ENPER-EXIST

Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST

WP1: Pilot tests of data acquisition

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ENPER-EXIST project information

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The Energy Performance of Building Directive (EPBD) sets a series of requirements specifically dedicated to existing buildings but the member states are facing difficulties to implement quickly these requirements. The main goal of the ENPER-EXIST project is to support the take off of the Energy performance of building directive (EPBD) in the field of existing buildings.

ENPER-EXIST has 4 main objectives:

1. To de-fragment technical work performed on existing buildings. Indeed actions already launched in CEN to apply the EPBD are de-fragmented but mainly focus on new buildings. On the other hand different projects on certification procedures are going on at the European level but are not coordinated.
2. To de-fragment work on legal, economical and organisational problems such as the analysis of certification on the market, the human capital and the national administrations.
3. To achieve a better knowledge of the European building stock.
4. To define a roadmap for future actions regarding existing buildings.

ENPER-EXIST uses an intensive networking of existing national and international projects to reinforce efforts to solve these issues. It works in close coordination with the Concerted Action set up by Member States to support the application of EPBD. The work program is split in 4 technical work packages in addition to dissemination and management activities.

WP1: Tools application
WP1 analyses how existing buildings are taken into account in technical tools such as CEN standards, national calculation procedures. Recommendations on how to improve the consideration of existing building are be defined.

WP2: Legal economical and organisational impact
WP2 analyses the impact of the certification procedures and regulations of existing buildings on the market, on the human capital and on the national administration. Surveys are carried out in the different member states and recommendations are drawn up.

WP3: Building stock knowledge
WP3 analyses the level of information available in each country regarding the existing building stock. A procedure enabling to refine this information and ways to use the certification procedure as a tool to collect data regarding this stock is developed.

WP4: Roadmap
An overview of possible legal measures for existing buildings is written. Indications are given about alternative strategies to improve on a wide scale the energy efficiency of existing buildings. Possibilities (including pro's and cons) to widen the scope of the EPBD in case of a future revision of the requirements of the directive are described.

A website, newsletters and workshops enable a strong interaction between ENPER-EXIST and different interest groups and a wide dissemination of ENPER-EXIST results. The workshops are organised with the different actors involved in the application of the EPBD.More information on the project website: www.enper-exist.com

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Executive Summary

The CEN working groups have done a tremendous job to deliver a huge amount of EPBD CEN standards to guide the implementation of the EPBD in the member states. Because of lack of time and priority it has been inevitable that most of the working groups had more focus on new than on existing buildings. ENPER Exist has jumped into this gap and has provided assistance to the EPBD CEN standards.

Within ENPER Exist various courses have been taken to provide this assistance:

- The expert knowledge of the participants of the project is used to analyse the most important CEN standards. This has been a desk research.
- The usability of the CEN standards on existing buildings has also been tested in practice in a pilot test which focussed on the gathering of the input data.
- The third practical test has been the performance of some detailed calculations with the CEN standards.
- The knowledge of the developers of existing EP methods for existing buildings (on national level and on EU level) is used to find alternative solutions for gaps which were found in the previous tasks.

This document provides the knowledge gained by the pilot study, which has been an important part of the study on the usability of the CEN standards on existing buildings. In total 28 buildings have been put up to a pilot test. Together with the study on detailed calculations this is the ultimate test of the usability of the standards in practice.

The focus of the pilot study has been on the installation standards. One subject we did not cover however is cooling installations. Unfortunately this was not possible because the standard on cooling installations was not evolved far enough for a meaningful evaluation within the timeframe of the project.

This report describes the results of the tests per CEN standard. Developers of CEN standards and of (inter)national methods are advised to read the detailed conclusions per standard, because for them the detailed information is the most valuable.

In more general terms the conclusions are the following:

Space heating:

Regarding '**Space heating distribution'** the 'tabulated method' in general is usable in existing buildings. An extension of the method is preferred. The other method which has been tested, 'the simplified method', is less suitable.

For **'Space heating generation of combustion systems'** the typology method is very suitable to be used as the bases for the development of a tabulated method. Directly the method is less suitable. This also applies to the other method which has been tested, 'the case specific method'.

Concerning **'District heating'** it appears that a more simplified method is needed. Perhaps such a method can be derived on national level, based on the CEN method.

Hot water:

The CEN method on **'Tap requirements'** appears to be suitable for existing buildings. Only some details need attention.

Regarding **'Distribution losses of delivery pipes'** the method based on dwelling area is very suitable in existing buildings. It would be preferred that a comparable method for non-residential buildings would be developed. The methods based on pipe lengths are less easy to use, among other things because determining pipe lengths and diameters is not always easily done in existing situations and can be very time consuming. The method based on taping profiles is also usable, but here also pipe lengths are needed.

Regarding **'Distribution losses of circulation system'** the method based on pipe length is simple, but still there can be problems with the gathering of the input (e.g. the pipe length). An even more simple method, e.g. only based on the fact that the heat loss for circulation systems is bigger than for delivery pipes (with a default) is preferred. The other method which has been tested, using a calculation, is probably not useful since too many defaults needs to be developed for the method to be usable in the existing building practice.

The method to determine the '**Auxiliary energy for distribution (pumps)'** is easy and usable. The problem is that the pump power rating is not always retrievable. So a default value for the auxiliary energy in general would be helpful.

Concerning **'Generation'** a tabulated method, as is suggested for space heating is preferred here as well.

Ventilation:

The most important inputs to calculate the energy use for ventilation, the ventilation and infiltration rates, are unknown in existing buildings. This makes this method proposed by CEN hard to use in existing situations. Suggested is to develop a method based e.g. on ventilation profiles (on national level).

Lighting:

The quick method for lighting is a very simple method. The installed power and amount of armatures is not always known. When this part of the method is extended with defaults, the method can be used in existing situations.

1. Introduction

The aim of WP 1 of Enper-Exist is to identify the gaps between EPBD CEN standards and practice for existing building. During the development of these standards, the focus heavily lay on new buildings and it was often forgotten to take into account the effects which are especially important for existing buildings. Within the project we have focussed on the standards which had no specific focus on existing buildings for themselves.

An important part of the study on the usability of the CEN standards on existing buildings has been the pilot test. Within Enper-Exist 28 buildings have been put up to a pilot test. The main pilot test studied the usability of the CEN standards by actually visiting 24 existing buildings and trying to gather all input parameters needed for the calculations conform the CEN standards. Together with the study on detailed calculations this is the ultimate test of the usability of the standards in practice.

In addition a small pilot test with 4 buildings has been performed to test a method developed for existing buildings where not the formula structure has been simplified, but a shell around the method allows for much more simplified input. The buildings which are used for this study are described in this report. A description of the study is given in chapter 10 and annex A of work document 4 'Investigation of alternatives'.

Enper-Exist has been working in close consultation with SAVE project EPA-NR. Both projects have focused on such topics that their work is complementary. This cooperation resulted in the decision within Enper-Exist to focus on the installation standards for the pilot tests: By covering heating (generation and distribution), hot water (tap requirement, generation and distribution), ventilation and lighting the most important installation standards are covered. Given the fact that EPA-NR focuses on the heating and cooling need (prEN 13790), within the two projects together the most crucial standards are covered in the pilot tests for the usability of CEN standards for the existing building practice. Like is said before: we have focused on the standards which did not have a specific focus on existing buildings themselves.

One subject we did not cover is cooling installations. This was not possible because the standard on cooling installations was not evolved far enough for a meaningful evaluation within the timeframe of the project.

2. Data acquisition input form

To test the CEN standards on the usability in the existing building practice, the standards were put up to a pilot test.

The following CEN standards, and methods within the standards, have been subject to the pilot study:

- Space heating: distribution (prEN 15316-2-3)
  - Calculation of annual auxiliary energy and heat emission for distribution systems -
  - Using tabulated values
  - Calculation of annual auxiliary energy and heat emission for distribution systems -
  - Using simplified calculation method
- Space heating: Generation - Combustion systems (prEN 15316-4-1)
  - Method 1. Example of typology method: SEDB_UK method
  - Method 2. Case specific boiler efficiency method
- Space heating: Generation - District Heating (prEN 15316-4-5)
- Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)
- Hot water: Pt.2. Distribution losses (prEN 15316-3-2)
  - Calculation of distribution losses
  - Calculation of the delivered pipe losses. Method 1: Based on dwelling area
  - Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method
  - Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method
  - Calculation of the delivered pipe losses. Method 4: Based on tapping profiles
  - Calculation of the circulation system losses
  - Method 1: Heat emission based on pipe length:
  - Method 2: Heat emission based on calculation method
  - Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method
  - Auxiliary energy for ribbon heating
- Hot water: Pt.3. Generation (prEN 15316-3-3)
  - Method 1. Heat generators tested as a whole (systems in single family dwellings)
  - Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes
  - Method 2. Component 1. Storage vessel - detailed method
  - Method 2. Component 1. Storage vessel - simplified method
  - Method 2. Component 2. Primary circulation pipes - detailed method
  - Method 2. Component 2. Primary circulation pipes - simplified method

    - Method 2. Component 3. Gas or oil fired boiler
    - Method 2. Component 3. Direct gas fired domestic storage water heater
- Ventilation energy (prEN 15241)
- Lighting energy (prEN 15193-1)
    - Quick method

All input parameters needed within these CEN calculations were gathered in a data acquisition list.

The following information about the input data was gathered:

- The data itself (a figure or qualitative information, e.g. the amount of square meters area, pipe diameter, emitter type, pipe material, …)
- When a fixed choice list is given: is your input among the list?
- When a figure is concerned: is the value measured or known (e.g. read out from a typology plate on the installation)? How sure are you about the figure, is it a wild guess, a global estimation/measurement, a good estimation/measurement or is the value known for sure/very accurately measured?
- Suggestions to improve the applicability of the input for existing buildings

3. Pilot buildings

Within Enper-Exist 28 buildings has been put up to pilot tests. A mix of residential buildings and non-residential buildings was chosen. The pilot project has been performed in cooperation with the SAVE project EPA-NR: Part of the non-residential buildings used in the pilot study of EPA-NR has been used for the pilot study in ENPER-Exist as well. The two pilot studies are complementary, as explained in the introduction of this document. The 4 buildings in the UK were used for an additional pilot test, which also is explained in the introduction of this document.

