



# Summer comfort and cooling: calculation methods and requirements





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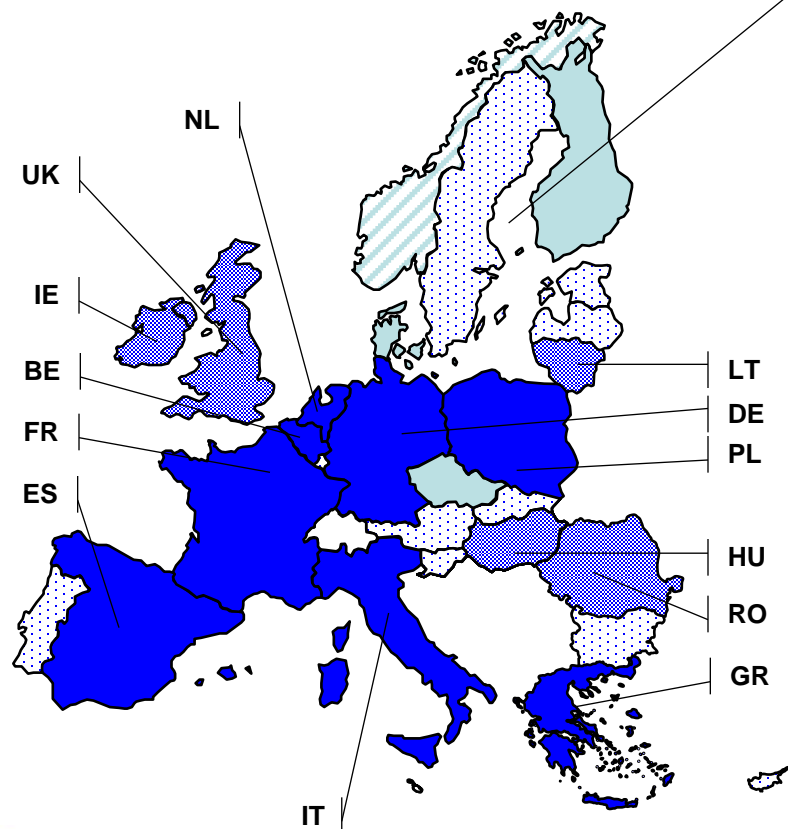
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## Preliminary notes

- ❖ an information paper (IP) on these topics will be published in the near future: consult [www.asiepi.eu](http://www.asiepi.eu)
- ❖ the results presented here are based on information which was mostly gathered in the summer of 2008 → since the EPB-regulations are rapidly evolving, the present situation may already have changed somewhat. Here only a snapshot view is given.
- ❖ also, since the EPB-philosophies in the different countries are so divergent, sometimes there may be misunderstandings in the information collection and reporting
- ❖ for the exact present situation in full detail in a given country: consult the present national regulations directly

# 13 countries covered by the survey

-  MS represented by one participant, including INIVE members and national contact points. There might be a second participant from this MS.
-  MS represented by a national contact point as subcontractor
-  Country outside EU-27 represented by a full participant
-  MS not represented



## Scandinavia:

- not in survey
- but oral reports that summer comfort is a growing concern. Possible reasons:
  - the mild ambient outdoor summer temperatures lower the acceptable indoor comfort temperature for overheating (adaptive comfort)
  - the long summer days with low solar positions generate a lot of solar gains

## General information

- ❖ At the time of the enquiry:
  - 9 out of 13 countries reported to have already an EPB-regulation in place
  - the countries without were situated in southern (GR, IT) and eastern Europe (HU, LT), but most of them were working intensely on the preparation of an EPB-regulation
  - in a few instances, the EPB-regulation related only to housing but not (yet) to non-residential buildings, or vice-versa
- ❖ The remainder of the presentation refers to the situation in the 9 countries with EPB-regs

## Part 1: calculation methods

- \* for cooling
- \* for summer comfort (overheating)

