Application of the local criteria/standards and their differences for very low-energy and low energy houses in the participating countries

Deliverable 2, IEE NorthPass project

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No & name	**D2 Application of the local criteria/standards and their differences for very low-energy and low energy houses in the participating countries**				
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DotA	The work package describes the application of the local criteria of the very low-energy house and other low energy house standards in the participating countries, also those with slightly higher energy demand, and it compares and collects experiences with very low-energy houses, user/market demands and national regulations. The objective of the work package is to provide a basis for the following work packages as to: Which different "concepts" for very low energy houses are known, and what do they imply Task 1 description: Very low-energy house criteria for the Northern climates In this task information is collected on local criteria for very low energy houses in the participating countries. The criteria are compared and the differences analysed, e.g., reference floor area, free heat gains, required ventilation rates and heat recovery options, indicators for good indoor climate and comfort, documentation demand. Output: Description of the application of local criteria for very low energy houses in the participating countries, and definitions of very low-energy levels for participating countries.				
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Table of contents

1 EXECUTIVE SUMMARY

This deliverable summarizes a part of the work done in NorthPass Work Package 2 Task 1: "Very low-energy house criteria and standards for the Northern climates"

In this task, the consortium collected information on local criteria and standards for very low-energy houses currently used in the participating countries.

The criteria and standards used in the participating countries were compared and their differences analysed (e.g., parameters like reference floor area, assumptions for free heat gains, required ventilation rates and heat recovery options, boundary conditions for indoor climate and comfort).

The work reported in this deliverable includes following topics:

- Collection of information on local criteria and standards for very low-energy houses currently used in the participating countries.
- Comparison of the criteria and standards used in the participating countries and analysis of their differences
- For the later comparison and as reference for the low energy definitions, also information on the national building regulations was gathered.

The comparison of the definitions was primarily qualitative and the purpose was to give a common context for the further work with the very low energy buildings and concepts in this project. A quantitative analysis and comparison will need a systematic approach with calculations according to the various definitions and by comparing these results. Some of this is planned to be a part of the later Tasks and Deliverables in this and other WP's.

The conclusion of the comparison performed in this report is that there exist definitions for **very low energy** buildings in Finland, Sweden, Norway and Denmark. In the other countries (Estonia, Latvia, Lithuania and Poland), there exist no national low energy definitions, but especially passive house concept by Passive House Institute, (PHI) is applied in these countries. The international approach of passive houses by PHI is practically the only very low energy building definition applied across the borders.

The very different requirements in the general building regulations as well as in various criteria for very low energy buildings can be seen as a challenge for a market driven penetration of very low energy houses in the Northern European countries.

2 INTRODUCTION

2.1 Purpose and target group

The objective of this deliverable is for the different very low energy houses criteria and standards currently used in the North European markets to make a state-of-the-art study and compare them. The questions to be answered are:

- Which definitions/descriptions/standards of very low energy buildings exist?
- How are these criteria (definitions/descriptions/standards) defined?
- Are the low energy classes graded to different energy classes?
- Is there any difference for different size of buildings (single-family-houses/apartment blocks)?

This Deliverable sums up the current situation of the building standards – both minimum requirements and low energy standards – in Northern Europe. Still establishing proposals for a better market penetration of low energy houses is the objective of later work in this project.

The target group of the presented results is therefore partly partners in the other WP's of this project and partly persons involved in standardisation work and politics related to the building sector.

2.2 Contributions of partners

The objective of WP2 Task 1 is to "Make a state-of-the-art study and comparison of the different very low energy houses criteria and standards currently in used in the North European markets".

The representatives from every partner country (Table 1) were therefore asked to deliver a short description of the national situation:

- Which minimum national energy requirements of national buildings codes exist?
- Which definitions/descriptions/standards of very low energy buildings exist?
- How are these criteria (definitions/descriptions/standards) defined?

The partners involved in this work package were asked to fill in a questionnaire describing those topics. Their main role in this WP2 is given in Table 1. All the partners in WP2 have contributed with the national descriptions that are placed in Appendices (Chapter 7). The national sections are more or less directly written by the respective partners. Passivhus.dk as a WP leader is the main contributor of the other chapters in this D2.

Table 1. Partners involved in WP2

Partner	Task(s) of this partner organisation	Contribution to D2 chapter
Passivhus.dk	WP leader Danish input and feedback	1-6 & 7
Tampere University of Technology	Finnish input and feedback	7
Lund University	Swedish input and feedback	7
SINTEF Building and Infrastructure	Norwegian input and feedback	7
National Energy Conservation Agency	Polish input and feedback	7
University of Tartu	Estonian input and feedback	7
Vilnius Gediminas Technical University	Lithuanian input and feedback	7
Riga Technical University	Latvian input and feedback	7

2.3 Role within the project

This is one of the first deliverables of the NorthPass project. Therefore, there are no previous deliverables to be taken into count. The report therefore takes the starting point in the existing national regulations and other definitions for very low energy buildings in the participating countries. The involved partners in each country are institutions/companies that are updated of the situation in their country. The starting point for this work is therefore the national up-to-date know-how and knowledge within energy efficient buildings and definitions related to them.

There are 3 deliverables to be completed within the work in WP2. D2 is the present one:

Table 2. Deliverables in WP2 and Current degree of completion

Nr	Deliverable	Due	Current degree of completion
D2	Application of the local criteria/standards and their differences for very low-energy and low energy houses in the participating countries	month 9	100%
D3	Principles of low-energy houses applicable in the participating countries and their applicability throughout the EU	month 17	5%
D4	Energy-demand levels and corresponding residential concept houses and the specific challenges of very low-energy houses in colder climates	month 17	5%

This deliverable is related to the work in this project by using the existing knowledge of the participants (because this is the first deliverable of this project) as an input and giving an output to be used in this work package and this project:

This report makes the starting point for the remaining work in WP2, where the focus will be on challenges and on the definition of local concept houses for every country. Also WP4 working on the barriers will make use of this collection and summary of existing definitions and criteria.

2.4 Contents of the report

In this report, first some of the central definitions and parameters are introduced and defined in order to give a uniform basis for the understanding of the collected information. Hereafter the different definitions are compared by summing the information up in tables with related topics. The purpose was to give as clear an overview as possible and in the same time keep the information as detailed as possible. The original national and local descriptions are placed in the appendix. The focus in the report is on the summary and the comparison of the different definitions and criteria.

3 DEFINITIONS

To give a comprehensive picture and comparison of the existing definitions and criteria in the Northern European countries is only possible when the definitions of different parameters are uniform. However, many of the definitions vary nationally.

This chapter gives an overview of these definitions according to standards and how the national and other definitions can be interpreted in this common context.

3.1 Area

The definition of area is quite open in the ISO 13790 for the energy calculation (Table 3). Each country has its own definition (mostly adopted from older local regulations). The division of the areas (Table 4) in several parts makes the three possibilities (internal, overall internal or external dimensions) in accordance to ISO 12790 visible. The precise definition of the conditioned area used in every country can be read in Table 7 in the next chapter.

Table 3. Extract of definitions of space and area by ISO 13790

heated space	room or enclosure, which for the purposes of a calculation is assumed to be heated to a given set·point temperature or set·point temperatures
conditioned space	heated and/or cooled space NOTE The heated and/or cooled spaces are used to define the boundaries of the thermal zones and the thermal envelope.
unconditioned space	room or enclosure that is not part of a conditioned space
conditioned area	floor area of conditioned spaces excluding non-habitable cellars or non-habitable parts of a space, including the floor area on all stories if more than one NOTE 1 Internal, overall internal or external dimensions can be used. This leads to different areas for the same building. NOTE 2 Some services, such as lighting or ventilation, might be provided to areas not included in this definition (e.g. a car park). NOTE 3 The precise definition of the conditioned area is given by national authorities.

Table 4. Division of areas in accordance with DIN 277 [4]

gross floor area [a]					
net floor area [b]				construction area/ structure area	
usable area [c]	service area	circulation area	residual area	external walls	internal walls, columns

a Total floor area of all floors of a building calculated with the external dimensions of the building including structures, partitions, corridors, stairs.
b Sum of all areas between the vertical building components (walls, partitions,…), i.e. gross floor area reduced by the area for structural components.
c The fraction of the net floor area for the intended use of the building, i.e. net floor area reduced by circulation areas (corridors, stairs etc.) and functional areas (WCs, storage rooms etc.).

3.2 Energy

The precise definition of the conditioned area used for calculations is given by national authorities and can be read in Table 7.

Table 5. Extract of definitions around energy and heating by ISO 13790 and EN 15615

energy need for heating or cooling (13790 – 3.4.1)	heat to be delivered to, or extracted from, a conditioned space to maintain the intended temperature conditions during a given period of time. NOTE 1 The energy need is calculated and cannot easily be rneasured. NOTE 2 The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing (decreasing) the effective temperature for healing (cooling) and not included in the heat transfer due to the healing (cooling) system.
auxiliary energy (13790 – 3.4.2)	electrical energy used by technical building systems for heating, cooling, ventilation and/or domestic water to support energy transformation to satisfy energy needs NOTE 1 This includes energy for fans, pumps, electronics, etc. Electrical energy input to a ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation. NOTE 2 In ISO 9488, the energy used for pumps and valves is called "parasitic energy".
technical building system (13790 – 3.4.3)	technical equipment for heating, cooling , ventilation, domestic hot water, lighting and electricity production NOTE 1 A technical building system can refer to one or to several building services (e.g. healing system, healing and domestic hot water system). NOTE 2 A technical building system is composed of different subsystems. NOTE 3 Electricity production can include cogeneration and photovoltaic systems.
energy use for space heating and cooling (13790 – 3.4.9)	energy input to the heating or cooling system to statisfy the energy need for heating or cooling, respectively NOTE If the technical building system serves several purposes (e.g. heating and domestic hot water), it can be difficult to split the energy use into that used for each purpose. It can be indicated as a combined quantity (e.g. energy use for space heating and domestic hot water).
delivered energy for space heating or cooling (13790 – 3.4.10)	energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.) or to produce electricity NOTE 1 For active solar and wind energy systems the incident solar radiation on solar panels or on solar collectors, or the kinetic energy of wind is not part of the energy balance of the building. NOTE 2 Delivered energy can be calculated or it can be measured.

heat gains (13790 – 3.6.1)	heat generated within, or entering into, the conditioned space from heat sources other than energy intention ally utilized for heating, cooling or domestic hot water preparation NOTE 1 These include internal heat gains and solar heat gains. Sinks that extract heat from the building are included as gains with a negative sign. In contrast with heat transfer, for a heat source (or sink) the difference between the temperature of the considered space and the temperature of the source is not the driving force for the heat flow. NOTE 2 For summer conditions heat gains with a positive sign constitute extra heat load on the space.
internal heat gains (13790 – 3.6.2)	heat provided within the building by occupants (sensible metabolic heat) and by appliances such as domestic appliances, office equipment, etc. , other than energy intentionally provided for heating, cooling or hot water preparation NOTE 1 In this International Standard, if not directly taken into account as a reduction to the system losses, the recoverable system thermal losses are included as part of the internal heat gains. It may be decided at national level to repol1 the recoverable system thermal losses separately. NOTE 2 Included are heat from (warm) or to (cold) process sources that are not controlled for the purpose of heating or cooling Of domestic hot-water preparation. The heat extracted from the building, from the indoor environment to cold sources (sinks), is included as gain with a negative sign.
solar heat gains (13790 – 3.6.3)	heat provided by solar radiation entering, directly or indirectly (after absorption in building elements), into the building through windows, opaque walls and roofs, or passive solar devices such as sunspaces, transparent insulation and solar walls NOTE Active solar devices such as solar collectors are considered as pall of the technical building system.
useful heat gains (13790 – 3.6.4)	proportion of internal and solar heat gains that contribute to reducing the energy need for heating
primary energy (15615 – 3.22)	energy that has not been subjected to any conversion or transformation process NOTE 1 Primary energy includes non-renewable energy and renewable energy. If both are taken into account it can be called total primary energy. NOTE 2 For a building, it is the energy used to produce the energy delivered to the building. It is calculated from the delivered and exported amounts of energy carriers, using conversion factors.
space heating (15615 – 3.29)	process of heat supply for thermal comfort
space cooling (15615 – 3.30)	process of heat extraction for thermal comfort

The received documents from the participating countries used also some other definitions. The Table 6 shows some more definitions in accordance to EN 13790 in Table 5.

Table 6. Definitions used by the participating countries around energy and heating

space heat demand	Equals to the Q_h as the net heating energy (mostly calculated in monthly time period - EN ISO 13790), in kWh or specific in kWh/m² or MJ/m².
(net) energy demand (by calculation) (net) energy consumption (by measurement)	For all uses of the building delivered net energy quantity from each energy source. Delivered energy minus redelivered energy
heat load (with and without earnings)	The total heat per unit time that must be supplied in order to maintain a specified temperature in any space or building. Accounting transmission losses, ventilation losses, without heat gains and solar radiation earnings - or with heat gains and solar radiation earnings. Heat load in watt or specific in W/m².
primary energy factor	This factor takes into account the energy that is required to generate the energy, to transform, refine, store, transport and distribute them, and any precedent that are required to supply the energy the building which needs this energy.
primary energy demand	With primary energy factors weighted energy consumption and energy demand, respectively, of a building
national weighted factor	From the national energy policy fixed assessment factor.
total energy demand	With national weighting factors weighted energy consumption and energy demand, respectively, of a building
delivered energy / purchased energy	Energy of the last stage of the trade (including neighbourly networks) on the perimeter of balance sheet delivered energy for the building in the form of delivered energy.
redelivered energy	Energy of the building redelivered to the energy trade over the perimeter of balance sheet.

