Ecoheat4cities

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Guidelines for technical assessment of District Heating systems

This report was elaborated in the framework of the Ecoheat4cities project supported by the Intelligent Energy Europe Programme.

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Project Summary

Supported by the Intelligent Energy Europe Programme (IEE), the Ecoheat4cities project promotes awareness and knowledge-based acceptance of District Heating and Cooling (DHC) systems through the establishment of a voluntary green heating and cooling label. The label will provide useful information on key energy related parameters of DHC systems to interested stakeholders throughout Europe and participating countries, including local policy makers, other DHC companies, citizens and related industries.

The three labeling criteria: **Renewability, Resource efficiency (Primary Energy Factor) and CO2 efficiency/emissions** reflect the aims of the EU 2020-targets and will thus enable stakeholders from all over Europe to see and show how District Heating and District Cooling can contribute to reaching the EU's energy targets and assess DHC as a competitive and viable option in Europe's heating and cooling market.

Project outcomes include:

- a label design tool, labeling governance and guidelines, including all details concerning the calculation methods as well as related technical and scientific background research on DH performance and best available and not available technologies;
- a tool enabling cities and municipal planners to compare different heating and cooling options;
- a guide for city planners and DHC companies to better understand the labeling process, also offering insight into how the label can provide added value and a green image.

The Ecoheat4cities label provides a way to measure sustainability and performance of DHC systems based on available and verified, local knowledge and resources.

If your organization would like to know more about the Ecoheat4cities green label, governance structure of the labeling scheme, or participate in any of its activities, please contact Euroheat & Power or its national partners. DHC companies and cities are actively invited to provide additional guidance and feedback about the on-going work by contacting us.

All information is available on the Ecoheat4cities website at www.ecoheat4cities.eu

Preface

The “Guidelines for technical assessment of district heating and cooling systems” were prepared by Boris Lubinski, and Ingo Weidlich, AGFW, in cooperation with the Ecoheat4cities project group and steering committee.

Based on the “Technical report on labelling criteria for DHC” (prepared by the Swedish Environmental Research Institute in cooperation with the Ecoheat4cities project group and steering committee), as well as on lessons learnt during the first round of test-labelling of DH systems and on standards/norms commonly used to measure energy performance, this report provides information on the process of gathering data input for the Ecoheat4cities heat performance label.

The label will enable DHC companies to express the energy performance of their existing district systems and shall encourage district heating designers, system owners and operators to improve their energy performance in existing systems. Furthermore, urban planners and end users will be informed about the performance of existing systems and future planned systems in new urban areas and districts.

This guideline is intended to be used:

- by the label certification bodies, (role of which has been defined in the “Labelling governance”) and other entities eligible to conduct district heating labelling;
- by district heating planners and district heating operators to assess the performance of a planned or an existing district heating system and thus to express this performance.

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1 Scope

This guideline specifies:

a) indicators to express the energy performance and energy source of district heating systems.

b) a procedure to define reference values;

c) a procedure for district heating energy certification.

2 Normative references

- EN 15316-4-5:2007, Heating systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-5: Space heating generation systems, the performance and quality of district heating and large volume systems

- EN 15603:2008, *Energy performance of buildings — Overall energy use and definition of energy ratings*

- CEN workshop agreement CWA 45547:2004, *Manual for Determination of Combined Heat and Power (CHP)*

- Commission implementing decision 2011/877/EU

- Commission decision 2008/952/EC

3 Terms and definitions

For the purposes of this document, terms and definitions given in EN 15603:2008 and in EN 15316-4-5:2007 and the following apply.

3.1
energy class
easy to understand metric for indicating the energy performance of a district heating system

3.2
reference value
standard calculated value against which an energy indicator is compared

3.3
energy performance indicator
energy input to or emissions from a district heating system divided by delivered energy

3.4
energy source indicator
energy output from a defined source divided by total energy output

3.5
measured energy indicator
energy performance indicator based on measured data of an existing system

3.6
design energy indicator
energy performance indicator based on design data for a future system

3.7
tailored energy indicator
energy performance indicator based on design, forecast and measured data

EXAMPLE applicable for existing systems that will be retrofitted (e.g. new heat generators, connection of existing networks)

3.8
delivered energy
energy, expressed per energy carrier, supplied to the technical building system through the system boundary

3.9
primary energy
energy that has not been subjected to any conversion or transformation process

NOTE Primary energy includes non-renewable energy and renewable energy. If both are taken into account it can be called total primary energy.

3.10
primary bio fuel
solid, fluid or gaseous fuel from renewable sources that is solely produced for energy purposes e.g. wood or energy crops

3.11
secondary bio fuel
solid, fluid or gaseous fuel from renewable sources that is a co-product or residue from another process with another main product e.g. biogas from sewage treatment or wood chips from timber production

3.12
refined bio fuel
solid, fluid or gaseous fuel from renewable sources that passes a refining step in the upstream fuel chain for energy purposes e.g. compression and drying of wood chips to obtain pellets or the production of biooil from energy crops

4 Symbols and abbreviations

Table 1 — Symbols

E	energy
Q	heat
K	emission coefficient
R	renewable and surplus heat fraction
β	ratio of any specified energy to total heat
EP	energy performance indicator
ES	energy source indicator
f	factor
ref	reference
s	power loss index
σ	power-to-heat ratio
η	efficiency

Table 2 — Subscripts

aux	auxiliary	hn	heating network
cond	in condensation mode	hp	heat producer
chp	combined heat and power	Hi	heating value Index i: inferior / Index s: superior
del	delivered	ng	natural gas
dh	district heating	nren	non-renewable
el	electricity	P	primary energy
ext	external	R	renewable and surplus heat
F	fuel	ref	reference
i	index for energy carrier		

5 Energy indicators

A district heating system is characterised by energy indicators:

The energy performance of a district heating system is represented by the two indicators EP

— primary energy factor $f_{\mathrm{P,dh}}$

— emission coefficient K_{dh}

The energy source of a district heating system is represented by the indicator ES

— renewable and surplus heat fraction R_{dh}

They may be complemented by additional indicators that shall be defined in a national annex.