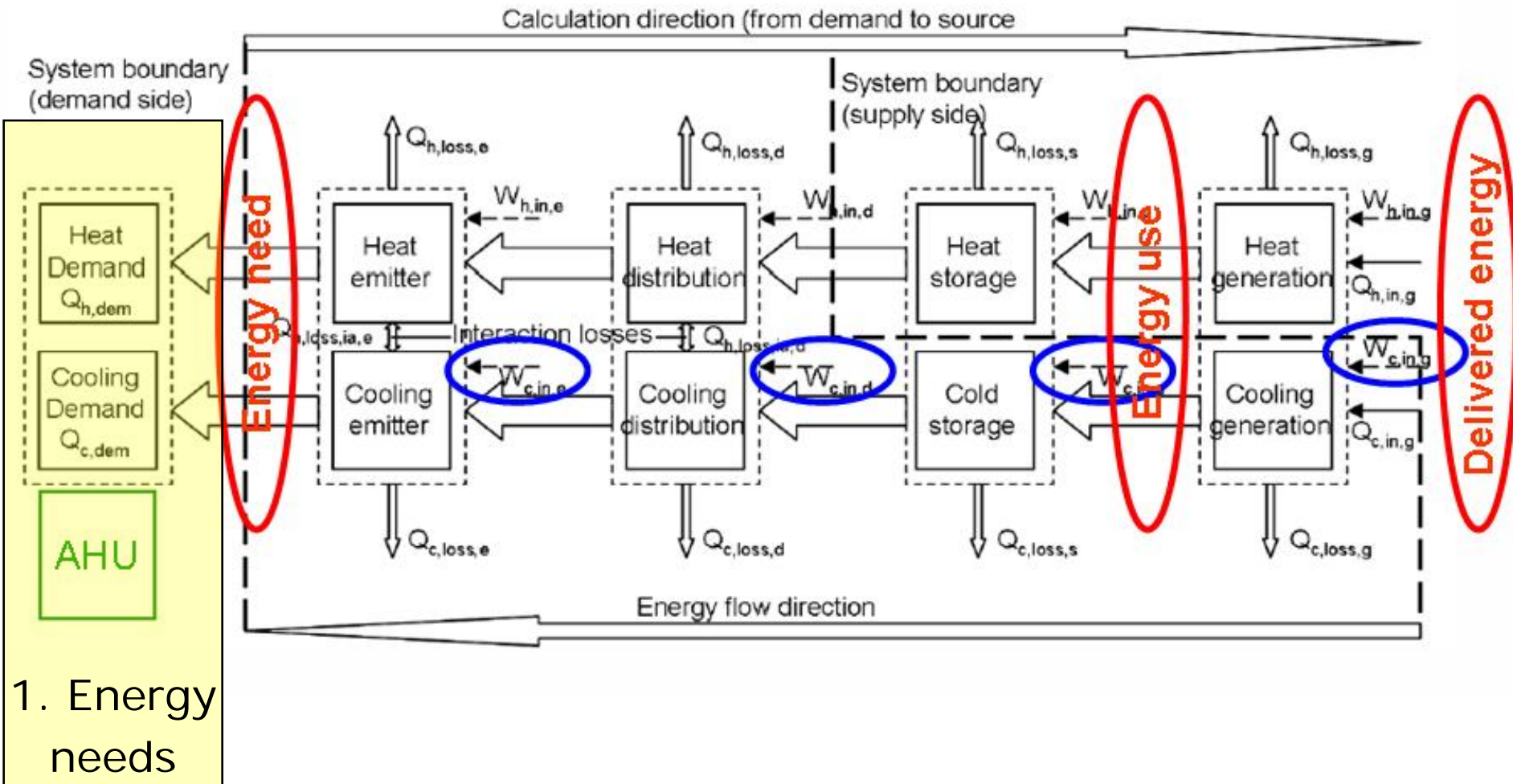
## General features

- ❖ in line with the EPBD-instructions, all 9 countries with an EPB-reg take cooling into account
  - but sometimes incomplete or with greater or lesser simplifications
- ❖ 5 countries have monthly calculations, 4 have hourly
- ❖ only in 2 out of the 9 countries the EPB-requirement is relaxed if cooling is applied
  - i.e. an extra allowance for the cooling is provided.
  - in the other countries, the extra consumption for cooling must thus be compensated by better energy efficiency in other areas such as heating, lighting, etc.

## General features: fictitious cooling consumption

- ❖ if no active cooling system is installed
- ❖ but e.g. when the risk of overheating is considered to be too high
- ❖ this may be a sort of anticipation that active cooling could be installed later in the course of the building life cycle if problems with overheating occur. By already including such fictitious cooling from the start, designers are stimulated to pay proper attention to the summer behaviour of the building in all cases.
- ❖ in some form or another in 4 countries

