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Promoting efficient district heating in Estonia

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Abstract

The Estonian Power and Heat Association (EPHA), in cooperation with Tallinn University of Technology (TalTech), has developed a methodological approach to calculating and awarding the Efficient District Heating Label (Label) that recognises and certifies the efficiency of the district heating (DH) system or certifies that the DH system mainly uses renewable energy and cogenerated heat. The Label informs the consumer about the efficiency of the DH system and highlights DH as an efficient, environmentally friendly, inexpensive, and convenient heating method.

The presence of the label serves as the basis for determining a lower primary energy factor (PEF) when calculating the energy performance of buildings that consume or will consume heat from a labeled DH system. Prior to this, a fixed DH PEF was used in Estonia.

It is important to note that using the EU Energy Performance Directive definition of efficient DH networks for PEF differentiation is a novel approach. According to the information available, such differentiation solutions have never been used before.

This study describes the main methodological approaches to Label assignment and calculation, as well as the most critical aspects of the system implementation in Estonia.

Graphical abstract

Another option could be based on the so-called *Fit for 55 package*. The EU is working on revising its climate, energy and transport-related legislation (under the Fit for 55 package) to align the current laws with the ambitions of 2030 and 2050. The package also includes several new proposals.

Introduction

According to Article 9 (1) of Directive (2010)/31/EU of the European Parliament and of the Council of May 19, 2010 on the energy performance of buildings (EU 2010), the Member States are required to develop national plans to increase the number of nearly zero-energy buildings. According to Article 2 (2) of the same Directive, energy used in nearly zero-energy buildings must be covered to a significant extent by energy from renewable resources, including energy from renewable sources produced on-site or nearby.

In addition to on-site sources, nearby generating units transferring heat through the district heating (DH) network should be considered when calculating the energy consumption of nearly zero-energy buildings and the percentage of renewable energy used in these buildings.

The widespread DH in Estonia provides one of the most effective opportunities at the national level to achieve the goals of increasing primary energy efficiency, increasing the share of renewable energy and reducing CO_2 emissions (Ministry of Economic Affairs and Communicationsand Ministry of the Environment and the Ministry of Rural Affairs, 2019). There are about 200 DH networks in Estonia, and DH covers more than 60% of heat production. Over the past 20 years, many boiler houses in DH networks have been renovated, and new biomass boilers and CHPs have been installed instead of old gas and oil boilers, leading to the decarbonisation of the DH sector in Estonia (Volkova et al., 2019, 2020).

The building's energy performance should be transparent and include an energy performance indicator and a numeric indicator of primary energy use based on primary energy factor (PEF) per energy carrier, which can be calculated using national or regional annual weighted averages or a specific value for on-site production (Garcia and Kranzl 2018).

In other words, the European Union policymakers have mandated the use of PEF when comparing the primary energy consumption of products using various energy sources.

In general, the purpose of using PEF has three aspects:

1). PEFs are used to account for the primary energy use required to generate the supplied energy and the associated environmental impact (e.g., CO_2 emissions). The lower the

primary energy consumption, the smaller the environmental footprint of the energy supply of a specific building.

2). PEFs are used to homogenise the effects of various fuel or energy types on the best available building construction methods. For example, adjusting the ratio of efficiency factors of electricity and other fuel or energy types to affect the effects of electrically driven equipment (e.g., heat pumps) on the selection of construction elements of the building envelope. The lower the primary energy consumption, the more energy-efficient the construction elements of the building envelope and utility systems (including renewable energy production systems and equipment that produce heat or electricity from solar, wind, water and geothermal energy sources located within the building or on-site).

3). PEFs are used to calculate the optimal cost levels of building energy performance. Optimal cost levels result in cost savings over the estimated economic life of a building. Lower costs are determined by taking into account investment costs, maintenance and operating costs, and, if necessary, disposal costs. A building with lower primary energy consumption is likely to have lower life cycle costs as well.

According to the Energy Performance of Buildings Directive, the methodology for calculating the energy performance of buildings must take into account European standards and comply with the relevant Union legislation. Meanwhile, the PEFs used to determine primary energy use can be based on national or regional annual averages and can consider the relevant European standards. Thus, the determination of PEFs is not directly standardised or uniform (Hamels et al., 2021).

The separation of efficient DH networks with low environmental impact will facilitate the transition of DH companies towards the use of renewable energy and the adoption of energy-efficient technical solutions.

PEF is a relevant EU energy policy tool for comparing various energy types and calculation approaches. Its determination differs significantly in the EU member states (Latõšov et al., 2017). The current situation shows that the EU Member States are flexible in adopting the concept of primary energy. The method for determining DH PEFs and their values differ significantly (Latõšov et al., 2017; Swing Gustafsson et al., 2016). There are single fixed DH PEFs that are valid for all DH networks in the country, differentiated DH PEFs that are used according to the fuel used or energy production technologies applied; there are also cases where DH PEF is calculated for each DH network individually (Latõšov et al., 2017). One possible solution to avoid these differences is to develop a uniform PEF determination procedure across all EU member states.

