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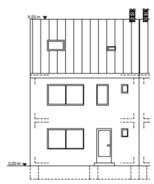
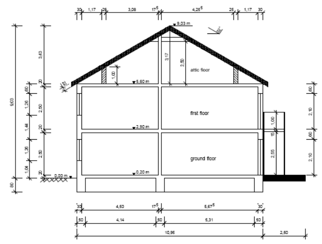
Energy performance requirements for new buildings in 11 countries from Central Europe – Exemplary Comparison of three buildings

performed on behalf of the
German Federal Office
for Building and Regional Planning
(Bundesamt für Bauwesen
und Raumordnung, Bonn)





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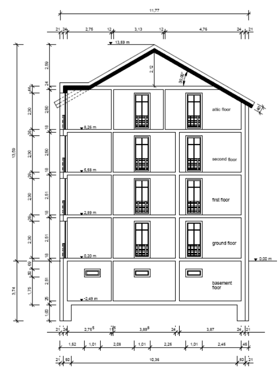

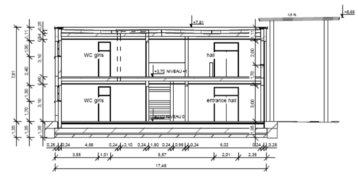

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1 Summary

The objective of the present comparison study is to show which energy efficiency requirements have to be complied in different European countries when a new building is going to be constructed. For this purpose three Model Buildings were defined: a single-family house, a multi-family house and a school building. For each involved country (or region) the energy quality of the thermal envelope was determined which is necessary in order to just comply with the building code. Due to requirements on the overall energy performance the requested envelope quality usually depends also on the type of heat supply system or energy carrier. Therefore the systems were varied in a parameter study. The main result for each of the three Model Buildings is a comparison table which shows the heat transfer coefficient by transmission (a sort of mean U-value) for the different countries differentiated by supply system types. In a final step the primary energy demand according to the German regulation (EnEV 2007) was calculated for every envelope/system combination of the different countries. This allows a comparison of buildings with different supply systems. The study was performed by experts from 11 European member states: Germany, Austria, Czech Republic, Poland, Sweden, Denmark, UK, The Netherlands, Belgium, Luxembourg and France.

2 About the project

In Germany the transposition of the Energy Performance of Buildings Directive (EPBD) was performed by an amendment of the German Energy Saving Ordinance (Energieeinsparverordnung EnEV) in the year 2007. During this process formal and methodological changes were applied whereas the requirements remained the same. In year 2007 the German government announced to undertake a new revision which mainly will introduce a higher energy performance mandatory for new and refurbished buildings. In the discussion about tightening the requirements in Germany the question often arises which energy efficiency standards are applied in other European countries with comparable climatic conditions. The present study aims at giving some more transparency in this field.

The concrete objective of the project is to compare the energy performance requirements for new buildings in Germany with those of several other European countries with similar climate conditions. Due to the very different methods and traditions it is clear that an exact comparison between the countries will not be possible. Therefore this study is based on example buildings and certain assumptions that have been chosen by IWU and which certainly reflect a specific (German) perspective. Certainly it would be possible to select other methodical approaches and maybe the results could be (slightly) different.

The question to be answered by each partner is: Which U-values have to be chosen for roof, walls, windows and floor if a given building is supposed to just comply with the requirements for new buildings in the respective country. Since generally the level of insulation indirectly depends on the building geometry and of the supply system type these parameters are varied. In the framework of the project three example buildings are analysed: a single family house (which is the subject of this report), a multi family house and a school building. Furthermore the installation of several different supply systems is assumed.

The analysis focuses on the comparison of the tangible quality of the building envelope defined by the national regulations. Neither the different certification methodologies nor the aspects of practical implementation of these standards are a topic of the study.

The analysis is performed on behalf of the German Federal Office for Building and Regional Planning (BBR) by IWU (Institut Wohnen und Umwelt / Institute for Housing and environment) with the assistance of the following partners:

Tab. 1: Project partners

N°		Country	Institution
1	de	Germany	IWU (Institute for Housing and Environment)
2	at	Austria	e7 - Energie-Markt-Analyse
3	cz	Czech Republic	Stu-k
4	pl	Poland	NAPE (National Energy Conservation Agency S.A.)
5	se	Sweden	Mälardalen Universität, Västerås/Eskilstuna
6	dk	Denmark	SBi (Danish Building Research Institute)
7	uk	UK	BRE (Building Research Establishment)
8	nl	The Netherlands	BuildDesk (former EBM-Consult)
9	be	Belgium (Flanders)	BBRI (Belgian Building Research Institute)
10	lu	Luxembourg	Goblet Lavandier & Associés S.A.
11	fr	France	ADEME - Agence de l'Environnement et de la Maîtrise de

3 Methodical approach

3.1 Proceeding

The analysis consisted of the following steps:

Step 1: Definition of the thermal envelope of the building (IWU)

The following documents were elaborated by IWU and distributed to the partners:

– a set of plans (scale 1:100, see Appendix),
– a table with the envelope element areas, determined according to the German regulations (basis: external dimensions, see chapter 4.1, 5.1 and 6.1 for the three buildings)
– an Excel sheet with the detailed envelope area calculation, which was the basis of the above mentioned table (see Appendix)

Step 2: Definition of the supply system variants (IWU)

IWU defined a set of supply systems for each Model Building (see chapter 4.2, 5.2 and 6.2). The partners received a table defining the different variants on two levels (see Appendix):

- a determination of the type of the components, which was often sufficient for the calculation;
- detailed information about the components (for example thermal power of the heat generator, electric power of pumps, length and heat loss of heating pipes), which were to be used only in case that national standard values are not available.

Step 3: Determination of the U-values (all partners)

Each partner was requested to determine the U-values which have to be chosen for this building in order to comply with the building code – under assumption of the different supply system variants.

The principles of this procedure were:

- In those countries in which the thermal envelope is not defined by the external dimensions the envelope area table delivered by IWU could not be used. The concerned partners were supposed to determine the envelope areas on their own by use of the building plans.
- For simplification purpose it was assumed that the thicknesses of the building envelope elements do not depend on the U-value (the U-value variation can therefore be seen as a variation of the thermal conductivity).
- The U-value for each construction element was supposed to be the "pure" thermal transmittance not including supplements or reductions caused by transmission losses at the border of the elements. (In case of the opaque elements the study may be see as a comparison of insulation thicknesses.)
- If there are different methods in a country the most common should be used (typically the most simple method).
- If for a country the requirements are different for certain regions a region had to be selected where the climate conditions are as close as possible to the German ones.
- If deviations from the building or system definitions were necessary these had to be documented.

The results of this analysis was documented by each partner in a uniform sheet (see Appendix: "Country Sheets")

Step 4: Calculation of a simplified heat transfer coefficient by transmission and cross-country comparison (IWU)

For purpose of comparison a weighted average of the U-values of the different construction elements were calculated by IWU. For this weighting the external area was used. The result is a sort of simplified heat transfer coefficient by transmission.[1] The calculation of these values can be found in the country sheets (Appendix), the results of the cross-country comparison are shown in chapter 4.3, 5.3 and 6.3.

Step 5: Calculation of the primary energy demand according to the German official method and cross-country comparison (IWU)

In order to compare the total energy performance of the building variants from the different countries the primary energy demand was calculated according to the rules of the German regulations (Energy Saving Ordinance / Energieeinsparverordnung EnEV 2007). The resulting values are shown in the chapters 4.4, 0 and 6.4.

3.2 Limits of evidence

The chosen method is capable to depict the level of national energy efficiency requirements in a concrete and exemplary way. Of course, the exactness and evidence of this comparison is limited since the results depend on factors which were not considered in this study:

- Number of Model Buildings: The example buildings considered in this study represent only a small fraction of possible building geometries. The dependence of the requirements from the surface to volume relation and from the building size is different for each country. In consequence the relation of the requirements between the different countries could possibly change if different buildings were considered.
- Definition of the thermal envelope: The definition of the thermal envelope in a unique way is not always possible, since the rules sometimes allow different solutions (cellar rooms, stair wells, garages, winter gardens, …). In order to avoid such uncertainties rather simple building geometries were selected for this investigation (which may have effects on the requirement level, see above). A special problem is the energy balance calculation for an apartment building. In some countries the thermal envelope is considered to be the surface of the whole building, in others only the thermal envelope of the apartments are considered, in some countries there is

[1] In case of a well designed building with minimized constructive thermal bridges this simplified heat transfer coefficient by transmission is very close to the real value including thermal bridging (to the experience of the authors). A precondition is that the envelope area determination is based on external dimensions.

a mix of both approaches. In order to compare the U-values one of these approach has to be chosen. (In the present study the surface of the whole building was used.)

- Variety of methods in some countries: In some countries different proofs of conformity are permitted. Applying different methods will typically produce different results for the same building. (The rule for the present study was to use the most common method, which is typically one with a lesser effort.)
- Frequentness of supply system types in each country: The comparison of the results for the primary energy (calculated according the German EnEV) shows that the maximum allowable demand of non-renewable energy can be very different, depending on the system or energy carrier. For a comprehensive comparison of the countries information about the frequentness of the installed supply system types is necessary.
- Implementation in practice: The practical realisation of equally designed buildings may be different from country to country. On the one hand the implementation of the building code certainly depends on the control mechanisms applied by state. It may also depend on traditions of planning and quality assurance.

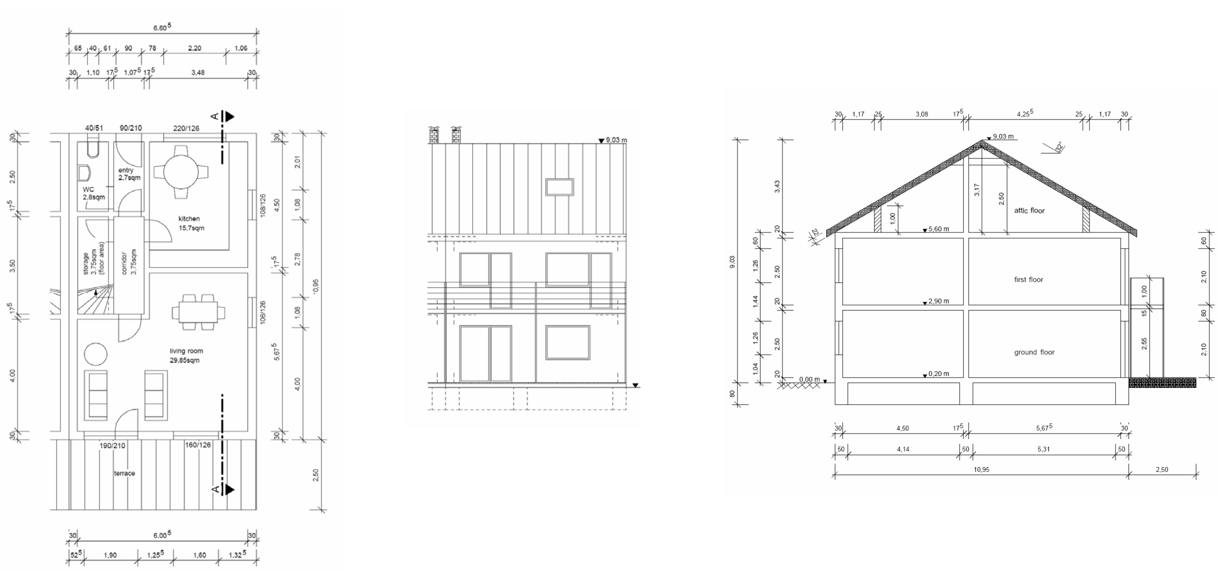
4 Model Building 1: semi-detached single family house

4.1 Thermal envelope

Model Building 1 is a semi-detached single family house with 140 m² living area. A building with a simple geometry has been chosen in order to keep the envelope area evaluation transparent. Two storeys and the attic is located inside the thermal envelope.