Figure 3 from EN 15243:2007; slightly adapted



# Cooling needs: input variables (1)

- ❖ thermal mass:
  - all countries consider sensible heat storage, albeit sometimes in a simplified manner.
  - none includes latent heat storage (through phase change materials) as yet.
- ❖ solar irradiation:
  - apart from 1 country, all determine direct, diffuse and ground reflected radiation separately.
- ❖ solar gains through transparent envelope components:
  - obviously, the g-value of the glazing, the area, slope and orientation of the windows and the shading by fixed objects are (quasi) always considered.
  - all 9 countries also report that solar protection devices, both mobile and fixed ones, are taken into consideration.
- ❖ solar gains through opaque envelope components:
  - 5 countries take them (partly) into account, e.g. for non-residential buildings and/or roofs only
  - then, the absorptance and U-value are usually input variables (but sometimes  $\alpha$  is fixed)

## Cooling needs: input variables (2)

### ❖ transmission heat transfer:

- only 2 countries report that the calculation is different between winter and summer calculations.
  - in Belgium, in the case of a simple penalisation of thermal bridges, the default value (which as a matter of principle is always negative) is different: high in winter, zero in summer.
  - in the Netherlands, the ground losses are treated differently in winter and summer.

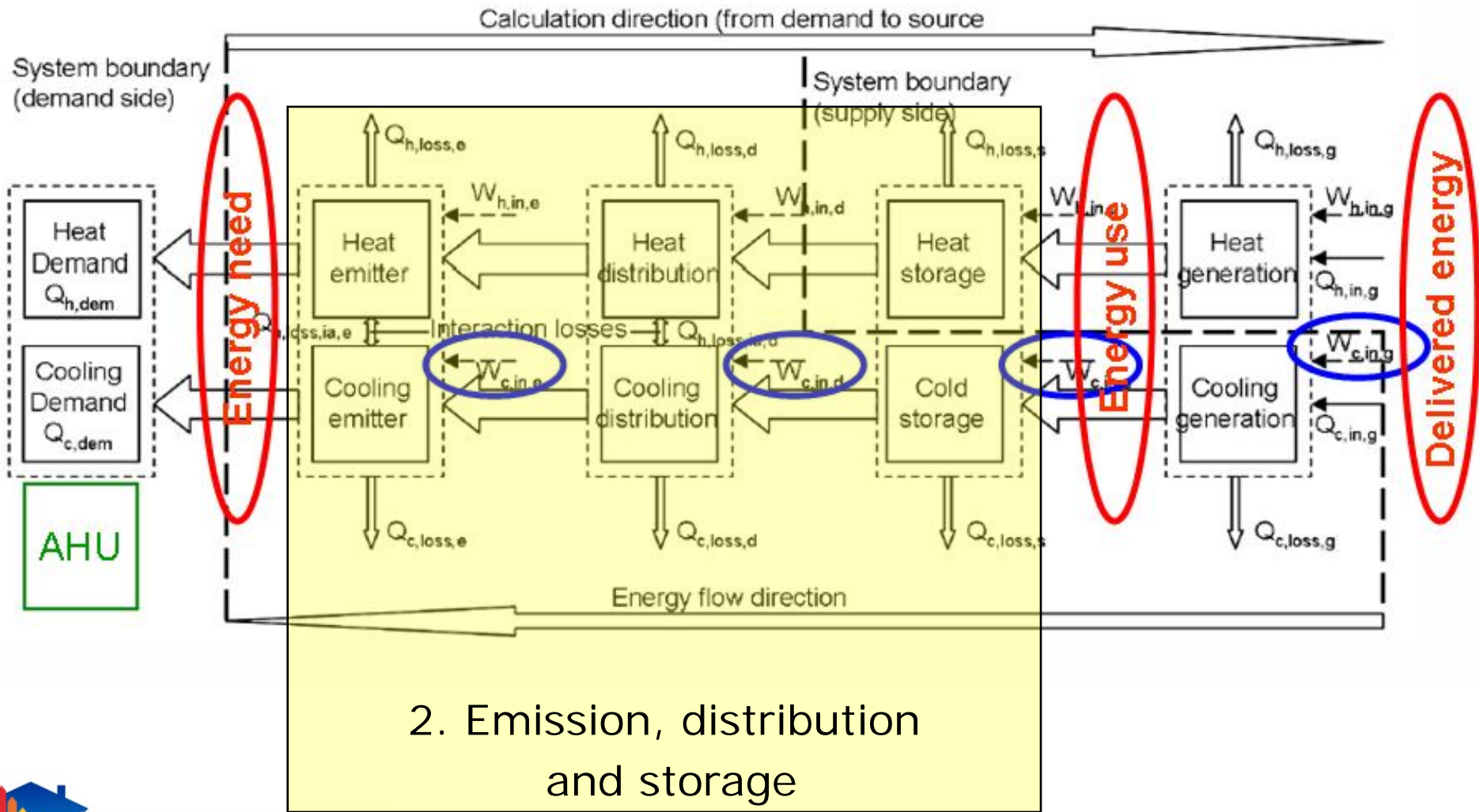
### ❖ heat transfer through the hygienic ventilation system:

- only 5 countries calculate the air handling units on the basis of a separate heat balance, although obviously this is physically important.
- if separate heat balance: sensible and latent cooling and reheat are then generally considered in detail.
- in both these and in the other countries, heat exchanger bypassing, direct or indirect evaporative cooling, night-time operation or ground heat exchangers are only occasionally considered.

## Cooling needs: input variables (3)

- ❖ heat transfer through intensive ventilation:
  - although this is a major means of evacuating excess heat (only at night on hot days, both during the day and at night on mild days), only 4 countries report to have it in the calculation method, but mostly in a strongly simplified, nearly fixed manner.
  - only France includes detailed input variables such as the area of the (supply and evacuation) openings (or stacks) and their flow characteristics, and mechanical extraction (including its electricity consumption).
- ❖ heat transfer through in/exfiltration:
  - usually the airtightness is considered when calculating the consumption for cooling
  - generally speaking a measurement of the airtightness can then serve as an input (instead of a default or estimated value).
  - in only 3 countries the default value is reported to be different between heating and cooling calculations.
    - for instance: in Belgium, it is 12 m<sup>3</sup>/h/m<sup>2</sup> of envelope area (i.e. very leaky) in winter and 0 in summer, in line with the general philosophy of a default value.

Figure 3 from EN 15243:2007; slightly adapted



# Cooling systems

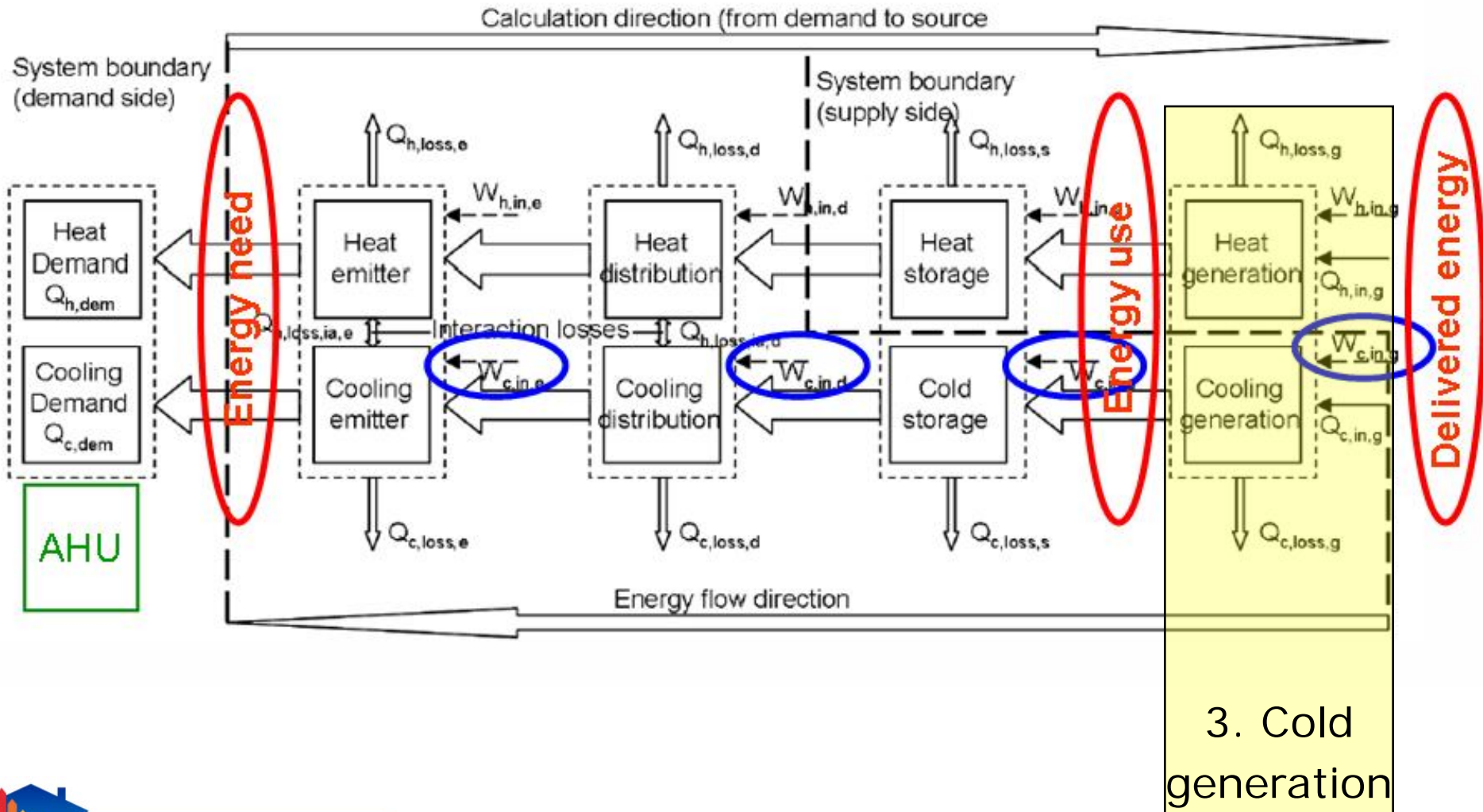
## ❖ distribution and emission systems:

- the great variety is not always included in the method
- and if so, often in a simplified manner.

## ❖ thermal cold storage:

- sensible storage (e.g. chilled water tanks): only in 2 countries
- latent storage (e.g. in ice banks) nowhere.

Figure 3 from EN 15243:2007; slightly adapted



# Cooling devices

- ❖ generation efficiency of a cooling machine
  - usually included as a matter of principle,
  - but sometimes in a very simplified manner such as a fixed value
  - otherwise, a machine dependent EER or SEER is used
- ❖ sorption cooling
  - if considered at all, it's usually only for closed cycles.
  - open cycles (such as desiccant cycles) are only rarely integrated in the calculation method.
  - in both instances, heat supply from with conventional boilers or direct firing, cogeneration or district heating is commonly considered, but solar heating only rarely.

# Central passive cooling

- ❖ meant here: central disposal of excess heat
  - i.e. in parallel with, or fully replacing cooling machines
- ❖ considered in a very variable manner.
  - surface water (from river or lake or sea) as natural heat dump is never considered in the standard calculation method
  - heat rejection to the ambient air by means of a dry or wet cooling tower: only in 2 countries
  - only 3 countries consider the ground as heat dump in the standard method: e.g. by means of:
    - ground water
    - closed-circuit boreholes or loops
    - heat exchangers in pillar foundations
  - radiative cooling to the night sky: not considered in any European country.
    - is only effective in desert-like conditions

## Auxiliary energy

- ❖ e.g. pumps, fans and control & activation devices
- ❖ generally speaking: more or less taken into account

## Conclusion/recommendations: general aspects

- ❖ most countries consider cooling consumption, with varying degree of simplification
- ❖ it seems desirable not to give an extra allowance for the maximum allowed primary energy consumption in the case active cooling is applied (as compared to the situation without active cooling)
  - this stimulates that a cooling system as efficient as possible is applied and/or that the extra consumption for cooling is compensated for by extra savings in other domains (heating, lighting, etc.).
  - 7 out of the 9 surveyed countries already apply this principle
- ❖ fictitious cooling
  - this strongly stimulates that also in buildings without active cooling proper attention is given to the summer situation,
  - i.e. the design does not focus exclusively on minimising heating in winter, to the detriment of summer comfort.
  - it also facilitates the application of the above uniform EPB-requirement whether or not active cooling is installed.
  - it can be advised to all countries to consider whether integrating such fictitious cooling could also be productive in their country.

## Conclusions/recommendations: calculation methods

- ❖ it is important that all aspects that have an impact on the cooling consumption, are integrated in the methods
  - in particular those variables that can contribute to the reduction of the consumption and that are cost-effective in a given country
- ❖ continued further improvement of the methods is therefore warranted
- ❖ major points of attention:
  - intensive ventilation, taking into account the sizing and real performance characteristics of the components (e.g. the flow features of ventilation openings), in combination with realistic user behaviour
  - active cooling devices (whether electrically or thermally driven) often deserve better treatment by the inclusion of real product characteristics in the methods (EER, or better SEER) instead of simple, fixed performance numbers.
  - natural, passive cooling is not yet well developed for central heat dumps (thus discharging the cooling machines, or even making them superfluous).
- ❖ a great number of smaller variables are not yet systematically considered in the methods. These should not be forgotten in any future update of methods.