The following buildings are used in the pilot studies:

Residential buildings:

The Netherlands:

- Single family house 1900
- Single family house 1992
- Multi family house 1900, fully renovated 1996
- Multi family house 1928

Belgium:

- Single family house 1976
- Single family house 1990
- Apartment building 60's
- Apartment building 60's

United Kingdom:

- Single family house pre-1900
- Single family house 1935
- Single family house 1955
- Single family house 1967

Greece:

- Single family house 1935
- Single family house 1974
- Two family house 1948
- Multi family house 1982

Non-residential buildings:

Germany:

- Health care building Nursery Home Stuttgart-Sonnenberg (KORIAS) 1965
- Office building Münchner Tor 2003
- School Plieningen 1936

Denmark:

- Health care 1977
- Elementary school 1950-52
- Office building 1952

The Netherlands:

- School 1984
- Health care 1974
- Office 1990

France:

- University Building 1995
- Health Care Building 2003
- Health Care Building 1963

A short description of all buildings is given on the next pages.

The Netherlands: Single family house 1900

Type of residential building : Single family edge house (partly detached on ground floor). **Location :** Tuinstraat 2, Delft, the Netherlands **Owner (optional):** privately owned building **Year of construction** : ca. 1900 **Total conditioned area (m²)** : ca. 65 m^2 **Number of occupants** : 1	**Short description :** Orientation of front façade is West, the garden is oriented to the East. The largest part of the roof is sloped, a small part of the roof on the back of the house is flat. The house has 2 floors and an attic. **Construction:** The house has brick facades, the sloped roof is tiled, the flat roof is made of wood with bitumen. The house is build on footings. The floors are wood. The walls to the neighbours are stone. The windows have a wooden frame and double glazing. Floor and walls are not insulated. **Heating / cooling/ ventilation/ lighting systems** : The house is naturally ventilated, is heated by a boiler and there is no cooling system present.

The Netherlands: single family house 1992

Type of residential building : Single family detached house **Location** : R.A. Kartinistraat 85, Utrecht, the Netherlands **Owner (optional):** privately owned building **Year of construction :** 1992 **Total conditioned area (m²) :** ca. 130 m^2 **Number of occupants** : 2	**Short description :** Orientation of front façade is North-West, the garden is oriented to the South-East. The largest part of the roof is sloped, part of the roof is flat and contains a roof terrace. The house has 2 floors. **Construction:** The construction of the house is made of concrete (floors, walls, roof). The foundation is made of concrete piles. The facades are made of sand-lime brick. The roof is covered with bitumen. The windows have an aluminium frame and double glazing. Floors, façade and roof and insulated. **Heating / cooling/ ventilation/ lighting systems :** The house is ventilated by a mechanical exhaust system, with exhaust points in the kitchen, toilet and 2 bathrooms. The house is heated by a condensing boiler and has no cooling system.

The Netherlands: multi family house 1900, fully renovated in 1996

Type of residential building : Multi family apartment. **Location** : Boekhorststraat 116, Den Haag, the Netherlands **Owner (optional)**: Housing cooperation **Year of construction :** ca. 1900, but fully **renovated in 1996** **Total conditioned area (m²) :** ca. 100 m^2 **Number of occupants :** 2	**Short description :** The apartment is situated on the top 2 floors of a 4 floor building. Orientation of front façade is West. The roof is flat. **Construction:** The house has brick facades. The construction is made of concrete. The floors are concrete, only the roof is made of wood with a bitumen cover. The floors are wood. Walls and roof are insulated (the floor is adjacent to a heated space and is not insulated). Windows have wooden frames and double glazing. **Heating / cooling/ ventilation/ lighting systems :** The house has a mechanical exhaust system, is heated by a condensing boiler and has no cooling system.

The Netherlands: multi family house 1928

Type of residential building : Multi family apartment.

Location : Kloosterkade 4, Delft, the Netherlands

Owner (optional): Housing cooperation

Year of construction : 1928

Total conditioned area (m²) : ca. 60 m^2

Number of occupants : 1

Short description : The apartment is situated on the top 2 floors of a 3 floor building. Orientation of front façade is North, a balcony is situated on the South façade. The roof is flat.

Construction: The house has brick facades. The construction is made of concrete. The floors and roof are partly wood, partly concrete. Windows have wooden frames and double glazing with coating and gas filling (so called HR++ glazing).

Heating / cooling/ ventilation/ lighting systems : The house has a mechanical exhaust system, is heated by a boiler and has no cooling system.

Belgium: Single family house 1976

Type of residential building : SINGLE-FAMILY HOUSE **Location :** Braine-L'Alleud - Belgium **Owner :** Private **Year of construction :** 1976 **Total conditioned area (m²) :** 162 **Number of occupants (approximately)** : 4	**Short description:** Row house with 2 main facades oriented NE-SW. no neighbours at one side of the dwelling. 3 storeys. The attic is not in the heated volume. The garage is well in the heated volume. **Construction:** Traditional bricks construction. No insulation in the building. Internal floor made in concrete. Light floor construction of the attic. High efficiency windows recently placed. **Heating / cooling/ ventilation/ lighting systems :** Central heating system on gas. Traditional combi boiler with a vessel of 65 litres. Heating pipes not insulated. Underbroken circulation pump. Emission via convectors equipped with thermostatic valves. Presence of a thermostat. No cooling system Natural ventilation via window airing. Passive stack ventilation in the bathroom. Lighting via traditional incandescent lamps

Belgium: Single family house 1990

Type of residential building :

SINGLE-FAMILY HOUSE

Location : Nivelles - Belgium

Owner : Private

Year of construction : 1990

Total conditioned area (m²) : 204 m²

Number of occupants (approximately) : 2

Short description: Detached house in the countryside. There's no attic nor basement. One groud-floor + one storey. The whole building is the heated volume.

Construction: Traditional bricks construction. The building is insulated according the building code of the period of construction (K55) – the outside walls (cavity wall) and the roof are insulated. The internal floors are made in concrete. Traditional double glazing.

Heating / cooling/ ventilation / lighting systems : Central heating system on fuel. Traditional combi boiler. Heating pipes partly insulated. Underbroken circulation pump. Emission via radiators equipped with thermostatic valves. Presence of a thermostat.

No cooling system

The building is naturally ventilated. Natural exhaust system is installed in the toilets.

Lighting via traditional incandescent lamps

Belgium: Apartment building 60's

Type of residential building :

APARTMENT BUILDING

Location : Brussels - Belgium

Owners : Private

Year of construction : Unknown (during the 60's)

Number of dwellings : 6 storeys (6 apartments)

Short description: Apartment building with 6 storeys and 6 apartments. The whole building is in the heated volume.

Construction: Traditional bricks and concrete construction. The building is not insulated. The majority of the apartments are equipped with single-glazed wooden windows. The visited apartment is equipped with PVC window with standard double glazing.

Heating / cooling/ ventilation / lighting systems: The central heating system on fuel is common to the whole building. The emission occurs via radiators equipped with thermostatic valves and heat meters.

The production of hot water is realised in each apartment with instantaneous gas boilers.

No cooling system

The building is naturally ventilated – window airing.

Lighting via traditional incandescent lamps.

UK: Single family pre-1900

17 St James Square, Bath, UK

Type of residential building: single family 2 storey maisonette. **Location**: city centre location **Owner (optional)**: owner occupied. **Year of construction**: pre-1900 **Total conditioned area (m²)**: 183 **Number of occupants (approximately)**: 4 (3 part-time).	**Short description**: south facing, 2 storey maisonette, occupying basement and ground floor of 5 storey historic terrace (Grade I listed). **Construction**: solid stone (sandstone) construction, solid ground floor, single glazed throughout. **Heating / cooling / ventilation / lighting systems**: gas fired central heating, non-condensing floor mounted boiler, insulated hot water cylinder supplied by gas boiler. 11% low energy lighting.

UK: Single family house 1935

9 Devonshire Road, Bathampton, Bath, UK

Type of residential building: Single family semi-detached bungalow. **Location**: village location, 3 miles from city centre of Bath, UK. **Owner (optional)**: owner occupied. **Year of construction**: 1935. **Total conditioned area (m²)**: 125 **Number of occupants (approximately)**: 2 adults and 1 infant.	**Short description**: south facing, single storey bungalow, pitched roof, with rear extension, conversion of a basement room, and converted room in the roof. **Construction**: Stone cavity construction, retrofitted cavity insulation, tiled roof, double glazed throughout. Rear extension (completed 2006) is part timber frame construction. **Heating / cooling / ventilation/ lighting systems**: Gas fired central heating, high efficiency condensing combi boiler, fully programmable, supplemented by open (coal) fireplace in living room. 13% low energy lighting.

UK: Single family 1955

102 Catherine Way, Batheaston, Bath, UK

Type of residential building: Single family 2 storey end of terrace house. **Location**: village (country) location 3 miles from city centre of Bath, UK. **Owner (optional)**: owner occupied. **Year of construction**: 1955 **Total conditioned area (m²)**: 80 **Number of occupants (approximately)**: 2 adults, 1 child.	**Short description**: east-facing, 2 storey, pitched roof, ex-council house, with small single storey flat roofed 'extension' converted from original coal storage shed. **Construction**: masonry construction, cavity wall, cavity insulation retrofitted, tiled roof, loft insulated with 100mm mineral fibre located at joists, recently installed double glazing throughout. Single storey extension is flat roofed, single brick construction with internal insulation recently applied. **Heating/ cooling/ ventilation/ lighting systems**: Electric storage heating throughout, supplemented by single room heater (log fired stove) located in main living room. No mains gas connection to property. Electric immersion water heating. 64% low energy lighting.

UK: Single family 1967

9 Damy Green, Neston, Wiltshire, UK

Type of residential building: single family, detached 2 storey house. **Location**: village/countryside location **Owner (optional)**: owner occupied. **Year of construction**: 1967 **Total conditioned area (m²)**: 160 **Number of occupants (approximately)**: 2 adults, 2 children.	**Short description**: north facing, 2 storey, pitched roof, with 2 small single storey flat roofed extensions. **Construction**: masonry constriction, filled cavity wall, tiled roof with 250mm insulation at joists, double glazed throughout. **Heating / cooling / ventilation / lighting systems**: gas fired central heating, wall mounted condensing gas boiler, supplemented by log fired room heater in living room. Insulated hot water storage supplied by main gas condensing boiler. 72% low energy lighting.

