eXTENDing the energy performance assessment and
certification schemes via a mOdular approach

Innovative EPC indicator: District Energy

Guideline to calculate innovative indicators related to district energy for EPCs

Beta version

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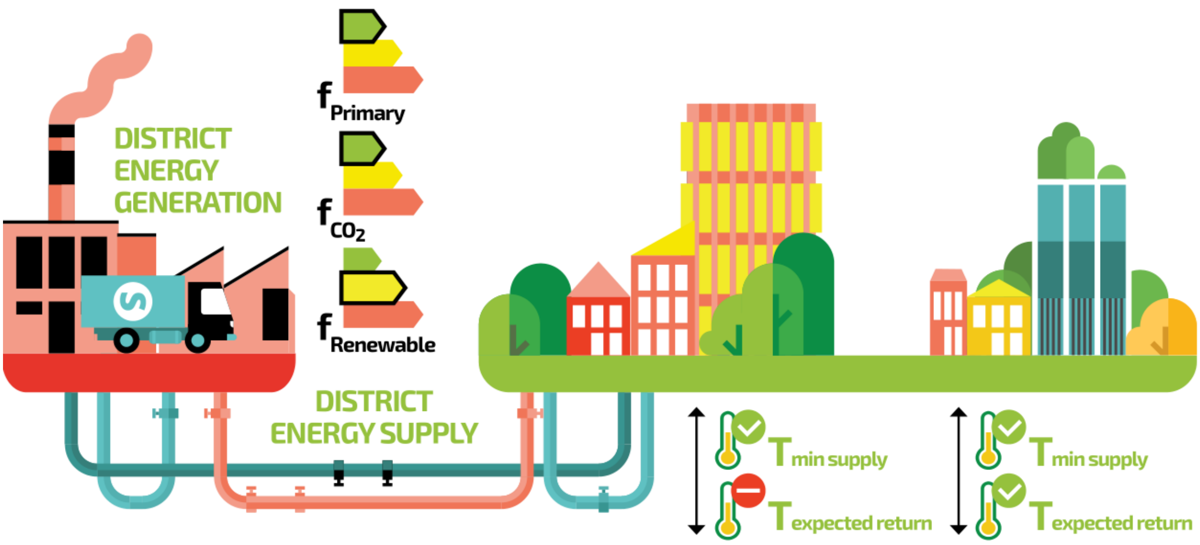

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AIM OF THE DOCUMENT

This document explains how parameters related to current and potential future district heating can be calculated to be included into an EPC of a building. These parameters characterise the nearest district heating system and its potential future development as well as the ability of the building to be potentially connected to a (low temperature) district heating system.

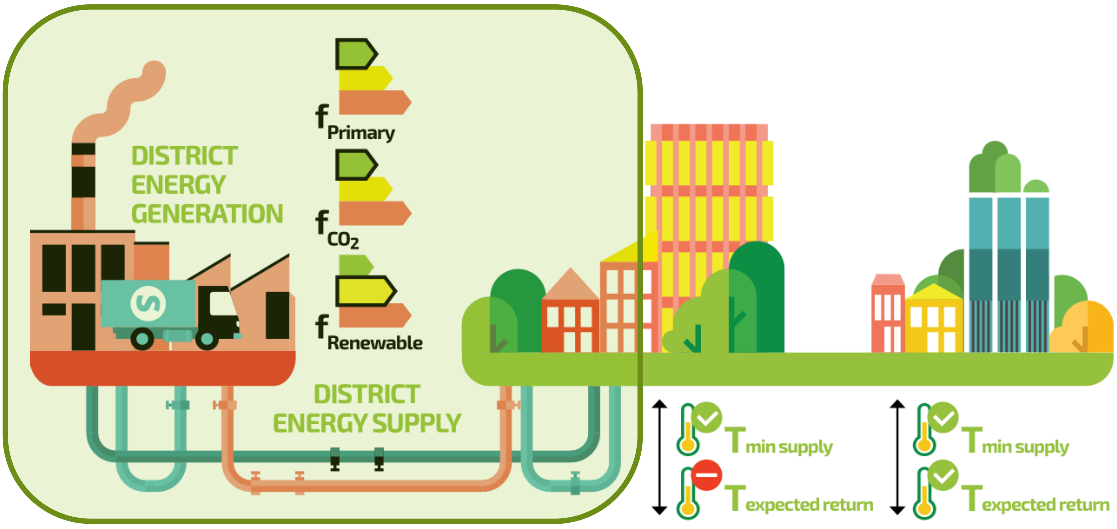
This document describes the calculation procedure and relates to the spreadsheet templates that have been developed in parallel. In case you do not already have the spreadsheet templates you can download them https://x-tendo.eu/toolboxes/district-energy/. Under this link you also find further information about the theoretical background of characterising district heating systems and the developed parameters, as well as a short overview of the parameters and its intention and implementation.