EXAMPLE Share of cogenerated heat is an energy source indicator

5.1 determining the energy data

The indicators shall be based on one of the three types of ratings:

— design energy rating;

— tailored energy rating;

— measured energy rating.

All indicators should be determined with the same energy data, system boundaries and time period. Due to the many factors that can affect district heating systems, the indicators can fluctuate over time. This variation can be limited by basing the calculation on a broad range of data. Existing schemes should be calculated using the energy data from the last three years. In cases where it is justified to do so, the calculation may be based on the energy data from a single year. If the time period is shorter than three years, a correction for weather may be performed. Indicators on the basis of measured energy rating reflect the energy performance of the past. In order to certify the most actual performance the time period between the energy data and the date of certification shall not exceed two years.

The energy data shall be validated by a plausibility check. Depending on the available data the following indicators can provide plausibility:

— efficiency of the heating network

— efficiency of heat generators

— power-to-heat ratio of chp units

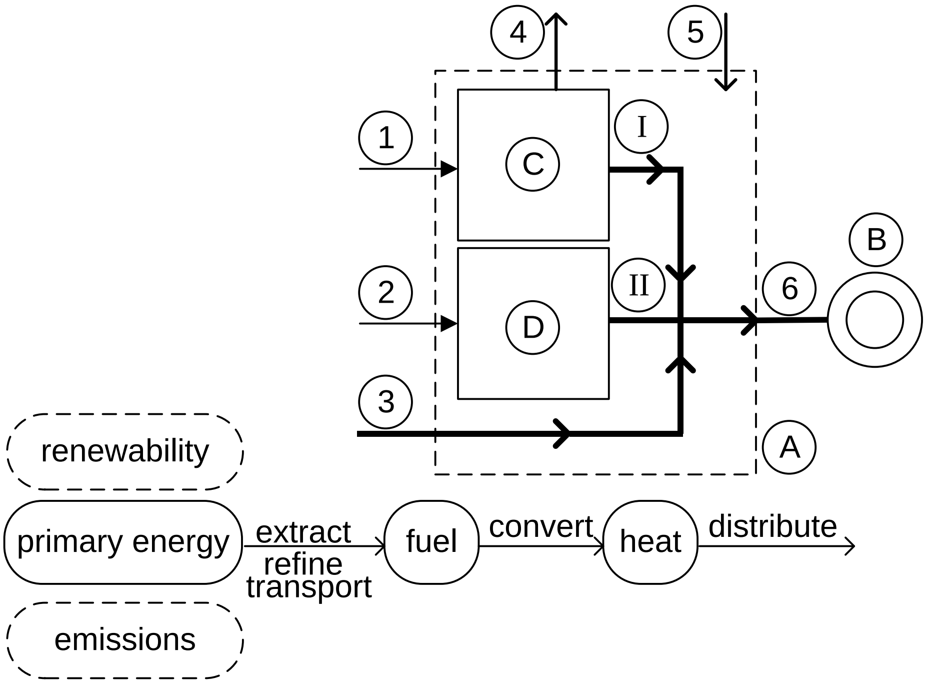
— ratio of auxiliary electricity to produced heat

Electricity from cogeneration $E_{\mathrm{el,chp}}$ and the related amount of fuel is determined according to 2008/952/EC. Additional calculation methods can be found in the CEN workshop agreement CWA 45547:2004.

5.2 determining the system boundaries

EP shall be determined within the thermodynamic system borders of the specific district heating system. This is usually the area supplied by one heating network bordered by the primary side of building substations. Within this area, all energy inputs and all energy outputs are considered. Energy as input to the system is weighted by its specific conversion factor. Thus, the heat losses of the heating network are taken into account as well as all other energy used for extraction, preparation, refining, processing and transportation of the fuels to produce the heat.

Figure 1 — system boundaries for district heating energy rating



A	system boundary	1	energy input to cogeneration unit	E_{chp}
B	heat consumers	2	energy input to heat producer	E_{hp}
C	cogeneration unit	3	heat from external source	Q_{ext}
D	heat producer	4	chp electricity	$E_{el,chp}$
		5	auxiliary electricity	$E_{el,aux}$
		6	delivered heat	Q_{del}
		I	heat from cogeneration unit	Q_{chp}
		II	heat from heat producer	Q_{hp}

If it is not possible or useful to calculate connected plants and networks together, they may be broken down into subsystems. This results in some subsystems which consume heat and others that supply heat. The heat from a supplier subsystem shall be assessed with its own energy indicators. For the consumer subsystem this is an external heat supply which is taken into account as an energy input Q_{ext} with its specific energy indicators.

Note: It may be useful or necessary to divide a system when parts of the district heating network are operated by different utility companies or with different system parameters.

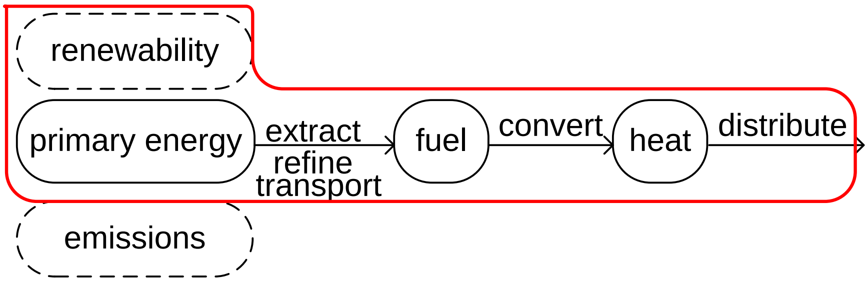
6 calculation

In some cases negative calculation results may occur. They shall be set to zero.

6.1.1 primary energy

According to clause 8 of EN 15603 there are two conventions of primary energy factor: Total primary energy factor and non-renewable primary energy factor. In this guideline the non-renewable primary energy factor is used and is calculated according to EN 15316-4-5 (2007) if no national calculation rules are given. National variations shall be defined in a national annex.