Greece: Single family house 1935

Type of residential building : one family house **Location :** Ekali, Athens, Greece **Owner (optional):** private **Year of construction :** 1935 **Total conditioned area (m²) :** 153 **Number of occupants (approximately) :** 3-4	**Short description :** north-west orientation of the front facade, three floors, tile roof **Construction:** material used for the façades is rock or reinforrced concrete covered with rock, concrete with tiles for the roof, concrete for the ground, single type of glass with wooden frames, no insulation (most walls are rock which provide insulation) **Heating / cooling/ ventilation/ lighting systems** : 16 radiators connected to a central system, no cooling, no mechanical ventilation. Electric lights plus natural lighting

Greece: Single family house 1974

Type of residential building : single **Location :** Agrinio, Greece **Owner (optional):** public **Year of construction :** 1974 **Total conditioned area (m²) :** 200 **Number of occupants (approximately) :** 3-4	**Short description :** east orientation of the front facade, two floors, tile roof **Construction:** the material that used for the façades is marble and clay, cement for the roof, concrete and marble for the ground, single type of glass with wooden frames, "iraklit" insulation. **Heating / cooling/ ventilation/ lighting systems** : four radiators connected to a central system, one fan for cooling, no mechanical ventilation system, electric lights plus natural lighting form front and side windows

Greece: Two family house 1948

Type of residential building : two family house **Location :** Filothei, Athens, Greece **Owner (optional):** private **Year of construction :** 1948 **Total conditioned area (m²) :** 200 **Number of occupants (approximately) :** 4-5	**Short description :** north-east orientation of the front facade, two floors, tile roof **Construction:** the material that used for the façades is clay, cement for the roof, concrete and tiles for the ground, single type of glass with wooden frames, expanded polysterene insulation. **Heating / cooling/ ventilation/ lighting systems** : 14 radiators which the temperature is checked by a central system, no cooling, no mechanical ventilation. Electric lights plus natural lighting

Greece: Multi family house 1982

Type of residential building : multi family house **Location :** Aigina, Greece **Owner (optional):** private **Year of construction :** 1982 **Total conditioned area (m²) :** 100 **Number of occupants (approximately) :** between 4and 5	**Short description :** north orientation of the front facade, two floors, flat type of roof **Construction:** the material used for the façades is marble, the roof construction is cement , concrete and metal tiles is the material on the ground, type of glass with wooden frames, “fenisol” insulation **Heating / cooling/ ventilation/ lighting systems :** eight radiators connected to a central system, three air-conditions for cooling, no mechanical ventilation system, electric lights

Germany: Health care building Nursery Home Stuttgart-Sonnenberg (KORIAS) 1965

Type of building: Office

Location: Stuttgart, Germany

Owner (optional): public

Year of construction: 1965

Total conditioned area (m²): 6901

Building occupancy: 24 hours/day, 365 days/year

Number of occupants: 120 patients + staff

Short description: The seven-storey building has the main facades in E/W-orientation with balconies. Besides the 120 patient rooms, the rooms for the staff, the bathrooms, the entrance hall, the kitchen and the dining room, the building also contains a kinder-garden at ground floor level.

Construction: The N/S façade was built with concrete plates, the walls to the balconies with a wooden construction. The windows had double panes in wooden frames. The roof included a minor cork insulation.

Heating/cooling/ventilation/lighting systems: The building was heated by 2 gas boilers, radiators with thermostats were used as emission system. The bathrooms and corridors at the inner core had a mechanical supply and exhaust ventilation system incl. electrical heating but without heat recovery. The lighting in the patient rooms was mostly realised by incandescent lamps, at the corridors with flourescent lamps.

Germany: Office building Münchner Tor 2003

Type of building: Office **Location:** Munich, Germany **Owner (optional):** private **Year of construction:** 2003 **Total conditioned area (m²):** 27172 **Building occupancy:** from 8 am - 5 pm, 5 days/week, all the year **Number of occupants:** unknown	**Short description:** The 22-storey office building comprises single and two-person office rooms, meeting rooms, traffic areas, a central core with toilettes and tea kitchens, a reception hall at the ground floor, and a building system storey at the 22nd floor. **Construction:** The office building is constructed with reinforced concrete frames. The façade is a double skin façade on all four orientations starting at the 1st floor (not at the ground floor and the 22nd floor). **Heating/cooling/ventilation/lighting systems:** The building is connected to the district heating system, convectors and the ceilings (water pipes incl. in the building mass) are used as emission systems. The building has a mechanical ventilation system with heat recovery and uses an earth channel for pre-heating and cooling. The meeting rooms are air-conditioned.

Germany: School Plieningen 1936

Type of building: Educational

Location: Stuttgart, Germany

Owner (optional): public

Year of construction: 1936/1957/1970

Total conditioned area (m²): 3143

Building occupancy: from 7:45 am- 3:30 pm on 5 days/week, 11 weeks holidays per year)

Number of occupants: approximately 1000 pupils

Short description: The MOSES school includes a primary school, a secondary school and a sports hall. The school was built in several parts during the 1930ies, 1950ies and 1970ies. The floor area includes classrooms, halls, lobbies and staircases as well as the gymnasium. A typical classroom is about 60 m² and meant for 20 to 25 pupils. There are 25 classrooms and 3 practical rooms.

Construction: Building 1 is a solid brick construction. Building 2 is a reinforced concrete building with solid brick cladding. Building 3 is made by reinforced concrete with a multi-layer chipboard/insulation combination on the outside and on some orientations on the inside. The windows were mostly composite windows with wooden frames (double glazing) without sealing. The roofs had wooden/ concrete constructions filled with peat dust (1+2) or were constructed as rib floors with insulation (3). The cellar ceilings were made of concrete with no insulation.

Heating/cooling/ventilation/lighting systems: The low-pressure steam boilers from 1969 of 800 kW capacity were originally fired with coal and later converted with to dual fuel with oil/gas burners. Building 1 was heated by steam, building 2 and 3 had a hot water heating system fed by a heat exchanger. Piping and radiators dated from the time of construction. The circuits had weather compensation control with fixed time settings. Ventilation was ensured by the windows and infiltration through the building envelope. Prismatic diffusers and louvered luminaires with flourescent tubes were used for lighting. The lighting and the shading systems were manually controlled.

Denmark: Health care building, 1977

Care Centre Møllegaarden, Gladsaxe
Sheltered Housing, elderly people's rest home and day centre.

Type of building: Health care

Location: Scattered urban environment

Owner: Public

Year of construction : 1977

Total gross area (m²): 10,139 m²

Total conditioned area (m²): 9,562 m²

Building occupancy: 24 hours per day all year

Number of occupants: about 140.

Short description: The scattered buildings at Møllegården consists of 50 individual, sheltered row houses and a 2 floor building with rooms for 56 elderly people's rest home. The housing is owned by Gladsaxe municipality. The buildings are oriented along a North-South axis and the rooms are thus oriented either East or West. There are three primary zones: the residential area, the common areas for day care and the kitchen area

Construction: Facades are made of concrete elements with light parts covered with wood on the external and boards at the internal faces. Roof is covered by roofing boards. The glass in the windows is traditional double pane thermo windows.

Heating / cooling/ ventilation/ lighting: Heating is via a local district heating plant. There are three boilers of which only two are running. The inhabitants do not want energy saving bulbs. There is mechanical ventilation in the kitchen and common areas for day care.

Denmark: Elementary school, 1950-52

Stengård elementary school, Gladsaxe

Type of building: Education

Location: Scattered urban environment of similar height

Owner: Public

Year of construction: 1950-52

Total gross area (m²): 12,995 m²

Total conditioned area (m²): 7,702 m²

Building occupancy: 80 hours week, except during summer holydays (late June – mid August)

Number of occupants: About 560, 512 pupils, 35 teachers and misc. staff.

Short description: The scattered buildings at Stengård school consists of 6 terraced buildings with most of the class rooms. The gymnasiums are located in an individual building. The school is owned by Gladsaxe municipality. The buildings are oriented along a North-West axis and the rooms are thus oriented either South-West or North-East.

Construction: Facades are made of hollow core masonry with insulation. Roof is covered by roofing tiles. The glass in the windows is traditional double pane thermo windows though in continuous replacement to low energy glazing when broken.

Heating / cooling/ ventilation/ lighting: Heating is via a local district heating plant running on natural gas. There are two boilers, a new condensing and an old traditional operating in cascade, with the new boiler as no 1. There is mechanical ventilation in gymnasiums and assembly hall while there is exhaust ventilation in the rest of the heated area.

Denmark: Office building 1952

Rosenkæret office building, Gladsaxe

Type of building : Office in old factory building

Location: City area with surrounding buildings in similar height and relatively low density.

Owner: Private

Year of construction: 1952/1962

Total gross area: 3622 m²

Total conditioned area: 3300 m²

Building occupancy: From 8 am to 5 pm, 5 days/week all the year

Number of occupants (approximately): 90.

Short description: The building is orientated South-East, surrounded by buildings of the same height and moderate density. The building can be considered being one zone, consisting of offices, reception and meeting rooms.

Construction: It is a typical Danish hollow core masonry building constructed in 1950'es. An extension building was constructed in the 60'es. There are two ordinary floors plus two floors in the attic and a full basement. At the West end of the building there is an extension with wooden facade covering. The 45 º sloping roof is covered by traditional red roofing tiles.

Heating / cooling/ ventilation/ lighting systems: All systems in the building can be described as traditional systems for low tech Danish office buildings. Heating is made by a natural gas boiler located in the basement.

The Netherlands : secondary school 'Damstede', Amsterdam, 1984

Type of building: Educational

Location: Amsterdam / The Netherlands

Owner: ISA-Amsterdam

Year of construction: 1984 (Extension: 2002)

Total gross area (m²): 8.040 m^2

Total conditioned area (m²): 6.850 m^2

Building occupancy: From 8:30 am – 4 pm, 5 days a week and 40 weeks a year

Number of occupants (approximately): 1050

Short description: School for secondary education, extended southeast wing, three floors, including own gym.

Construction: façades are insulated (older part slightly less than newer part). The roof of the older part is refurbished (and insulated) in 2004. The windows in the older part mainly consist of single glazing. Insulation of new part meets Dutch standards for new buildings.

Heating: Gas-fired (condensing) heating system. Emission by radiators. Floor heating in auditorium. Pre-heating of air in air handling units (see ventilation).

Ventilation: The multimedia room and the auditorium are equipped with air handling units. Exhaust ventilation in toilet groups. The rest of the building is naturally ventilated.

Lighting: conventional TL-lighting.

The Netherlands : Health centre (Institution for the blind), Apeldoorn, 1974

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Type of building: Health centre (Institution for the blind)

Location: Apeldoorn / The Netherlands

Owner: Visio

Year of construction: 1974

Total gross area (m²): 3.108 m^2

Total conditioned area (m²): 2650 (of which 332 m^2 are cooled)

Building occupancy: From 7:00 am – 7 :30 pm, 5 days a week/ 37 weeks a year)

Number of occupants (approximately): 55

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Short description: Institution for education and therapy for the blind.

Construction: façades and floor are not insulated. The roof is refurbished and insulated. The windows on the second and third floor consist of double glazing, the windows on the first two floors consist of single glazing.

Heating: Gas-fired (condensing) heating system. Emission by radiators.

Cooling: Local coolers in several rooms oriented on the south on the first two floors of the building.