Fig. 1 displays the geometry, Tab. 2 the thermal envelope areas. A complete set (floor plans of all storeys, vertical section, façade plans) and a table specifying the envelope area calculation can be found in the Appendix.

Fig. 1: Model Building 1 – semi-detached single family house:
Overview of the building (the complete set of plans can be found in the Appendix) [2]



[2] Source for the plans of this building: Kadir Durmaz: Modellrechnungen zur kommenden Energieeinsparverordnung. Vertieferarbeit an der TU Darmstadt. Supervisors: Susanne Schwickert (TUD) / Tobias Loga (IWU); TU Darmstadt August 2000
revised by Christina Kappich A-HP/Energie&Haus on behalf of IWU

Tab. 2: General building data / thermal envelope areas

Model building N° 1			
Single family house (semi-detached / end-terrace)			
General building data			
gross floor area of all storeys	ext. dim.	(inside therm. env.)	217,0 m²
useful floor area	int. dim.	(inside therm. env.)	151,3 m²
lving area	int. dim.	(inside therm. env.)	140,2 m²
building volume	ext. dim.	(inside therm. env.)	538,5 m³
relation envelope surface area to building volume			0,588 m²/m³
Envelope surface area (ext. dim.)			
roof			82,5 m²
walls			133,4 m²
floor above soil			72,3 m²
door			1,9 m²
windows	North	vertical	6,8 m²
	North	skylight	1,5 m²
	East	vertical	4,1 m²
	South	vertical	12,8 m²
	South	skylight	1,3 m²
sum envelope surface area			316,6 m²

ext. dim. = external dimensions
int. dim. = internal dimensions

4.2 Types of supply systems

Reference case: variant "basis"

As a base case for the parameter variation a system with the following components has been defined:

- low temperature boiler (non-condensing) for heating and domestic hot water (dhw), installed in the central heating room (attic)
- hot water storage, installed in the central heating room (attic)
- distribution system for space heating completely inside of the thermal envelope
- distribution system for DHW completely inside the thermal envelope, no circulation ducts
- no ventilation system

The details of the system can be found in the Appendix.

Variation of parameters

Starting from the base case a variation of heat generators (hg-*), of the domestic hot water system (dhw-*) and of the ventilation system (vent-*) was performed. Furthermore two variants were considered where more than one component was changed (sys-*). The complete definition of these systems is documented in the Appendix.

Tab. 3: Definition of the supply system variants

Label	Type	Varied component
basis	basis variant	low temperature boiler for heating and dhw, no vent. system
hg-cond	variation heat generator	condensing boiler
hg-pellet	variation heat generator	wood pellet boiler
hg-hp	variation heat generator	electric heat pump
dhw-el	variation hot water system	decentral electric
dhw-sol	variation hot water system	thermal solar system
sys-el	variation heating & hot water system	electric resistance system
vent-exh	variation ventilation	exhaust ventilation system
vent-rec	variation ventilation	ventilation system with heat recovery
sys-cond/sol/rec	variation heating, hot water and ventilation system	condensing boiler + solar dhw system + ventilation system with heat recovery

4.3 Results for the thermal quality of the envelope

Compliance with national requirements for new buildings – maximum respectively adapted U-values

For the above described building the level of thermal insulation was identified which is determined by the building regulations of each participating country. As a result each partner provided a table with U-values of floor, roof, walls and windows which have to be selected for this building in order to comply with the national / regional requirements. If the thermal insulation requirements depend on the supply system efficiency the U-values were determined for different system types.

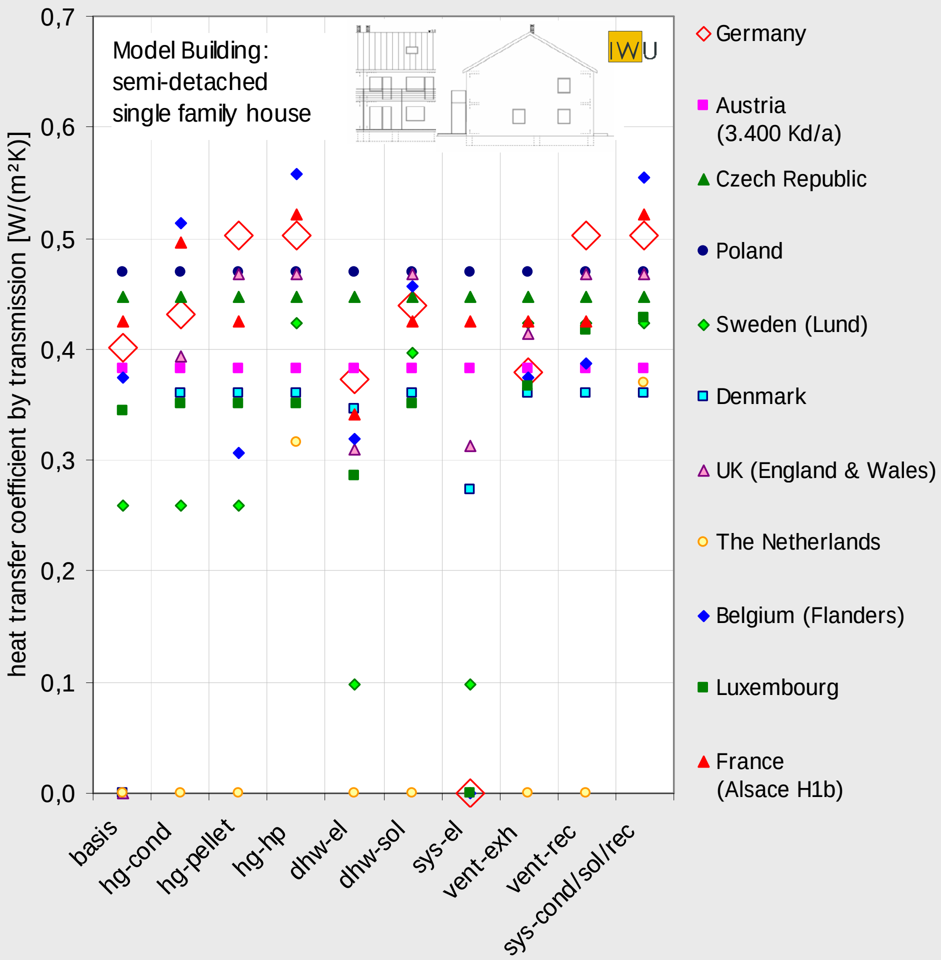
The U-values determined by each partner can be found in the Appendix (“Country Sheets”).

Simplified heat transfer coefficient by transmission

For each of the variants the U-values of the different construction elements were weighted by their areas (external dimensions, considering reduction factors for losses to soil, if applicable). The result is a simplified heat transfer coefficient (without losses caused by thermal bridging), which is sort of a mean U-value of undisturbed elements. The resulting values for the different countries are displayed in Tab. 4 and Fig. 2.

After collecting the results from the partners it turned out that the pre-defined basis variant could not be realised in 5 countries, partly because non-condensing gas boilers are not allowed any more for new buildings (Denmark, UK), partly because the installation of ventilation systems is obligatory (Sweden, Belgium) and in one case because the overall requirements are so severe (the Netherlands). Also some of the other variants were changed by the respective partners (see footnotes at the table) in order to achieve a compliance. In these cases the heat transfer coefficient can not directly be compared with the others. In consequence the definition of the variants was changed when the second building was analysed (see chapter 5.3)

Fig. 2: Results for Model Building 1 (semi-detached single-family house) – simplified heat transfer coefficient by transmission
(zero = requirements can not be complied, "-" in **Tab. 4**)



Tab. 4: Results for Model Building 1 (semi-detached single-family house) – simplified heat transfer coefficient by transmission

variant name	basis	hg-cond	hg-pellet	hg-hp	dhw-el	dhw-sol	sys-el	vent-exh	vent-rec	sys-cond / sol / rec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system	variation heating & hot water system	variation ventilation	variation ventilation	variation heating, hot water and ventilation system
short description	low temperature boiler for heating and dhw, no vent. system	condensing boiler	wood pellet boiler	electric heat pump	decentral electric	thermal solar system	electric resistance system	exhaust ventilation system	ventilation system with heat recovery	condensing boiler + solar dhw system + ventilation system with heat recovery
	Heat transfer coefficient by transmission* [W/(m²K)]									
Germany	**0,40**	**0,43**	**0,50**	**0,50**	**0,37**	**0,44**	**-**	**0,38**	**0,50**	**0,50**
Austria (3.400 Kd/a)	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**
Czech Republic	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**
Poland	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**
Sweden (Lund)	**0,26** 2)	**0,26**	**0,26**	**0,42** 2)	**0,10**	**0,40** 2)	**0,10** 2)	**0,42** 3)	**0,42**	**0,42**
Denmark	**-**	**0,36**	**0,36**	**0,36**	**0,35** 1)	**0,36** 1)	**0,27**	**0,36** 1)	**0,36** 1)	**0,36**
UK (England & Wales)	**-**	**0,39**	**0,47**	**0,47**	**0,31** 1)	**0,47** 1)	**0,31**	**0,41** 1)	**0,47** 1)	**0,47**
The Netherlands	**-**	**-**	**-**	**0,32**	**-**	**-**	**-**	**-**	**-**	**0,37**
Belgium (Flanders)	**0,37** 2)	**0,51** 2)	**0,31** 2)	**0,56** 2)	**0,32** 2)	**0,46** 2)	**-**	**0,37**	**0,39**	**0,55**
Luxembourg	**0,34**	**0,35**	**0,35**	**0,35**	**0,29**	**0,35**	**-**	**0,37**	**0,42**	**0,43**
France (Alsace H1b)	**0,43**	**0,50**	**0,43**	**0,52**	**0,34**	**0,43**	**0,43**	**0,43**	**0,43**	**0,52**
	relation to variant "basis" of Germany									
Germany	100%	108%	125%	125%	93%	110%	-	95%	125%	125%
Austria (3.400 Kd/a)	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Czech Republic	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%
Poland	117%	117%	117%	117%	117%	117%	117%	117%	117%	117%
Sweden (Lund)	65% 2)	65%	65%	106% 2)	24%	99% 2)	24% 2)	106% 3)	106%	106%
Denmark	-	90%	90%	90%	86% 1)	90% 1)	68%	90% 1)	90% 1)	90%
UK (England & Wales)	-	98%	116%	116%	77% 1)	116% 1)	78%	103% 1)	116% 1)	116%
The Netherlands	-	-	-	79%	-	-	-	-	-	92%
Belgium (Flanders)	93% 2)	128% 2)	76% 2)	139% 2)	80% 2)	114% 2)	-	93%	97%	138%
Luxembourg	86%	87%	87%	87%	71%	87%	-	92%	104%	107%
France (Alsace H1b)	106%	124%	106%	130%	85%	106%	106%	106%	106%	130%