Figure 2 — non-renewable primary energy factor of district heating $f_{P,dh,nren}$



NOTE Renewability, recyclability and emissions are attributes of primary energy. Renewability and recyclability are conventions that may be taken into account by setting renewable and recycled primary energy to zero.

$$f_{P,dh,nren} = \frac{\sum_i E_i \cdot f_{P,nren,i} + Q_{ext} \cdot f_{P,nren,ext} + \left(E_{el,aux} - E_{el,chp}\right) \cdot f_{P,el}}{\sum_j Q_{del,j}}$$

E_i energy content of input to the system of energy carrier i in MWh_{Hi}

$f_{P,nren,i}$ non-renewable primary energy factor of energy carrier i from table 3

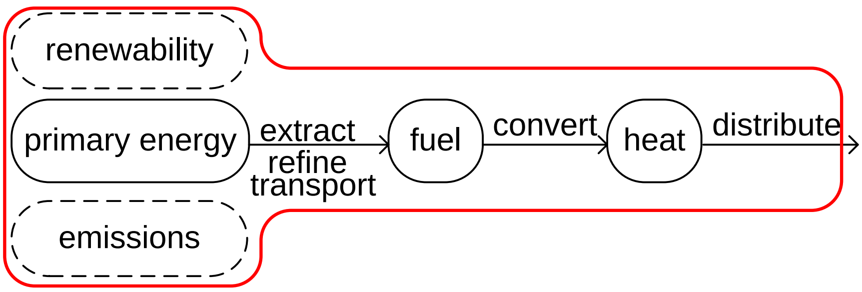
$f_{P,nren,ext}$ non-renewable primary energy factor of the external heat supply

$f_{P,el}$ primary energy factor of electricity from table 3

6.1.2 emissions

For the purpose of certification according to this guideline the non-renewable primary CO_2-emission coefficient represents the emissions of a district heating system if no national calculation rules are given.

Figure 3 — non-renewable primary emission coefficient of district heating $K_{P,dh,nren}$



$$K_{P,dh,nren} = \frac{\sum_i E_i \cdot K_{P,nren,i} + Q_{ext} \cdot K_{ext} + E_{el,aux} \cdot K_{el} - \left(\sum_i \frac{E_{el,chp,i} \cdot K_{P,nren,chp,i}}{\eta_{el,i}} \right)}{\sum_j Q_{del,j}}$$

$K_{P,dh,nren}$ non-renewable primary CO_2-emission coefficient of district heating in kg/MWh

E_i energy content of energy carrier i input to heat producer and cogeneration unit in MWh_{Hi}

$K_{P,nren,i}$ non-renewable primary CO_2-emission coefficient of energy carrier i in kg/MWh_{Hi} from table 3

Q_{ext} energy content of heat from external source in MWh

K_{ext} non-renewable CO_2-emission coefficient of external heat in kg/MWh

K_{el} non-renewable CO_2-emission coefficient of electricity in kg/MWh from table 3

$E_{el,chp,i}$ cogenerated electricity produced with fuel i in MWh

$K_{P,nren,chp,i}$ non-renewable primary CO_2-emission coefficient of energy carrier i that was used in chp-unit in kg/MWh_{Hi} from table 3

$\eta_{el,i}$ electric efficiency of fuel i from 2011/877/EU, Annex I

NOTE Correction factors according to Annex III and Annex IV shall not be applied. The year of construction may be taken into consideration.

$Q_{del,j}$ delivered heat to customer j in MWh

6.1.3 renewable and surplus heat fraction

R is the ratio of heat from renewable and/or surplus heat carriers to total heat in %. If electricity is used as fuel (e.g. for heat pumps or electric boilers) 20% of this electricity is regarded as renewable/surplus heat

6.2 conversion factors and coefficients

According to EN 15603 clause 8.2 average, marginal and end-use factors and coefficients may be applied. Values for factors and coefficients needed to calculate the energy performance indicators should be defined in a national annex.

6.2.1 primary energy factors for fuels

The primary energy factors for fuels are calculated by taking into account losses that occur during extraction, processing/refining, storage and transport of the fuels. For a given fuel the primary energy use is divided by the net energy content of the fuel (lower heating value) at the gate where it is finally transformed into heat. The gate could be represented by either an energy plant or a building with its own boiler. The energy taken into account is all energy required from cradle to the final use of one unit of fuel at the gate and is calculated accordingly:

$$f_{P,F} = \frac{E_{P,extract} + E_{P,refine} + E_{P,transport} + E_{P,F}}{E_{F,del}}$$

$E_{P,extract}$ primary energy demand for fuel extraction

$E_{P,refine}$ primary energy demand for fuel processing/refining

$E_{P,transport}$ primary energy demand for transport of the fuel

$E_{P,F}$ primary energy content of the fuel

$E_{F,del}$ net energy content of the fuel delivered to the gate (using lower heating value)

NOTE A primary energy factor for one fuel may consist of different energy sources such as natural gas, oil and coal.

Lower heating values are used to convert primary energy and fuels into energy units. The factor is applicable for fuels used for district heating generation, electricity generation as well as for fuels delivered into buildings where they are finally transformed into heat.

6.2.2 CO_2-emission coefficients for fuels

The primary carbon dioxide emission coefficients are calculated by taking into account emissions that occur during extraction, processing/refining, storage, and transport of the fuels. The carbon dioxide emission coefficients of fuels are calculated according to:

$$K_P = K_{F,extract} + K_{F,refine} + K_{F,transport} + K_F$$

K_P primary carbon dioxide emission coefficient of the fuel (kg CO_2/MWh_{Hi})

$K_{F,extract}$ carbon dioxide emissions (kg CO_2) during extraction of 1 MWh_{Hi} of fuel

$K_{F,refine}$ carbon dioxide emissions (kg CO_2) during processing/refining of 1 MWh_{Hi} of fuel

$K_{F,transport}$ carbon dioxide emissions (kg CO_2) during transport of 1 MWh_{Hi} of fuel

K_F carbon dioxide emissions (kg CO_2) during combustion of 1 MWh_{Hi} of fuel

If no national values are given the following default values shall be used:

Table 3 — conversion factors

		f_P		K_P (kg/MWh_{Hi})
		total	nren	CO_2, nren
fossil fuels	natural gas	1,1	1,1	230
	liquid gas	1,1	1,1	260
	light oil	1,1	1,1	290
	heavy oil	1,1	1,1	300
	coal	1,1	1,1	370
renewable	primary bio fuel	1,1	0,1	20
	refined primary bio fuel	1,2	0,2	40
surplus heat	secondary bio fuel	0,1	0,1	20
	refined secondary bio fuel	0,2	0,2	40
	residual fuel from another process	0,2	0,2	40
	municipal waste as fuel	0	0	0
	industrial waste heat	0	0	0
electricity		3	2,6	420

6.3 simplifications for external heat supply

If Q_{ext} is supplied to a district heating system and EP/ES of Q_{ext} are unknown default values are required. For this purpose default values may be determined on national level.