Ventilation: Natural ventilation except for the toilets and main kitchen.

Lighting: conventional TL-lighting throughout the whole building.

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The Netherlands : Office building, Amsterdam, 1990

Type of building: Office

Location: Amsterdam / The Netherlands

Owner: ING-investment

Year of construction: 1990

Total gross area (m²): 2.250 m^2

Total conditioned area (m²): 1900 (of which 550 m^2 is cooled)

Building occupancy: From 9:00 am – 5 :30 pm, 5 days a week/ 40 weeks a year)

Number of occupants (approximately): 40

Short description: Office building is used by a sport management company. Building was being renovated during inspection.

Construction: façades, roof and floor are insulated. The windows consist of double glazing and a sun reflecting foil.

Heating: Gas-fired (condensing) heating system. Emission by radiators. Pre-heating of air in air handling units (see ventilation).

Cooling: Only the top floor is equipped with air conditioners.

Ventilation: The whole building is equipped with air handling units.

Lighting: conventional TL-lighting in parking garage. Offices are lighted with halogen lamps.

France : University Building 1995

Université Marne La vallée – Bâtiment Lavoisier

Type of building : Educational / University **Location :** Champs sur Marne / France **Owner :** public – the state **Year of construction :** 1995 **Total gross floor area (m²):** 15000 **Total conditioned floor area (m²) :** 15000 **Building occupancy :** from 7am – 6, 5 days/week all the year	**Short description :** the building is composed of laboratories, offices and study rooms. The central part is a hall allowing the traffic between offices and various laboratories. There are four levels with a parking at the lowest level. The peculiarity of this building concerns its level of glazing, indeed the façade is completely glazed (4/8:4 glazing and metallic frame **Heating / cooling/ ventilation/ lighting systems :** collective boiler(gas) for heating, heat pump for cooling of laboratories, mechanical ventilation, fluorescent lighting

France : Health care building, 2003

Hôpital de Nevers

Type of building : Health care **Location :** Nevers / France **Owner :** public **Year of construction :** 2003 **Total conditioned floor area (m²) :** 64000m^2 **Building occupancy :** 24h a day / 7 days a week **Number of occupants:** 480 beds	**Short description :** The hospital consists of various zones: care with residence, care without residence, administration, restoration, laboratories, stocking and technical rooms. There are two under ground and two floors. **Construction:** façades : concrete walls insulated from the inside, roofs : flat roof insulated from the outside, ground : parking, type of glass : double glazing. **Heating / cooling/ ventilation/ lighting systems :** gaz boiler + cogeneration / no cooling / Cross ventilation with heat exchanger / fluocompact & fluorescent lighting

France : Health care building, 1963




Type of building : Health care

Location : Lagny sur Marne / France

Owner : public

Year of construction : the hospital wich is composed on several buildings was built on 1963. the studied building uncludes four different parts, two were enlarged in 2003 with restoration of the existing parts and construction of a new part. One part was not changed since 1963.

Total conditioned floor area (m²) : part1 : 3119, part2 : 2498, part 3 : 2130, part 4: 960m²

Building occupancy : from 8 am - 6 pm, 5 days/week all the year for the offices activities and 24 h a day, 7 days/week for health care activities.

Number of occupants: approximately 200

Short description : The building consists of various zones : care with residence, care without residence, administration, restoration,

Construction : for the renovated part: good insulation of the envelope without being lawful, double glazing windows and external solar protection.

The no renovated part is not insulated and glass is simple

Heating / cooling/ ventilation/ lighting systems : One central heating plant connected to the different buildings with heat exchangers in substations. No cooling. Ventilation by mechanical exhaust system and balanced system in renovated parts

4. Results

General

A general remark which concerns almost all standards (and also new buildings!) is the no clear definition of floor area is given. This is something which can be handled on national level. But it is clear good guidance is needed here.

Space heating: distribution (prEN 15316-2-3)

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

This is a simple method, which in general is applicable for existing buildings. Because various categories of heating systems are missing, the method can only be used in limited situations.

Various inputs are unclear or unknown in existing situations:

- Type of distribution system: it was mentioned in one of the pilot cases that it is not always clear if the distribution system is a one or two pipe system. This probably can be solved with good guidance with the intake.
- Concerning 'Emission system': not all systems are covered. Systems like convectors and air heating are not taken into account. It is not clear if the standard is not suitable for these systems or that the list can easily be extended.
- The options given regarding 'Type of heat generator' are not clearly defined : what is 'standard' and what is 'small'? What to do when no storage is present at all?
- There are other types of pump control than the choices given in the standard. In Dutch houses e.g. when pump control is present, often a pump control with pump after run time is used. This option is not given in the list. In addition: if pump control is present is not always clear on site. And how should 'on/off' control be considered? So suggested here are an extension of the list and some guidance.
- The design supply and return temperature are not always known in existing situations. Suggested is to give some guidance and default values. This should perhaps be country specific.
- A default is given for 'Heating hours per year'. This default is too large for southern countries. : A default is given. Default values can e.g. be provided on national level according to the level of insulation.
- The question if 'the pump is turned off during a setback mode at night' is aimed at systems with a heating curve. And is not relevant for room thermostat situations.
- The running hours per day (of the pump) are often unknown. This is depending on heating demand since pump is controlled by room thermostat. So this is something that should be calculated and is not an input.

Conclusions:

- In principle this is a usable method for existing buildings

- Because various categories are missing, the method can only be used in limited situations.
- Various problems can be solved with good guidance to obtain the inputs. Such guidance cannot be part of a standard (neither CEN nor national).
- Various inputs need better definitions in the standard, because otherwise different interpretations will result in different input values
- Various defaults are needed.

Recommendations to developers of CEN standards:

- By extending the categories the method can be made usable for a larger range of situations, e.g.:
    - Types of emission systems
    - Types of heat generators (among other things: systems without storage)
    - Types of pump control
- Develop default values for various inputs, e.g.:
    - Designs supply and return temperatures
- Give better definitions of various inputs, e.g.:
    - Standard and small volume systems (heat generators)
    - Pump control systems
- The question if 'the pump is turned off during a setback mode at night' is aimed at systems with a heating curve. And is not relevant for room thermostat situations. A note about this would make it clearer.
- Add a method to calculate the running hours per day (of the pump) in stead of leaving it as an input.

Recommendations to developers of (inter)national methods based on CEN:

- Develop good guidelines for obtaining various input parameters preferably related to local situations, e.g.:
    - To recognise one and two pipe systems
    - To recognise the type of heat generator (standard or small volume)
    - To recognise the type of pump control
- Various defaults (see above) may be better derived at national level
    - Specially mentioned here are 'Heating hours per year'. This default is too large for southern countries. Default values can e.g. be provided on national level according to the level of insulation.
    - In addition it is probably more effective to determine defaults for 'design supply and return temperature' on national level, based on building practice. E.g. in the Netherlands, for older radiators, the design temperatures were 90/70, while for newer systems the design temperatures are 80/60 (when no low temperature systems are concerned). Defaults can be given here e.g. based on the age of the emission system. In other countries, other methods may be followed to define defaults.

Calculation of annual auxiliary energy and heat emission for distribution systems -

Using simplified calculation method

This method is more detailed than the tabulated method, described above and needs the same and more inputs.

In addition to what is described above, various inputs are unclear or unknown in existing situations:

- There is a distinction made between new buildings and old buildings, but it is not described clearly what is meant by new and old. In addition, 'existing' is probably a better word than 'old'.
- The design heat load is mostly unknown. Default values in a table based on distribution type options could be a solution.
- It is not clear what is meant with 'The mean distribution load'. A definition or guidance could be a solution. Probably this will not be enough and default values in a table based on distribution type options are needed as well.
- 'Ratio of mass flow over the heat emitter to the mass flow in the ring' is unclear and unknown. Default values could be a solution.
- The typologies mentioned in 'type of heat generator' are confusing. The options are 'standard', 'wall hanging' and 'condensing'. It is not clear what 'standard' is and condensing boilers can be wall hanging. A better description is needed what is meant. In practice sometimes more than one boiler is installed. The method does not mention what should be done in that situation.
- It is not possible to detect on site if the hydraulic system is balanced or not. Default values are needed here.
- Be clear what to do when there is more than one pump: just add the powers?
- A distinction is made between vertical shafts inside or outside the building. It is more logical to make a distinction between inside and outside the thermal envelope. A good definition of thermal envelope is relevant than. It is not clear what to do in mild temperature basements.

Conclusions:

- The amount of default values needed to make this method usable in existing situations probably is so large that it will make more sense to use a more simplified method with various fixed values. Maybe this method can be used as a basis to derive such a simplified method, like of course the tabulated method (described above) is.
- Various inputs need better definitions in the standard, because otherwise different interpretations will result in different input values

Recommendations to developers of CEN standards:

- Develop default values for various inputs, e.g.:
    - design heat load
    - mean distribution load
    - Ratio of mass flow over the heat emitter to the mass flow in the ring
    - Balanced/non-balanced hydraulic system

- Give better definitions of various inputs, e.g.:
  - New and old buildings, e.g. based on age
  - mean distribution load
  - of the types of heat generators
- Give a method what to do in case of more than one generator and more than one pump
- Make a distinction between inside and outside the thermal envelope and define thermal envelope.

Recommendations to developers of (inter)national methods based on CEN:

- Probably some of the default values are better defined at national level.

<u>Space heating: Generation - Combustion systems (prEN 15316-4-1)</u>

Method 1. Example of typology method: SEDB_UK method

SEDB_UK is a British method, included here as an example of a national method. Other national typology methods can be derived.

Various inputs are unclear or unknown in existing situations:

- Full load net efficiency: for existing boilers, this value is not always known; it is not always printed on a tag. In those situations, this method is not usable.
- Part load net efficiency: this efficiency is not mentioned on the type plate of the boiler. In NL this efficiency is known for various types of condensing boilers, but for other types this value is unknown. A table with default values based in boiler typology on national level would be helpful.
- It is not always evident to know if a boiler control is an on/off control or a modulating control. Perhaps guidance may help here?
- Hot water storage volume is not always mentioned on the type plate and can in those cases only be estimated roughly.
- Thickness of the insulation of the storage: it is hard to see/measure the thickness without breaking the insulation material. Are there default thicknesses?

Conclusions:

The method is simple, but there are some essential inputs which are not known in existing situations. Therefore the method is not usable as it is. With the method it is possible to derive tables with typology specific efficiencies. Those tables would be very useful in existing situations.

Method 2. Case specific boiler efficiency method

The method is case specific, which can result in a detailed value in existing situations, provided that all the inputs are known, which in practice will often not be the case.