Remarks

*) considering transmission losses through thermal envelope areas determined by external dimensions, not explicitely considering possibly supplements or reductions by thermal bridging

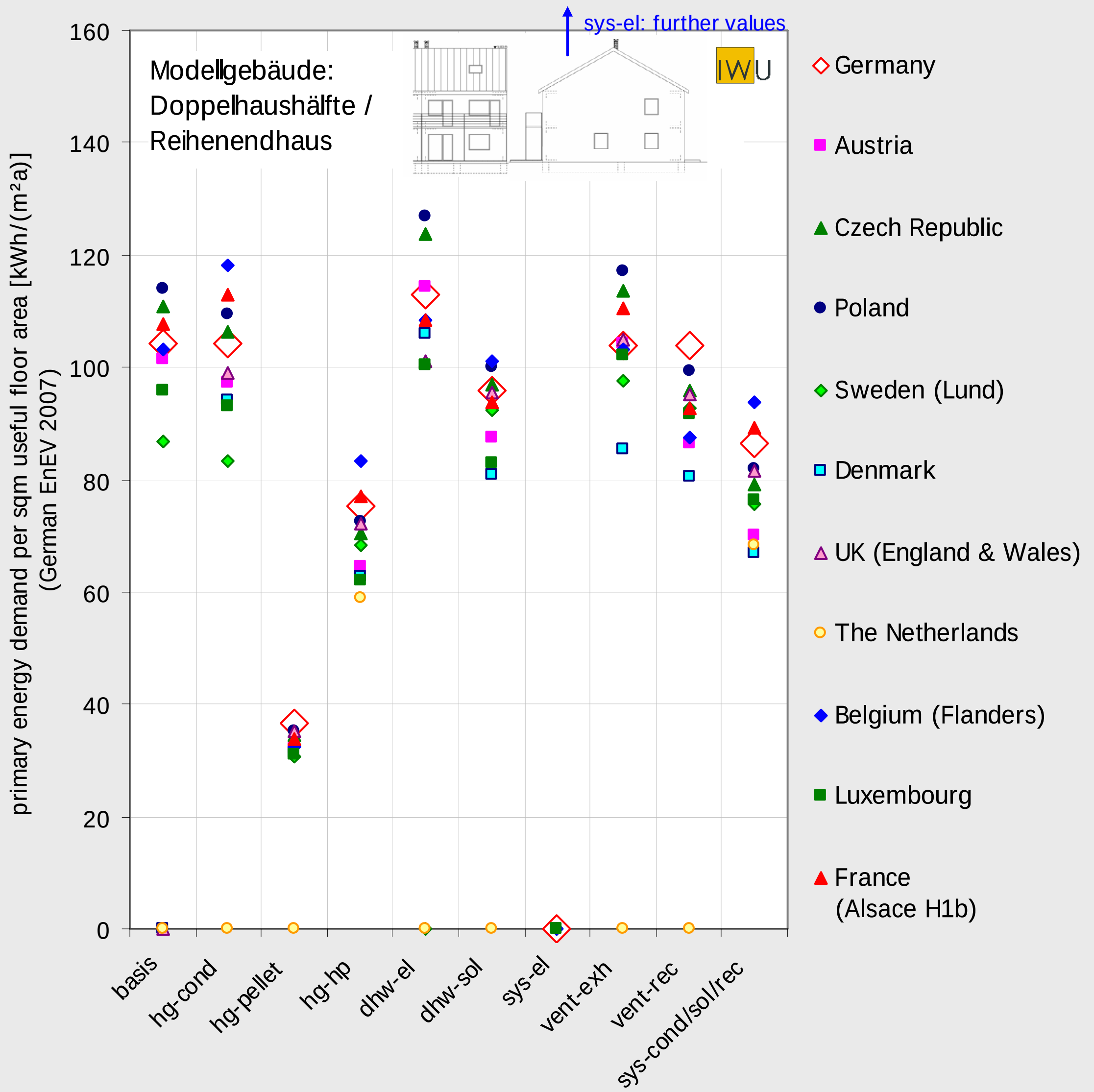
Deviations from the variant definition

1) condensing boiler (mandatory) in place of low temperature boiler
2) with exhaust ventilation system (mandatory)
3) with an additional dhw heatpump

4.4 Primary energy demand (according to German regulations)

Based on the U-values and the type of supply system the primary energy demand was calculated according to the German Energy Saving Ordinance (EnEV 2007) for each variant from each country. The simplified procedure based on seasonal energy balance for the building and table values for the system calculation was applied.[3] Supply system variants which differ from the prescribed definitions were calculated accordingly, therefore these values can be compared with the others (of course using the German perspective). The results are shown in Tab. 5 and Fig. 3.

Fig. 3: Results for Model Building 1 (semi-detached single-family house) – primary energy demand calculated according to the German regulations
(zero = requirements can not be complied, "-" in **Tab. 5**)



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[3] "vereinfachtes Verfahren" nach EnEV 2007 Anlage 1, Nr. 3 / e_P nach DIN V 4701-10 Anhang C

Tab. 5: Results for Model Building 1 (semi-detached single-family house) – primary energy demand calculated according to the German regulations

variant name	basis	hg-cond	hg-pellet	hg-hp	dhw-el	dhw-sol	sys-el	vent-exh	vent-rec	sys-cond / sol / rec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system	variation heating & hot water system	variation ventilation	variation ventilation	variation heating, hot water and ventilation system
short description	low temperature boiler for heating and dhw, no vent. system	condensing boiler	wood pellet boiler	electric heat pump	decentral electric	thermal solar system	electric resistance system	exhaust ventilation system	ventilation system with heat recovery	condensing boiler + solar dhw system + ventilation system with heat recovery
	Primary energy demand per sqm reference area* [kWh/(m²a)]									
Germany	**104**	**104**	**37**	**75**	**113**	**96**	**-**	**104**	**104**	**87**
Austria	**101**	**97**	**32**	**65**	**114**	**87**	**216**	**104**	**87**	**70**
Czech Republic	**111**	**106**	**35**	**70**	**124**	**97**	**238**	**114**	**96**	**79**
Poland	**114**	**109**	**35**	**72**	**127**	**100**	**245**	**117**	**99**	**82**
Sweden (Lund)	**87** 2)	**83**	**31**	**68** 2)	**-**	**92** 2)	**-** 2)	**98** 3)	**93**	**76**
Denmark	**-**	**94**	**31**	**63**	**106** 1)	**81** 1)	**209**	**85** 1)	**80** 1)	**67**
UK (England & Wales)	**-**	**99**	**35**	**72**	**101** 1)	**95** 1)	**194**	**105** 1)	**95** 1)	**82**
The Netherlands	**-**	**-**	**-**	**59**	**-**	**-**	**-**	**-**	**-**	**68**
Belgium (Flanders)	**103** 2)	**118** 2)	**32** 2)	**83** 2)	**108** 2)	**101** 2)	**-**	**103**	**87**	**94**
Luxembourg	**96**	**93**	**31**	**62**	**100**	**83**	**-**	**102**	**92**	**76**
France (Alsace H1b)	**108**	**113**	**34**	**77**	**108**	**94**	**231**	**111**	**93**	**89**
	relation to variant "basis" of Germany									
Germany	100%	100%	35%	72%	109%	92%	-	100%	100%	83%
Austria	97%	93%	31%	62%	110%	84%	208%	100%	83%	67%
Czech Republic	106%	102%	33%	68%	119%	93%	229%	109%	92%	76%
Poland	110%	105%	34%	70%	122%	96%	236%	112%	95%	79%
Sweden (Lund)	83% 2)	80%	30%	66% 2)	-	89% 2)	- 2)	94% 3)	89%	73%
Denmark	-	91%	30%	60%	102% 1)	78% 1)	201%	82% 1)	77% 1)	64%
UK (England & Wales)	-	95%	34%	69%	97% 1)	92% 1)	186%	101% 1)	91% 1)	78%
The Netherlands	-	-	-	57%	-	-	-	-	-	66%
Belgium (Flanders)	99% 2)	114% 2)	31% 2)	80% 2)	104% 2)	97% 2)	-	99%	84%	90%
Luxembourg	92%	89%	30%	59%	97%	80%	-	98%	88%	73%
France (Alsace H1b)	103%	109%	32%	74%	104%	90%	221%	106%	89%	86%

Remarks

*) calculated according to the rules of the German Energy Saving Ordinance (Energieeinsparverordnung EnEV 2007)

Deviations from the variant definition

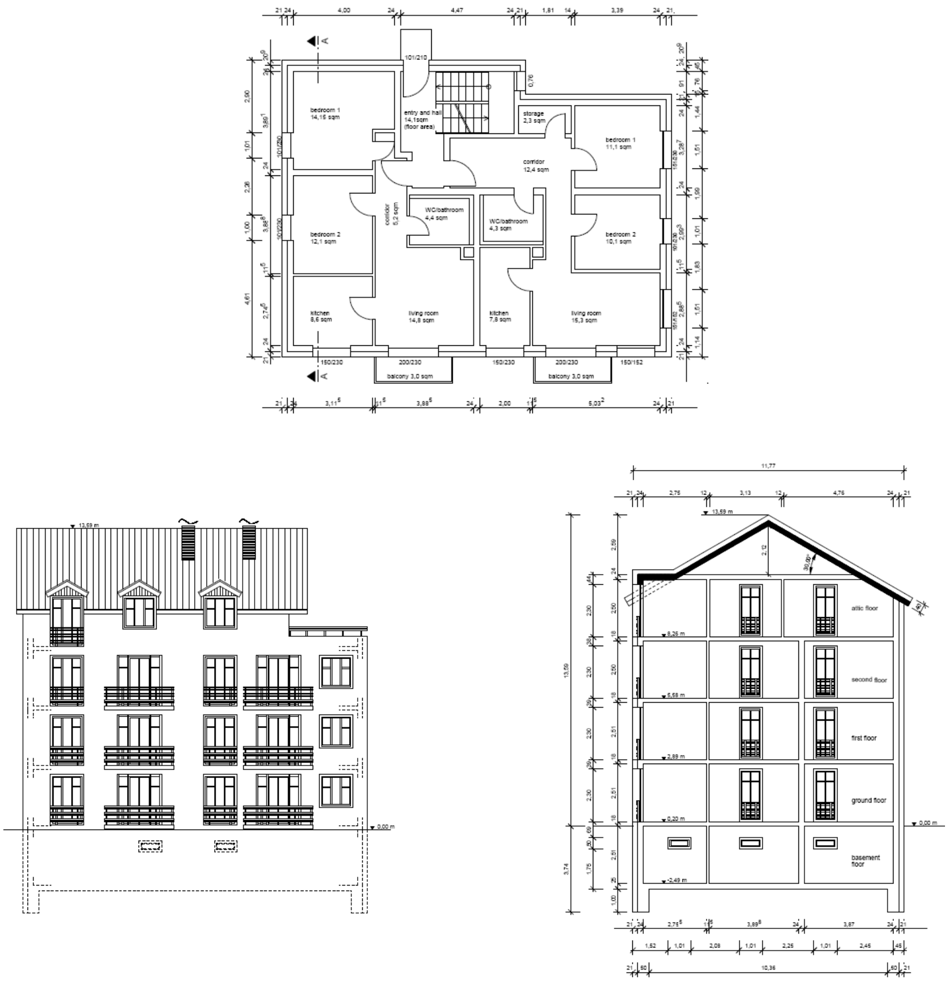
1) condensing boiler (mandatory) in place of low temperature boiler
2) with exhaust ventilation system (mandatory)
3) with an additional dhw heatpump