These definitions give the base for the following comparison of standards and very low energy building criteria from the participating countries.

4 EVALUATION AND COMPARISON OF THE DIFFERENT DEFINITIONS AND THEIR APPLICABILITY

This chapter presents the main contents of this report; the comparison of the different definitions. The comparison is enabled with collecting and setting the different parts of the definition and criteria up in tables. The more detailed description of these building energy requirements or criteria is found in Appendix (Chapter 7).

There are first – both in the tables and in the text – referred to the national building regulations and thereafter to the existing very low energy definitions. Some of the very low energy definitions are not included in this comparison, because they are less ambitious and there exists a parallel, more ambitious one. But a short description of also these definitions/criteria is found in Appendix.

4.1 Overview of regulations and very low energy criteria

In this section, an overall overview of the referred criteria and definitions is given with respect to the reference area and contents of definitions together with the definitions of energy to be included. This overview relates to the definitions in the previous Chapter. To make an overall overview possible has been the motivation for the tables.

The information in the tables is made as detailed as possible by using footnotes.

In accordance to the area definitions, Table 7 shows the used reference floor area in each country and according to the different very low energy definitions.

The definitions are quite different between the countries (Table 8 and Table 9).

Almost every country has a U-value requirement (direct or over normative U-values which are defining a space heat demand). In a second step, there are also values for the space heating. The very low energy buildings generally do not have U-value requirements allowing more flexible design to meet the requirements. In this spirit the required net, total or primary energy is composed of different energy sources of the building service. The used sources change from country to country too (Table 9).

Table 7. Different definitions of reference area used in calculation (PEB is short for Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

Definition	Finland	Sweden	Norway	Estonia	Lithuania	Latvia	Poland	Denmark		PEB by VTT, Finland	PEB by RIL, Finland	PH by FEBY, Sweden	PH by Norwegian Standard	LEB Class 1 in Denmark	PH by PHI
external dimensions → gross floor area	X							X[a]		X	X			X[a]	
overall internal dimensions (including internal walls)		X[b]	X[c]									X[b]	X[c]		
Internal dimensions (not including internal walls) → net floor area				X	X[d]	X	X[e]								X[f]

a Floor area is calculated by adding the gross areas of all floors, including basements and useable roof spaces, enclosed balconies, conservatories, connecting passages etc.

b The area of all floors, which are temperature controlled and meant to be heated above + 10 °C. The area is limited by inside of the building envelope. The area covered by interior walls, openings for stairs, shafts or the like is included. The area for garage, within dwellings or other premises than garage, is not included.

c internal dimensions, but not subtracted internal walls and staircases, etc. In the attic (sloped ceiling) an area 0.6 meters outside a ceiling height of 1.9 meter is calculated as "reference area" (it is called usable area, BRA). Only heated parts of the building are calculated (unheated cellars, parking garages, storage rooms are not counted in BRA). Defined in Norwegian Standard NS 3940 Area and volume calculations of buildings.

d The useful area of a building shall be calculated using the internal dimensions of a building, i.e by subtracting thickness of walls. This area shall include the sum of floor areas of all heated premises of a building, including the floor area of heated basements, heated stairwells, heated shared and other premises, as well as the floor area of premises which are surrounded by heated premises fully.

e A clear definition of reference area for calculation – the reference area is not clearly defined in the regulation. Mostly it is assumed as internal area of heated space higher then 1,9 m. So it is similar to living area calculated in accordance to PN-ISO 9836 but also includes other heated areas, e.g. corridor, garage (if heated).

f The reference floor area is the internal floor area of the heated part of the building. Stair cases are not taken into account, and technical rooms and basements are only taken into account by 60%. Areas with one to two meter clear height are taken into account by 50%.

Table 8. Ways of criteria definitions for heat losses (PEB is short to Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

Criteria which have to be met. Some criteria have two different approaches, in this table denoted "1" resp. "2". Example: In Sweden simply the requirements for space heat demand (1) and U-values (1) must be met. In Poland either U-values (1) or the primary energy demand (2) must be met. Recommendations are marked with an X.	Finland	Sweden	Norway	Estonia	Lithuania	Latvia	Poland	Denmark		PEB by VTT, Finland	PEB by RIL, Finland	PH by FEBY, Sweden	PH by Norwegian Standard	LEB Class 1 in Denmark	PH by PHI
U-value		1	12[a]		1		1	1[a]			1[b]	1[c]			X
Heat load								1[ad]				1	1		1
Space heat demand	1[e]				1[e]	1[e]				1	1		1	1	2
Net, total or primary energy demand		1	2	1			2	1		1	1	X			12
Cooling demand				X											12
Air tightness	X		12	X		1	X	1		1	1	1	1	1	12
Heat recovery in the mechanical ventilation	X		X									X			X

a less pronounced criteria when met heat or energy demand criteria, but used as an absolute minimal criteria to give some boundaries.
b See Table 32 and Table 33 in the Appendix
c Criteria only for Windows
d Even if the energy performance framework has been complied with, the design transmission loss from single storey buildings, excluding the loss from windows and doors may not exceed 6 W/m² of the building envelope, excluding windows and doors. For two-storey buildings, the corresponding transmission loss may not exceed 7 W/m², and for buildings of three or more storeys, the corresponding design transmission loss may not exceed 8 W/m² of the building envelope.
e Calculated by use of normative/reference U-values

Table 9. Included sources in the total or primary energy demand (PEB is short to Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

Includes	Finland [a]	Sweden	Norway	Estonia	Lithuania [a]	Latvia [a]	Poland	Denmark		PEB by VTT, Finland	PEB by RIL, Finland	PH by FEBY, Sweden	PH by Norwegian Standard [a]	LEB Class 1 in Denmark	PH by PHI
heating (transmission +ventilation losses, internal gains)		X	X	X			X	X		X	X	X		X	X
domestic hot water		X	X	X			X	X		X	X	X		X	X
mechanical ventilation system		X	X	X			X	X		X	X	X		X	X
auxiliary energy (pumps, controls)		X	X	X				X		X	X	X		X	X
cooling		X	X	X			X	X		X	X	X		X	X
lighting			X	X			X[b]	c		X	X			c	X
household			X[d]	X						X	X				X
weighting factors used															
no use			X												
national weighting factors		X[e]		X				X[f]				X[g]		X[f]	
primary energy factors							X[h]			X[i]	X				X
Is called															
net energy demand		X[e]	X												
total energy demand				X				X				X[g]		X	
primary energy demand							X			X	X				X

a the main criteria is space heating demand or maximum U-values

b Lighting has only calculated in residential buildings for groups (temporary residence, e.g. for students), public utility buildings and industrial buildings.

c only in non domestic buildings

d Equipment/Appliances

e The building code (BBR i.e. Boverket 2009) requires the energy use to be 55 kWh//m²year lower for dwellings with electric heating (heat pumps, direct electric heating, electric boiler etc.) than for buildings with non-electric heating.

f Weighting factor for heat in the primary energy calculation is 1,0 and for electricity 2,5.

g The weighting factors take into account the quality of the energy. The weight of electricity is currently two.

h As examples: oil 1,1; natural gas 1,1; biomass 0,2; electricity as mixed production related to the electricity supply from the national network 3,0 or electricity from PV systems 0,7

i Primary energy weighing factors are as follows: oil and gas 1,1; district heating 0,4 and wood based 0,2

4.2 Comparison of the national building regulations

The relevant parts of the energy requirements in the current national building codes are described shortly for each country in Appendix 7.1. A summary and comparison of these building regulations in the Northern European countries is presented in this section. The objective is to show the very low energy definitions to be introduced in the next section in relief to the business-as-usual.

These current building codes – by **January 1st, 2010** – used in the participating countries are used as the reference for the later evaluation of the very low energy concepts and success criteria of the whole project.

Table 8 gives a first overview of the central criteria for the minimum energy requirements in the existing (by 1st January, 2010) national building codes.

There are two main concepts for criteria, based on:

- Maximum/reference U-values of the building envelope, etc

  Used by all of the participating countries
- Maximum energy demand (net, total or primary energy for building services):

  Sweden, Norway, Poland and Denmark (used as a different second or additional criterion)

The comparison of the different criteria for energy demand (Table 9) is not easy as the figures include different energy sources (with or without auxiliary energy, lighting or household). Also a cooling demand are taken account into these four countries.

The indoor temperature used for calculation is between 21 °C for Finland and Sweden and 20 °C for the other countries. Big differences were found by the internal heat gains. There is a range from 2,5 to 5 W/m². The differences of the floor area are big too. The ratio between net and gross floor area is typically 75-85%.

Calculation methods for energy demand are generally based on EN 13790.

Table 10. Information about calculation values

	Data source	Requirement / Method	Indoor temp.	Internal heat gains appliances and persons	Area for calc. (Table 7)
Finland	C3-2007, D3-2007, D5-2007	U-values calculated in a monthly method (EN 13790)	21 °C	For single family house 8 kWh/brm² Year [a] Other residential buildings (houses):17 kWh/brm² Year [a]	gross floor area
Sweden	Boverket 2009; BBR 16 (BFS 2008:20)	Calculation of total energy and monitoring.	21 [b] °C	the given values are adapted values from EN 13790	overall internal dim.
Norway	NS3031 (2007) [c]	Maximum U-values or total net energy consumption combined with max. U-values (EN 13790)	20 °C, night set-back to 19°C	5 W/m² [d]	overall internal dim.
Estonia	Energiaatõhususarv (2008)	Figure of Energy efficiency (weighed specific energy use for heating, cooling, hot water production, ventilation, lighting and equipment usage at standard usage)	21 °C	given as dynamic profile; as average: for small living house 3,44 W/m²; for apartment house 4,4 W/m²;	net floor area
Lithuania	STR 2.01.09:2005[e] STR 2.05.01:2005	Energy performance: lower than C for new building lower than D for existing building with more than 1000 m² after renovation U-values calculated in a monthly method (EN 13790)	20 °C	One- and two-apartment residential buildings (houses): 1,2 W/m² indoor heat source plus 70 W/P / 60m²/P Other residential buildings (houses): 1,8 W/m² indoor heat source plus 70 W/P / 40m²/P	net floor area
Latvia	LBN 002-01 and Law on the Energy Performance of Buildings [f]	U-values calculated in a monthly method (EN 13790)	20 °C	are used according LVS EN ISO 13790:2008 reference numbers	net floor area
Poland	Official Journal nr. 201 position 1240 [g]	Maximum U-values or total energy consumption (EN 13790)	20 °C	single family building: 2,5 – 3,5 W/m² [h] multifamily building: 3,2 – 6,0 W/m² [h]	net floor area
Denmark	SBi-anvisning 213 [5]	Total energy consumption (EN 13790) combined with max. U-values and specific maximum losses of building envelope	20 °C	5 W/m²	gross floor area

a The given values from D5 are used (persons, heating systems internal heat losses, lighting and electrical equipments heating energy, solar radiation from windows) for example heat gains for persons:
b Commonly used value. The building code recommends 22 °C if nothing is known about the indoor temperature.
c The new building code was mandatory from 1st August 2009. The voluntary standard NS 3700 will be released on 1st April 2010.
d Will probably be reduced to 4 W/m² in a revision 1 July 2010.
e came into force on 4 January 2006
f Latvian building code LBN 002-01 were put in force from 01.01.2003 and Law on the energy performance of building was put in force from 16.04.2008 with some transition time and from January 2009 it's mandatory. EN 13790:2008 for calculation
g The regulations were put in force on 1st January 2009 and are mandatory
h Internal heat gains appliances and persons – Internal heat gains without gains from heating and DHW system

Table 11. Maximal limits for U-values

	Average U-value [W/m²K]	U-value roof [W/m²K]	U-value wall [W/m²K]	U-value floor slap [W/m²K]	U-value window (incl. frames) [W/m²K]	Thermal bridges [W/mK]
Finland [ab]		0,15 / 0,28 [c]	0,24 / 0,38 [c]	0,19 / 0.28 [c] floor to outside: 0,15 / 0,28 [c]	1,4 / 1,8 [c] skylight: 1,5 / 1,8 [c]	
Sweden	0,5					included
Norway [db]		0,13/ 0,18[e]	0,18 / 0,22[e]	exposed floor 0,15 / 0,18[e]	1,20[i] / 1,60[ef]	0,03 (standard)
Estonia	no requirements					
Lithuania [a]		0,16 x κ [g]	0,20 x κ [g]	0,25 x κ [g]	1,60 x κ [g]	0,18 x κ [g]
Latvia [a]		0,20	0,25; 0,30[h]	0,25	1,80	0,20
Poland		0,30	0,30	0,30	1,7-1,9[i]	[j]
Denmark		0,25	0,40	0,30	2,0	different values

a reference U-values for the reference heat space demand
b special requirements for timber log houses and leisure dwellings
c U-Value for heated spaces/"semi-heated" spaces
d 40% of electricity and/or fossil fuels supplied by alternative energy carriers
e Moderated criteria when total net energy criteria is fulfilled
f maximum percentage of the buildings heated floor area as defined in NS3031 from 20%
g corrective coefficient - "Thermal Technologies of Partitions of a Building" requires to multiply the normative value of thermal transmittance coefficient by the multiplier κ. The effect of this multiplier is considered in equations used to calculate heat loss through partitions of a building. Usually 1,0.
h >100kg/m²
i maximum area of windows and glazed or transparent partitions with U-value > 1,5 W/m²K cannot exceed: $A_{0max} = 0,15\ A_z + 0,03\ A_w$
j Thermal bridges can be taken from PN-EN ISO 14683:2008 have to be calculated in accordance to PN-EN ISO 10211:2008

The differences between the U-values in Table 11 compare almost with the age of the building regulation in Table 10. Maximum/reference U-values for the involved countries are found within a span, where Norway typically represents the lowest U-values and Latvia the highest, see Table 12. Denmark and Poland have some high U-values too, but they are maximal limits and in practice the values have to be smaller to meet the other criteria.