6.3.1 industrial waste heat

Industrial waste heat comes from processes whose primary purpose is the manufacturing of goods. It usually consists of a process-related component and a district heating component. The process-related component is the minimum amount of waste heat which is generated in the production process and must be released to the environment via cooling systems if not used for district heating. The energy input for this portion of the industrial waste heat is entirely allocated to the product and is evaluated using the primary energy factor and emission coefficient 0 (see table 3). The district heating component is the amount of additional heat that is required to supplement the process component in order to meet the requirements of the district heating system (e.g. boosting pressure, temperature and flow rate). The energy input for generating the district heating component shall be integrated into the numerator of the formulas above. If the district heating component cannot be identified a default value may be determined on national level. If no national default values are set, external heat from industrial sites is assessed with the f_P = 0,4, K_P = 90 kg/MWh, R = 0,6.

6.3.2 heat from waste-to-energy plant

Municipal waste comes from processes whose primary purpose is not energy production. So its energy content is not allocated to the energy products (heat and electricity) and is evaluated using the primary energy factor and emission coefficient 0 (see table 3). The energy input for processes such as ignition, auxiliary firing and flue gas cleaning shall be integrated into the numerator of the formulas above. If this energy input cannot be identified a default value may be determined on national level. If no national default values are set, external heat from waste-to-energy plants is assessed with the f_P = 0,1, K_P = 25 kg/MWh, R = 0,9.

6.3.3 heat from nuclear power plants

If heat is extracted from a condensation turbine of a nuclear power plant it shall be calculated by

$$f_{P,ext} \cdot Q_{ext} = f_{P,el} \cdot \Delta E_{el,ext}$$

$f_{P,ext}$ primary energy factor of the external heat

Q_{ext} amount of heat supplied by external system

$f_{P,el}$ primary energy factor of electricity

$\Delta E_{el,ext}$ annual power loss of the external power plant due to heat extraction and transport with $\Delta E_{el,ext} = (s+\beta_{aux}) \cdot Q_{ext}$ where s is the power loss index and β_{aux} is the ratio of auxiliary electricity (e.g. pumps for the district heating transportation) to produced heat.

If $\Delta E_{el,ext}$ is not available default values for s and β_{aux} may be determined on national level. The values for s usually range between 0,1 and 0,3. If no national default values are set, external heat from nuclear power plants is assessed with the $f_P = 0{,}25 \cdot f_{P,el}$, $K_P = 0{,}25 \cdot K_{el}$, R = 0.

6.4 documentation

The documentation of the calculation shall contain at least:

- description and connection scheme(s) of the district heating system
- all energy input and output per energy carrier and time period
- plausibility checks
- conversion factors
- explanation of assumptions and simplifications if necessary

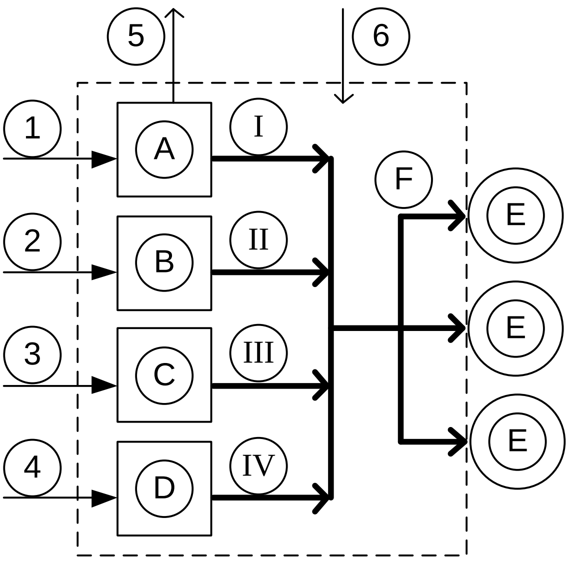
— resulting energy indicators

— date, name of auditor, confirmation of compliance with this guideline

7 Reference district heating system

The reference values for the determination of the energy classes in clause 7 is calculated with a set of data according to table 4 and a system set-up according to figure 4.

Figure 4 — set-up of the reference system



A	extraction-condensation chp-unit with η_{chp}	1	hard coal with $f_{P,coal}$ and $K_{P,coal}$
B	heat producer for natural gas with $\eta_{hp,ng}$	2	natural gas with $f_{P,ng}$ and $K_{P,ng}$
C	heat producer for biogas with $\eta_{hp,biogas}$	3	biogas with $f_{P,biogas}$ and $K_{P,biogas}$
D	heat producer for wood chips with $\eta_{hp,wood}$	4	wood chips with $f_{P,wood}$ and $K_{P,wood}$
E	heat consumers	5	chp-electricity with $f_{P,el}$ and $\sigma \cdot \beta_{chp}$
F	district heating network with η_{hn}	6	auxiliary electricity with $f_{P,el}$, K_{el}, β_{aux}
I	heat from coal chp-unit with β_{chp}	III	heat from biogas with $\beta_{hp,biogas}$
II	heat from natural gas with $\beta_{hp,ng}$	IV	heat from wood chips with $\beta_{hp,wood}$

The formulas for $f_{P,dh,ref}$ and $K_{P,dh,ref}$ are derived from the formulas in clause 6.1.1 and 6.1.2 and thus provide the same results.