5 Model Building 2: multi-family house

5.1 Thermal Envelope

Model Building 2 is a multi-family house with 3 storeys plus conditioned attic storey. The cellar is not heated. The living area of the 7 apartments is 461 m² in total.

Fig. 4: Model Building 2 – multi-family house: Overview of the building
(the complete set of plans can be found in the Appendix) [4]



[4] Source for the plans of this building: Kadir Durmaz: Modellrechnungen zur kommenden Energieeinsparverordnung. Vertieferarbeit an der TU Darmstadt. Supervisors: Susanne Schwickert (TUD) / Tobias Loga (IWU); TU Darmstadt August 2000
revised by Christina Kappich A-HP/Energie&Haus on behalf of IWU

Tab. 6: General building data / thermal envelope areas

Model building N° 2 Apartment house			**according to German regulations**	**for comparison (simplified)**
General building data				
floor area	ext. dim.	(inside therm. env.)	657,5 m²	657,5 m²
useful floor area	int. dim.	(inside therm. env.)	520,3 m²	520,3 m²
lving area	int. dim.	(inside therm. env.)	461,2 m²	461,2 m²
building volume	ext. dim.	(inside therm. env.)	1936,7 m³	1936,7 m³
relation envelope surface area to building volume			0,517 m²/m³	0,517 m²/m³
Envelope surface area (ext. dim.)				
tilted roof			150,4 m²	150,4 m²
flat roof (terrace floor)			36,7 m²	36,7 m²
dormer roof			7,5 m²	7,5 m²
walls			454,4 m²	454,4 m²
dormer walls			4,4 m²	4,4 m²
cellar ceiling			158,2 m²	173,5 m²
floor to soil			15,3 m²	0,0 m²
walls to soil			18,0 m²	0,0 m²
walls to cellar			24,9 m²	0,0 m²
door to cellar			2,0 m²	0,0 m²
outside door			2,1 m²	2,1 m²
windows	East	vertical	45,7 m²	45,7 m²
	South	vertical	63,1 m²	63,1 m²
	West	vertical	18,6 m²	18,6 m²
sum envelope surface area			1001,3 m²	956,4 m²

ext. dim. = external dimensions
int. dim. = internal dimensions

According to the German regulations the stairwell is included in the thermal envelope. Since there is no door to the stair running down to the cellar the stairwell part of the cellar storey is considered to be heated as well. Therefore the thermal envelope in this area consists of the cellar floor of the stairwell, the walls bordering on soil as well as the walls and the door bordering on the cellar rooms. Since in some countries this is not considered in the same way a simplified envelope was defined for the determination of the simplified heat transfer coefficient used for comparison (see Tab. 6).

5.2 Types of supply systems

In order to avoid the problem which had occurred concerning the definition of the basis variant of the single family house (see 4.3) it was decided to change the variants definition for Model Building 2 in the following way:

- The new basis variant is a system with a condensing boiler for heating and hot water and an exhaust ventilation system.
- The variant "hg-cond" (condensing boiler) is replaced by "hg-bnc" (non-condensing boiler). This variant will not be calculated for countries in which non-condensing boilers are not allowed.
- The variant "vent-exh" (exhaust ventilation system) is replaced by "vent-nomec" (no mechanical ventilation). This variant will not be calculated for countries in which ventilation systems are mandatory.

In consequence the following supply systems were defined:

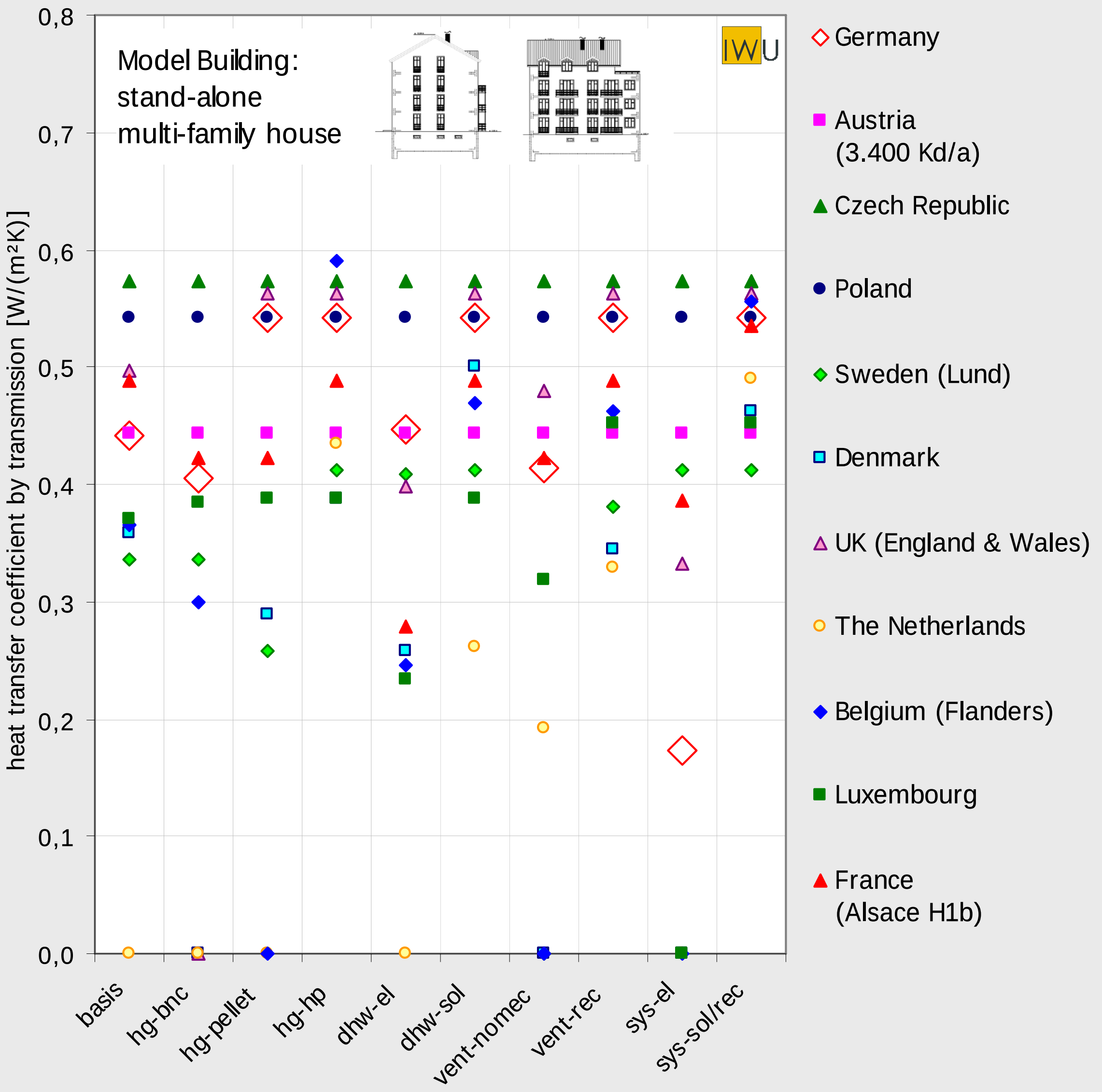
Tab. 7: Definition of the supply system variants

Label	Type	Varied component
basis	basis variant	central system with condensing boilder for heating and hot water, exhaust ventilation system
hg-bnc	variation heat generator	low temperatur boiler, non-condensing
hg-pellet	variation heat generator	wood pellet boiler
hg-hp	variation heat generator	electric heat pump
dhw-el	variation hot water system	decentral electric
dhw-sol	variation hot water system	thermal solar system
vent-nomec	variation ventilation	no mechanical ventilation system
vent-rec	variation ventilation	ventilation system with heat recovery
sys-el	variation heating, hot water and ventilation system	electric resistance system
sys-cond / sol / rec	variation heating, hot water and ventilation system	condensing boiler + solar dhw system + ventilation system with heat recovery

5.3 Results for the thermal quality of the envelope

The calculations of the thermal standard which just complies with the national requirements for new buildings was performed in the same way as for Model Building 1. The results are shown in Tab. 8 and in Fig. 5.