Table 12: Comparing the lowest and the highest U-values

	Lowest	Highest
U-value roof	0,13	0,2
U-value wall	0,18	0,3
U-value slab on ground	0,24	0,25
U-value window	1,2	1,8
ψ (thermal bridge)	0,03	0,2

The different requirements in heat demand and energy demand showed in Table 13 and Table 14 are not analogues at this time. The next task will force a calculation after which the standards should be comparable. It is visible that the needs of each country are really different.

Table 15 shows the differences for heat recovery, air tightness and cooling load. There are not similarities located. Least of all, the air tightness has different approaches referring to volume (air change), floor area or envelope area. So these values are not comparable without a building example.

Table 13. Requirements for annual space heat demand or heat load

	Annual space heat demand [kWh/m²]	Heat load or heat loss [W/m²]
Finland	Calculated with required U-values (see Table 11)	no requirements
Sweden	no requirements	no requirements
Norway	no requirements	no requirements
Estonia	no requirements	no requirements
Lithuania	Calculated with required U-values (see Table 11)	no requirements
Latvia	Calculated out of required U-values or simplified method can be used: For one storey buildings normative heat losses can be calculated as 1,05 W/(m²K) (m² is for floor area), two storey buildings – 0,8 W/(m²K), three and four storey buildings – 0,7 W/(m²K), five and more storey buildings – 0,6 W/(m²K). This means normative heat losses through building envelope have to be in range from ~60 kWh/m² (five and more storey buildings) to ~100 kWh/m² (one storey buildings).	no requirements
Poland	no requirements	no requirements
Denmark	no requirements	The U-values have to result in a specific design heat loss of the building envelope: "Even if the energy performance framework has been complied with, the design transmission loss from single storey buildings, excluding the loss from windows and doors may not exceed 6 W/m² of the building envelope, excluding windows and doors. For two-storey buildings, the corresponding transmission loss may not exceed 7 W/m², and for buildings of three or more storeys, the corresponding design transmission loss may not exceed 8 W/m² of the building envelope." (at -12 °C)

Table 14. Requirements for total or primary energy demand including weighting factors

	Total (primary) annual energy demand [kWh/m²]
Finland	no requirement
Sweden	The total energy use includes the energy delivered to a building (often referred to as purchased energy) for heating, comfort cooling, domestic hot water, fans and pumps. Southern Sweden. 110 Central Sweden 130 Northern Sweden 150 With electrical heating as the main source of heating: Southern Sweden. 55 Central Sweden 75 Northern Sweden 95
Norway[b]	One family house: 125 + 1600/m² heated floor area Apartment building: 120 40% of electricity and/or fossil fuels supplied by alternative energy carriers
Estonia	New buildings: 1) Detached houses (including single family houses, semi-detached and row houses): 180 kWh/year·m². 2) Storey houses: 150 kWh/year·m². Significant renovation: 1) Detached houses (including single family houses, semi-detached and row houses): 250 kWh/year·m². 2) Storey houses: 200 kWh/year·m².
Lithuania	no requirement
Latvia	no requirement
Poland	a performance character and defines permissible values of specific non-renewable primary energy use EP [kWh/(m²year)]: 1) In residential buildings the energy use for heating, ventilation and hot water supply (EP_{H+W}) is calculated for a whole year: a) for $A/V_e \leq 0,2$; $EP_{H+W} = 73 + \Delta EP$; b) for $0,2 \leq A/V_e \leq 1,05$; $EP_{H+W} = 55 + 90 \cdot (A/Ve) + \Delta EP$ c) for $A/V_e \geq 1,05$; $EP_{H+W} = 149,5 + \Delta EP$; $\Delta EP = \Delta EP_W$ – the addition to specific use of non-renewable primary energy for supply of hot water during the year, $\Delta EP_W = 7800/(300 + 0,1 \cdot Af)$; [kWh/(m²year)], A – the sum of surface areas of all outer partitions which separate the building's heated parts from ambient air, ground or adjacent unheated spaces defined along outer boundaries, Ve – the cubic capacity of the building's heated section defined along outer boundaries, diminished by the volume of balconies, loggias and galleries, Af – the useful heated area of the building (apartment). 2) In residential buildings, the energy use for heating, ventilation, cooling and supply of hot water (EP_{HC+W}) is calculated for a whole year: $EP_{HC+W} = EP_{H+W} + (5 + 15 \cdot A_{w,e}/A_f)\ (1 – 0,2 \cdot A/V_e) \cdot A_{f,c}/A_f$; Aw,e – the sum of surface areas of all outer walls defined along outer boundaries Af,c – the useful cooled area of the building (apartment)

Denmark	The total primary energy demand "of the building for supplied energy for heating, ventilation, cooling, domestic hot water and, where appropriate, lighting." The limit is expressed as follows: (70+2200/A) kWh/m² per annum, where A is the heated floor area in m² Weighting factor for heat in the primary energy calculation is 1,0 and for electricity 2,5.

a As an alternative to the requirements on specific energy consumption for buildings, where the floor area does not exceed 100 m², the window and door area does not exceed 20 % of the floor area and there is no requirement for cooling specific requirements may be applied relating to the thermal insulation of the building, the air tightness of the building envelope and heat recovery.

b According to the requirements; in areas where connecting to district heating is mandatory buildings shall be equipped with heating systems to facilitate the use of district heating.

Table 15. Requirements for heat recovery, air tightness and cooling load

	Heat recovery in the mechanical ventilation	Air tightness by 50 Pa	Cooling demand
Finland	30%	4,0 h^{-1}	included in the energy efficiency category calculation according to RakMk D5, when the building has a cooling system
Sweden	no requirement	no requirement	The demand for cooling shall be minimized by constructional and engineering measures. Included in the specific energy use.
Norway	70% [a]	2,5 h^{-1} 3 h^{-1} [b]	Local cooling shall be avoided → automatic solar shading devices or other measures should be used to fulfil the thermal comfort requirements without use of local cooling equipment
Estonia	no requirements	no requirement	residential houses: requirement for room temperature: 27 °C should not be exceeded more than 150 degree hours
Lithuania	no requirements	prescriptive air tightness (not required): $n_{50} < 3,0\ h^{-1}$ for buildings with natural ventilation, $n_{50} < 1,5\ h^{-1}$ for buildings with mechanical ventilation	no requirement on demand Indoor temperature in summer for calculation 24°C limit parameters of microclimate in summer time 18-28 °C
Latvia	not specified	3,0 m³/m²h [c]	is not specified (only in building labelling it should consider energy consumption for cooling)

Poland	if the total air flow rate of mechanical ventilation is > 2000 m³/h the heat recovery should be used with efficiency > 50 %	prescriptive air tightness (not required): $n_{50} < 3,0\ h^{-1}$ for buildings with natural ventilation, $n_{50} < 1,5\ h^{-1}$ for buildings with mechanical ventilation	Included in the performance method. maximum solar radiation coefficient for windows and glazed or transparent partitions, $g_C < 0,5$ (total energy transmittance corrected by shading factor), but in case of windows or transparent partitions that exceed 50% of the external wall area, the requirement becomes $f_G \cdot g_C < 0,25$, where f_G is the share of transparent parts in external wall
Denmark	65% [d]	1,5 l/sm² [c]	Cooling demand to limit indoor temperature in summer is calculated and included no matter if a cooling system has been established (max. temperature 25 ºC) or not (maximum temperature 26 ºC). This motivates the designer to avoid designs that results in excessive temperatures.

a Annual mean temperature efficiency
b Moderated criteria when total net energy criteria is fulfilled
c m² heated floor area
d With heat recovery also the requirement for electricity consumption is tighter: For a unit for one dwelling one kitchen and one bathroom with heat recovery the limit for the electricity demand is 368 kWh/a, and without heat recovery as pure exhaust system the limit is 400 kWh.

4.3 Comparison of the very low energy building definitions

This part will present a summary and comparison of the existing definitions and standards for very low-energy houses currently in use in the participating countries. A more detailed description is found in Appendix 7.2.

In opposite to the building regulation requirements described in the previous chapter, one low energy definition can be used in all the countries or there are several parallel definitions/concepts in use in a single country. Validity date for these low energy standards is present, i.e. **January 1st , 2010**.

There exist national definitions for **very low energy** buildings in Finland, Sweden, Norway and Denmark. In the other countries (Estonia, Latvia, Lithuania and Poland), there exist no national low energy definitions, but especially passive house concept by PHI is applied in the Baltic countries. The international approach of passive houses by PHI is practically the only definition applied across the borders.

In Finland, Sweden and Denmark there are also a **low energy** definition, typically representing around 50% of the space heating demand/total energy consumption according to the building regulations.

These very low energy concepts generally do not have own requirements for maximum U-Table values (except Passive Energy Building by RIL, Finland – only referenced and listed in). For windows, there is a recommendation for maximum U-value of 0,8 Table 33 and 32 W/m²/K (for Passive House by PHI) and requirement of maximum U-value of 0,9 W/m²/K (for Passive house by FEBY). Air tightness (determined by the blower door test, n_{50} value) is a common criterion or in individual cases references to floor area or building envelope.

The maximum energy demand – given mostly as a space heating demand – varies from 10 to 30 kWh/m²/a (Table 16) depending on the definition. An exception is the FEBY-definition, where the main criteria is the heat load and the corresponding (recommended) total energy demand is given to be 50 – 58 kWh/m²/a. Another exception is the Danish Low energy class 1 definition, where the 35 kWh/m²/a includes the total **primary** energy use in a building, which makes this definition one of the most challenging (Table 17)! A comparison between all of these criteria has to be made with calculations. So just the boundary conditions are really different (internal heat gains, floor area) and the criteria too.

In all countries the building regulations have to be met anyway.

Table 16. Definitions for space heat demand or heat load (PEB is short to Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

	Concerned countries	Space heat demand [kWh/m²]	Heat load [W/m²]
PEB by VTT, Finland	Finland	Southern Finland 20 Middle Finland 25 Lapland 30	no requirements
PEB by RIL, Finland	Finland	Single family house: 10-20 ordinary winter use, 25 by use of design situation peak load Apartment building: 10-15 ordinary winter use, 20 by use of design situation peak load	no requirements
PH by FEBY, Sweden	Sweden	no requirements. The energy use demand includes the energy for heating, comfort cooling, domestic hot water, fans and pumps.	Southern Sweden 10 Central Sweden 11 Northern Sweden 12 For dwellings less than 200 m²: Southern Sweden 12 Central Sweden 13 Northern Sweden 14.
PH by Norwegian Standard	Norway	15 and increment for smaller houses (< 250 m²) and for colder locations than Oslo (annual mean temperature: 6,3 °C)	no requirements
LEB Class 1 in Denmark	Denmark	no requirements	no requirements
PH by PHI	All	15 (space heat demand and heat load are alternative criteria)	10 (space heat demand and heat load are alternative criteria)

Table 17. Definitions for total or primary energy demand including weighting factors (PEB is short to Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

	Total (or primary) energy demand [kWh/m²]
PEB by VTT, Finland	South Finland 130 Middle Finland 35 Lapland 140
PEB by RIL, Finland	Single family house: 140 Apartment building: 135
PH by FEBY, Sweden	Just a recommendation: The weight of electricity is currently two: Southern Sweden 60 Central Sweden 64 Northern Sweden 68 Without a weighting factor: Southern Sweden 50 Central Sweden 54 Northern Sweden 58 With direct electrical heating as the main source of heating: Southern Sweden 30 Central Sweden 32 Northern Sweden 34
PH by Norwegian Standard	half of the DHW demand shall be covered by local renewable energy supply
LEB Class 1 in Denmark	50% of the building code (BR08). → $Q \leq (35 + 1100\ m^2 / A)$
PH by PHI	120 for heating, domestic hot water, ventilation and electricity (light, household, etc.) with primary energy factors

Table 18. Definitions for heat recovery, air tightness and cooling load (PEB is short to Passive Energy Building; LEB to Low Energy Building and PH to Passive House)