$$f_{P,dh,ref} = \frac{(1+\sigma)\cdot\beta_{chp}\cdot f_{P,coal}}{\eta_{chp}\cdot\eta_{hn}} + \frac{\beta_{hp,wood}\cdot f_{P,wood}}{\eta_{hp,wood}\cdot\eta_{hn}} + \frac{\beta_{hp,biogas}\cdot f_{P,biogas}}{\eta_{hp,biogas}\cdot\eta_{hn}} + \frac{\beta_{hp,ng}\cdot f_{P,ng}}{\eta_{hp,ng}\cdot\eta_{hn}} - \frac{(\sigma\cdot\beta_{chp}-\beta_{aux})\cdot f_{P,el}}{\eta_{hn}}$$

$$K_{P,dh,ref} = \frac{(1+\sigma)\cdot\beta_{chp}\cdot K_{P,coal}}{\eta_{chp}\cdot\eta_{hn}} + \frac{\beta_{hp,wood}\cdot K_{P,wood}}{\eta_{hp,wood}\cdot\eta_{hn}} + \frac{\beta_{hp,biogas}\cdot K_{P,biogas}}{\eta_{hp,biogas}\cdot\eta_{hn}} + \frac{\beta_{hp,ng}\cdot K_{P,ng}}{\eta_{hp,ng}\cdot\eta_{hn}} + \frac{\beta_{aux}\cdot K_{el}}{\eta_{hn}} - \frac{\sigma\cdot\beta_{chp}\cdot K_{P,coal}}{\eta_{hn}\cdot\eta_{el,cond,coal}}$$

Table 4 — Data for the reference district heating system

obligatory		
σ	0,53	power-to-heat ratio
η_{chp}	0,87	overall efficiency of the chp-unit (0,3 electric + 0,57 thermal)
$\eta_{hp,ng}$	0,9	overall efficiency of the heat producer natural gas
$\eta_{hp,biogas}$	0,9	overall efficiency of the heat producer biogas
$\eta_{hp,wood}$	0,85	overall efficiency of the heat producer wood chips
η_{hn}	0,9	efficiency of the heating network
$\eta_{el,cond,coal}$	0,442	electric efficiency of a coal power plant in condensing mode from 2011/877/EU
β_{aux}	0,04	ratio of auxiliary electricity to produced heat
β_{chp}	0,75*(1-β_R)	ratio of cogenerated heat to total heat
$\beta_{hp,ng}$	1-β_{chp}-β_R	ratio of heat from natural gas to total heat
adaptable in a national annex		
β_R		national target for market-share of renewables from table 5
$\beta_{hp,biogas}$	$\beta_R/2$	ratio of heat from biogas to total heat
$\beta_{hp,wood}$	$\beta_R/2$	ratio of heat from wood chips to total heat
$f_{P,coal}$	1,1	primary energy factor coal from table 3
$f_{P,ng}$	1,1	primary energy factor natural gas from table 3
$f_{P,biogas}$	0,2	primary energy factor biogas from table 3 (refined secondary biofuel)
$f_{P,wood}$	0,1	primary energy factor wood chips from table 3 (primary biofuel from energy forest)
$f_{P,el}$	2,6	primary energy factor electricity from table 3
$K_{P,coal}$	370	primary emission coefficient coal from table 3
$K_{P,ng}$	230	primary emission coefficient natural gas from table 3
$K_{P,biogas}$	40	primary emission coefficient biogas from table 3 (refined secondary biofuel)
$K_{P,wood}$	20	primary emission coefficient wood from table 3 (primary biofuel from energy forest)
K_{el}	420	primary emission coefficient electricity from table 3

The reference value for the non-renewable primary energy factor is 0,8. The reference value for the non-renewable CO_2 emission coefficient is 222 kg_{CO2}/MWh. The reference value for the share of renewable and surplus heat according to the environmental targets is shown in table 5. Deviating district heating specific national targets may be used if defined in a national annex. If national variations or deviations on primary energy factors and emission coefficients are applied EP and the reference values shall be calculated with the same table of primary energy factors and emission coefficients and the same calculation method.

Table 5 — country specific targets for the share of renewable energy for 2020 in %

Austria	34	Germany	18	Netherlands	14
Belgium	13	Greece	18	Poland	15
Bulgaria	16	Hungary	13	Portugal	31
Cyprus	13	Ireland	16	Romania	24
Czech Rep.	13	Italy	17	Slovak Rep	14
Denmark	30	Latvia	40	Slovenia	25
Estonia	25	Lithuania	23	Spain	20
Finland	38	Luxemburg	11	Sweden	49
France	23	Malta	10	UK	15
EU27	20				

8 Energy certificate

8.1 content

The energy certificate shall contain at least or be accompanied by:

a) administrative data:

1) reference to a specific procedure for district heating certification, including its date;

2) names of persons and institutions responsible for issuing the energy certificate;

3) name and location of the district heating system;

4) date on which the energy certificate was issued and its limit of validity.

b) technical data:

1) the energy indicators as defined in Clause 5;

2) types of indicators used;

3) the energy classes.

8.2 scale

The scale is subdivided into seven classes. The class limits for the energy indicators are determined with the following rules:

Table 6 — determination rules for energy classes

class	$f_{P,dh}$ and K_{dh}	R_{dh}
1	$EP < 0,5\ ref$	$ES > 0,5 \cdot (100 - \beta_R) + \beta_R$
2	$0,5\ ref \leq EP < ref$	$0,5 \cdot (100 - \beta_R) + \beta_R \geq ES > \beta_R$
3	$ref \leq EP < 1,5\ ref$	$\beta_R \geq ES > 0,8\ \beta_R$
4	$1,5\ ref \leq EP < 2\ ref$	$0,8\ \beta_R \geq ES > 0,6\ \beta_R$
5	$2\ ref \leq EP < 2,5\ ref$	$0,6\ \beta_R \geq ES > 0,4\ \beta_R$
6	$2,5\ ref \leq EP < 3\ ref$	$0,4\ \beta_R \geq ES > 0,2\ \beta_R$
7	$3\ ref \leq EP$	$0,2\ \beta_R \geq ES$