1 INTRODUCTION

Many advantages result from the correct use of district heating networks. Waste heat, which will play a major role in the future, as well highly efficient CHP can only be used efficiently, if distributed through a grid. Today the average CO_2 emissions from district heating networks are lower than for other energy sources. However, this is very different from one individual grid to another due to the fact, that they differ in source types, supply temperature amount of connected demand… The following parameters briefly describe the qualitative production and distribution of heat energy. Our proposal is to include these parameters of the nearest grid in every relevant EPC. The relevance in this case is defined via the distance to the heating grid. Furthermore, we propose to include an outlook on the prospective development of the heating grid into these EPCs. Therefore, the three parameters would be available for the actual state as well as for a future state. With these parameters end-users will get a clearer picture about the impact of the heat in the network and about the plans of the district heat provider.

By using low temperatures in the heating sector, waste heat sources, solar heat and other renewable energy sources can be included into the heating system more efficiently. We therefore propose the inclusion of two more parameters. On the one hand, the minimum supply temperature, which gives information about the threshold temperature with which a building must be supplied at least in case of a possible connection. And on the other hand, the minimum expected return flow temperature. This would provide a first estimation of the possibility of a connection and thus help both the district heating network operator and the final consumer.

2 PARAMETERS RELATED TO THE DISTRICT HEATING SYSTEMS



The following parameters describe the efficiency and the sustainability of the heat generation in a district heating network. By including the parameters of the closest network, a certificate holder can find out about the efficiency and sustainability of the heat generation in the district heating system nearby and can compare it with the currently installed system.

2.1 Parameters

- Primary energy factor

  indicates how much primary energy is used to generate a unit of usable thermal energy delivered to the consumer.

- Carbon emission coefficient

  converts activity data (process/processes) into CO 2 emissions, calculated based on primary energy.

- Renewable energy factor

  gives the share of renewable energy in the heat supplied by the district heating system, calculated based on primary energy.

2.2 Calculation procedure

To calculate these parameters, each district heating operator works together with a certified engineering office. The engineering office calculates the parameters for the current situation of the heat supply and distribution based on data provided by the district heating operator. The engineering office or the district heating operator passes the final calculations on to a (public) authority, which checks and approves them.

This results in a database of parameters for each district heating network in the country. This database should be publicly available via the internet. EPC issuers are then able to find these parameters for the network that is nearest to the building(s) they are currently analyzing.

Future state

In addition to the parameters calculated for the current state of the district heating network, the development of these parameters in the upcoming years should also be estimated and provided for the database.

We suggest estimating these parameters for the time interval of 10 years. This allows on the one hand a low effort and on the other hand a close outlook. If no changes are planned in the network, the current values should be used.

If the network operator has plans for modifications, it can set a specific target in cooperation with the engineering office. The office then calculates the corresponding parameters. In addition, 2-3 milestones should be set in the development process to ensure that the target can be met.

Also, these milestones and goals should be stored in the publicly accessible database. The publication should motivate the district heating operators to comply with their definition of goals. Also, end-users with older versions of the EPCs could verify the current state of the networks in case they are interested.

2.3 Threshold distance for including parameters into the EPC

In case that the nearest district heating system is far away from the building it is not meaningful to include such parameters into the EPC. We suggest defining a threshold in the range of 200-500m distance of the building. If no district heating network is within this threshold, the EPC should contain a note, describing that no network is nearby. Nevertheless, we would propose here the inclusion of the national average values to provide the opportunity to compare district heating with individual solutions in case this is interesting for the EPC owner. These values, however, should be marked as national average values in the EPC.

To facilitate the work of the EPC issuers we propose to set up a database of district heating networks including the information in which LAU2 region (municipality level) the network is located. The issuer is then able to easily find the networks in the LAU2 region of the building under analysis. If multiple networks are in operation in the respective LAU2 region, the EPC issuer must choose the relevant network. He could do this by getting in contact with the network operators and distinguish the one that applies for the building under analysis.