	Heat recovery in the mechanical ventilation	Air tightness by 50 Pa	Cooling demand
PEB by VTT, Finland	no requirement	0,6 h^{-1}	no requirement
PEB by RIL, Finland	75%	0,6 h^{-1}	included in the primary energy demand too
PH by FEBY, Sweden	70% recommended	0,3 l/sm² [a]	The indoor temperature during the period April – September should not exceed 26 °C more than 10 % of the time in the most exposed room.
PH by Norwegian Standard	80 %	0,6 h^{-1}	Cooling is not allowed in residential buildings
LEB Class 1 in Denmark	65% [b]	1,5 l/sm² [c]	Cooling demand to limit indoor temperature in summer is calculated and included no matter if a cooling system has been established (max. temperature 25 ºC) or not (maximum temperature 26 ºC). This motivates the designer to avoid designs that results in excessive temperatures.
PH by PHI	75 % recommended	0,6 h^{-1}	There is a mandatory maximum of 15 kWh/m² of cooling demand, if active cooling is applied (rarely). Any cooling demand is included in the primary energy demand, which may not exceed 120 kWh/m². It is recommended that the temperature should not exceed 25 ºC for more than 10% of the time.

a m² building envelope

b With heat recovery also the requirement for electricity consumption is tighter: For a unit for one dwelling one kitchen and one bathroom with heat recovery the limit for the electricity demand is 368 kWh/a, and without heat recovery as pure exhaust system the limit is 400 kWh.

c m² floor area

Table 19. Information about calculation values

	Indoor temp.	Internal heat gains appliances and persons	Reference area for calculation (Table 7)
PEB by VTT, Finland	21 °C	not specified	gross floor area
PEB by RIL, Finland	21 °C	not specified	gross floor area
PH by FEBY, Sweden	22 °C	4 W/m²	overall internal dimensions
PH by Norwegian Standard	20 °C	4 W/m²	overall internal dimensions
LEB Class 1 in Denmark	20 °C	5 W/m²	gross floor area
PH by PHI	20 °C	2,1 W/m²	net floor area

On the European level, there was in 2007-2008 compiled a somewhat similar comparison of the national building regulations and the low energy standards "European national strategies to move towards very low energy buildings", SBi 2008:07, an EuroACE project.[2]

4.4 Comparison of the calculation and performance criteria

The definitions and standards used in the participating countries are compared with each others also with the focus on the way they are determined and calculated. The short analysis of the differences is given here.

Calculation methods

- There exists different national and international calculation methods and tools but all are based on European standard EN 13790
- Generally monthly average values are used
- Reference areas are very different: heated internal, overall internal or external dimensions.
  - Example: Typically the reference area in passive houses by PHI amounts to 75-85% of the gross heated floor area as used in the Danish building regulations
- Internal heat gains vary: from 2,1 (passive house by PHI) to 4,0 (FEBY) and 5,0 W/m² (Danish low energy Class 1 – and Danish building regulations in general). A part of the explanation is probably tradition, yet another part is that there is a strong focus on reducing electricity consumption, thus limiting internal heat gains in passive houses by PHI.
  - Example: The combination of differences in internal heat gain and reference area means that Danish low energy building class 1 can take into account roughly three times as much internal heat gain as passive houses by PHI
- Weighting- or primary energy factors for different forms of energy are different, and are defined differently.
  - Example: The Danish building regulations use the factors 1,0 and 2,5 as simple weighting factors. Passive house by PHI assumes 1,1 for e.g. gas, i.e. a "real" primary energy factor, making a difference of 10% when comparing limits for primary or weighted energy demand
- There exist some assumptions for indoor temperature for determination of the energy demand (22 °C for PEB by FEBY, 21° C in Finland otherwise generally 20 °C)

Performance monitoring

- There are very few requirements for monitoring
- Normally only electricity and heat consumption are monitored (mainly for charging the energy costs for each dwelling)
- Still more common: pressurization test for air tightness

5 CONCLUSIONS

5.1 Contribution to overall picture

There exist very low energy criteria locally in Denmark, Norway, Sweden and Finland. Only Norway and Denmark have official criteria for very low energy buildings. The criteria for passive houses by PHI are being used in most of the countries, and are practically the only definition that is used across borders.

The existing national building regulations and the existing low energy building definitions were compared as far as possible without calculating energy demand for sample buildings. Special focus was employed to get detailed information about the different criteria and especially any specific assumptions for the determination of the energy performance.

The overall comparison shows that, while the minimum criteria according to existing building regulations in the Northern European countries are of different types and levels, the existing very low energy definitions and criteria are less different, aiming at a low energy demand.

Still utmost attention must be shown by such comparisons, as the sheer requirements do not tell much without the reader knowing the boundary conditions. The comparison shows that there are decisive differences between boundary conditions in terms of reference area, internal heat gain and weighting of electricity and different heat sources.

The very different requirements in the general building regulations as well as in various criteria for very low energy buildings do not leave the impression of a movement towards a more uniform way of defining these requirements. The traditions to define national regulations are very strong. Even criteria that have been published recently seem to ignore the possibility of using consistent ways of defining these, or even using criteria already existing.

This practice (or lack of practice) constitutes an unnecessary technical barrier to trade and can be seen as a challenge for a market driven penetration of very low energy houses across the borders in the Northern European countries.

5.2 Relation to the state-of-the-art and progress beyond it

The presented overall comparison of the existing criteria and definitions for very low energy buildings in the Northern European countries goes down to details and is therefore a unique comparison. It is also very up to date, as some of the definitions are rather newly introduced, some of them are from 2010. In the European context, a similar work, though less detailed, was done a couple years ago to gather information on the existing low energy building definitions [2]. The aim of that study was also to determine the saving potential by implementing these definitions.

5.3 Impacts to other WPs

The comparison in this report gives valuable and essential input to later work in this work package WP2 when defining the concept houses.

The information about existing national building regulations together with the existing definitions for very low energy buildings and the concepts to be defined in this WP2 form input to WP3 (Impact and saving potential).

WP 4 is working on overcoming barriers. The identified differences may form potential conflicts that act as barriers. On the other hand, the comparison presented in this report may help to reduce the barriers in implementing very low energy houses in the Northern Europe.

6 REFERENCES

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[3] Boverket 2009. Building Regulations – Mandatory provisions and general recommendations – Section 9 Energy management.

[4] Measuring code, Final version, Applicable to Commission buildings in Brussels, 11th May 2009

[5] SBi-anvisning 213, 2. udgave, Danish Building Research Institute, Aalborg University, 2005

7 APPENDICES

7.1 Minimum energy requirements of national building codes

In this section, all the relevant energy requirements in the current national building codes are described shortly for each country. For every country there is written a short and for this purpose edited version of the current building regulations with focus on the energy efficiency and the criteria relevant to this.

In order to get the most updated version of the national descriptions, the current building regulations are defined as they were by **January 1st, 2010**.

Summary of the collected definitions is given in the Chapter 4.

7.1.1 Finland

The Ministry of Environment published the official Finnish buildings regulations.

From 1.1.2007 to 31.12.2009 the buildings' needs for heating energy, heating load (dimensioning heating effect) and electricity consumption are calculated according part D5-2007. The method also includes a very simple method for evaluating the cooling energy and the high indoor temperatures in summertime. D5 is also related to C3-2007 Thermal insulation and D3- Energy management in buildings Regulations and guidelines.

The calculation method was published in the year 2007 and it is based on the standard EN ISO 13790 in the calculation of heating energy need. The method is an energy balance method and the energy use is calculated monthly. The need for cooling energy is roughly estimated monthly and does not take into account the cooling energy in different spaces.

Also the energy consumption of technical systems is handled in a quite common level. For example the heat losses and the electricity consumption of the technical heating system in buildings are calculated using the exterior floor area of the building and tabulated values based on overall features of the buildings technical system. Energy consumption of the buildings includes annual energy needed for heating, electricity of buildings technical systems and cooling energy. Other than small residential building the technical systems electricity includes facilities electricity too. Parts D5 includes all together only 72 pages, so it doesn't provide really detailed calculation methods for different cases. The overall structure is presented in Figure 1.

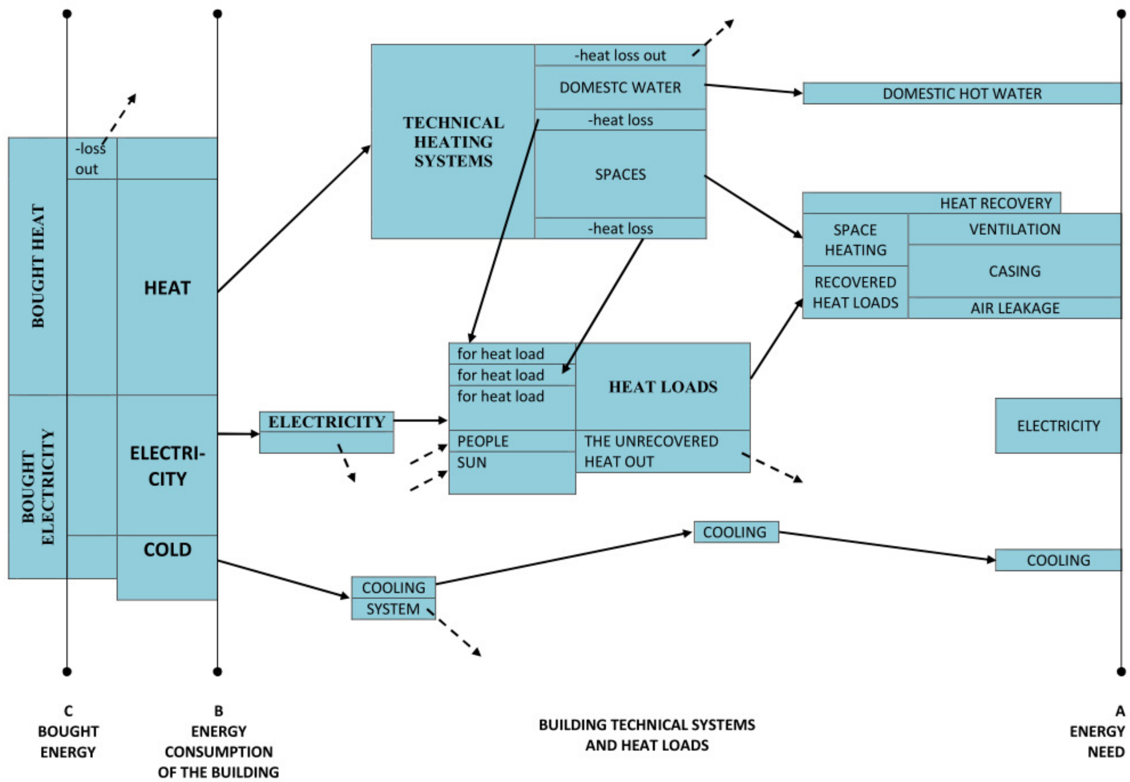

Figure 1. The building's energy balance and the principle of the Finnish calculation method.

The arrows in the picture represent the energy flows. The normal arrows represent the energy flows inside the building's balance and the arrows with dash lines represent the energy flows from outside to inside the building balance or vice versa.

The structure and order of the building energy consumption calculation in Finland can also be presented as follows:

1. heat losses (building's envelope, air leakage, ventilation)
2. domestic hot water
3. heat losses due to the building's heating system
4. design heating load
5. electricity consumption of technical systems
6. very simple estimation on risks for high indoor temperatures in summer
7. heating energy consumption
8. building total energy consumption
9. delivered (bought) energy

The Finnish method includes both the calculation of heating energy as well as the heating load, which is important for an energy efficient design of the technical systems in buildings. On the other hand it includes only a very simple and rough calculation of the cooling energy need. It also covers the calculations of the technical building systems (heat losses as well as electricity consumption) on a very common level, and there is no calculation of primary energy consumption or CO_2-emissions.

The energy certificate for buildings has to be given, with some exceptions, to most buildings when they are built, rented or sold. For existing buildings the energy certificate is based on measured energy consumption so that the measured yearly consumption of heating energy (for space heating and domestic hot water) and auxiliary electricity is divided by the overall floor-area of the building and given as kWh/m². For new buildings, the energy efficiency is also given as kWh/m² but it is calculated using the method in D5. The energy certificate for buildings represents the "energy efficiency category" of the building using letters from A to G, and besides the consumption kWh/m², the chosen category depends on the building type

Maximum space heating demand [kWh/m²/year]:

	more efficient
Class A:	-100
Class B:	101-120
Class C:	121-140
Class D:	141-180
Class E:	181-230
Class F:	231-280
Class G:	282-
	less efficient

According to the Ministry of Environment, C3-2007 Thermal insulation in a building the reference U-values that apply from the beginning of the year 2007 are as follows (U values given for heated/"semi-heated" spaces)

Table 20. Reference U-values (U values given for heated/"semi-heated" spaces)

wall	0,24 W/m²K / 0,38 W/m²K
roof and base floor that is between the inside of the building and the outside	0,15 W/m²K / 0,28 W/m²K
floor that is between the inside of the building and the subfloor space	0,19 W/m²K / 0,28 W/m²K
building element that is between the inside of the building and the ground	0,24 W/m²K / 0,34 W/m²K
window, door	1,4 W/m²K / 1,8 W/m²K
skylight window	1,5 W/m²K / 1,8 W/m²K

According to the Ministry of Environment, D3-2007 Energy management in buildings Regulations and guidelines, when designing a low energy building, the calculated heat loss should only be 60 % of the reference values.