Fig. 5: Results for Model Building 2 (multi-family house) – simplified heat transfer coefficient by transmission
(zero = requirements can not be complied, “-“ in **Tab. 8**)



Tab. 8: Results for Model Building 2 (multi-family house) – simplified heat transfer coefficient by transmission

variant name	basis	hg-bnc	hg-pellet	hg-hp	dhw-el	dhw-sol	vent-nomec	vent-rec	sys-el	sys-sol/rec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system	variation ventilation	variation ventilation	variation heating and hot water system	variation hot water and ventilation system
short description	condensing boiler for heating and hot water + exhaust ventilation system	low temperature boiler (non-condensing)	wood pellet boiler	electric heat pump	decentral electric	thermal solar system	no mechanical ventilation system	ventilation system with heat recovery	electric resistance system	solar dhw system + ventilation system with heat recovery
	Heat transfer coefficient by transmission* [W/(m²K)]									
Germany	**0,44**	**0,41**	**0,54**	**0,54**	**0,45**	**0,54**	**0,41**	**0,54**	**0,17**	**0,54**
Austria (3.400 Kd/a)	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**	**0,44**
Czech Republic	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**	**0,57**
Poland	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**	**0,54**
Sweden (Lund)	**0,34**	**0,34**	**0,26**	**0,41**	**0,41**	**0,41**	**-**	**0,38**	**0,41**	**0,41**
Denmark	**0,36**	**-**	**0,29**	**0,39**	**0,26**	**0,50**	**-**	**0,34**	**-**	**0,46**
UK (England & Wales)	**0,50**	**-**	**0,56**	**0,56**	**0,40**	**0,56**	**0,48**	**0,56**	**0,33**	**0,56**
The Netherlands	**-**	**-**	**-**	**0,43**	**-**	**0,26**	**0,19**	**0,33**	**-**	**0,49**
Belgium (Flanders)	**0,37**	**0,30**	**-**	**0,59**	**0,25**	**0,47**	**-**	**0,46**	**-**	**0,56**
Luxembourg	**0,37**	**0,38**	**0,39**	**0,39**	**0,23**	**0,39**	**0,32**	**0,45**	**-**	**0,45**
France (Alsace H1b)	**0,49**	**0,42**	**0,42**	**0,49**	**0,28**	**0,49**	**0,42**	**0,49**	**0,39**	**0,54**
	relation to variant "basis" of Germany									
Germany	100%	92%	123%	123%	101%	123%	94%	123%	39%	123%
Austria (3.400 Kd/a)	101%	101%	101%	101%	101%	101%	101%	101%	101%	101%
Czech Republic	130%	130%	130%	130%	130%	130%	130%	130%	130%	130%
Poland	123%	123%	123%	123%	123%	123%	123%	123%	123%	123%
Sweden (Lund)	76%	76%	59%	93%	93%	93%	-	86%	93%	93%
Denmark	81%	-	66%	88%	58%	113%	-	78%	-	105%
UK (England & Wales)	112%	-	127%	127%	90%	127%	109%	127%	75%	127%
The Netherlands	-	-	-	98%	-	59%	44%	75%	-	111%
Belgium (Flanders)	83%	68%	-	134%	56%	106%	-	105%	-	126%
Luxembourg	84%	87%	88%	88%	53%	88%	72%	102%	-	102%
France (Alsace H1b)	111%	96%	96%	111%	63%	111%	96%	111%	87%	121%

Remarks

*) considering transmission losses through thermal envelope areas determined by external dimensions, not explicitely considering possibly supplements or reductions by thermal bridging

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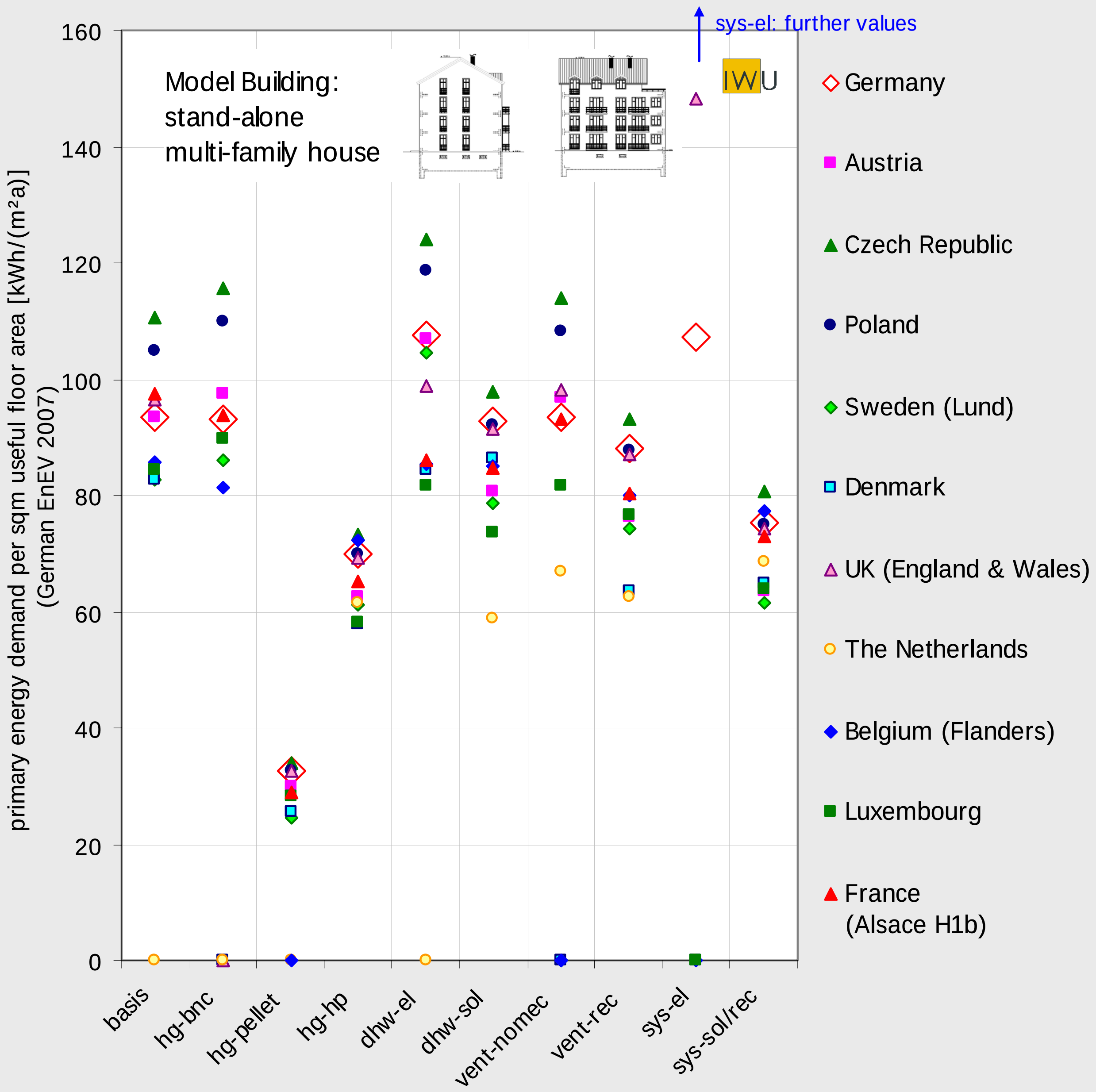
5.4 Primary energy demand (according to German regulations)

Starting from the U-values for each variant from each country the primary energy demand was calculated according to the German Energy Saving Ordinance (EnEV 2007). The proceeding was the same as for Model Building 1 (see chapter 4.4). The results are shown in Tab. 9 and Fig. 6.

Fig. 6: Results for Model Building 2 (multi-family house) – primary energy demand calculated according to the German regulations
(zero = requirements can not be complied, "-" in Tab. 9)



Tab. 9: Results for Model Building 2 (multi-family house) – primary energy demand calculated according to the German regulations

variant name	basis	hg-bnc	hg-pellet	hg-hp	dhw-el	dhw-sol	vent-nomec	vent-rec	sys-el	sys-sol/rec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system	variation ventilation	variation ventilation	variation heating and hot water system	variation hot water and ventilation system
short description	condensing boiler for heating and hot water + exhaust ventilation system	low temperature boiler (non-condensing)	wood pellet boiler	electric heat pump	decentral electric	thermal solar system	no mechanical ventilation system	ventilation system with heat recovery	electric resistance system	solar dhw system + ventilation system with heat recovery
	Primary energy demand per sqm reference area* [kWh/(m²a)]									
Germany	**93**	**93**	**33**	**70**	**108**	**93**	**93**	**88**	**107**	**75**
Austria	**93**	**98**	**30**	**62**	**107**	**81**	**97**	**76**	**185**	**63**
Czech Republic	**110**	**116**	**34**	**73**	**124**	**98**	**114**	**93**	**225**	**81**
Poland	**105**	**110**	**33**	**70**	**119**	**92**	**108**	**88**	**212**	**75**
Sweden (Lund)	**83**	**86**	**25**	**61**	**105**	**79**	**-**	**74**	**181**	**61**
Denmark	**83**	**-**	**25**	**58**	**84**	**86**	**-**	**64**	**-**	**65**
UK (England & Wales)	**96**	**-**	**32**	**69**	**99**	**91**	**98**	**87**	**148**	**74**
The Netherlands	**-**	**-**	**-**	**62**	**-**	**59**	**67**	**62**	**-**	**68**
Belgium (Flanders)	**86**	**81**	**-**	**72**	**85**	**85**	**-**	**80**	**-**	**77**
Luxembourg	**84**	**90**	**28**	**58**	**82**	**74**	**82**	**77**	**-**	**64**
France (Alsace H1b)	**97**	**94**	**29**	**65**	**86**	**85**	**93**	**80**	**167**	**73**
	relation to variant "basis" of Germany									
Germany	100%	100%	35%	75%	115%	99%	100%	95%	115%	81%
Austria	100%	105%	32%	67%	115%	86%	104%	82%	199%	68%
Czech Republic	118%	124%	36%	78%	133%	105%	122%	100%	241%	86%
Poland	112%	118%	35%	75%	127%	99%	116%	94%	228%	80%
Sweden (Lund)	89%	92%	26%	66%	112%	84%	-	80%	194%	66%
Denmark	88%	-	27%	62%	90%	93%	-	68%	-	69%
UK (England & Wales)	103%	-	35%	74%	106%	98%	105%	93%	159%	80%
The Netherlands	-	-	-	66%	-	63%	72%	67%	-	73%
Belgium (Flanders)	92%	87%	-	77%	92%	91%	-	86%	-	83%
Luxembourg	90%	96%	30%	62%	88%	79%	88%	82%	-	69%
France (Alsace H1b)	104%	100%	31%	70%	92%	91%	100%	86%	179%	78%

Remarks

*) calculated according to the rules of the German Energy Saving Ordinance (Energieeinsparverordnung EnEV 2007)