Until 2019, Estonia was using a fixed DH PEF, but this seemed impractical considering the changes in the DH sector that were discussed earlier. This approach did not consider changes in the DH sector, nor did it allow for the recognition and appreciation of efficient DH systems (Latõšov et al., 2016). In 2019, a new wording of the *Minimum Requirements for Energy Performance of Buildings* regulation (Estonian Ministry of Economy and Commu

was adopted, according to which two PEFs were to be used for the Estonian DH networks which made it possible to implement a differentiated solution. The basis for differentiation is the compliance of DH networks with energy performance requirements (European Parliament 2018). According to these requirements, a DH network is efficient if it uses at least 50% of renewable energy, 50% of waste heat, 75% of cogenerated heat or 50% of a combination of such energy and heat. The DH systems that meet these requirements are considered efficient and are assigned a lower PEF.

The transition from a fixed solution to a differentiated solution took four years from concept to implementation (a solution set by law). The process was headed by the Estonian Power and Heat Association (EPHA) in cooperation with Tallinn University of Technology (TalTech). EPHA's task was to identify problems and issues requiring solutions, actively participate in discussions on the results of relevant studies and exchange information with the Government of the Republic.[1] The primary role of TalTech was to research the issues raised and develop a methodological approach that would allow for a systematic and transparent performance check of DH systems.

Primary energy factors have been used as an indicator of district heating performance in some studies. For example (Živković and Ivezić 2021), use the primary energy factor as a key performance indicator to provide deeper insight into the energy efficiency of district heating systems. The calculation methodology in this study was based on the European standard EN 15316- 4–5. The results showed that introducing modern technologies, such as the use of treated wastewater by heat pumps, will reduce the average PEF for district heating by 3.5%. In (Noussan 2018), the study focused on calculating the PEF and CO2 emission factors based on actual operating data for a large sample of district heating networks in Italy. As in (Živković and Ivezić 2021), the calculation methodology is based on the European standard EN 15316-4-5. Fuel PEFs are based on Italian legislation. In (Ziemele et al., 2021), the PEF was used as one of the indicators in the 4 E (energy, exergy, environment and economy) assessment of various scenarios for the development of DH system performance. The primary resource factors used for the PEF calculation were taken from various sources such as projects, legislation and scientific papers.

To the best of the authors' knowledge, the labeling procedure for district heating and cooling systems networks is only described in one paper (Kveselis et al. 2017). In this case, ecolabeling is used to promote sustainable district heating development in Lithuania. Sustainability criteria are used for labeling purposes for DH systems and are related to a reference system where the above indicators meet minimal efficiency and environmental requirements, indicating that the system is in line with the goals of the 2020 EU energy policy.

Taking into account Estonia's background and the lack of experience in labeling district heating networks, it was necessary to develop a clear and detailed procedure for assigning energy labels based on the determination of the PEF values.

The primary purpose of the current study is to share our experience with other interested parties, reflect on this long-term process, describe the issues and solutions fou

process, and detail the resulting methodology for evaluating the efficiency of DH networks.

The following sub-objectives were established to achieve the main objectives of the study and an optimal understanding of the planned activities:

1. Determination of the PEF values until 2019 and a description of the principles for their application.
2. Identification of developments in the Estonian DH sector until 2019.
3. Report on the methods for determining DH PEFs and the existing experience in the European Union, their advantages and disadvantages, as well as a description of the concept behind the selected solution.
4. Detailed description of the methodological approach to implementing the selected solution and presentation of the algorithm for determining the efficient DH PEF.
5. Description of the efficiency of implementing the new solution (since 2019).
6. Description of vulnerabilities encountered during implementation of the solution and aspects requiring further development.

The methodology presented in this article focuses primarily on policymakers. However, the same decision-making principles and calculation logic can be used in other scientific studies to illustrate the current situation or development trends in a specific area (city, county, country or even EU as a whole) in accordance with the efficiency of DH networks located in this area.

Section snippets

Methods

This section organises the basic factors and reasons behind developing a new solution for determining DH PEF and describes the methodological approach used....

Results

The above approach identifying efficient DH networks and the DH system efficiency label statute was drawn up based on the methodology approved by the EPHA managing board on April 10, 2018. In parallel with the development of the methodology, discussions were held with the State Government on implementing various primary energy factors for efficient DH systems that have been awarded the Label.

The EPHA initiative proved to be very successful, and on May 22, 2018, the EPHA awarded the Label to the ...

Key findings of the study

The current study describes the long process of introducing the Label (developments in 2015–2018), related experiences, as well as the problems encountered and their solutions. It also includes a detailed description of the final methodology for identifying efficient DH networks.

The final solution is based on the definition of efficient DH networks provided in the *EU Energy Efficiency Directive*. According to this definition, a DH heating network is efficient if it uses at least 50% of renewable ...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

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