The reference value for the air tightness (n_{50}) is set to be 4,0 1/h and the reference value for the yearly efficiency of the heat recovery in the mechanical ventilation system is set to be 30 %

7.1.2 Sweden

Buildings shall be designed in such a way that energy use is limited by low heat losses, low cooling demands, efficient use of heat and cooling and efficient use of electricity [3]. Reference (general recommendations) is made to the building regulations on ventilation, thermal comfort and moisture control.

Dwellings shall be designed so that the specific energy use of the building does not exceed 110 kWh per m² of (heated) floor area and year in the Southern climate zone, 130 kWh per m² of floor area and year in the Central climate zone, and 150 kWh per m² of floor area and year in the Northern climate zone. For dwellings with electrical heating as the main source of heating (such as heat pumps, direct electric heating, electric boilers with installed electric power higher than 10 W/m²), the specific energy use of the building must be 55 kWh per m² of floor area and year lower than above requirements. The energy use includes the energy delivered to a building (often referred to as purchased energy) for heating, comfort cooling, domestic hot water, fans and pumps. Household electricity is not included. The specific energy consumption of the buildings may be reduced with energy from thermal solar collectors and photovoltaic cells installed in the building.

The maximum average heat transfer coefficient ($U_{average}$) must not exceed 0.50 W/m²K for parts included in the building envelope. The airtightness of the building envelope must be sufficient airtight to enable fulfilment of the energy use requirement. There is no specific requirement on air tightness of the building envelope.

As an alternative to the requirements on specific energy consumption for buildings, where

- the floor area does not exceed 100 m²
- the window and door area does not exceed 20 % of the floor area and
- there is no requirement for cooling

Specific requirements may be applied relating to the thermal insulation of the building, the air tightness of the building envelope and heat recovery.

Heating and cooling installations in buildings shall be designed in such a way that they provide adequate efficiency during normal operation.

The demand for cooling shall be minimized by constructional and engineering measures.

To ensure that the building can maintain thermal comfort and adequate energy efficiency, building installations must have a regulation system.

Building services installations, which require electrical energy, such as ventilation, lighting fixtures, electrical heaters, circulation pumps and motors shall be designed so that the power requirement is limited and energy is used efficiently. General recommendations are given.

<u>Calculation method to prove compliance with the requirements</u>

The specific energy requirements are recommended to be verified partly by calculating the predicted specific energy consumption of the building and average heat transfer coefficient at the design stage, partly by measuring specific energy consumption in the finished building.

<u>Important boundary conditions in the calculations/requirements</u>

When calculating the predicted specific energy consumption of the building, appropriate safety margins should be applied so that the requirement for the specific energy consumption of the building is fulfilled when the building is put in use. Calculations should be carried out based on the current indoor and outdoor temperature, normal consumption of domestic hot water and airing.

<u>Performance monitoring and evaluation to prove compliance with the requirements</u>

The energy consumption of the building shall continuously be monitored by a method of measurement. The method of measurement shall enable that the energy consumption of the building can be calculated for the required time period. In the general recommendations it is stated that the energy use of a building should be measured during a continuous period of 12 months, which is to be finished at the latest 24 months after the building has been occupied. Average year correction and possible correction for not normal domestic hot water consumption and airing should be documented in a special report.

7.1.3 Norway

The technical requirements in the building regulations were revised in 2007 (TEK07), introducing two ways to fulfill the energy efficiency requirements:

- Energy Measure Method
- Total Net Energy Demand

Energy Measure Method

The energy measure method set requirements for certain building elements and installations. The measures are listed in the table below. For code compliance these requirements have to be fulfilled and documented.

Table 21. Energy measures from TEK07, for commercial and residential buildings

Building components Elements Air tightness	TEK 07	
	Commercial	Residential
Glass and door area [a]	20 %	20 %
U-value exterior wall (W/m²K)	0.18	0.18
U-value roof (W/m²K)	0.13	0.13
U-value exposed floor (W/m²K)	0.15	0.15
U-value windows and doors [b] (W/m²K)	1.20	1.20
U-value glazed walls and roofs (W/m²K)	same as for windows	same as for windows
Standardized thermal bridge value (W/m²)	0.06	0.03
Air tightness [c] (ach)	1.5	2.5
Heat recovery [d] (%)	70	70
Specific fan power (SFP) (kW/(m³/s))	2.0/1.0 [e]	2.5
Local cooling	shall be avoided [f]	shall be avoided [f]
Temperature control	night set-back to 19°C	night set-back to 19°C

a maximum percentage of the buildings heated floor area as defined in NS3031
b incl. frames
c air changes per hour at 50 Pa pressure
d annual mean temperature efficiency
e SFP day/night
f automatic solar shading devices or other measures should be used to fulfil the thermal comfort requirements without use of local cooling equipment

Deviation from one or more of the above component requirements is permitted, providing the specific heat loss of the building does not increase, due to compensating measures.

Total Net Energy Demand

Alternatively, if the total net energy demand for the building, calculated according to the methodology established in the new Norwegian Standard NS3031 (2007), is within the energy frame for the building's category, the regulations are also satisfied.

For calculation of floor area the definitions given NS 3940 shall apply.

Table 22. Frame for aggregated total net energy demand for the basic residential building types

Building type	kWh/m² (heated floor area) /yr
One family house	125 + 1600/m² (heated floor area)
Apartment building	120

Fixed values of user-dependent data and normalised climatic data set (Oslo) shall be used for energy calculations.

However, there are still minimum requirements concerning the U-values and air tightness of the building envelope which help to maintain a good insulation standard. These are listed in the table below.

Table 23. Minimum requirements for all buildings except timber log houses and leisure dwellings

Minimum requirements	All buildings except timber log houses and leisure dwellings
U-value exterior wall (W/m²K) [a]	0.22
U-value roof (W/m²K)	0.18
U-value floor facing free air (W/m²K)	0.18
U-value windows and doors [b] (W/m²K)	1.60
Air tightness [c] (ach)	3.0

a maximum percentage of the buildings heated floor area as defined in NS3031
b incl. frames c air changes per hour at 50Pa pressure

Special requirements

Timber log houses and leisure dwellings

Only the minimum requirements, shown in the table below, shall apply for:

- Dwellings erected with traditional construction methods, like timber log houses
- Leisure dwellings below 150 m² and leisure dwellings using timber logging technique

Table 24. Minimum requirements for timber log houses and leisure dwellings

Minimum requirements	Buildings with timber log outer walls	Leisure dwellings under 150 m² with timber log outer walls
U-value exterior wall (W/m²K)	0.60	0,72
U-value roof (W/m²K)	0.13	0,18
U-value exposed floor (W/m²K)	0.15	0,18
U-value windows and doors (W/m²K)	1.4	1,6

For leisure dwellings below 50 m² energy efficiency requirements shall not apply.

Energy supply

According to the requirements; a significant part, minimum 40 %, of the energy need for space heating and domestic hot water heating is to be supplied by alternative energy carriers to that of electricity and/or fossil fuels. This requirement does not apply to building with a particularly low need for heating or if it results in additional cost throughout the life span of the building. In such cases dwelling units must be equipped with a chimney and an enclosed fireplace suitable for the burning of bio fuels.

The requirement for alternative energy supply does not apply for leisure dwellings under 150 m².

District heating

According to the requirements; in areas where connecting to district heating is mandatory buildings shall be equipped with heating systems to facilitate the use of district heating.

Norwegian Standard NS3031, calculation method

The calculation method has been revised in Norway in 2007 (NS3031 2007). The standard provides national rules for calculation of buildings' energy performance. NS3031 is limited to a detailed description of the monthly calculation method, but also provides guidelines for basic hourly calculations in accordance with EN 13790 and other validated methods of calculation. So it is useful for the application of a computer tool, or spreadsheet for monthly calculations. In addition, NS3031 gives rules for reporting and rules / methods for the calculation of net energy, the need for delivered energy and primary energy, CO_2 emissions, energy costs and heat losses. Factors for primary energy, CO_2 and costs are not provided. [1]

7.1.4 Estonia

The energy use of new buldings (and significally renovated buildings) is limited by the Figure of Energy efficiency (in estonian „Energiaatõhususarv").

By definition the Figure of Energy efficiency is the calculated sum of weighed specific energy use of a building for heating, cooling, hot water production, ventilation, lighting and equipment usage at standard usage (units are kWh/year·m²).

The living houses are calculated to the room temperature 21 °C.

U-values of building elements are not regulated.

The national sofware tool designed especially for minimum requirement calculation is currently under preparation. Any validated sofware tool could be used for energy calculations (meeting the European, ISO, ASHRAE, CIBSE, IEA BESTTEST methods/standards).

The weighing factor for different energy sources are given as follows:

1) Fuels based on renewable sources (timber, other timber based fuels and other biofuels, peat not included): 0,75
2) district heating: 0,9
3) liquid fuels: 1,0
4) natural gas: 1,0
5) solid fossil fuels (coal etc.): 1,0
6) peat: 1,0
7) electricity: 1,5

The Figure of Energy Efficiency for different building types are given as follows:

New buildings:

1) Detached houses (including single family houses, semi-detached and row houses): 180 kWh/year·m².
2) Storey houses: 150 kWh/year·m².
3) Office and administrative buildings: 220 kWh/year·m².
4) Commercial buildings, hotels, other buildings for accommodation, catering and services: 300 kWh/year·m².
5) Public buildings and buildings for entertainment sector: 300 kWh/year·m².
6) Educational and scientific buildings (libraries, clinics and dormitories NOT included): 300 kWh/year·m².
7) Buildings for healthcare sector: 400 kWh/year·m².
8) indoor swimming pools: 800 kWh/year·m².

Significant renovation:

1) Detached houses (including single family houses, semi-detached and row houses): 250 kWh/year*m².
2) Storey houses: 200 kWh/year·m².
3) Office and administrative buildings: 290 kWh/year·m².
4) Commercial buildings, hotels, other buildings for accommodation, catering and services: 390 kWh/year·m².
5) Public buildings and buildings for entertainment sector: 390 kWh/year·m².
6) Educational and scientific buildings (libraries, clinics and dormitories NOT included): 390 kWh/year·m².
7) Buildings for healthcare sector: 520 kWh/year·m².
8) indoor swimming pools: 1000 kWh/year·m².

Currently, there is no official definition of low or very low-energy building. Both definitions are planned to be given during 2010.

7.1.5 Lithuania

The main provisions regarding the energy performance of buildings and the certification are described in 'The Law Amending the Law on Construction' and 'The Law on Energy'. The energy performance requirements are described in the 'Building Technical Regulation STR 2.01.09:2005' and came into force on 4 January 2006. The energy performance class may not be:

- Lower than C for new buildings;
- Lower than D for existing buildings with a floor area exceeding 1000 m² after renovation.

The calculation procedure is described in the 'Building Technical Regulation STR 2.01.09:2005' regarding the 'Energy Performance of Buildings; Certification of Buildings', adopted on 20 December 2005 by Order no. D-1-624. The calculation procedure is based on standards EN 15217:2005 and EN 15203:2005 and has to incorporate a special calculation programme NRG-sert.

The energy consumption for building space heating is determined according to the default coeficient value of each building component:

- Normative values are taken from the requirements laid down in the 'National Building Technical Regulation STR 2.05.01:2005' on the 'Thermal Technique of Building Envelopes' (in Lithuanian). The standard regulates the thermal technical designing of building enclosures (thermal insulation) in the buildings where the temperature inside during the heating season is kept higher than outside. The requirements for air infiltration rate in buildings are given in regard to ventilation type. Calculation methods for determination of building element design heat transmittance are included into edition. The default values of linear thermal bridges are presented in annexes of Building Code, as well as thermal properties of most popular building materials for user's sake. The calculation method of moisture behaviour is also given in the standard;
- Reference values are determined according to the requirements of the Building Codes and the construction guides from the corresponding construction period;
- Calculated values are determined according to the design data for new buildings and the standard data base with respect to the construction year, and the type of building element for existing buildings;
- Energy consumption for domestic hot water and electricity is determined according to the default values without taking into account the usage of individual tenants.

The calculation programme is the same for new and existing buildings. However, the energy consumption during summer is only assessed for domestic hot water and electricity use. Ventilation related consumption is assessed only during the heating period. The energy consumption of air conditioning systems and cooling is not included in the calculation as at present there are no normative values for this.

Other building regulations regarding energy requirements: STR 2.01.03:2003 'Declared and Design Values of Thermal Technical Variables of Construction Materials and Products'; LST EN ISO 6946:2000 'Construction Components and Elements. Thermal Resistance and Thermal Transmittance. Method for Calculation (ISO 6946:1996)'; LST EN ISO 6946:2000/A1:2003 'Construction Components and Elements. Thermal Resistance and Thermal Transmittance. Method for Calculation (ISO 6946:1996/Amd. 1:2003)'; LST EN ISO 13370:2000 'Thermal Characteristics of Buildings. Thermal Transmittance by Soil. Methods for Calculation (ISO 13370:1998)'; Lithuanian Hygiene Standard on Microclimate in Residential and Public Buildings – HN 42:2009; Technical Regulation on Heating, Ventilation and Air Conditioning – STR 2.09.02:2005.