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6 Model Building 3: School

6.1 Thermal envelope

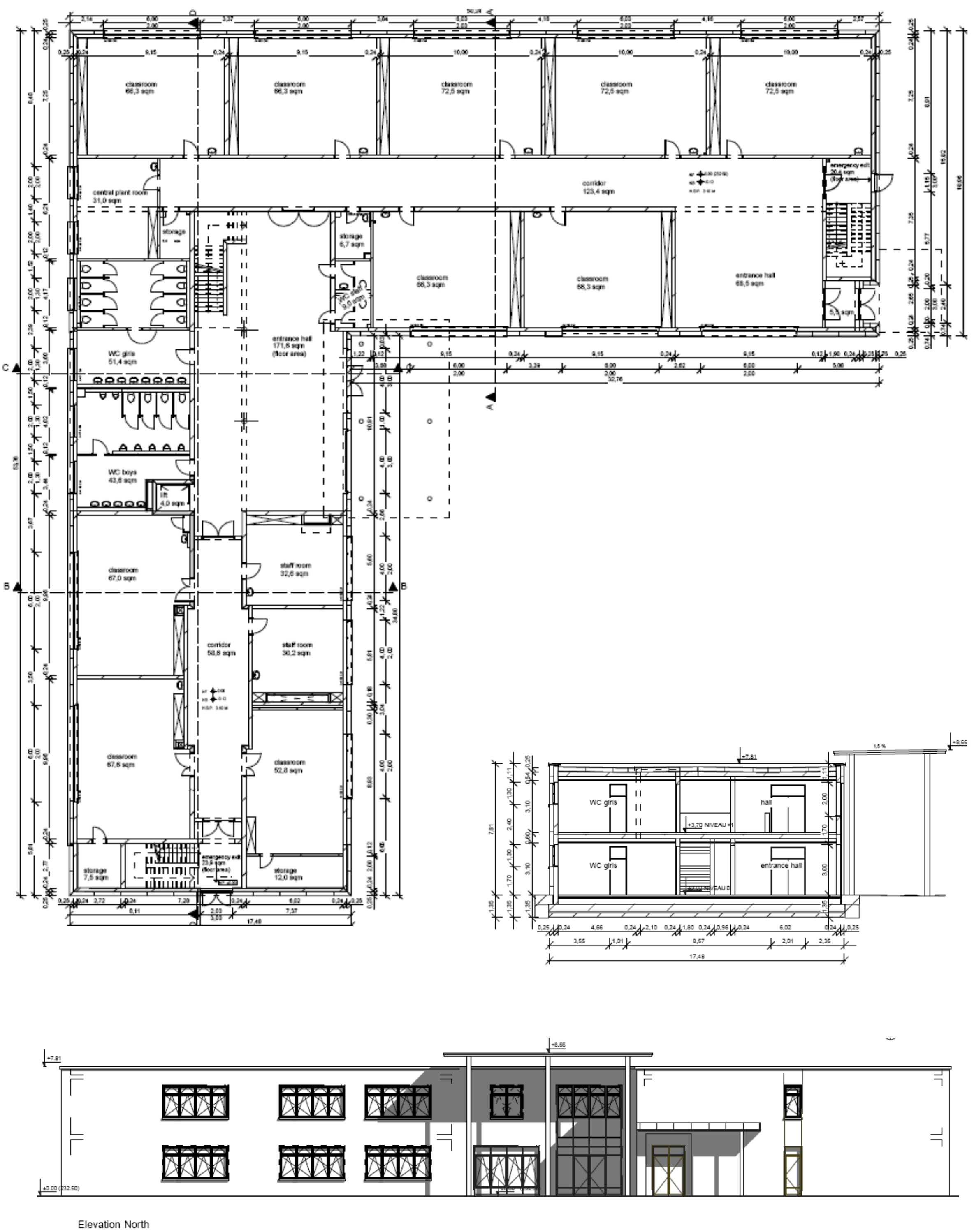
Model Building 3 is a two storey school building with about 2700 m² net floor area. It has a flat roof, a cellar is not existent. An overview of the building geometry is given by Fig. 7. In Tab. 10 the surface areas of the thermal envelope elements determined by use of external dimensions are listed. The complete set of plans and the details of the envelope area calculation can be found in the Appendix.

Tab. 10: General building data / thermal envelope areas

Model building N° 3 school building				
General building data				
gross floor area	ext. dim.	(inside therm. env.)	3121,7	m²
net floor area	int. dim.	(inside therm. env.)	2724,9	m²
useful floor area	int. dim.	(inside therm. env.)	1876,2	m²
building volume	ext. dim.	(inside therm. env.)	13891,1	m³
relation envelope surface area to building volume			0,358	m²/m³
Envelope surface area (ext. dim.)				
roof			1560,9	m²
wall N			324,1	m²
wall E			310,4	m²
wall S			335,1	m²
wall W			272,4	m²
wall to soil N			58,6	m²
wall to soil E			54,8	m²
wall to soil S			58,6	m²
wall to soil W			54,8	m²
window N			84,0	m²
window E			76,0	m²
window S			84,8	m²
window W			120,0	m²
door N			11,8	m²
door E			6,0	m²
floor			1560,9	m²
sum envelope surface area			4973,2	m²

ext. dim. = external dimensions
int. dim. = internal dimensions

Fig. 7: Model Building 3 – school:
Overview of the building
(the complete set of plans can be found in the Appendix) [5]



5 Source for the plans of this building: Atelier d'Architecture Arlette Feierstein, Luxembourg revised by Christina Kappich A-HP/Energie&Haus on behalf of IWU

6.2 Types of supply systems

A central heating system with a condensing gas boiler is defined as the basis variant. The heat generator is installed in a central heating room. The heating room and all heat ducts are located inside of the thermal envelope. The two lavatories are very close to the central heating room and are supplied with hot water by circulation pipes. In the class rooms conventional radiators are installed for heat emission. In order to make sure that the basis variant can be realised in all countries a ventilation system with heat recovery is considered.

Starting from this basis system variations are defined: Instead of the condensing boiler a low temperature gas boiler (non-condensing), an electric heat pump and a wood pellet boiler are used for heat generation. In a further variant the ventilation system is omitted.

The details of the supply system variants (system temperatures, duct lengths, thermal and electric power, …) are documented in the Appendix.

Tab. 11: Definition of the supply system variants

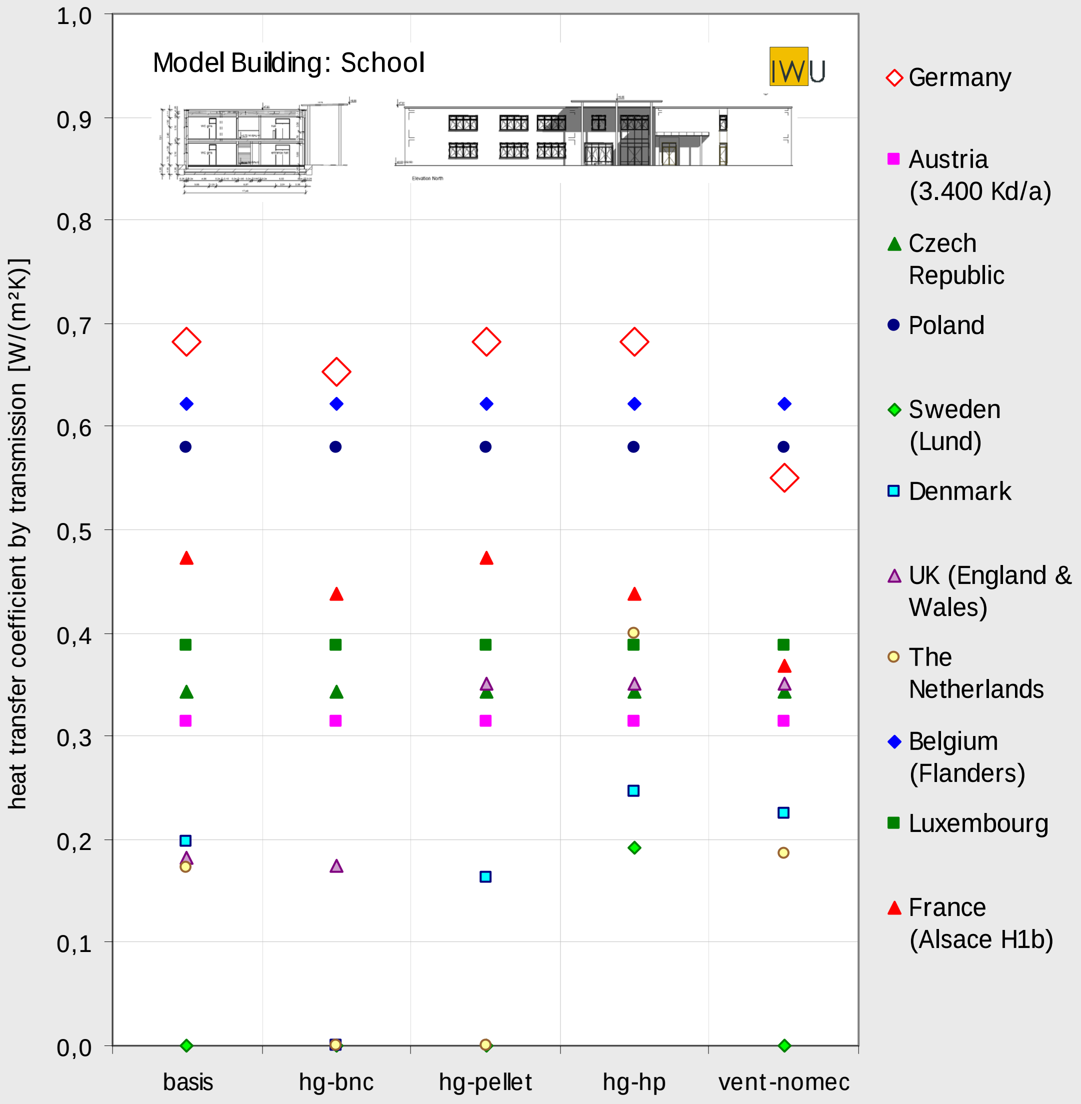
Label	Type	Varied component
basis	basis variant	condensing boiler for heating and hot water + exhaust ventilation system
hg-bnc	variation heat generator	low temperature boiler (non-condensing)
hg-pellet	variation heat generator	wood pellet boiler
hg-hp	variation heat generator	electric heat pump (soil)
vent-nomec	variation ventilation	no mechanical ventilation system

6.3 Results for the thermal quality of the envelope

The calculations of the thermal standard which just complies with the national requirements for new buildings was performed in the same way as for Model Building 1 and 2. The results are shown in Tab. 12 and in Fig. 8. Information about the calculation methods which were used in the different countries can be found in the “Country Sheets” (Appendix).

The lowest values can be found for the countries Sweden, UK, Denmark and the Netherlands. Similar to the previous example buildings the missing values (indicated by “-“ in the table) are caused by the fact that the U-values have to be reduced below a level which can be realised in practice (U-value of opaque elements < 0,08 W/(m²K) / of windows < 0,8 W/(m²K)). In case of Sweden the requirements are so severe that only one of the five variants could be built.