2.4 Calculation of the parameters

The spreadsheet “DH Parameter related to DH systems” for the calculation consists of 6 sheets. “DH input data” serves as a general input to enable an assignment of the calculation to a specific DH grid. In the three red sheets the respective calculations for the primary energy factor, the carbon emission coefficient and the renewable energy factor can be found. In general, only the fields marked in grey should be filled out in all calculations and the green fields show the results. In the following, the calculation of each of the factors is described.

Primary energy factor

For the overall primary energy factor, the primary energy factors of the various energy sources are weighted according to the energy supplied to the network.

As described in the introduction, the calculation is carried out by an engineering office in close cooperation with the district heating network operator. The district heating network operator provides the necessary data and describes how these data have been recorded. Also, national standards should exist for the primary energy factors.

For the correct calculation, all capacities for heat generation in a district heating network must be included in the calculation. That means renewable as well as conventional generation units.

The table PEF1 is filled with the primary energy content and the corresponding primary energy factor for each energy source used. Table PEF3 shows default values for the factors of the individual energy carriers. However, if other values apply nationally, these should be used.

The second table (table PEF2) shows the primary energy content of the exported energy with the corresponding primary energy factor on the one hand and the total energy supplied to energy consumers on the other.

Carbon emission coefficient

The calculation of the carbon emission coefficient differs only slightly from the calculation of the primary energy factor. Here too, the individual carbon emission coefficients of the energy sources are weighted according to the energy supplied to the network from the different sources. Here the different CO_2 factors are used instead of the primary energy factors. Table CEC3 gives an overview of the CO_2 factors for different energy carriers.

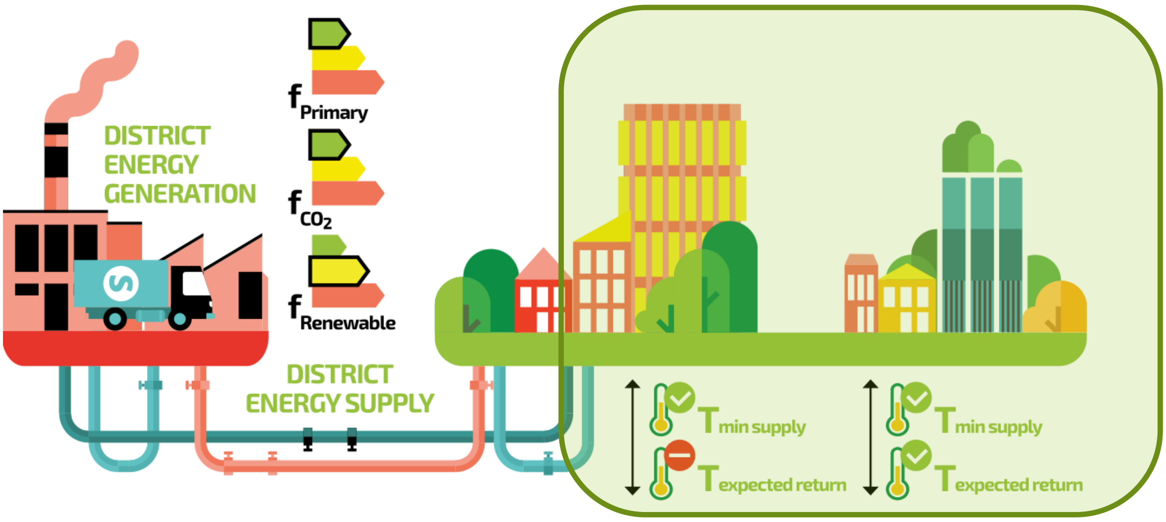
As for the primary energy content, national values should be used in case they are defined in a national standard or regulation.

Renewable energy factor

For the calculation of the renewable energy factor, generation plants are divided into three categories: energy systems with one input and one output (sos), energy systems with one input and several outputs (mos), and energy systems with several inputs and several outputs (mig). Several inputs or outputs could be for example heat and electricity. Their renewable energy factors are then weighted according to the energy they supply.

By filling the calculation table completely, the total renewable energy factor is obtained.

3 PARAMETERS RELATED TO THE BUILDING



Three parameters are proposed for calculation that characterise the heat distribution system of a building: the minimum supply temperature, the minimum expected return temperature and a parameter called heating element sizes with low supply temperatures. They give an indication on how this building can be connected to an existing or a planned district heating system. By announcing these values in the EPC of a building, not only district heating system planning can be facilitated, but also the evaluation of the use of on-site low-temperature renewable energy systems.

Since an exact calculation of potential minimum supply and minimum expected return temperatures involves many parameters and has large uncertainties, we propose to perform a rough estimation as presented in these guidelines. This rough estimation is based on the analysis of a room that is assumed to be representative for the situation of the entire building. I.e. it should reflect the entire building or flat in the estimation of the parameters listed before. This room is furtheron called the representative room.