Values of normative thermal transmittance coefficients U_N (W/(m²·K)) and linear thermal bridges thermal transmittance coefficients Ψ_N, W/(m·K) of various partitions of various purpose buildings:

Table 25. Values of normative thermal transmittance coefficients and linear thermal bridges

	Residential buildings (houses)
Roofs, External ceilings	U_N=0,16·κ
Partitions touching soil	U_N=0,25·κ
Ceilings above unheated basements and cellars	
Walls	U_N=0,20·κ
Windows	U_N=1,6·κ
Doors	U_N=1,6·κ
Linear thermal bridges	Ψ_N = 0,18·κ

Values of various indicators of various purpose buildings for calculation of energy performance of buildings:

Table 26. Values of various indicators

	Residential buildings
Indoor temperature during heating season, °C	20
Indoor temperature in summer, °C	24
Area per one person, m^2/person	60
Heat emitted by humans, W/person	70
Heat emission from indoor heat sources, W/m^2	1.2
Time of human presence in premises (monthly average), hours	12
Annual electricity consumption per one area unit of building, kWh/(m^2a)	20
Part of a building consuming electricity	0.7
Amount of outside air for ventilation of 1 m^2 of a building, m^3/(h·m^2)	0.7
Annual energy demand for hot water per 1 m^2 of a building, kWh/(m^2·year)	10

Values of limit parameters of microclimate of residential and public buildings:

Table 27 Values of limit parameters of microclimate of residential and public buildings

Parametres of microclimate	Limit values	
	In summer time	During heating season
Air temperature, °C	18–28	18–22
Difference in temperature 0,1 m and 1,1 m from the floor, no more than °C	3	3
Humidity, %	35–65	35–60
Air speed, m/s	0,15–0,25	0,05–0,15

7.1.6 Latvia

There are two main legislative documents addressing energy consummation for new and renovated building:

- Latvian building code LBN 002-01 specified normative heat losses through building envelope that must not exceed certain level (Ht, W/K) and also it's specified minimum U values that should be reached for different constriction parts. Normative heat losses through building envelope are calculated using normative U values. Also simplified method can be used for example for living houses, hospitals, kindergartens and boarding houses one storey buildings.
- Law on the Energy Performance of Buildings is for building labelling for new buildings with a total useful floor area over 1000 m² and building undergo major renovation with a total useful floor area over 1000 m² or the total reconstruction costs of which exceed 25% from the cadastral value of the relevant buildings or the reconstruction works of which affect 25% from the scale of construction. For building labeling indicator kWh/m² year is used and these kWh includes energy for heating, hot water supply, air-conditioning, ventilation and built-in lighting. And it is end use energy.

There is not official very low energy building definition (written in law) but in practise definition of this type of very law energy building is taken from the German definition of passive houses. For example association of passive house Latvia is using this definition.

When building a house, normative heat losses through building envelope must not exceed the normative values, which are described in Latvian building code LBN 002-01 "Thermotechnics of building envelope". Normative U-values shall be used to calculate normative heat losses through building envelope, when building a house real U-values of some building envelope parts can exceed normative values but the total heat losses through building envelope shall be smaller or equal to normative heat losses through building envelope.

Normative U-values and heat losses through building envelope are dependant of the type of building. There are three partitions of building types:

1. Living houses, hospitals, kindergartens and boarding houses;
2. Public buildings except hospitals, kindergartens and boarding houses;
3. Industrial buildings.

Normative U-values are given in table below.

Table 28. Normative U-values in Latvian building code for residential buildings.

Element of building envelope	Living houses, hospitals, kindergartens and boarding houses, W/(m²K)
Roofs and floors that face outdoor air	0,2
Ground floors	0,25
Walls with mass less than 100 kg/m²	0,25
Walls with mass more than 100 kg/m²	0,3
Windows, doors and glass facades	1,8
Thermal bridges	0,2 W/(mK)

For first type of buildings simplified method can be used. For one storey buildings normative heat losses can be calculated as 1,05 W/(m²K) (m² is for floor area), two storey buildings – 0,8 W/(m²K), three and four storey buildings – 0,7 W/(m²K), five and more storey buildings – 0,6 W/(m²K). This means normative heat losses through building envelope have to be in range from ~60 kWh/m² (five and more storey buildings) to ~100 kWh/m² (one storey buildings). For public buildings and industrial buildings normative heat losses are bigger.

Air tightness of buildings at 50 Pa pressure difference for living houses, hospitals, kindergartens and boarding houses should not exceed 3 m³/(m²h), for public buildings except hospitals, kindergartens and boarding houses - 4 m³/(m²h) and for industrial buildings – 6 m³/(m²h).

Energy consumption for other types of energy usage (hot water preparation, lighting, electrical appliances) is not defined.

Calculation method to prove compliance with the requirements

Calculated data has to be compared to measured energy consumption of a building in order to validate the calculations. For new buildings, which do not have measured data, only calculated data are asked.

ISO 13790:2008 usually is used to calculate the energy efficiency of buildings.

Important boundary conditions in the calculations/requirements

No important boundary conditions.

Performance monitoring and evaluation to prove compliance with the requirements

No energy consumption monitoring is compulsory. Usually heat energy consumption is monitored with step of one month. Building heat energy consumption (for hot water preparation and space heating) usually is monitored with one heat meter and afterwards separated by means of calculations.

7.1.7 Poland

Requirements for new and modernized buildings

Polish regulations make provision for two alternative ways of fulfilling energy requirements. The first method is prescriptive and consists of a list of detailed requirements for different building components. The second method has a performance character and defines permissible values of specific non-renewable primary energy use EP, expressed in kWh/(m²year). The second method offers more freedom for designers. For instance, lower quality thermal insulation can be compensated with better systems or utilization of a more environmentally friendly source of energy.

Both methods allow for lower quality energy performance of modernized buildings, in comparison to new buildings identical in form and use. In the first method, the mean heat transfer coefficient for the whole building envelope can be 15 % higher than in the new building. In the second method, modernized buildings can also have a 15% higher primary energy use (EP).

Prescriptive method

The energy requirements for all the new buildings and for modernized buildings with a useful area over 1000 m² encompass:

- maximum permissible U-value, 0,3 W/m²K for external walls, 1,7-1,9 W/m²K for windows;
- maximum solar radiation coefficient for windows and glazed or transparent partitions, gc < 0,5 (total energy transmittance corrected by shading factor), but in case of windows or transparent partitions that exceed 50% of the external wall area, the requirement becomes $f_G \cdot g_c < 0{,}25$, where f_G is the share of transparent parts in external wall;
- maximum area of windows and glazed or transparent partitions with U-value > 1,5 W/m²K cannot exceed: $A_{0max} = 0{,}15\ A_z + 0{,}03\ A_w$
  (Az – sum of areas of horizontal projection of all levels above the ground that are closer than 5 m to external walls, Aw –sum of areas of horizontal projection of all levels above the ground reduced by Az.)

For public buildings, the area of windows can be larger, if it is required by other regulations addressing day lighting. The requirement does not apply to industrial buildings or storage facilities (for these types of buildings, the regulation defines only the maximum share of transparent partitions: 15% of external walls in case of single-storey buildings and 30% in case of multi-storey buildings);

- parameters of indoor air quality: introduction of the requirement to provide the necessary rate of outdoor air, through vents mounted in external partitions or through mechanical supply ventilation;
- prescriptive air tightness (not required): n_{50} < 3,0 1/h for buildings with natural ventilation, n_{50} < 1,5 1/h for buildings with mechanical ventilation,
- if the total air flow rate of mechanical ventilation is > 2000 m³/h the heat recovery should be used with efficiency > 50 %
- minimum efficiency and requirements for the components of heating and cooling installations, as well as lighting, e.g., maximum permissible specific fan power, minimal thickness of thermal insulation;
- a reference electric specific power PN depending on time of electric light utilization.

Performance method

The regulations define an alternative way of fulfilling the requirements by allowing that the permissible values of specific non-renewable primary energy use EP, expressed in kWh/(m²year), are not exceeded. The permissible values depend on the type of the building and the building shape coefficient:

1) In residential buildings the energy use for heating, ventilation and hot water supply (EP_{H+W}) is calculated for a whole year:

a) for $A/V_e \leq 0{,}2$; $EP_{H+W} = 73 + \Delta EP$; [kWh/(m²year)],

b) for $0{,}2 \leq A/V_e \leq 1{,}05$; $EP_{H+W} = 55 + 90 \cdot (A/Ve) + \Delta EP$; [kWh/(m²year)],

c) for $A/V_e \geq 1{,}05$; $EP_{H+W} = 149{,}5 + \Delta EP$; [kWh/(m² year)]

ΔEP = ΔEPW – the addition to specific use of non-renewable primary energy for supply of hot water during the year,
$\Delta EP_W = 7800/(300 + 0{,}1 \cdot Af)$; [kWh/(m²year)],
A – the sum of surface areas of all outer partitions which separate the building's heated parts from ambient air, ground or adjacent unheated spaces defined along outer boundaries,
Ve – the cubic capacity of the building's heated section defined along outer boundaries, diminished by the volume of balconies, loggias and galleries,
Af – the useful heated area of the building (apartment).

2) In residential buildings, the energy use for heating, ventilation, cooling and supply of hot water (EP_{HC+W}) is calculated for a whole year:

$$EP_{HC+W} = EP_{H+W} + (5 + 15 \cdot A_{w,e}/A_f)\ (1 - 0{,}2 \cdot A/V_e) \cdot A_{f,c}/A_f;\ [kWh/(m^2year)]$$

Aw,e – the sum of surface areas of all outer walls defined along outer boundaries
Af,c – the useful cooled area of the building (apartment)
Af – the useful heated area of the building (apartment)
Ve – the cubic capacity of the building's heated section defined along outer boundaries, diminished by the volume of balconies, loggias and galleries

3) In residential buildings for groups (temporary residence, e.g. for students), public utility buildings and industrial buildings, the energy use for heating, ventilation, cooling, hot water supply and lighting (EP_{HC+W+L}) is calculated for a whole year:

$$EP_{HC+W+L} = EP_{H+W} + (10 + 60 \cdot A_{w,e}/A_f)\ (1 - 0{,}2 \cdot A/V_e) \cdot A_{f,c}/A_f;\ [kWh/(m^2year)]$$

Aw,e – the sum of surface areas of all outer walls defined along outer boundaries
Af,c – the useful cooled area of the building (apartment)
EPH+W – as defined in p. 1), but ΔEP = EPW + EPL
EPW – the addition to specific use of non-renewable primary energy for supply of hot water during the year, for buildings with building parts constituting separate technical – functional areas, the average value EPW is defined:

$$EP_W = 1{,}56 \cdot 19{,}10 \cdot V_{CW} \cdot b_t/a_1;\ [kWh/(m^2year)]$$

VCW – the specific daily use of hot water, [dm³/((j.o.) ·day)], according to designing assumptions,
a1 – the ratio of area Af to reference unit (j.o.), typically per person, [m²/j.o.], according to designing assumptions,
bt - the dimensionless time of operation of the hot water system during a year, according to designing assumptions.

For new buildings, the assessment of conformity with the regulations is performed in two steps:

- upon the application for a building permit, the energy performance of the design has to be presented,
- upon preparation of the energy performance certificate, the assessment of energy performance is compared to the performance calculated for the reference building.

Calculation method to prove compliance with the requirements, a short description

- The calculation are being done in accordance with European Standards e.g. ISO 6946 and "An ordinance on the methodology of energy performance calculations for whole buildings, separate apartments or building parts that constitute separate technical/functional areas, along with the scope of and a template for the energy performance certificates, signed on the 13th of November 2008 by the Minister of Infrastructure and published in the Official Journal nr. 201 position 1240" – methodology similar to ISO 13790

Important boundary conditions in the calculations/requirements?:

- there are big problems with definition of reference heated floor area, free heat gains are assumed in accordance with the ordinance, the value of internal heat gains shall be determined based on: technical documentation of the building and its installation and equipment; technical knowledge and object's local inspection,

Requirements for the performance monitoring and evaluation to prove compliance with the requirements, a short description:

- energy and domestic hot water meters should be installed but there are no requirements for the performance monitoring, the meters are used only for cons calculations.

7.1.8 Denmark

Maximum space heating demand [kWh/m²/year]

No specific limit. Instead of the total primary energy demand requirement has to be fulfilled, see below "Requirements to other energy use".

Maximal U-values for different parts of the building envelope

To limit the transmission losses from buildings there are maximum limits for the transmission heat loss from the opaque parts of the building envelope:

"Even if the energy performance framework has been complied with, the design transmission loss from single storey buildings, excluding the loss from windows and doors may not exceed 6 W/m² of the building envelope, excluding windows and doors. For two-storey buildings, the corresponding transmission loss may not exceed 7 W/m², and for buildings of three or more storeys, the corresponding design transmission loss may not exceed 8 W/m² of the building envelope." Design heat loss is calculated by -12 ºC, thus 6, 7 resp. 8 W/m² corresponds to average U-values of 0,19 to 0,25 W/m²/K.