# Summer comfort

- ❖ 5 out of the 9 countries included some kind of evaluation of the summer comfort
  - but the summer analysis did not necessarily apply to all buildings.
- ❖ usually, an explicit requirement was associated with the summer analysis
- ❖ calculation method:
  - apart from a few exceptions, the same variables as for cooling calculations are considered for evaluating the risk of overheating on "room" level.
  - however, none of the countries incorporates as yet passive cooling techniques with a central heat dump (soil, surface water, ambient air through a heat exchanger etc.) in the overheating analysis.

# Summer comfort: national situations

- ❖ Belgium:
    - dwellings only (whether with or without air conditioning)
    - a maximum allowable value is imposed
  - ❖ France:
    - all non air-conditioned buildings
    - a maximum allowable value is imposed (namely that of a reference building with reference technological measures)
  - ❖ Germany (in the form of a “solar gains indicator”):
    - dwellings only
    - a maximum allowable value is imposed
  - ❖ Ireland:
    - both domestic and non-domestic
    - no maximum, only as indicator.
  - ❖ the Netherlands:
    - dwellings only (whether with or without air conditioning)
    - no maximum, only as indicator.
- ➔ great variety of approaches: this topic is still developing
- ➔ not yet applied in truly Mediterranean countries

## Part 2: requirements (contributed by Servando Alvarez)

# Requirements can be on different levels

- ❖ most global level: the overall energy performance of the building, in which the cooling energy is included
- ❖ second level: the energy efficiency use by use (heating, lighting, cooling, etc. separately).
  - in this case, for cooling, a minimum efficiency of the combined effect of the building envelope and the cooling system is imposed
- ❖ a third level: the effect of the envelope and the HVAC systems are independently limited. The minimum requirements can refer to:
  - maximum cooling needs allowed
  - minimum efficiency (probably nominal EER) of the cooling system allowed
  - alternatively, if no cooling system exists, or else additionally, the minimum requirements can concern an overheating indicator
  - another possible requirement at this level is to fix a certain percentage of the cooling needs that have to be covered by renewable energies
- ❖ a fourth level, the cooling demand (or the overheating) is limited in a very indirect way, by limiting some relevant parameters that influence them, such as:
  - a reduction of the solar gains
  - a modulation of the solar gains
  - a dissipation of the solar and internal gains via ventilation losses.

# Overview of the situation in the countries

	Spain	Netherlands	Belgium Flanders	France	Portugal	Germany	Poland	Italy	Greece	U.K.	
1. Limitation of the overall energy performance or CO2 emissions of the building including cooling	NO	YES	YES	YES	YES	YES	NO	NO	YES	YES	7/10
2. Independent limitations for cooling	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0/10
3.1 Limitations regarding cooling needs	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	2/10
3.2 Prescriptions regarding the use of renewable energies for cooling	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	1/10
3.3 Limitations regarding efficiency of cooling system	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	2/10
3.4 Requirements regarding summer comfort in case of non-air conditioned buildings	NO	NO	YES	YES	NO	YES	NO	NO	NO	NO	3/10
4.1. Limitations of the glazed area	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	1/10
4.2 Requirements regarding solar protection	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	8/10
4.3 Other requirements for summer comfort	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	1/10

# Recommendations (1)

- ❖ a global requirement for the energy consumption and/or CO<sub>2</sub> emissions in which cooling must be obviously included.
- ❖ additional requirements limiting the cooling needs for air-conditioned buildings
- ❖ additional requirements for non-air conditioned buildings
  - limiting the overheating risk
  - or, in a complementary way, clear indicators that allow identifying the necessity or not of air conditioning (for both residential and non-residential buildings)
- ❖ the inclusion of such indicators about summer comfort should be based on indoor temperature levels consistent to the adaptative comfort criteria of EN 15251.
- ❖ if practically feasible in the context of the national EPB-regulation, the inclusion of such indicators about summer comfort should be based on hourly calculations of the indoor temperatures at a zone level, due to the temperature differences that can exist between zones of the same building.

## Recommendations (2)

- ❖ the use of additional requirements on a component level (shading factors) or the necessity of using certain strategies (ventilation rates or thermal inertia) is not recommended in general
- ❖ it is considered that requirements that are too prescriptive reduce the free choice for alternative methods that may achieve the same result
- ❖ the use of the absolute (fully performance) approach or the relative (reference building) approach to state the requirements have no specific aspects for cooling or summer comfort.
  - consequently, there are no special recommendations about the way of defining the requirements.

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