Table 7 — energy classes determined with $f_{P,dh,ref}$ = 0,8, $K_{dh,ref}$ = 222 kg/MWh and β_R = 20%

class	$f_{P,dh}$	K_{dh}	R_{dh}
1	$f_{P,dh} < 0,40$	$K_{dh} < 111$	$R_{dh} > 60\%$
2	$0,40 \leq f_{P,dh} < 0,80$	$111 \leq K_{dh} < 222$	$60\% \geq R_{dh} > 20\%$
3	$0,80 \leq f_{P,dh} < 1,20$	$222 \leq K_{dh} < 333$	$20\% \geq R_{dh} > 16\%$
4	$1,20 \leq f_{P,dh} < 1,60$	$333 \leq K_{dh} < 444$	$16\% \geq R_{dh} > 12\%$
5	$1,60 \leq f_{P,dh} < 2,00$	$444 \leq K_{dh} <555$	$12\% \geq R_{dh} > 8\%$
6	$2,00 \leq f_{P,dh} < 2,40$	$555 \leq K_{dh} < 666$	$8\% \geq R_{dh} > 4\%$
7	$f_{P,dh} \geq 2,40$	$K_{dh} \geq 666$	$R_{dh} \leq 4\%$

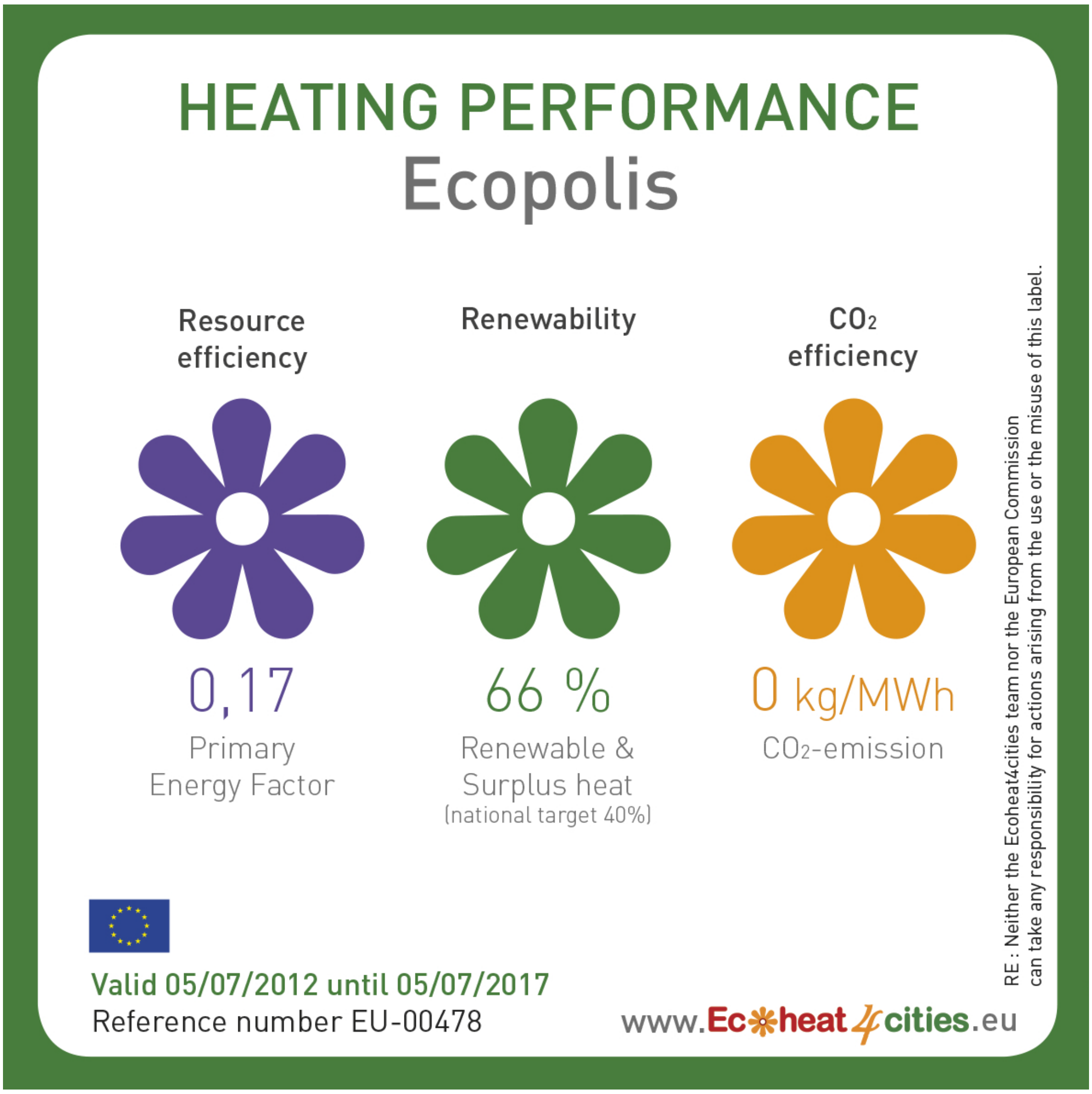
8.3 validity period

Validity of the certificate depends on the energy input data. Certificates based on three years' energy data are valid for ten years. If the indicators are calculated using data from less than three years, the certificate is only valid for three years. Certificates based on design or tailored energy rating are valid for three years. The validity period is not affected by changes to the conversion factors and reference values. If there are changes to the plant configuration or the plant's energy carrier mix which significantly increase $f_{P,dh}$ or K_{dh} or decrease R_{dh}, the certification procedure shall be repeated using the next year's energy data.

8.4 issuing body

The certificate of a district heating system according to this document shall be issued by a certification body as described in the 'Labelling governance' document.

8.5 Format



Note: The label design above is indicative for the purpose of illustrating the design and lay-out of a label for a district heating system.

Your DH system's label will always be personalised with the individual performance parameters and the following details:

- national flag,
- serial number,
- validity date.

Additional information can be obtained via Euroheat & Power in Brussels and/or via your national contact point.

