substation Equipment	The Substation should be protected whilst any third party works are completed within the Substation Plantroom to prevent damage to the equipment (including the Substation)
Doors	The Substation Plantroom should be provided with lockable doors sized to allow safe access for the plant (including the Substation)
Fire Detection	Provide fire detection system and breakglass to meet regulations
Fire Compartmentalization	Provide necessary structures, seals and finishes to meet regulations
Noise and Vibration	The Substation Plantroom (s) should be designed and constructed to prevent noise and vibration
Emergency Push Button	Should be located adjacent to door and should isolate power supply to Substation Plantroom

Source: London Borough of Enfield Technical Specification Supplementary Planning Document, https://governance.enfield.gov.uk/documents/s51104/Appendix%201%20-%20DEN%20Technical%20SPD%202.pdf

12. ANNEX 5. UKRAINIAN LEGAL DOCUMENTS MENTIONED IN THE REPORT

Civil Code of Ukraine	https://zakon.rada.gov.ua/laws/show/435-15
Law No. 417 "On Peculiarities of Exercising the Right of Ownership in Multi-family buildings"	https://zakon.rada.gov.ua/laws/show/417-19
Law "On energy efficiency of buildings"	https://zakon.rada.gov.ua/laws/show/2118-19
Law "On Regulation of Urban Development"	https://zakon.rada.gov.ua/laws/show/3038-17
CMU Resolution No. 869 "On the Procedure for forming tariffs for heat energy, its production, transportation, and supply, and hot water supply" of 1 June 2011	https://zakon.rada.gov.ua/laws/show/869-2011-п
CMU Resolution No. 1198 "On approval of the Rules for the use of heat energy" of 3 October 2007 (the Rules for the use of heat energy)	https://zakon.rada.gov.ua/laws/show/1198-2007-п
CMU Resolution No. 830 "On the Rules for the provision of heat supply services" of 21 August 2019	https://zakon.rada.gov.ua/laws/show/830-2019-п - Text
NEURC Resolution No. 1174 "On the Procedure for setting tariffs for heat energy, its production, transportation, and supply" of 25 June 2019	http://www.nerc.gov.ua/index.php?id=42232
NEURC Resolution No. 1232 "On the Rules for issuing and approving technical conditions for connection to heat networks" of 29 October 2009 (the Rules for issuing TP)	https://zakon.rada.gov.ua/laws/show/za138-09
NEURC Resolution No. 343 "On Rules for connection to heating networks" of 19 October 2012 (the Rules for connection to heating networks)	https://zakon.rada.gov.ua/laws/show/z1856-12
Ministry of Energy Order No. 71 "On approval of the Rules for technical operation of heating installations and networks" of 14 February 2007 (the Rules for technical operation of heating installations and networks)	