Still no transmission coefficient respectively linear transmission coefficient should exceed:

Table 29. Requirements to the building envelope

Part of building	Limit
External walls and basement walls in contact with the ground.	0,40 W/m²K
Partition walls adjoining rooms that are unheated or heated to a temperature more than 8 K lower than the temperature in the room concerned.	0,50 W/m²K
Suspended upper floors to rooms that are unheated or heated to a temperature more than 8 K lower than the temperature in the room concerned.	0,40 W/m²K
Ground slabs, basement floors in contact with the ground and suspended upper floors above open air or a ventilated crawl space.	0,30 W/m²K
Suspended floors below floors with underfloor heating adjoining rooms that are heated.	0,70 W/m²K
Ceiling and roof constructions, including jamb walls, flat roofs and sloping walls directly adjoining the roof.	0,25 W/m²K
Windows and external doors, including roof lights, glass walls and hatches to the outside or to rooms that are unheated or heated to a temperature more than 8 K below the temperature in the room concerned.	2,00 W/m²K
Foundations around spaces that are heated to a minimum of 5°C.	0,40 W/mK
Foundations around floors with underfloor heating.	0,20 W/mK
Joint between external wall and windows or external doors and hatches.	0,06 W/mK
Joint between roof construction and windows in the roof or roof lights.	0,20 W/mK

<u>Requirements to the air tightness</u>

"Air changes through leakage in the building envelope may not exceed 1.5 l/s/m² of the heated floor area when tested at a pressure of 50 Pa. The result of the pressure test must be expressed as the average of measurements using overpressure and underpressure."

"The municipal council may require documentation of air changes." Some municipal councils do this consequently, and some consequently do not.

<u>Requirements to the ventilation system, e.g. the heat recovery efficiency</u>

"Ventilation installations must incorporate heat recovery with a temperature efficiency of no less than 65%. This requirement may, however, be waived when the surplus heat from the exhaust air cannot reasonably be used."

"For ventilation installations with a constant air volume, the power consumption for air movement may not exceed 2,100 J/m³ fresh air.

For installations with a variable air volume, the power consumption for air movement may not exceed 2,500 J/m³ fresh air at a maximum output and at maximum pressure drops."

"For ventilation installations with a constant or variable air volume and heat recovery supplying a dwelling, the specific power demand for air movement may not exceed 1,200 J/m³ for the mode of operation with the maximum pressure drop."

Pure exhaust systems may have a specific electricity consumption of 1000 J/m3, in spite of having no heat recovery:

"For extraction systems without mechanical fresh air supply, the specific power consumption for air movement may not exceed 1,000 J/m³.

This provision does not apply to installations associated with industrial processes and installations whose annual power demand for air movement is less than 400 kWh."

For a unit for a dwelling with one kitchen and one bathroom this means that with heat recovery the limit for the electricity demand is 368 kWh/a, and without heat recovery as pure exhaust system the limit is 400 kWh.

<u>Requirements to other energy use</u>

The building regulations define a limit for the total primary energy demand "of the building for supplied energy for heating, ventilation, cooling, domestic hot water and, where appropriate, lighting." The limit is expressed as follows:

(70+2200/A) kWh/m² per annum, where A is the heated floor area in m²

<u>Calculation method to prove compliance with the requirements, a short description</u>

Compliance with the requirements for energy performance should be demonstrated according to SBi-anvisning 213 [5]. The calculation is based on EN 13790. For all locations in Denmark average monthly mean data from Copenhagen are used.

Most relevant thermal bridges are accounted for specifically.

<u>Important boundary conditions in the calculations/requirements</u>

The reference floor area is the gross area of the heated part of the building:

"Floor area is calculated by adding the gross areas of all floors, including basements and useable roof spaces, enclosed balconies, conservatories, connecting passages etc."

"Rooms which rise through several storeys are included only in the storey in which the fl oor is situated. Both external and internal staircases, stairwells, access balconies and lift shafts are, however, included in each storey."

Internal heat gains are 5 W/m².

Weighting factor for heat in the primary energy calculation is 1,0 and for electricity 2,5.

In energy calculations an indoor temperature of 20 ºC is assumed.

Cooling demand to limit indoor temperature in summer is calculated and included no matter if a cooling system has been established (max. temperature 25 ºC) or not (maximum temperature 26 ºC). This motivates the designer to avoid designs that results in excessive temperatures.

<u>Requirements for the performance monitoring and evaluation to prove compliance with the requirements, a short description</u>

"Large central heating boilers must be provided with monitoring points and measuring equipment to monitor energy-efficient operation."

"Plumbing systems must be designed so that the consumption of hot and cold water can be metered."

"See the executive order on individual metering of electricity, gas, water and heat issued by the National Building and Housing Agency and the executive order issued by the National Building and Housing Agency amending the executive order on individual metering of electricity, gas, water and heat."

7.1.9 More information about the national building regulations

In this section, links to relevant information on the described regulations are gathered.

Table 30. Information about the national building regulations

Finland	Ministry of Environment, The National Building Code of Finland: http://www.ymparisto.fi/default.asp?contentid=271665&lan=FI&clan=en
Sweden	Building Regulations – Mandatory provisions and general recommendations – Section 9 Energy management. BBR 2006:12, 2007-12-06: http://www.boverket.se/Sok/?quicksearchquery=energy+requirement
Norway	Statens bygningstekniske etat (BE). Revision of the Technical Regulations 1997 concerning requirements to construction works and products for construction works. – New energy requirements. http://www.be.no/beweb/info/energi.html (downloaded 2010-01-21).
Estonia	Link to the legal text (in estonian): http://www.riigiteataja.ee/ert/act.jsp?id=12903585 Link to the appendix of legal text (in estonian): http://www.riigiteataja.ee/ert/act.jsp?id=12903585&subid=12905682
Latvia	Latvian building code LBN 002-01 "Thermotechnics of building envelope": http://www.likumi.lv/doc.php?id=56049
Lithuania	The calculation procedure: http://www.am.lt/VI/files/0.017516001256017620.doc
Poland	www.buildup.eu
Denmark	The Danish Building Regulations in English at the Danish Enterprise and Construction Authority: http://www.deaca.dk/file/17044/Bygningsreglementet_englesk.pdf

7.2 Existing definitions for very low energy buildings

This part will present the existing definitions and standards for very low-energy houses currently in use in the participating countries.

A short summary of the main parts of the very low energy building definitions in use in the respective countries is given. In opposite to the building regulation requirements described in the previous chapter, one low energy definition can be used in all the countries or there are several parallel definitions/concepts in use in a single country.

Validity date for these low energy standards is present, i.e. **January 1st , 2010**.

Summary of the collected definitions is given in the chapter 4.

7.2.1 Low Energy Building of Finland

According to the Ministry of Environment, C3-2010 Thermal insulation in a building the reference U-values that apply from the beginning of the year 2010 are as follows (U values given for heated/"semi-heated" spaces):

Table 31. Future references U-values

wall	0,17 W/m²K / 0,26 W/m²K
a log wall (minimum medium thickness of the log structure 180 mm)	0,40 W/m²K / 0,6 W/m²K
roof and base floor that is between the inside of the building and the outside	0,09 W/m²K / 0,14 W/m²K
floor that is between the inside of the building and the subfloor space	0,17 W/m²K / 0,26 W/m²K
building element that is between the inside of the building and the ground	0,16 W/m²K / 0,24 W/m²K
window, skylight window, door	1,0 W/m²K / 1,4 W/m²K

According to the Ministry of Environment, D3-2010 Energy management in buildings Regulations and guidelines, when designing a low energy building, the calculated heat loss should only be 85 % of the reference values.

The reference value for the air tightness (n_{50}) is set to be 2,0 1/h and the reference value for the yearly efficiency of the heat recovery in the mechanical ventilation system is set to be 45 %.

7.2.2 Passive Energy Building by VTT, Finland

- n_{50}<0,6 1/h
- three categories for heating and cooling energy demand
    - South Finland 20 kWh/(m²a)
    - Middle Finland 25 kWh/(m²a)
    - Lapland 30 kWh/(m²a)
- three categories for primary energy demand
    - South Finland <130 kWh/(m²a)
    - Middle Finland <135 kWh/(m²a)
    - Lapland <140 kWh/(m²a)

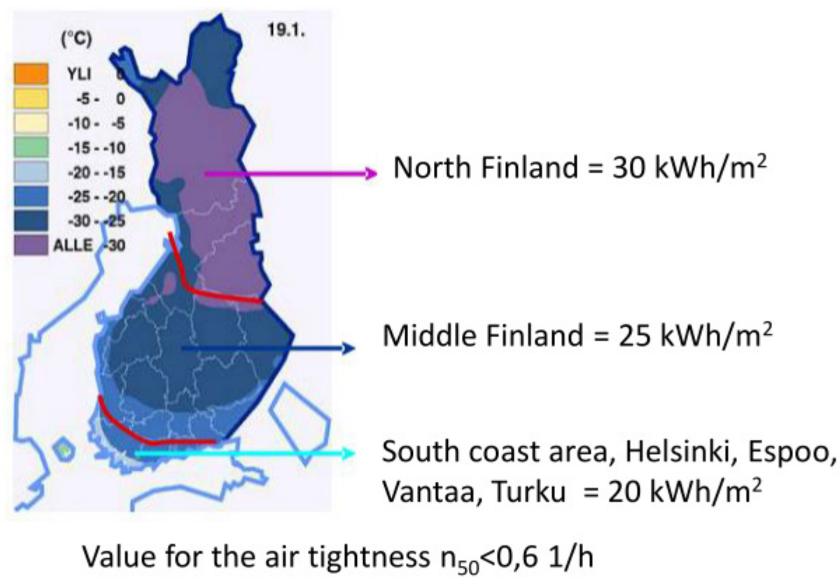

Figure 2. The three categories for heating and cooling energy demand.

Primary energy weighing factors are as follows:

Oil and gas:	1,1
District heating:	0,4
Wood based	0,2

7.2.3 Passive Energy Building by RIL, Finland

According to RIL 249-2009, Low Energy Construction the reference U-values are as follows for apartment building:

Table 32. Apartment building reference values for Norm RakMk (C3, 2010), Low Energy Building (M-50) and Passive House (P-25)

Technical factor	Norm RakMk C3, 2010	Low Energy Building M-50	Passive House P-25
U-values, W/m²K			
- building element between the inside of the building and the ground	0,16	0,12	0,10
- floor that is between the inside of the building and the subfloor space	0,17	0,10	0,10
- inside of the building and the outside	0,09	0,09	0,09
- wall	0,17	0,14	0,12
- roof	0,09	0,08	0,08
- window	1,0	0,9	0,8
- door	1,0	0,6	0,5
Envelope air tightness (n_{50}), h^{-1}	<2,0	<0,8	<0,6
Yearly efficiency of the heat recovery in the mechanical ventilation system %	>45	>65	>75
Air ventilation specific electricity consumption, kW/m³/s	<2,5	<2,0	<1,5
Primary energy demand, kWh/m²a	-	<180	<135
Space heat demand, kWh/m²a			
ordinary winter use	30	15-20	10-15
design situation peak load	50	30	20

According to RIL 249-2009, Low Energy Construction the reference U-values are as follows for single family house:

Table 33. Single family house reference values for Norm RakMk (C3, 2010), Low Energy Building (M-50) and Passive House (P-25)

Technical factor	Norm RakMk C3, 2010	Low Energy Building M-50	Passive House P-25
U-values, W/m²K			
- building element between the inside of the building and the ground	0,16	0,12	0,10
- floor that is between the inside of the building and the subfloor space	0,17	0,10	0,08
- inside of the building and the outside	0,09	0,08	0,08
- wall	0,17	0,14	0,08-0,10
- roof	0,09	0,08	0,07
- window	1,0	0,9	0,7/0,8[a]
- door	1,0	0,6	0,5
Envelope air tightness (n_{50}), h^{-1}	<2,0	<0,8	<0,6
Yearly efficiency of the heat recovery in the mechanical ventilation system %	>45	>65	>75
Air ventilation specific electricity consumption, kW/m³/s	<2,5	<2,0	<1,5
Primary energy demand, kWh/m²a	-	<180	<140
Space heat demand, kWh/m²a			
ordinary winter use	35	20-30	10-20
design situation peak load	50	40	25

a Fixed window, openable window

7.2.4 Passive House by FEBY, Sweden

The aim of the performance specifications, issued by the Swedish "Forum for energy efficient buildings", FEBY, on passive houses is to minimize the demand of supplied power and energy for heating so that the necessary thermal comfort can be obtained using the supply of heat using the hygienic air flow (Specification of requirements for passive houses. Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, June 2009, in Swedish). This is a possibility but not a prerequisite as the heat can be supplied using conventional heating systems. Supplementing requirements are made to limit the total use of purchased energy e.g. operations electricity, hot water and heat. The indoor environmental requirements are high and residential buildings may not use mechanical cooling. The current version of the performance specifications apply to dwellings and premises except premises for sport and athletics.

For passive houses the delivered power at the outdoor winter design temperature for the entire building for space heating is restricted to 10-12 W/m², depending on climate zone. The calculations may include internal heat gains from appliances and persons, max 4 W/m² (residential floor area). The power requirements are higher for dwellings less than 200 m² heated floor area, 12-14 W/m².