Fig. 8: Results for Model Building 3 (school) – simplified heat transfer coefficient by transmission
(zero = requirements can not be complied, “-“ in **Tab. 12**)



Tab. 12: Results for Model Building 3 (school) – simplified heat transfer coefficient by transmission

variant name	basis	hg-bnc	hg-pellet	hg-hp	vent-nomec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation ventilation
short description	condensing boiler for heating and hot water + exhaust ventilation system	low temperature boiler (non-condensing)	wood pellet boiler	electric heat pump	no mechanical ventilation system
	Heat transfer coefficient by transmission* [W/(m²K)]				
Germany	**0,68**	**0,65**	**0,68**	**0,68**	**0,55**
Austria (3.400 Kd/a)	**0,31**	**0,31**	**0,31**	**0,31**	**0,31**
Czech Republic	**0,34**	**0,34**	**0,34**	**0,34**	**0,34**
Poland	**0,58**	**0,58**	**0,58**	**0,58**	**0,58**
Sweden (Lund)	**-**	**-**	**-**	**0,19**	**-**
Denmark	**0,20**	**-**	**0,16**	**0,25**	**0,23**
UK (England & Wales)	**0,18**	**0,17**	**0,35**	**0,35**	**0,35**
The Netherlands	**0,17**	**-**	**-**	**0,40**	**0,19**
Belgium (Flanders)	**0,62**	**0,62**	**0,62**	**0,62**	**0,62**
Luxembourg	**0,39**	**0,39**	**0,39**	**0,39**	**0,39**
France (Alsace H1b)	**0,47**	**0,44**	**0,47**	**0,44**	**0,37**
	relation to variant "basis" of Germany				
Germany	100%	96%	100%	100%	81%
Austria (3.400 Kd/a)	46%	46%	46%	46%	46%
Czech Republic	50%	50%	50%	50%	50%
Poland	85%	85%	85%	85%	85%
Sweden (Lund)	-	-	-	28%	-
Denmark	29%	-	24%	36%	33%
UK (England & Wales)	27%	26%	52%	52%	52%
The Netherlands	25%	-	-	58%	27%
Belgium (Flanders)	91%	91%	91%	91%	91%
Luxembourg	57%	57%	57%	57%	57%
France (Alsace H1b)	69%	64%	69%	64%	54%

Remarks

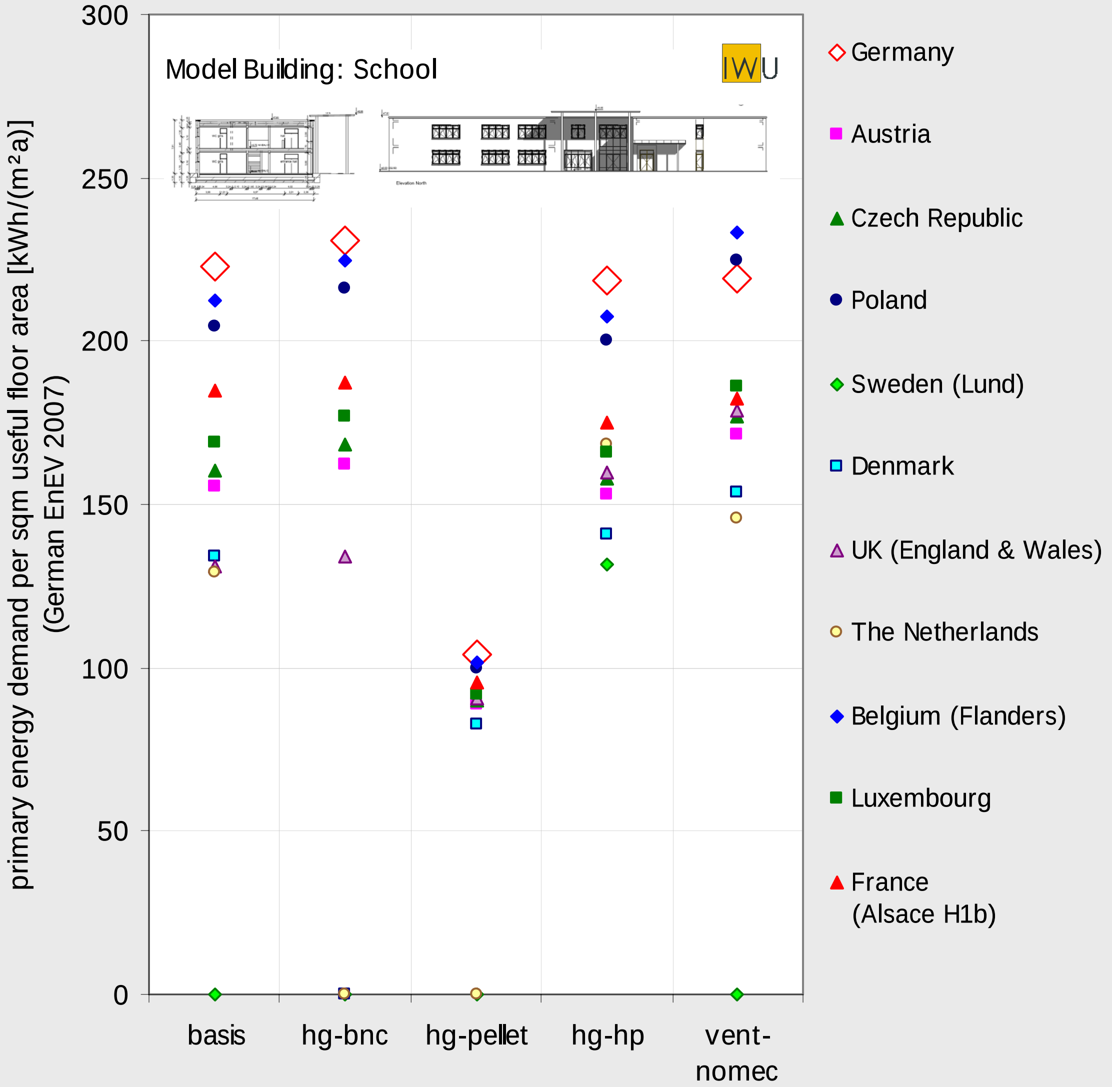
*) considering transmission losses through thermal envelope areas determined by external dimensions, not explicitely considering possibly supplements or reductions by thermal bridging

6.4 Primary energy demand (according to German regulations)

Starting from the U-values for each variant from each country the primary energy demand was calculated according to the German Energy Saving Ordinance (EnEV 2007, calculation procedure DIN V 18599, 1 zone building). The results are shown in Tab. 13 and Fig. 9.

The results are in principle similar to the previous ones. The poorest requirements can be found in Germany, the severest in Sweden.

Fig. 9: Results for Model Building 3 (school) – primary energy demand calculated according to the German regulations
(zero = requirements can not be complied, “-“ in **Tab. 13**)



Tab. 13: Results for Model Building 3 (school) – primary energy demand calculated according to the German regulations

variant name	basis	hg-bnc	hg-pellet	hg-hp	vent-nomec
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation ventilation
short description	condensing boiler for heating and hot water + exhaust ventilation system	low temperature boiler (non-condensing)	wood pellet boiler	electric heat pump	no mechanical ventilation system
	Primary energy demand per sqm reference area* [kWh/(m²a)]				
Germany	**223**	**231**	**104**	**218**	**219**
Austria	**155**	**162**	**89**	**153**	**171**
Czech Republic	**161**	**168**	**90**	**158**	**177**
Poland	**204**	**216**	**100**	**200**	**225**
Sweden (Lund)	**-**	**-**	**-**	**132**	**-**
Denmark	**134**	**-**	**82**	**141**	**154**
UK (England & Wales)	**131**	**134**	**90**	**160**	**179**
The Netherlands	**129**	**-**	**-**	**168**	**146**
Belgium (Flanders)	**212**	**225**	**102**	**208**	**233**
Luxembourg	**169**	**177**	**92**	**166**	**186**
France (Alsace H1b)	**185**	**187**	**96**	**175**	**182**
	relation to variant "basis" of Germany				
Germany	100%	104%	47%	98%	98%
Austria	70%	73%	40%	69%	77%
Czech Republic	72%	75%	40%	71%	79%
Poland	92%	97%	45%	90%	101%
Sweden (Lund)	-	-	-	59%	-
Denmark	60%	-	37%	63%	69%
UK (England & Wales)	59%	60%	41%	72%	80%
The Netherlands	58%	-	-	75%	65%
Belgium (Flanders)	95%	101%	46%	93%	105%
Luxembourg	76%	79%	41%	74%	83%
France (Alsace H1b)	83%	84%	43%	78%	82%

Remarks
*) calculated according to the rules of the German Energy Saving Ordinance (Energieeinsparverordnung EnEV 2007)

7 Résumé

The here performed investigations give an impression of the energy performance requirements of new buildings in Germany and the 10 neighboured countries Austria, Czech Republic, Poland, Sweden, Denmark, UK, Netherlands, Belgium (Flanders), Luxembourg and France. The results which are to be considered as exemplary show certain tendencies: Regarding the two residential buildings the German requirements (EnEV 2007) are settled on a more or less average level. The best energy performance is achieved by the regulations in the Netherlands, Sweden, Denmark and Luxembourg. Especially the German requirements on the thermal transmittance of the envelope turned out to be comparably poor. It is the restricting limit in cases of supply systems with high efficiency or biomass. In case of the school building the German energy performance level is the poorest of all considered countries - for nearly all variants. The most ambitious requirements can be found in UK, Netherlands, Sweden and Denmark.

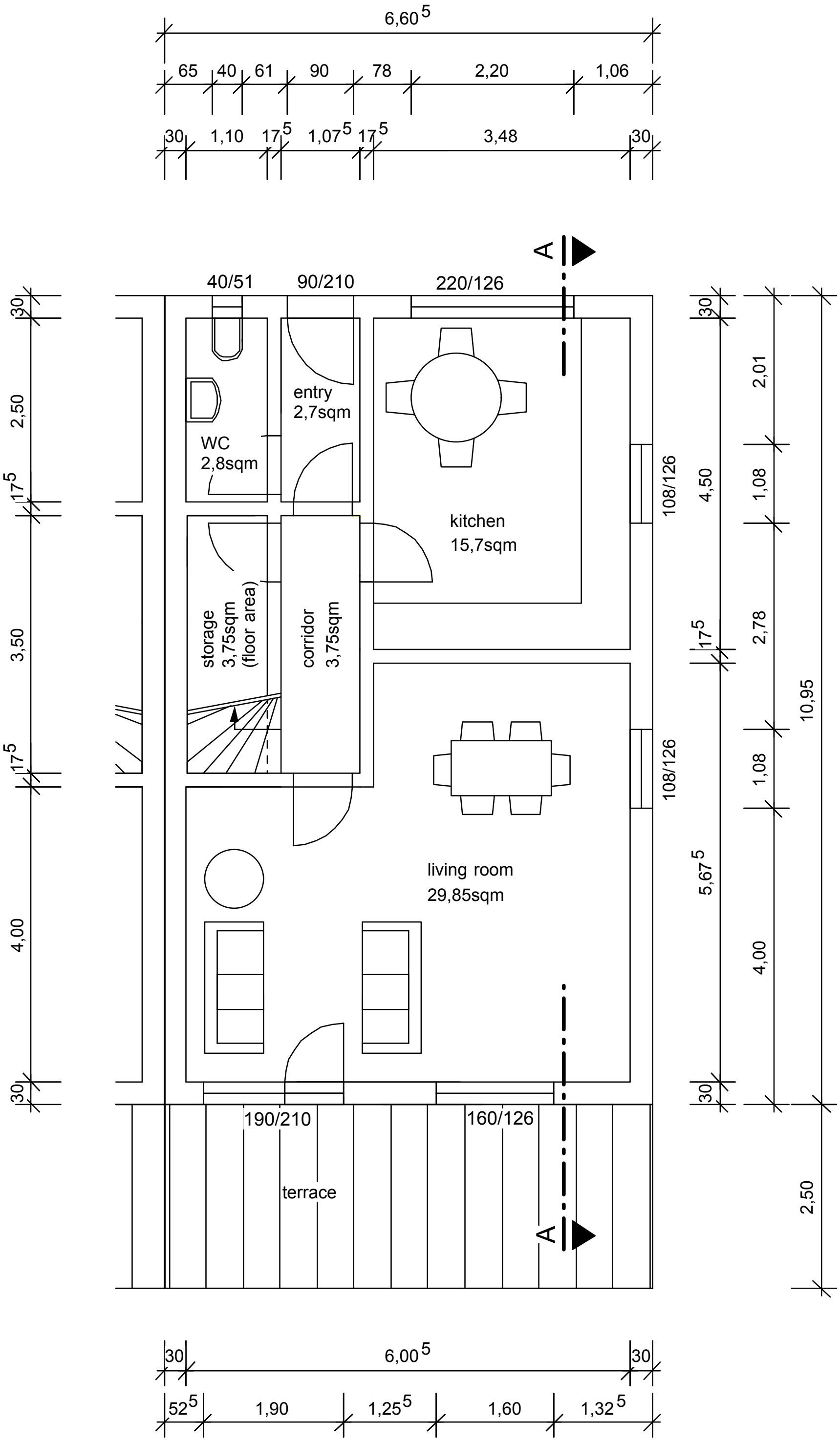
Facing the fact that an analytic comparison of the national methods was not a subject of this study the reasons for the dependencies of the different parameters can not be explained in detail. With regard to the objective of this study – the determination of the requirement level for a considerable number of countries – the applied method proved its worth. The documented building examples show how plans and tabled descriptions can be designed in order to make possible the application of national methods by experts from different countries. From this experience a two-step approach can be recommended for future investigations: In a first step the supply system of the basis variant should be selected in co-operation with the involved partners making sure that the respective building-system combination can be realised in all countries. Usually this will result in the selection of a more efficient supply system. Based on this reference case the parameter variations can be performed in a concerted way – omitting a variant in case that it cannot be built in a certain country.