Various inputs are unclear or unknown in existing situations:

- Burner type: it is not always evident if the burner is fan assisted or atmospheric. This will probably be solved with guidance.
- In existing situations the nominal output power of the boiler is not always known. Is the method usable without this input, can defaults be used?
- Boiler room temperature: this value is not evident and can vary a lot. Can defaults be given, based on descriptions of the room (inside the thermal envelope, outside the thermal envelope, highly ventilated, etc)?
- Boiler control type: the interpretation of this input in not always clear. Some guidance would be helpful, perhaps based on national used control types.
- Internal temperature: because this value will vary, and the measured temperature at a specific time is not per se the temperature which is meant, probably default values are useful here to prevent arbitrary values.
- Nominal power of the heat emitter is mostly unknown. Is it possible to give default values per radiator type? What to do when various different radiaters are used in one room, add the powers? Probably default values based in estimations per square meter floor area and radiator type are the post practical.
- Nominal temperature of the heat emitter: this value is often unknown. And what to do when floor heating is combined with radiators? Guidance and default values are necessary.
- The sizing temperature for heating distribution when a heating curve is applied is not always known. Maybe guidance can be of assistance here.

Conclusions:

A lot of essential inputs will often not be known in existing situations. Guidance and default values will help with some inputs. The question is if the value of this method, namely being case specific, will not be lost when using too much default values.

Space heating: Generation - District Heating (prEN 15316-4-5)

Only few pilot cases had district heating. In one of the cases almost all inputs were unknown so the method could not be used. In another situation no cogeneration and no dwelling substation was present, so a lot of input could be dropped. It is unclear if the method is still valid in these situations.

Conclusion:

The method can not always be used in existing situations because of lack of input values. For existing situations a method with fewer inputs (so more defaults) is valuable. Perhaps such method can be derived on national level, based on this method.

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

No problems mentioned. The categorisation seems not always logical, though. Perhaps a categorisation on national level is more suitable.

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

No problems mentioned.

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned.

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

This method is simple and a bit more specific than method 1.

Various inputs are unclear or unknown in existing situations:

- Total pipe length can be roughly estimated in dwellings, but this becomes harder in large non-residential buildings. A default option would be helpful.
- Internal pipe diameter is not always easily derived from the external pipe diameter. Guidance is necessary, e.g. based on the pipe material.
- The external pipe diameter will differ from place to place in a building. A good definition of where the pipe diameter should be measured is needed. In addition, it is not always possible to measure the pipe diameter, since pipes are often placed in invisible places.
- The number of tapings per day is something which can only be very roughly estimated, if it can be estimated at all (e.g. for non-residential buildings) and will be an arbitrary input. A fixed value based on the building function would probably be a good idea.

Conclusions:

This method is more specific than method 1 and can in some cases be useful. In existing buildings several of the inputs and sometimes even all inputs can be unknown. If for those situations a more simple method is available, this method is very well usable.

Recommendations to developers of (inter)national methods based on CEN:

- Develop defaults for at least:
  - The internal pipe diameter, based on external pipe diameter and pipe material
  - The number of tapings per day per building function
- Guidance to derive the external pipe diameter (where to measure) is needed
- Guidance how to estimate the pipe length (a procedure) would be helpful
- Extend the list with pipe materials which are still present in existing buildings (like steel)

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

This method is again more detailed than the previous one.

Various inputs are unclear or unknown in existing situations:

- Length of pipe to taping point can be roughly estimated without a drawing, but for large, especially for non-residential buildings, this is very time consuming. Good guidance is needed because it is not clear what to do with shared pipes (which split up to various taping points).

- Internal diameter of pipe to taping point: see the problems with internal diameter at the previous method. It might be easier to determine the external diameter and base the internal diameter in this and the pipe material (with default values of the thickness of the pipe).
- Fraction of total hot water demand: this can be very roughly estimated, but probably this value will be very arbitrary.

Conclusion:

This method is again more detailed than the previous one, but the question is if the accuracy of the inputs are good enough to give better results than the less detailed methods. In addition, in large, especially in non-residential buildings, this method is very time consuming. And since in most of those buildings the energy use for hot water is not very large, this method might not be cost effective in those situations.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

This method is very simple.

Some guidance is needed to understand what input is asked exactly. Specially for non-residential buildings, the input can often only be very roughly estimated.

Calculation of the circulation system losses. Method 1: heat emission based on pipe length

This is a simple method.

Various inputs are unclear or unknown in existing situations:

- Length of the circulation pipe is in practice, especially in large buildings (non-residential) not known.
- The default value given for the specific heat loss of the pipe can be different in some countries.

Conclusion:

- The method is simple, but still there can be problems with the gathering of the input, so an even more simple method, e.g. only based on the fact that the heat loss for circulation systems is bigger than for delivery pipes (with a default) is needed.

Calculation of the circulation system losses. Method 2: heat emission based on calculation method

This method is an extension of method 1.

Various inputs are unclear or unknown in existing situations:

- For pipe length the same remark is valid as mentioned for method 1.
- In this method no default values are given for the specific heat loss of the pipe. These default values would be helpful, preferably derived on national level.

- The duration of the provision of domestic hot water can only be estimated very roughly and becomes rather arbitrary in this way. Default values would be helpful, e.g. based on the building type.
- Idem for the running time of the circulation pump. Default values would be helpful.
- Nr. Of circulation pump operating cycles: this value is unknown, a default per building function would be helpful.
- Inner diameter of the pipe: see remarks about this input above.
- Configuration of pipe systems: this is too detailed. There will be various diameters present in the building, so it is not clear which one to choose.

Conclusion:

This method is no solution for the problem mentioned for method 1. For existing buildings this method is probably not useful since too many defaults are needed for the method to be usable in the existing building practice.

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

The method is easy. The problem is that the pump power rating is not always retrievable. So a default value for the auxiliary energy in general would be helpful.

Auxiliary energy for ribbon heating

Various inputs are often unknown in existing situations (the length of the trace heated pipe, specific heat coefficient of the pipe, duration of the provision of domestic hot water). Developing default values for these inputs means more or less making the entire method default, which would be a good idea (meaning: when ribbon heating is present, a default energy use is taken into account).

<u>Hot water: Pt.3. Generation (prEN 15316-3-3)</u>

No problems mentioned

Method 1. Heat generators tested as a whole (systems in single family dwellings)

All inputs for this method are unknown.

Conclusion: give defaults based on typology or use another method.

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

This is a detailed method, but various defaults are already given. Three inputs remain, which are not always known:

- Some guidance is needed to estimate the average ambient temperature, preferably with some default values.
- The duration of the provision of hot water (in days per month) is not always known. Some guidance and default values may help.
- The largest problem is the stand-by-heat loss which in existing situation almost always is unknown.

Conclusions:

Because stand-by-heat losses are often unknown in existing situations, this method is often not suitable for existing buildings. In those situations, the simplified method can be used.

Method 2. Component 1. Storage vessel - simplified method

This is a simplified version of the previous method. The only input is the vessel volume. Because in existing situations, the vessel volume is not always known, an even more simple method, with a fixed default value would be preferred.

Method 2. Component 2. Primary circulation pipes - detailed method

This detailed method contains inputs which are unclear or unknown in existing situations:

- The length of the circulation pipe is hard to estimate in some of existing situations.
- The specific heat transfer coefficient is often unknown. Default values are possible for this input.
- Average temperature of the pipe: some guidance is necessary here and preferably some defaults
- Idem for the average ambient temperature
- Idem for the duration of the provision of hot water

Conclusions:

It appears that the less detailed method (see below) would be more suitable in a lot of existing situations.

Method 2. Component 2. Primary circulation pipes - simplified method

This is a default method, worked out at national level. This method is preferred in various existing situations.

Method 2. Component 3. Gas or oil fired boiler

The inputs for the detailed method are almost all unknown or (in few cases) could only very roughly be estimated. The development of a simplified method is preferred here.

Method 2. Component 3. Direct gas fired domestic storage water heater

This is a default method, worked out at national level. This method is preferred in various existing situations.

<u>Ventilation energy (prEN 15241)</u>

This detailed method contains inputs which are unclear or unknown in existing situations:

- Most problematic is the air flow or air change rate (during occupancy and unoccupancy periods). In existing buildings these amounts are unknown and can hardly be estimated. Guidance (e.g. default values per building type on national level) is preferred. Various national methods use default ventilation profiles.

- In existing buildings with mechanical ventilation, the temperature of the ventilation air preheating and precooling (when applicable) often is unknown. And it is not always known if a defrosting system is present. Default values and guidance are preferred.
- Another value which is very hard to estimate is the leakage level. The method already contains 3 default levels (low, average and high) but because no references are present it is unknown what is meant by those levels. Guidance is needed here (e.g. a method based on some characteristics of the building)
- The total fan power is not always known.
- The position of the fan motor related to the air flow could not always be detected
- It is not always known if the air is humidified. In case it is, the setpoint for humidity is not always known

Conclusion:

The most important inputs to calculate the energy use for ventilation, the ventilation and infiltration rates, are unknown in existing buildings. This makes this method not usable in existing situations.

Lighting energy (prEN 15193-1)

Quick method

This method is a very simple method. The installed power and amount of armatures is not always known. When this part of the method is extended with defaults, the method can be used in existing situations. Guidance is needed with some building types, e.g. what category is ‘day care’?

5. Conclusions and recommendations

The aim of the pilot study has been to put the CEN standards to the test and see in practice if it is possible to gather all the inputs which are needed to perform the calculations. When various methods are offered by CEN, the simplified and often also the comprehensive method have been tested.

In the previous chapter the results of the tests are given per CEN standard. Developers of CEN standards and of (inter)national methods are advised to read the detailed conclusions per standard in chapter 4, which are not copied here.

In more general terms the conclusions are the following:

Space heating:

- **prEN 15316-2-3 Space heating: distribution**:
  - **The tabulated method** is simple and can in principle be used in existing situations. The amount of categories which are taken into account in the table is limited which limits the usability of the table. The usability of the method can be extended by extending the lists within the categories, by giving default values for some of the inputs in case these values are unknown and by giving better definitions of various inputs. Also guidelines to help obtain various inputs would be helpful.
  - **The simplified calculation method** is more detailed than the tabulated method. The amount of default values needed to make this method usable in existing situations probably is so large that it will make more sense to use a more simplified method with various fixed values. Probably, this method can be used as a basis to derive such a simplified method, like of course the tabulated method (described above) is. Various inputs need better definitions in the standard, because otherwise different interpretations will result in different input values
- **prEN 15316-4-1 Space heating: Generation – Combustion systems**
  - As an example of **the typology method, the SEDB_UK method** has been tested. The method is simple, but there are some essential inputs which are not known in existing situations. Therefore the method is not directly usable in existing buildings as it is. With the method it is possible to derive tables with typology specific efficiencies. Those tables would be very useful in existing situations.
  - **The case specific method** relates to the specific situation in which the boiler is present. The problem with this method is that a lot of essential inputs often will be unknown in existing buildings. The question is if the value of this method, namely being case specific, will not be lost when using too much default values.
- **prEN 15316-4-5 Space heating: Generation – District heating**
  - This method was not thoroughly tested, because few buildings in the pilot test were equipped with district heating. It appears that the inputs are not always easy to collect. For existing situations a method with fewer inputs (so more

defaults) is valuable. Perhaps such method can be derived on national level, based on this method.