In order to identify the representative room for the estimation of the proposed parameters the following guiding principles can be applied:

- The representative room should represent the room that is most difficult to heat in the entire building. Thus, it should have the highest heat load of all rooms of the building.
- In order to keep the efforts of performing the calculations small, it is recommended that this room is selected based on the expertise of the certificate issuer

An EPCs can be issued either for entire buildings or separately for individual units in a building. A guidance for the individual specific types is briefly discussed below.

EPC for each unit in a building

- The representative room is a frequently used and heated room. (In residential buildings in most cases it will be the living room)

EPC for an entire building

If the EPC is prepared for an entire building, in particular with several residential/commercial units, the following should be taken into account when selecting the representative room:

- The representative room is a frequently used and heated room. (In residential buildings in most cases it will be the living room)
- If there are several residential/commercial units in the building, the room should be located in a unit that is difficult to heat. (E.g. in the ground floor or in the attic)

In any case, the name and location of the representative room chosen for the calculations should be stated in the EPC (e.g. living room in flat nr. 2 in the ground floor)

3.1 Minimum supply temperature

This parameter is intended to give a rough estimate of the minimum temperature a heating system must provide to be able to heat the EPC object. An approximately accurate calculation of this temperature includes a large amount of parameters difficult to obtain, it is still subject to great uncertainty and it also needs remarkable efforts. Thus, we consider a rough estimate to be more efficient and useful for the implementation into the EPC. In the following a method to derive such a rough estimate is described. Also, an associated spreadsheet file named "DH parameter related to the building" is available to follow this method and thereby derive this parameter. However, the minimum supply temperature can also be directly estimated by the certificate issuer based on his/her experience.

The **first step** for the certificate issuer is to find the representative room. For this room, the heat load is estimated. This can be done by scaling the total heat load of the building with the heated area of the room. It could also be calculated like the calculation of the heat load of the entire building. In the calculation spreadsheet file a template for this calculation step can be found in the sheet "Minimum supply temp" on the top in table MST1 and is based on the input of the total heat load of the building, the area of the representative room and the total heated area of the building.

In the **second step** the issuer will have to determine the dimensions (length and width) and types of heat transfer systems that heat the representative room. This can be done by measuring the dimensions and noting down the types of the heat transfer systems in the room. Many buildings also have documents about the technical infrastructure, which can also be used. These data are collected in table MST2 in the spreadsheet file in the sheet "Minimum supply temp".

The **last step** is to estimate the minimum supply temperature based on standard values of thermal output of different types and dimensions of heat transfer elements at different temperatures. This minimum temperature can be found by identifying the lowest temperature at which the thermal output is still higher than the necessary heat load of the representative room.

For this estimation of the thermal output based on types and dimensions of the heat transfer elements the additional sheets provided in the spreadsheet file can be used. For different supply temperatures as well as different types and dimensions of radiators the thermal output of the radiators can be found. This data is extracted from the German standard DIN EN 442. In case a different standard applies (or applied in the period when the building was established/equipped) for the dimensioning of heat transfer elements in buildings in your country, please use your national data.

Calculation

The first part of the sheet "Minimum supply temp" in the "DH parameter related to building" spreadsheet serves as an aid for calculating the heat load of the representative room. If the heat load is known, it can also be entered manually at P l,rep in cell C18. However, if a calculation is required, this can be done by using table MST1.

In the second step of the calculation the thermal output of the heat transfer elements in the representative room is determined. This is done by listing each heat transfer element in the room. A table with 10 lines is available. Each of these lines is filled with a heat transfer element (for example a radiator) by entering its type and dimensions. Then the expected thermal output at different temperatures must be determined and entered. In the following, typical heat transfer elements are briefly described.

- Radiators

  For radiators there are further sheets available in the spreadsheet file showing the expectable thermal output of the radiator for different sizes, types and supply temperatures. By reading the tables in these sheets it is possible to find the expectable thermal output at given temperatures.

- Electric heating elements

  The thermal output of electric heating elements is not dependent on flow temperatures, as they are not in the heating water circuit. Therefore, the nominal power of the electric heating element can be applied here for every temperature.

- Other heat transfer systems

  If other heat transfer elements are used, a performance estimation at different temperatures from the certificate issuer is necessary. If the tests within the X-tendo project show the need to add more types and respective estimation tables, these will be added in next versions of the document.