9 District cooling

District cooling systems are assessed according to the principles of district heating, i.e. *EP* (energy performance indicator) is calculated by the ratio of energy input to the system and energy output from the system.

$$f_{P,dc} = \frac{\sum_i E_i \cdot f_{P,i}}{\sum_k Q_{del,k}} \text{ and } K_{P,dc} = \frac{\sum_i E_i \cdot K_{P,i}}{\sum_k Q_{del,k}}$$

$f_{P,dc}$ primary energy factor of district cooling

E_i energy content of input to the system of energy carrier *i* in MWh_{Hi}

$f_{P,i}$ primary energy factor of energy carrier *i*

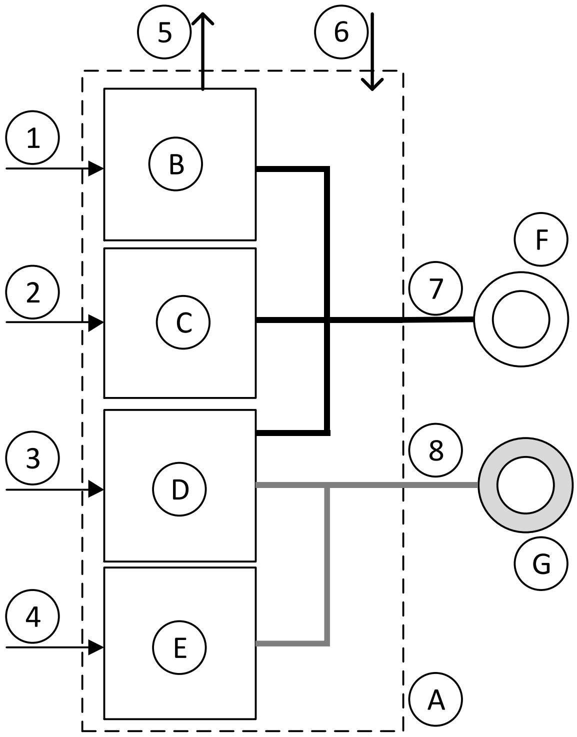
$Q_{del,k}$ delivered cooling to customer *k*

$K_{P,dc}$ primary emission coefficient of district cooling

$K_{P,i}$ primary emission coefficient of energy carrier *i*

In case of combined heating and cooling or combined heating, cooling and power (trigeneration) there is a thermodynamic connection of the heating and the cooling supply via heat pump or absorption chiller and the performances of the heating and the cooling systems are interrelated. *EP* shall be determined within the thermodynamic system borders of the specific system. This results in one *EP* for the district heating and cooling system.

NOTE From a physical perspective heating and cooling are the same: A temperature difference is supplied to customers via energy carrier (usually water) and a flow rate



A	system boundary	1	energy input to cogeneration unit	E_{chp}
B	cogeneration unit	2	energy input to heat producer	E_{hp}
C	heat producer	3	electricity input chiller/heat pump	$E_{\mathrm{el,c}}$
D	heat pump / absorption chiller	4	electricity input electric chiller	$E_{\mathrm{el,c}}$
E	electric chiller	5	chp electricity	$E_{\mathrm{el,chp}}$
F	heat consumers	6	auxiliary electricity	$E_{\mathrm{el,aux}}$
G	cooling consumers	7	delivered heat	$Q_{\mathrm{del,dh}}$
		8	delivered cooling	$Q_{\mathrm{del,dc}}$

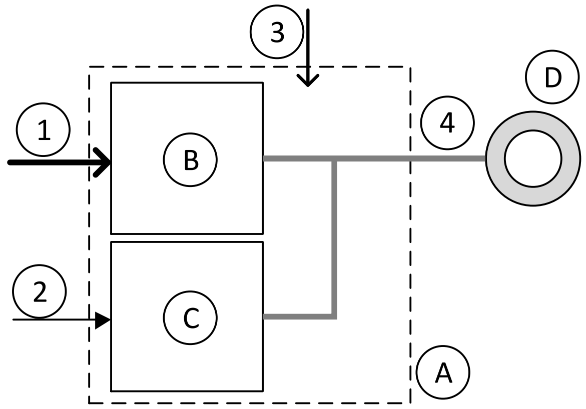
$$f_{P,dhc} = \frac{\sum_i E_i \cdot f_{P,i}}{\sum Q_{del}} = \frac{(E_{chp} + E_{hp}) \cdot f_{P,F} + (E_{el,c} + E_{el,aux} - E_{el,chp}) \cdot f_{P,el}}{\sum_j Q_{del,dh,j} + \sum_k Q_{del,dc,k}}$$

$$K_{P,dhc} = \frac{\sum_i E_i \cdot K_{P,i}}{\sum Q_{del}} = \frac{(E_{chp} + E_{hp}) \cdot K_{P,F} + (E_{el,c} + E_{el,aux} - E_{el,chp}) \cdot K_{P,el}}{\sum_j Q_{del,dh,j} + \sum_k Q_{del,dc,k}}$$

If it is not possible or useful to calculate the connected systems together, the district cooling system may be calculated separately.

9.1 District cooling as a subsystem: absorption chillers

In the case of an absorption chiller the cooling system is a heat consuming subsystem. The heat from the supplier subsystem shall be assessed with its own energy indicators. For the consumer subsystem this is an external heat supply which is taken into account as an external energy input Q_{ext} with its specific energy indicators that have to be calculated separately.