Hot water:

- **prEN 15316-3-1 Hot water: Tapping requirements**
  - Besides some details this method appears to be suitable in existing buildings
- **prEN 15316-3-2 Hot water: Distribution losses**

  Delivered pipe losses:
  - The **method based on dwelling area** is simple and can be used in existing buildings. It would be preferred that a comparable method for non-residential buildings would be developed.
  - The **simple method based on delivery pipe lengths** is more specific and can in some cases be useful. In existing buildings several of the inputs and sometimes even all inputs can be unknown. Determining pipe lengths and diameters is not always easily done in existing situations. If for those situations a more simple method is available, this method is very well usable. Especially when for some inputs default values are developed and some guidance is given to gather the inputs.
  - The **tabulated method based on delivery pipe lengths** needs more detailed input than the previous method (input per taping point). Because the inputs often can only be roughly estimated, it is doubted whether the accuracy of the inputs is good enough to give better results than the less detailed methods. In addition, in large, especially in non-residential buildings, this method is very time consuming.
  - The **method based on tapping profiles** is very simple, but also here pipe lengths are needed, which is not always easily done in existing situations.

  Circulation system losses:
  - **Heat emission based on pipe length** is a simple method, but still there can be problems with the gathering of the input (e.g. pipe length). An even more simple method, e.g. only based on the fact that the heat loss for circulation systems is bigger than for delivery pipes (with a default) is preferred.
  - **Heat emission based on calculation method** is no solution for the problem mentioned for the previous method. For existing buildings this method is probably not useful since too many defaults are needed for the method to be usable in the existing building practice.

  Auxiliary energy for distribution (pumps):
  - The method is easy. The problem is that the pump power rating is not always retrievable. So a default value for the auxiliary energy in general would be helpful.

  Auxiliary energy for ribbon heating:
  - This method contains various inputs which are often unknown in existing situations. Developing default values for these inputs means more or less making the entire method default, which actually would be preferred (meaning: when ribbon heating is present, a default energy use is taken into account).
- **prEN 15316-3-3 Hot water: Generation**

- **Heat generators tested as a whole (systems in single family dwellings)** uses inputs which are completely unknown in existing situations. E.g. defaults based on typology are needed here.
- With the **method based on components** a detailed and simplified method are developed for every component. The simplified methods are mostly usable in existing situations and are preferred. Regarding the storage vessel even the input for the simplified method (the storage volume) is not always retrievable in existing situations. A default method would be preferred in addition here.

Ventilation:

- **prEN 15241 Ventilation energy:**
  - The most important inputs to calculate the energy use for ventilation, the ventilation and infiltration rates, are unknown in existing buildings. This makes this method proposed by CEN hard to use in existing situations. Suggested is to develop a method based e.g. on ventilation profiles (on national level).

Lighting:

- **prEN 15193-1 Lighting energy:**
  - This is a very simple method. The installed power and amount of armatures is not always known. When this part of the method is extended with defaults, the method can be used in existing situations.

Annex A: Analysis data acquisition residential buildings per country

Please note that the results mentioned in the analyses of the input forms per country are resulting from 3 or 4 pilot cases only. The results cannot be extrapolated to assessment of the total building stock of the particular county.

A.1 Analysis Dutch input forms

Space heating: distribution (prEN 15316-2-3)

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Emission system: not all systems are covered. In one house radiators and convectors were present. Extend list.

Type of heat generator: There are only options with some kind of storage. What to do when there is no storage at all? Extend options.

Type of pump control: in Dutch houses when pump control is present, often a pump control with pump after run time is used. This option is not given in the list. Extend list.

Is the pump turned off during a setback mode at night?: This question is aimed at systems using heating curves and not relevant here.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Design heat load: this value is unknown. Maybe it is known to installation advisors? Give default values based on radiator type en radiator area or give other method (e.g. simple table with some distribution type options)

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Space heating: Generation - Combustion systems (prEN 15316-4-1)

Method 1. Example of typology method: SEDB_UK method

Part load net efficiency: this value is not given on the type plate. In NL this value is known for various types of condensing boilers, but no default lists are available for other boilers: give defaults on national level based on typology.

Hot water store volume: the volume is not mentioned on the type plate and can only be roughly estimated. Give a few default values to make estimation more easy or use other method (e.g. simple tables based on typology)

Thickness of insulation of store: are there standard values used? It is hard to see the thickness without breaking the insulation.

Method 2. Case specific boiler efficiency method

Nominal power heat emitter: Maybe it is known to installation advisors? Give default values based on radiator type en radiator area or use other method.

<u>Space heating: Generation - District Heating (prEN 15316-4-5)</u>

No houses tested with district heating

<u>Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)</u>

No problems mentioned.

<u>Hot water: Pt.2. Distribution losses (prEN 15316-3-2)</u>

Calculation of distribution losses

General part: No problems mentioned.

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned.

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Number of tappings per day: this is a very rough estimation, made by the person who lives in the house. Give some defaults to choose from to make it less randomor use other method.

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Fraction of total hot water demand (per pipe): this is a very rough estimation, made by the person who lives in the house. Give some defaults to choose from to make it less random or use other method.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

No problems mentioned.

Calculation of the circulation system losses

No houses tested with circulation system

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

No problems mentioned.

Auxiliary energy for ribbon heating

No houses were tested with ribbon heating.

<u>Hot water: Pt.3. Generation (prEN 15316-3-3)</u>

General part: No problems mentioned.

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Efficiency at low tapping cycle: Value is unknown.

Efficiency at average tapping cycle: idem

Efficiency at high tapping cycle: idem

Conclusion: Give defaults based on typology or use method 2

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Stand-by heat loss: this value is unknown. Give default or use simplified method.

Method 2. Component 1. Storage vessel - simplified method

No problems mentioned.

Method 2. Component 2. Primary circulation pipes - detailed method

No houses with circulation pipes

Method 2. Component 2. Primary circulation pipes - simplified method

No houses with circulation pipes

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, give defaults.

Stand-by heat loss of the boiler: give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned.

Ventilation energy (prEN 15241)

Air flow during occupancy period or estimation of Air change rate: this is hard to estimate. Use default on national level

Air flow during unoccupancy period or estimation of Air change rate: idem

Leakage level of the zone: the classes should be defined more clearly.

Total fan power: Not in all houses the fans could be reached to read the type plate (which indicates the power). Sometimes the fan is positioned on the roof and the roof can not always be reached. Sometimes there was no type plate present and the power is unkown.

Position of the fan motor related to the air flow: Not in all houses the fans could be reached to see if the fan is positioned in or outside the air flow.

No houses with mechanical balanced system were tested (only a few existing houses in the Netherlands have a mechanical balanced system).

Lighting energy (prEN 15193-1)

Quick method

Not relevant for houses

A.2 Analysis Belgium input forms

Space heating: distribution (prEN 15316-2-3)

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Heated floor area: There is no clear definition of heated floor area. A convention has to be defined. This can be done on national level. It is clear that in the pilot study different definitions are used.

Emission system: not all systems are covered. List should be coherent with pren15316-4-1. E.g. convectors are not covered. Extend list.

Type of heat generator: definition of standard and small should be given. The quantity of water is known.

Type of pump control: How to detect this on site? How has a ON-OFF control (decided by the room thermostat) to be considered?

Design supply temperature: Is not always known. Give defaults.

Design return temperature: idem

Heating hours per year: A default is given. On national level default values should be provided according to the level of insulation.

Is the pump turned off during a setback mode at night?: Our interpretation of the question is that the pump is tuned off without user intervention. Interesting to know how this can be detected on site?

Running hours per day (of the pump): is unknown. This is depending on heating demand since pump is controlled by room thermostat. So this is something that should be calculated and is not an input.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Design heat load: this value is unknown. Maybe it is known to installation advisors? Give default values based on radiator type en radiator area or give other method (e.g. simple table with some distribution type options)

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Hydraulic system: Is it possible to detect this information on site?

Vertical shafts: There are not always shafts for heating. It is not always evident to define the thermal envelope in not insulated buildings.

Space heating: Generation - Combustion systems (prEN 15316-4-1)

Method 1. Example of typology method: SEDB_UK method

Full load net efficiency: Not always information of the boiler is present. In that case, yhis input is unknown and this method cannot be used.

Part load net efficiency: idem

Boiler control: The interpretation to give to this question is not evident. There are several things:

1. How the water temperature inside the boiler is controlled (constant temperature - or not).

2. How the burner is used - we guess this is meant with this question. Even modulating burner are stopping and could be considered with an OFF position. Make the interpretation more clear.

Thickness of insulation of store: is not always known and hard to estimate.

Method 2. Case specific boiler efficiency method

Nominal output power: Be clear that with a modulating boiler, it is the full capacity that has to be indicated.

Boiler control type: Again the interpretation is unclear. Room thermostat can be combined with the two other options according to the way the pump is controlled. Sometimes the room thermostat is only controlling the pump and not the water temperature. How do we have to consider a boiler than can fully cool down but with a constant upper limit of the water temperature (no heating curve).

Nominal power heat emitter: Maybe it is known to installation advisors? Give default values based on radiator type en radiator area or use other method.

Nominal temperature difference of heat emitters: Since the mean temperature of the heat emitter is unknown, this value is unknown too.

Space heating: Generation - District Heating (prEN 15316-4-5)

No houses tested with district heating

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

No problems mentioned.

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

General part: No problems mentioned.

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned.

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Pipe diameter (int and ext): Providing the values of the standard pipe dimensions would help.

Pipe material: for some inspectors this might be a wild guess.

Number of tapings per day: this is a very rough estimation, made by the person who lives in the house. Give some defaults to choose from to make it less random or use other method.

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Length of pipe to tapping point: The way to measure this should be defined. How is it necessary to consider parts of pipes common to several tapping points.

Fraction of total hot water demand (per pipe): this is a very rough estimation, made by the person who lives in the house. Give some defaults to choose from to make it less random or use other method.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

Average length of distribution pipe within heated space: Give a better description of what input is asked.

Calculation of the circulation system losses

No houses tested with circulation system

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

No pump for hot water present.

Auxiliary energy for ribbon heating

No ribbon heating in the houses present.