Not all temperature levels in table MST2 must be filled, it is sufficient to find the threshold temperature that allows to heat the room with the existing heat transfer elements (radiators, etc.). This is done by an iterative estimation process: first, one of the tables from the standard DIN EN 442 reflecting a defined temperature is chosen by the issuer. For this temperature, the thermal output of the heat transfer elements at this temperature can be identified in the table provided in the spreadsheet file (in the additional sheets). Based on this evaluation, the next temperature to be looked up in a different table / sheet is chosen ("Convector 75°", "Convector 70°", "Convector 55°"): a higher temperature should be chosen if the thermal output is lower than the heat load of the room, or a lower temperature should be chosen if the thermal output is higher than the heat load of the room. The threshold temperature is then found with the lowest temperature that results in a thermal output higher than the necessary heat load.

3.2 Minimum expected return flow temperature

As for the previous parameter, it is suggested to estimate this parameter due to the high effort for calculating it. The following guide together with the sheet called “Minimum return flow temperature” in the excel file “DH Parameter related to building” can be used for this estimation. However, the minimum return flow temperature can also be directly estimated by the certificate issuer based on his/her experience.

If there are several heating circuits in the building under consideration, the value should be derived as a mixture of the different return temperatures of the different heating circuits. This also applies if there are several residential units in one building. By assessing 2 to 3 representative residential units, a sufficiently accurate estimate for the entire building can again be made by averaging. If, for example, the minimum flow temperature was calculated for the unit that is the most difficult to heat and this was used as the starting point for the return flow temperature, the result should be corrected upwards because the other units have higher return flow temperatures due to the lower heat consumption.

As the return flow temperature depends on the supply temperature, the minimum supply temperature estimated in the previous step is chosen as the starting point. The sheet called “calculation” in the provided spreadsheet file contains default return flow values for various supply temperatures, which then serve as the basis for the estimation. The certificate issuer can then select a type of control system of the heating circuit and if the heating system has been adjusted after a major renovation has been performed in the building. The spreadsheet file then contains rough estimations on the effect of the control system and its adjustment on the expectable minimum return flow temperature.

Calculation

The estimation of the minimum expectable return flow temperature should be done after the estimation of the minimum supply temperature, as it is the first input for the procedure. This is done automatically if the minimum supply temperature has been calculated in its sheet. However, if the temperature has been estimated and not entered, it must be entered in D6.

The following table MRFT2 in the spreadsheet file is filled by selecting the control type of the heat distribution system. Here, only one option can be chosen. If a thermal renovation of the object was carried out without subsequent adjustment of the heating system, this should be marked in table MRFT3. After successful entry, the result of the estimation is shown in the cell minimum expected return flow temperature.

3.3 Heating element sizes with low supply temperatures

This parameter is primarily used to inform the EPC end-users whether their flat/house can be connected to a newer generation of district heating network. A simple way to do this is to provide the theoretical area required for a few typical heat transfer installations (radiator, wall heating, underfloor heating).

Since the newer generations of district heating have a low flow temperature, the heating capacity of the installed heating elements may be insufficient. By roughly estimating the heat transfer surface of typical heating elements, the user can get an idea of the conditions under which the connection to such a district heating network is possible.

In order to keep the effort within limits, we recommend to perform the calculation for one representative room. In addition, the end user can quickly compare the heat transfer area of currently installed heating elements with the calculated values. To maintain transparency, it is recommended to list the specifications used for the calculation also in the EPC (like given in table HES3 in the calculation sheet with the additional heat power density).

Calculation

The calculation can be found in the Excel calculation tool “DH parameter related to building” in the sheet "heating element sizes". The first input of this file is the heating load of the representative room. Since this was already required under "Minum supply temperature", it is automatically inserted from that sheet. However, if the temperature has been estimated and not calculated, the heating load can also be entered directly into the field C11.

After deriving the heat load, the necessary dimensions of some typical heat transfer elements (radiator, floor heating and wall heating) for defined specifications are displayed (Table HES2). For calculating these dimensions several other data have to be specified in table HES3: the supply, return and room temperatures, for floor as well as wall heating also the distance of single heating pipes in the floor or wall and for the floor heating also the grounding. It should be borne in mind that the results should represent the necessary dimensions of these heating elements when connected to a fourth generation district heating system. That is why we advise using the currently set flow temperatures of 40°C for floor and wall heating. The 55°C flow temperature of the radiators is currently the lowest possible for which data has been found so far. The specifications of the standard heating elements can be edited by selecting a value in the lists. The grey cells indicate which of the values can be changed.

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