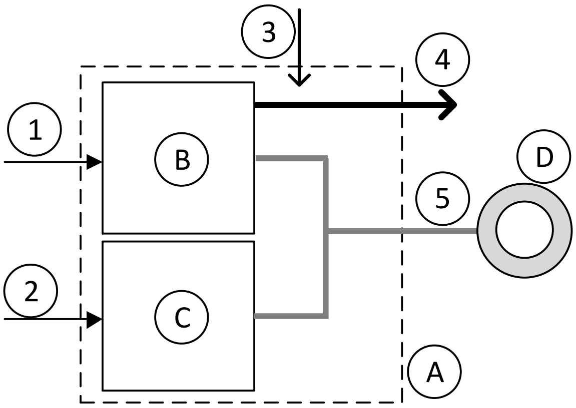
A	system boundary	1	heat input to absorption chiller	Q_{ext}
B	absorption chiller	2	electricity input electric chiller	$E_{el,c}$
C	electric chiller	3	auxiliary electricity	$E_{el,aux}$
D	cooling consumers	4	delivered cooling	$Q_{del,dc}$

$$f_{P,dc} = \frac{Q_{ext} \cdot f_{P,ext} + (E_{el,c} + E_{el,aux}) \cdot f_{P,el}}{\sum_k Q_{del,dc,k}}$$

$$K_{P,dc} = \frac{Q_{ext} \cdot K_{P,ext} + (E_{el,c} + E_{el,aux}) \cdot K_{P,el}}{\sum_k Q_{del,dc,k}}$$

9.2 District cooling as a subsystem: heat pumps

In the case of a heat pump the cooling system is a heat supplying subsystem. The heat is exported to a district heating system. This exported heat displaces heat that would have been produced with other energy carriers. Thus the exported heat is a bonus for the dc-system that is assessed with the *EP* of the displaced heat and subtracted from the energy input of the dc-system. The *EP* of the displaced heat has to be calculated separately.



A	system boundary	1	electricity input to heat pump	$E_{el,c}$
B	heat pump	2	electricity input electric chiller	$E_{el,c}$
C	electric chiller	3	auxiliary electricity	$E_{el,aux}$
D	cooling consumers	4	exported heat	Q_{exp}
		5	delivered cooling	$Q_{del,dc}$

$$f_{P,dc} = \frac{(E_{el,c} + E_{el,aux}) \cdot f_{P,el} - Q_{\exp} \cdot f_{P,displ}}{\sum_k Q_{del,dc,k}}$$

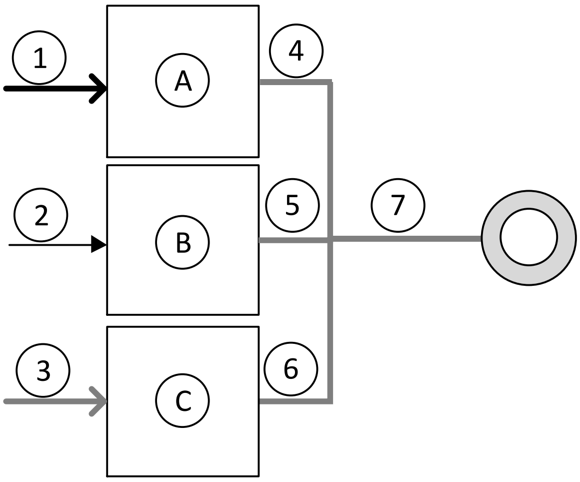
$f_{P,displ}$ primary energy factor of the displaced heat

$$K_{P,dc} = \frac{(E_{el,c} + E_{el,aux}) \cdot K_{P,el} - Q_{\exp} \cdot K_{P,displ}}{\sum_k Q_{del,dc,k}}$$

$K_{P,displ}$ emission coefficient of the displaced heat

9.3 Renewable cooling

R is the ratio of cooling from renewable and/or surplus heat carriers to total cooling in %. If electricity is used as fuel (e.g. for heat pumps or electric chillers) 20% of this electricity is regarded as renewable. Auxiliary electricity is not considered. If heat is used as fuel (absorption chillers) R of this cooling output is the same as R of the heat. Free cooling is renewable. The exhaust heat from the recooling circuits of chillers is not regarded as free cooling input to the cooling system.



A	absorption chiller	1	heat input to absorption chiller	Q_{ext}
B	electric chiller	2	electricity input electric chiller	$E_{el,c}$
C	heat exchanger / cooling tower	3	cooling input from river / air	$Q_{in,free}$
		4	cooling output from absorption	$Q_{c,th}$
		5	cooling output from el. chiller	$Q_{c,el}$
		6	cooling output from heat exchanger / cooling tower	$Q_{c,free}$
		7	total cooling production	$Q_{c,total}$

$$R_{dc} = \frac{\sum_i Q_{c,i} \cdot R_i}{Q_{c,total}}$$

Example:

I	$Q_{c,i}$	R_i	$Q_{c,i} \cdot R_i$
Heat	5	0,3	1,5
Electricity	10	0,2	2
River	15	1	15
Sum	**30**		**18,5**

→R_{dc} = 18,5 / 30 = 0,62 (62%)

NOTE: *R* is not an energy performance indicator that reflects efficiency but an energy source indicator that shows the origin of the energy. Thus only this attribute R_i of the energy input to the system is considered, not the amount (1,2 and 3 in figure). Auxiliary electricity influences neither the energy source as an attribute nor the composition of the total produced cooling. Therefore auxiliary electricity is not considered.

9.4 Definition of the reference district cooling system

The system uses electricity as energy input. The annual electricity input includes all devices that belong to the system (pumps, fans, compressors etc.). The efficiency is defined by annual delivered cooling / annual electricity input = 3,5. The class limit between class 2 and 3 for primary energy factor and emission coefficient is determined by $f_{P,el}/3,5$ and $K_{P,el}/3,5$. The class limit for the renewable and surplus heat fraction is determined on national level according to clause 6 of the technical guidelines for district heating. $f_{P,el}$ = 2,6 and $K_{P,el}$ = 420 and R = 20% would result in the following class limits for the labelling of a district cooling system:

class	$f_{P,dc}$		$K_{P,dc}$		R_{dc}	
1	<	0,37	<	60	>	60%
2	0,37	0,74	60	120	60%	20%
3	0,74	1,11	120	180	20%	16%
4	1,11	1,49	180	240	16%	12%
5	1,49	1,86	240	300	12%	8%
6	1,86	2,23	300	360	8%	4%
7	>	2,23	>	360	<	4%

In the case of one *EP* for the district heating and cooling system the respective reference value is determined case-specific according to

$$f_{P,dhc,ref} = f_{P,dh,ref} \cdot \frac{\sum_j Q_{del,dh,j}}{\sum Q_{del,dhc}} + f_{P,dc,ref} \cdot \frac{\sum_k Q_{del,dc,k}}{\sum Q_{del,dhc}}$$