<u>**Hot water: Pt.3. Generation (prEN 15316-3-3)**</u>

General part: No problems mentioned.

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Efficiency at low tapping cycle: Value is unknown.

Efficiency at average tapping cycle: idem

Efficiency at high tapping cycle: idem

Conclusion: Give defaults based on typology or use method 2

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Stand-by heat loss: this value is unknown. Give default or use simplified method.

Method 2. Component 1. Storage vessel - simplified method

No problems mentioned.

Method 2. Component 2. Primary circulation pipes - detailed method

No houses with circulation pipes

Method 2. Component 2. Primary circulation pipes - simplified method

No houses with circulation pipes

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, give defaults.

Stand-by heat loss of the boiler: give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned.

<u>**Ventilation energy (prEN 15241)**</u>

Air flow during occupancy period or estimation of Air change rate: this is hard to estimate. Use default on national level

Air flow during unoccupancy period or estimation of Air change rate: idem

Leakage level of the zone: the classes should be defined more clearly.

No houses with mechanical balanced system were tested.

Lighting energy (prEN 15193-1)

Quick method

Not relevant for houses

A.3 Analysis Greek input forms

<u>Space heating: distribution (prEN 15316-2-3)</u>

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Heating hours per year: A default is given. For Greece this default is too high. Give defaults on national level.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Type of heat generator: the options are not clear: what is a wall hanging type? A condensing boiler can also hang on a wall… And what is 'standard'.

<u>Space heating: Generation - Combustion systems (prEN 15316-4-1)</u>

Method 1. Example of typology method: SEDB_UK method

Part load net efficiency: With an on-off system the part loas net efficiency is not relevant. Is the method suitable for on-off systems?

Method 2. Case specific boiler efficiency method

Nominal power heat emitter: Maybe it is known to installation advisors? Give default values based on radiator type en radiator area or use other method.

<u>Space heating: Generation - District Heating (prEN 15316-4-5)</u>

No houses tested with district heating

<u>Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)</u>

No problems mentioned.

<u>Hot water: Pt.2. Distribution losses (prEN 15316-3-2)</u>

Calculation of distribution losses

General part: No problems mentioned.

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned.

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

No problems mentioned.

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

No problems mentioned.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

No problems mentioned.

Calculation of the circulation system losses

Specific heat transfer coefficient of pipe : unknown

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

No problems mentioned.

Auxiliary energy for ribbon heating

Specific heat transfer coefficient of pipe : unknown

<u>Hot water: Pt.3. Generation (prEN 15316-3-3)</u>

General part: No problems mentioned.

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Efficiency at low tapping cycle: Value is unknown.

Efficiency at average tapping cycle: idem

Efficiency at high tapping cycle: idem

Conclusion: Give defaults based on typology or use method 2

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

No storage

Method 2. Component 1. Storage vessel - simplified method

No storage

Method 2. Component 2. Primary circulation pipes - detailed method

Specific heat transfer coefficient of pipe: only rough estimation possible, give defaults.

Method 2. Component 2. Primary circulation pipes - simplified method

No problems mentioned.

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Only rough estimations possible, give defaults.

Stand-by heat loss of the boiler: Only rough estimations possible, give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned.

Ventilation energy (prEN 15241)

Air flow during occupancy period or estimation of Air change rate: this is hard to estimate. Use default on national level

Air flow during unoccupancy period or estimation of Air change rate: idem

Leakage level of the zone: the classes should be defined more clearly.

No houses with mechanical balanced system were tested.

Lighting energy (prEN 15193-1)

Quick method

Not relevant for houses

Annex B: Analysis data acquisition non-residential buildings per country

B.1 Analysis German input forms (non-residential buildings)

<u>**Space heating: distribution (prEN 15316-2-3)**</u>

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Type of pump control: in one of the cases no pump was present (steam heating), give guidance what to do in that situation.

Type of heat generator: in one case a standard or small water volume was not applicable: there was district heating present. Give guidance what to do in that case.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Floor heights: in one of the pilot building different zones have different heights. Give guidance what to do in that case.

Design heat load: guidance is needed here. This information cannot be retrieved.

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Type of heat generator: it is not clear if a steam boiler is a ‘standard generator’. Also it is not clear what to do when district heating is present.

Hydraulic system: based on the age of the building an estimation is made if the system is balanced or not.

Pipe insulation: the only options that are given are ‘pipes insulated’ and ‘pipes not insulated’. Give guidance or extra options for situations when the insulation is poor, damaged and/or partly missing.

<u>**Space heating: Generation - Combustion systems (prEN 15316-4-1)**</u>

Method 1. Example of typology method: SEDB_UK method

Fuel: what to do when two fuels are used?

Full net load efficiency: this value is not always known

Boiler control: it is unclear if the boiler is modulating

Thickness of insulation of store: this input can not be obtained.

Method 2. Case specific boiler efficiency method

Nominal output power: is sometimes known and is sometimes unknown. Give guidance and defaults.

Internal temperature: is not always known: can be different for different rooms. Give guidance what to do and/or a defaults.

Nominal power of the heat emitter: is not known. Give defaults.

Nominal temperature difference of heat emitters: is not known, give defaults

Space heating: Generation - District Heating (prEN 15316-4-5)

Because no cogeneration is present, various of the inputs are not relevant.

Because no dwelling substation is present, several of the inputs are not relevant.

Efficiency of the heat distribution network: unknown, give default.

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

No problems mentioned

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

No problems mentioned

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Total pipe length: unknown input. In Germany there have been national defaults developed.

Pipe diameter internal: unknown input. In Germany there have been national defaults developed.

Pipe diameter external: unknown input. In Germany there have been national defaults developed.

Number of tapings per day: unknown input. In Germany there have been national defaults developed.

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Total pipe length: could be measured when plans are available, but is very time consuming for non-residential building

Pipe diameter internal: unknown input. In Germany there have been national defaults developed.

Fraction of total hot water demand per taping point: unknown.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

Average length of distribution pipe within heated space: unknown, but in Germany national default values have been derived based on building geometry.

Average length of distribution pipe within unheated space: could be measured when plans are available, but is very time consuming for non-residential building

Calculation of the circulation system losses. Method 1: Heat emission based on pipe length

Length of pipe: unknown, but in Germany national default values have been derived.

Calculation of the circulation system losses. Method 2: Heat emission based on calculation method

Length of pipe: in Germany national default values have been derived

Specific heat transfer coefficient of pipe: in Germany national default values have been derived

Average temperature of the pipe: in Germany national default values have been derived

Average ambient temperature: in Germany national default values have been derived

Duration of the provision of domestic hot water: in Germany national default values have been derived

Running time of the circulation pump: in Germany national default values have been derived

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

No problems mentioned

Auxiliary energy for ribbon heating

No ribbon heating present

Hot water: Pt.3. Generation (prEN 15316-3-3)

General part: no problems mentioned

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Pilot cases do not concern single family dwellings

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Average ambient temperature: unknown, standard German value used

Duration of provision of hot water: this is unknown, standard German utilization profile used

Stand-by heat loss: unknown, standard German value used

Method 2. Component 1. Storage vessel - simplified method

No problems mentioned

Method 2. Component 2. Primary circulation pipes - detailed method

Length of pipe is unknown, standard German value used

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material, standard German value used

Average temperature of the pipe is unknown, standard German value used

Average ambient temperature is unknown, standard German value used

Method 2. Component 2. Primary circulation pipes - simplified method

No problems mentioned

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, standard German value used

Stand-by heat loss of the boiler: Values unknown, standard German value used or could be roughly calculated

Method 2. Component 3. Direct gas fired domestic storage water heater

Heat loss from boiler during firing in one 24 hour period: unknown, but German standard values used

Stand-by heat loss of the boiler: unknown, German standard values used or could be roughly calculated

Ventilation energy (prEN 15241)

Air flow: unknown (narural ventilation), German utilization profile used.

Temperature precooling: unknown, depends on outdoor temperature.

Total fan power: Not in all buildings this input could be collected.

Lighting energy (prEN 15193-1)

Quick method

No problems mentioned

B.2 Analysis Danish input forms (non-residential buildings)

<u>Space heating: distribution (prEN 15316-2-3)</u>

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Type of heat generator: There are great differences in water volumes: what is 'standard'?

Type of pump control: it is not always clear if pump control is present. Give more guidance here.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Building type (new versus existing building): it is better to give guidance by using ages to indicate what is new and what is old.

Design heat load: Only a rough estimation can be made.

Mean distribution load: this value is unknown. Give default values or give other method (e.g. simple table with some distribution type options)

Type of heat generator: What to do when there are two (or more!) generators?

Hydraulic system: It is not clear what is meant.

Pipes between generator and vertical shaft: What to do when the pipes are in a 'mild temperature' basement? Now the choice is only 'heated' or 'unheated'.

<u>Space heating: Generation - Combustion systems (prEN 15316-4-1)</u>

Method 1. Example of typology method: SEDB_UK method

Full net load efficiency: this value is not known, needs to be specified.

Part load net load efficiency: this value is not known, needs to be specified.

Hot water storage volume: is not always known. If not, this input can only be roughly estimated.

Thickness of insulation of store: this input can only be roughly estimated.

Method 2. Case specific boiler efficiency method

Nominal power of the heat emitter: is not known. Give defaults.

Space heating: Generation - District Heating (prEN 15316-4-5)

No district heating present in the pilot cases

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

It was mentioned that the type of activity is unknown. Some extra guidance is needed here.

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

No problems mentioned

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

Not relevant: circulation system present, no delivery pipes

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Not relevant: circulation system present, no delivery pipes

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Not relevant: circulation system present, no delivery pipes

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

Not relevant: circulation system present, no delivery pipes

Calculation of the circulation system losses. Method 1: Heat emission based on pipe length

Length of pipe: is unknown. Give default.

Specific heat transfer coefficient of pipe: In Denmark a lower default value is used.

Calculation of the circulation system losses. Method 2: Heat emission based on calculation method

Length of pipe: is unknown. Give default.

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Nr of circulation pump operating cycles: this value is unknown.

Inner diameter of pipe: this value is unknown.

Configurations of pipe systems: is too detailed! Plus: there will be various diameters present is a building!

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

No problems mentioned

Auxiliary energy for ribbon heating

No ribbon heating

Hot water: Pt.3. Generation (prEN 15316-3-3)

General part: no problems mentioned

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Pilot cases do not concern single family dwellings

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Stand-by heat loss: this value is unknown. Give default or use simplified method.

Method 2. Component 1. Storage vessel - simplified method

No problems mentioned

Method 2. Component 2. Primary circulation pipes - detailed method

No problems mentioned

Method 2. Component 2. Primary circulation pipes - simplified method

No problems mentioned

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, give defaults.