The weighted purchased (see chapter 7.1.2) energy is limited to 60 – 68 kWh per m² of floor area and year depending on climate zone. The weighting factors take into account the quality of the energy. The weight of electricity is currently two. The advice concerning yearly purchased (not weighted) energy results in approximately a 60 % reduction compared with the Swedish building code, BBR (Boverket, 2009. BBR 2008, boverkets byggregler, avsnitt 9, supplement 2009, in Swedish). In order to turn a passive house into a zero energy house an additional requirement can be used, which says that the sum of used energy must be lower or equal to the sum of produced energy during a year.

Other requirements: Air leakage through the building envelope must not exceed 0.3 l/(s m² of building envelope) at ± 50 Pa, according to SS-EN 13829. The building must have windows with a verified U-value of maximum 0.9 W/m²K. The average U-value of all windows and glazed areas must not exceed 0.9 W/m²K.

Advice: The ventilation system should be equipped with heat recovery, which at design outdoor temperature reduces the ventilation heat losses with minimum 70 % compared with a exhaust ventilation system without heat recovery. The ventilation system should have a SFP-value of maximum 1.5 kW/(m³/s). Class A white goods and low energy lamps should be used. Furthermore also other use of electricity for household and activity should be limited, partly to limit the total energy use, but also to avoid high temperatures and reduce the need for mechanical cooling.

When marketing a verified passive house according to the forum for energy efficient buildings (FEBY) can be used if the building fulfils the requirements in operation, according to directions for verification (Measurement and verification. Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, July 2009).

Calculation method to prove compliance with the requirements

The power demand is calculated as the sum of the heat losses from the building due to transmission and ventilation at the design outdoor temperature, after deduction of given default value for internal gains (waste heat).

The energy demand is calculated as the sum of purchased energy for heating, hot water and operations electricity. The calculation must be carried out with a dynamic building simulation tool, which handles in- and output of energy from the building structure, with a simulation tool which is using a ”utility factor” that limits the use of available energy (ISO EN 13790) or for dwellings with the web based program Energihuskalkyl. The energy calculations must take into account solar energy as well as waste heat from activity (persons) and appliances.

Important boundary conditions in the calculations/requirements

In the calculations of the power demand a deduction of given default value for internal waste heat is made. The floor area is equal to the heated floor area.

The requirement on indoor climate is not specified in detail but is expressed as necessary thermal comfort to be fulfilled. However, one requirement is that the supply air temperature must not exceed 52 °C. The ventilation is assumed to fulfil the requirements according to the building code i.e. 0.35 l/sm². The indoor temperature during the period April – September should not exceed 26 °C more than 10 % of the time in the most exposed room.

The indoor climate advice according to the Swedish building code (Boverket 2009) does of course apply.

<u>Performance monitoring and evaluation to prove compliance with the requirements</u>

Requirement: in the finished building the energy use for household electricity, operations electricity must be readable monthly and separately. The average indoor temperature and outdoor temperature during the measuring period is recorded if the power requirement is to be verified and a time resolution of one week is recommended. In addition the water volume for hot water heating is measured and the number of occupants is noted. In the general advice of the current Swedish Building Code it is stated that the energy use of a building should be measured during a continuous period of 12 months, which is to be finished at the latest 24 months after the building has been occupied.

Advice: If the yearly purchased energy is monitored, then result should be normalized for climate, internal gains from persons, appliances, household electricity and hot water. This result should not exceed the recommended yearly purchased energy with more than 20 %, taking into account the uncertainty in the measurements and method of normalization (Monitoring and verification – Basis for criteria document for passive houses and mini energy houses, Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, July 2009, in Swedish).

7.2.5 Mini energy house by FEBY, Sweden

The aim of the performance specifications, issued by the Swedish "Forum for energy efficient buildings", FEBY, on mini energy houses is to minimize the demand of supplied power and energy for heating so that the necessary thermal comfort can be obtained in a rational manner (Specification of requirements for mini energy houses. Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, June 2009, in Swedish). Forced air heating is a possibility but not a requirement. Heat can also be supplied using conventional heating systems. The power requirements are however, in contrast to passive houses, made so that the heating demand cannot be made without return air or supplemented with a conventional heating system. The indoor environmental requirements are high and residential buildings may not use mechanical cooling.

For mini energy houses the delivered power at the outdoor winter design temperature for the entire building for space heating is restricted to 16-20 W/m², depending on climate zone. The calculations may include internal heat gains from appliances and persons, max 4 W/m² (residential floor area). The power requirements are higher for dwellings less than 200 m² heated floor area, 20-24 W/m².

The weighted purchased (see chapter 7.1.2) energy is limited. The weighting factors take into account the quality of the energy. The weight of electricity is currently two. The advice concerning yearly purchased (not weighted) energy results in a reduction of 1/3 compared compared with the Swedish building code, BBR (Boverket, 2009. BBR 2008, boverkets byggregler, avsnitt 9, supplement 2009, in Swedish).

Other requirements: Air leakage through the building envelope must not exceed 0.3 l/(s m² of building envelope) at ± 50 Pa, according to SS-EN 13829. The building must have windows with a verified U-value of maximum 1.0 W/m²K. The average U-value of all windows and glazed areas must not exceed 1.0 W/m²K.

Advice: The ventilation system should be equipped with heat recovery, which at design outdoor temperature reduces the ventilation heat losses with minimum 70 % compared with a exhaust ventilation system without heat recovery. The ventilation system should have a SFP-value of maximum 2.0 kW/(m³/s). Class A white goods and low energy lamps should be used. Furthermore also other use of electricity for household and activity should be limited, partly to limit the total energy use, but also to avoid high temperatures and reduce the need for mechanical cooling.

When marketing a verified mini energy house according to the forum for energy efficient buildings (FEBY) can be used if the building fulfils the requirements in operation, according to directions for verification (Measurement and verification. Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, July 2009).

Calculation method to prove compliance with the requirements

The power demand is calculated as the sum of the heat losses from the building due to transmission and ventilation at the design outdoor temperature, after deduction of given default value for internal gains (waste heat).

The energy demand is calculated as the sum of purchased energy for heating, hot water and operations electricity. The calculation must be carried out with a dynamic building simulation tool, which handles in- and output of energy from the building structure, with a simulation tool which is using a ”utility factor” that limits the use of available energy (ISO EN 13790) or for dwellings with the web based program Energihuskalkyl. The energy calculations must take into account solar energy as well as waste heat from activity (persons) and appliances.

Important boundary conditions in the calculations/requirements

In the calculations of the power demand a deduction of given default value for internal waste heat is made. The floor area is equal to the heated floor area.

The ventilation is assumed to fulfil the requirements according to the building code i.e. 0.35 l/sm². The indoor temperature during the period April – September should not exceed 26 °C more than 10 % of the time in the most exposed room.

The indoor climate advice according to the Swedish building code (Boverket 2009) does of course apply.

Performance monitoring and evaluation to prove compliance with the requirements

Requirement: in the finished building the energy use for household electricity, operations electricity must be readable monthly and separately. The average indoor temperature and outdoor temperature during the measuring period is recorded if the power requirement is to be verified and a time resolution of one week is recommended. In addition the water volume for hot water heating is measured and the number of occupants is noted. In the general advice of the current Swedish Building Code it is stated that the energy use of a building should be measured during a continuous period of 12 months, which is to be finished at the latest 24 months after the building has been occupied.

Advice: If the yearly purchased energy is monitored, then result should be normalized for climate, internal gains from persons, appliances, household electricity and hot water. This result should not exceed the recommended yearly purchased energy with more than 20 %, taking into account the uncertainty in the measurements and method of normalization (Monitoring and verification – Basis for criteria document for passive houses and mini energy houses, Forum för energieffektiva byggnader, energimyndighetens program för passivhus och lågenergihus, July 2009, in Swedish).

7.2.6 Passive House by Norwegian Standard

According to climate conciliation of the Norwegian Parliament in January 2008 the government will consider imposing a passive house level for all new buildings by 2020. The term passive house refers to the concept of well insulated and airtight building envelope.

A Norwegian standard for passive houses is under construction. The purpose is to give the term passive house a clear Norwegian significance. The standard will probably set the maximum for heating to 15 kWh / m² year for sites where the annual mean temperature is at least 6.3° C. A somewhat higher heating demand is allowed for single-family homes below 250 m² and houses in the colder regions of the country. There is a minimum requirement of renewable energy. [1]

7.2.7 Low energy building in Poland

The definition is given by energy and air tightness demand

- Maximum space heating demand: ≤ 80 [kWh/m²/year], Maximum heat load: ≤ 30 [W/m²]
- Requirements to the air tightness: $n_{50} \leq 1{,}5$ 1/h
- Requirements to the ventilation system, e.g. the heat recovery efficiency > 70 %, energy consumption ≤ 0,45 W/m³h
- Requirements to other energy use: no
- Requirements to the primary energy use: no

More information about:

- calculations can be done in accordance with ISO 13790, precise calculation of the thermal bridges, windows U-values
- reference floor area evaluated in accordance with Polish Standard, heat gains evaluated in accordance with ISO 13790, internal temperatures evaluated in accordance with "Ordinance on the technical criteria to be met by buildings and their location"
- no requirements for performance monitoring

7.2.8 Low Energy Building Class 1 in Denmark

In the current Building Regulation two low energy classes are defined. Low Energy Class 2 and Low Energy Class 1. The two classes are defined as having a calculated energy performance that is 25 and 50 per cent respectively better than the minimum energy performance for new buildings.

There are other ongoing works related to implementation of different low energy definitions in Denmark:

- Bolig+. 'Invented' in a Danish 24h workshop in 2007. Corresponds to Danish low energy building class 1 + an amount of energy must be produced on the site which annually corresponds to the consumption for building services + household for a family of electricity conscious residents (about 2100 kWh electricity per year for a family in a small dwelling). Also demands "good architecture" and indoor climate. No built examples, but there is an on-going competition, and the list of recipients of the newsletter is impressive.

- Bolig for livet, Home for Life, Active House. An initiative by the company Velfac. The "very low" energy consumption for building services shall be compensated totally by renewables (so far photo voltaics) on site. Velfac has initiated 8 houses around Europe.

7.2.9 Passive house according to Passive House Institute (PHI)

Maximum space heating demand [kWh/m²/year], Maximum heat load [W/m²]

15 kWh/m²/y, alternatively 10 W/m².

Requirements to the air tightness

n_{50} maximum 0,6 changes per hour of the net air volume of the building.

Requirements to the ventilation system, e.g. the heat recovery efficiency

A minimum temperature efficiency of the heat recovery of 75% is recommended. This is measured by mass balance with the thermal envelope as control volume. To achieve the product certificate "Component Suitable for Passive Houses", a ventilation unit must meet this criteria and have a specific electricity demand less than 0,45 Wh/m3 (1560 J/m3) as a specified pressure drop.

Requirements to other energy use: Maximum energy consumption for hot water, lighting, household electricity, etc

Maximum cooling demand 15 kWh/m²a.

Requirements to the primary energy use

Maximum total primary energy demand for heating, cooling, domestic hot water, auxiliary and house hold electricity, lighting etc.: 120 kWh/m²a.

Calculation method to prove compliance with the requirements, a short description

To prove compliance with the requirements for energy performance, the open source, spread sheet based calculation tool PHPP (PHI) must be used. PHPP is based on EN 13790. For dozens of locations climate data sets with average monthly mean data are available. One way to compile new data sets is by a standard output function in the program Meteonorm (Meteotest).

Relevant thermal bridges are accounted for specifically.

Important boundary conditions in the calculations/requirements

The reference floor area is the internal floor area of the heated part of the building. Stair cases are not taken into account, and technical rooms and basements are only taken into account by 60%.

Internal heat gains in dwellings are 2,1 W/m².

Weighting factor for heat in the primary energy calculation is 0,7 to 1,5 and for electricity 2,7.

In energy calculations an indoor temperature of 20 ºC is assumed. The temperature should not exceed 25 ºC for more than 10% of the time.

The recommended air change is based on a maximum increase of CO_2-concentration of 600 ppm requiring an outdoor air supply of 30 m³/h/person.

<u>Requirements for the performance monitoring and evaluation to prove compliance with the requirements, a short description:</u>

There are no specific demands for monitoring. Some projects are monitored intensively to gain experiences with the extremely low energy demand. Other projects are used to proof that individual monitoring is not economically viable.

7.2.10 More information about very low energy definitions

In this section, links to relevant information on the described definitions are gathered.

Table 34. Information about very low energy definitions

Passive Energy Building by VTT, Finland	http://passivehouse.vtt.fi/energian_kulutus.html, (only finish)
Passive Energy Building by RIL, Finland	http://www.rakennusinsinoori.fi/uusin-lehti/julkaisut/tilaa-rilin-uusimmat-julkaisut.html (only finish)
Passive House by FEBY, Sweden	http://www.energieffektivabyggnader.se/
Mini energy house by FEBY, Sweden	http://www.energieffektivabyggnader.se/
Passive House by Norwegian Standard	http://www.be.no/beweb/info/energi.html (downloaded 2010-01-21).
Low Energy Building Class 1 in Denmark	http://www.deaca.dk/file/17044/Bygningsreglementet_englesk.pdf
Passive House according to Passive House Institute (PHI)	http://www.passivehouse.com http://www.passiv.de http://www.passive-on.org http://passivehouse.lv/lv/ http://www.passiivitalo.fi http://www.passivhus.dk