Stand-by heat loss of the boiler: give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned, but not used in DK: very few importers of this system.

Ventilation energy (prEN 15241)

Building function: there are more building functions than those which are given in the list (e.g. health care); extend list.

Air flow/air change rate (during occupancy period and unoccupancy period): unknown!

Temperature of air preheating: not known.

Temperature of air precooling: the value is estimated, but not known.

Leakage level: roughly estimated (low, medium, high). The categorisation is totally arbitrary, there is no reference.

Lighting energy (prEN 15193-1)

Quick method

Installed power and amount of light is not always known. Give defaults.

Building type: what category is 'day care'? Extend list or give guidance.

B.3 Analysis Dutch input forms (non-residential buildings)

Space heating: distribution (prEN 15316-2-3)

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Type of heat generator: It is not clear what is meant with 'standard water volume'. The water volume is not displayed on the product and it is not clear how much water volume is standard.

Type of pump control: it is not clear if pump control is present. Give more guidance here.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Design heat load: guidance is needed here. Sometimes it can be read from a tag on the boiler, sometimes it may be can be derived from the numbers on the tag (but how is unclear) and in other cases this information cannot be retrieved.

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Hydraulic system: it is unknown if the hydraulic system is balanced or not. May be more guidance can solve this?

Power of the pump: what to do when there is more than one pump, just add the power?

Space heating: Generation - Combustion systems (prEN 15316-4-1)

Method 1. Example of typology method: SEDB_UK method

Full net load efficiency and part load net efficiency: these values are unknown

Boiler control: it is unclear if the boiler is modulating when there is a heating curve.

Hot water storage volume: is not always known. If not, this input is not retrievable.

Thickness of insulation of store: this input can not be ubtained.

Method 2. Case specific boiler efficiency method

Heating curve – sizing temperature for heating distribution: this input is unknown. Maybe guidance is enough to obtain the input?

Space heating: Generation - District Heating (prEN 15316-4-5)

No houses tested with district heating

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

No problems mentioned

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

General part: no problems mentioned

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Pipe length: in practice only a rough estimation will be given.

Pipe diameter (internal): give guidance to derive a internal diameter from the external diameter, because now the estimation is done arbitrary and will differ from audit to audit.

Pipe diameter (external): this is a lot of work, because the diameter differs over the building. It is not clear what to do with the different diameters.

Number of tappings per day: this is a very rough estimation, made by the person who uses the building and cannot always be done for non-residential buildings. Give some defaults to choose from to make it less random or use other method.

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Pipe length for every taping point: this is only a rough estimation.

Internal pipe diameter: this input is unknown or can only be roughly estimated. Give guidance to estimate this based on the external diameter to make this process less arbitrary. Another difficult point is that there is no one diameter. It is a lot of work and maybe even not possible to gather all the diameters (with their lengths), because most of the pipes are in hided places.

Fraction of total hot water demand (per pipe): this is a very rough estimation, made by the building manager. Give some defaults to choose from to make it less random or use other method.

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

Average length of distribution pipe within heated space: this is a rough estimation, not always possible. Drawings are not always present.

Calculation of the circulation system losses. Method 1: Heat emission based on pipe length

No problems mentioned

Calculation of the circulation system losses. Method 2: Heat emission based on calculation method

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Duration of the provision of domestic hot water: this is a rough estimation. Give guidance and maybe default values or examples.

Running time of the circulation pump: this is a rough estimation. Give guidance and maybe default values or examples.

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

Pump power rating: this information is not retrievable.

Auxiliary energy for ribbon heating

No ribbon heating present in the pilot cases.

<u>Hot water: Pt.3. Generation (prEN 15316-3-3)</u>

General part: no problems mentioned

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Pilot cases do not concern single family dwellings

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Duration of provision of hot water: this is unknown. Interview with building user gives some idea, but it remains a wild guess.

Stand-by heat loss: this value is unknown. Give default or use simplified method.

Method 2. Component 1. Storage vessel - simplified method

No problems mentioned

Method 2. Component 2. Primary circulation pipes - detailed method

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Duration of provision of hot water: this is unknown. Interview with building user gives some idea, but it remains a wild guess.

Method 2. Component 2. Primary circulation pipes - simplified method

No problems mentioned

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, give defaults.

Stand-by heat loss of the boiler: give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned

<u>Ventilation energy (prEN 15241)</u>

VAV present: it is not always known: give guidance

Efficiency of heat exchanger: the input is unknown. Give default values based on exchanger typology.

Control present to limit supply temperature: it is not known if this is present. Give guidance or default values.

Temperature of air preheating: the value is estimated, but not known.

Temperature of air precooling: the value is estimated, but not known.

Defrosting system present: not always known.

Total fan power: Not in all buildings this input could be collected.

Is air humidified: not always known

Setpoint for humidity in winter: this input is unknown

Lighting energy (prEN 15193-1)

Quick method

No problems mentioned

B.4 Analysis France input forms (non-residential buildings)

Space heating: distribution (prEN 15316-2-3)

Calculation of annual auxiliary energy and heat emission for distribution systems - Using tabulated values

Type of distribution system: it is not always clear if the distribution system is a one or two pipe system. Some guidance might be enough.

Type of heat generator: the type of heat generator is unknown. Give guidance about what is meant.

Type of pump control: it is not clear if pump control is present. Give more guidance here.

Design supply temperature: is unknown. Give guidance and perhaps default values

Design return temperature: is unknown. Give guidance and perhaps default values

It is not always known if the pump is turned off at night: give default values.

Calculation of annual auxiliary energy and heat emission for distribution systems - Using simplified calculation method

Building type (new versus existing building): it is not clear what to do when a building is extended

Design heat load: guidance is needed here. This information cannot be retrieved.

Mean distribution load: it is not clear what is asked. Give default values or give other method (e.g. simple table with some distribution type options)

Ratio of mass flow over the heat transmitter to mass flow in the ring: this is not known. Give default values.

Hydraulic system: it is not always known if the hydraulic system is balanced or not. May be more guidance can solve this? Otherwise default values are needed.

Space heating: Generation - Combustion systems (prEN 15316-4-1)

Method 1. Example of typology method: SEDB_UK method

Full net load efficiency: this value is not always known

Boiler control: it is unclear if the boiler is modulating

Hot water storage volume: is not always known. If not, this input is not retrievable.

Thickness of insulation of store: this input can not be obtained.

Method 2. Case specific boiler efficiency method

Burner type: it is not always known if the burner type is atmospheric or fan assisted. Maybe more guidance will solve the problem, otherwise default values are needed.

Nominal output power: is sometimes known, can sometimes be roughly estimated only and is sometimes unknown. Give guidance and defaults.

Boiler room temperature: it appears to be hard to estimate this input. Perhaps guidance is enough, otherwise give defaults.

Boiler controle type: this input is unknown in the pilot cases. Give guidance and defaults.

Internal temperature: is not always known. Give a default.

Nominal power of the heat emitter: is not known. Give defaults.

Nominal temperature difference of heat emitters: is not known, give defaults

Heating curve – sizing temperature for heating distribution: this input is unknown. Maybe guidance is enough to obtain the input? Or give defaults.

Space heating: Generation - District Heating (prEN 15316-4-5)

Almost all of the inputs are unknown. Method is not usable in practice.

Hot water: Pt.1. Tapping requirements (prEN 15316-3-1)

No problems mentioned

Hot water: Pt.2. Distribution losses (prEN 15316-3-2)

Calculation of distribution losses

It is not always clear if the distribution is done by delivery pipes or a circulation system.

Calculation of the delivered pipe losses. Method 1: Based on dwelling area

No problems mentioned

Calculation of the delivered pipe losses. Method 2: Based on delivery pipe lengths – simple method

Almost all information is unknown. Give default values or use another method

Calculation of the delivered pipe losses. Method 3: Based on delivery pipe lengths – tabulated data method

Almost all inputs are unknown. Give default values or use another method

Calculation of the delivered pipe losses. Method 4: Based on tapping profiles

Almost all inputs are unknown. Give default values or use another method

Calculation of the circulation system losses. Method 1: Heat emission based on pipe length

Length of pipe: is unknown. Give default.

Calculation of the circulation system losses. Method 2: Heat emission based on calculation method

Length of pipe: is unknown. Give default.

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Duration of the provision of domestic hot water: this is a rough estimation. Give guidance and maybe default values or examples.

Running time of the circulation pump: this is a rough estimation. Give guidance and maybe default values or examples.

Calculation of auxiliary energy for distribution - Auxiliary energy for pumps - simplified method

Pump power rating: this information is not always retrievable.

Auxiliary energy for ribbon heating

Length of the trace heated pipe is unknown

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Hot water: Pt.3. Generation (prEN 15316-3-3)

General part: no problems mentioned

Method 1. Heat generators tested as a whole (systems in single family dwellings)

Pilot cases do not concern single family dwellings

Method 2. Heat generators consisting of a vessel, heater and primary circulation pipes

Method 2. Component 1. Storage vessel - detailed method

Average ambient temperature: give a default

Duration of provision of hot water: this is unknown.

Stand-by heat loss: this value is unknown. Give default or use simplified method.

Method 2. Component 1. Storage vessel - simplified method

Vessel volume is not always known

Method 2. Component 2. Primary circulation pipes - detailed method

Length of pipe is unknown

Specific heat transfer coefficient of pipe: this input is unknown. Give default values based on e.g. pipe material.

Average temperature of the pipe is unknown

Duration of provision of hot water: this is unknown.

Method 2. Component 2. Primary circulation pipes - simplified method

No problems mentioned

Method 2. Component 3. Gas or oil fired boiler

Heat loss from boiler during firing in one 24 hour period: Values unknown, give defaults.

Stand-by heat loss of the boiler: give defaults in national annex

Method 2. Component 3. Direct gas fired domestic storage water heater

No problems mentioned

Ventilation energy (prEN 15241)

Building function: there are more building functions than those which are given in the list (e.g. health care); extend list.

VAV present: it is not always known: give guidance

Heat exchanger present: not always known. Guidance needed.

Efficiency of heat exchanger: the input is unknown. Give default values based on exchanger typology.

Control present to limit supply temperature: it is not known if this is present. Give guidance or default values.

Temperature of air preheating: the value is estimated, but not known.

Temperature of air precooling: the value is estimated, but not known.

Defrosting system present: not always known.

Leakage level: it is not possible to estimate this (low, medium, high), because there is no reference. The categorisation is totally arbitrary.

Total fan power: Not in all buildings this input could be collected.

Setpoint for humidity in winter: this input is unknown

Lighting energy (prEN 15193-1)

Quick method

Installed power and amount of light is not always known. Give defaults.