Since primary energy demand and carbon dioxide emissions are defined differently in the national regulations (especially regarding biomass) these quantities are not adequate for a comprehensive cross-country comparison of the overall energy performance. They can only be used in a single country for illuminating comparison results by applying the national definition framework. The primary energy values shown in this study can therefore be considered as translation to understand the results from the viewpoint of the German energy saving ordinance and are addressing especially German experts. On an international level the simplified transfer coefficient by transmission has proved to be a good comparison criterion which gives – being a sort of average U-value – an indication of the “insulation quality” for a given building geometry and its supply system. However, the application of this method is restricted to countries with similar climates and to building types with an energy consumption that considerably depends on the thermal transmittance of the envelope.

APPENDIX

Appendix 1: Definition of Model Building 1 – semi-detached single family house

Appendix 1a: Plans



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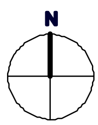
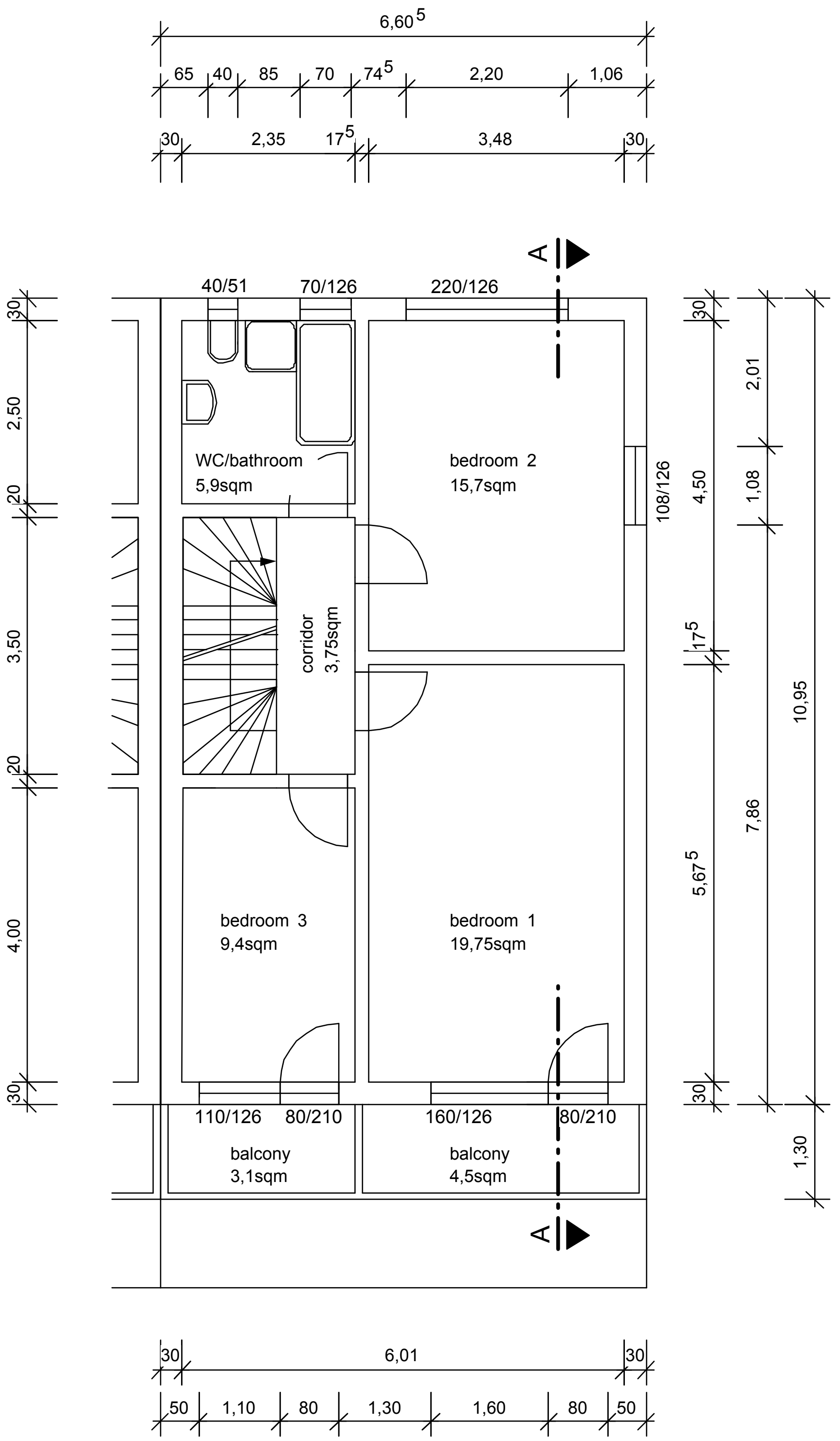
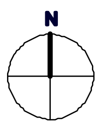


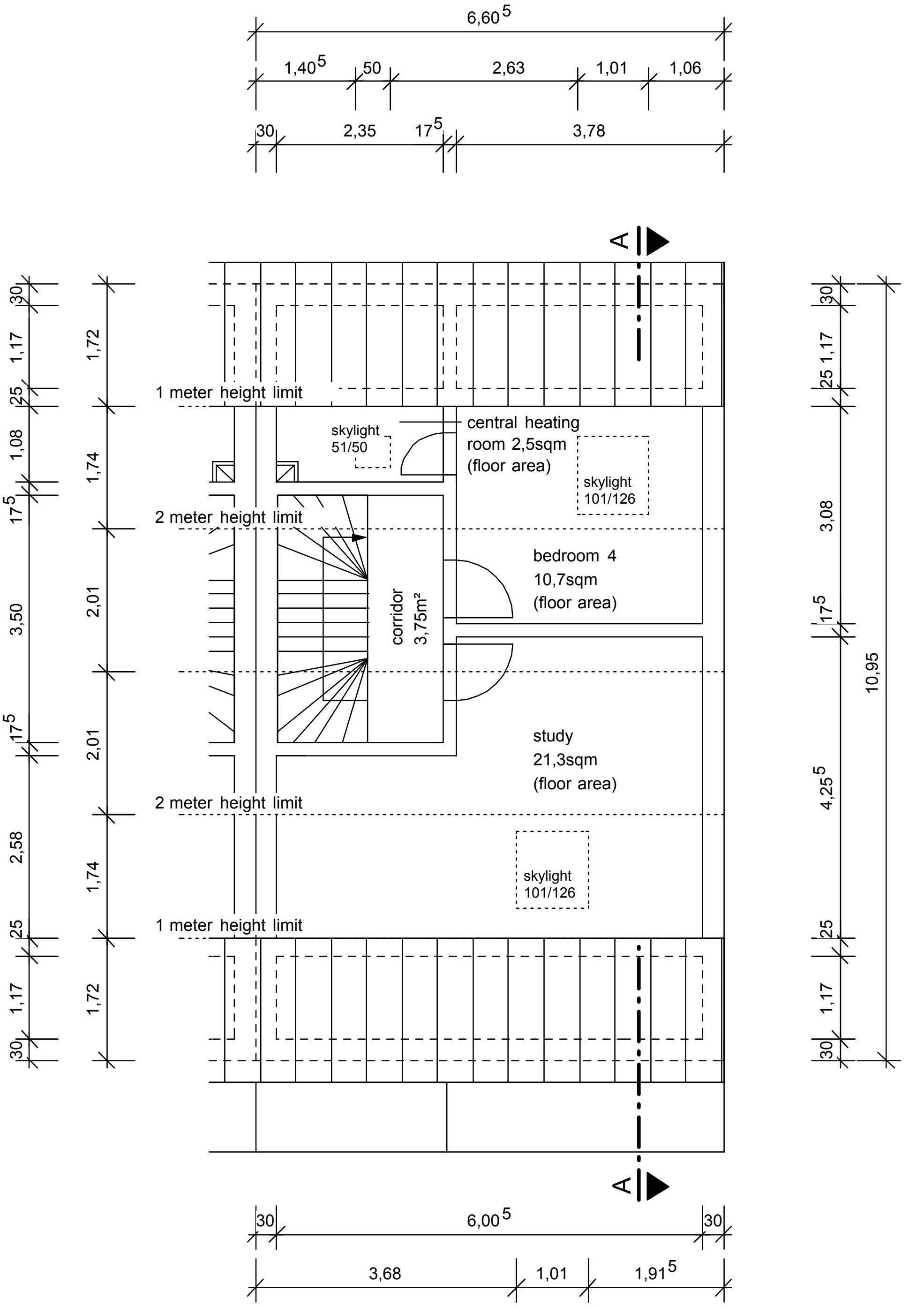
Building	END-TERRACE HOUSE
Floor Plan	**Ground Floor**
Scale	1:100
Date	Jan 2008



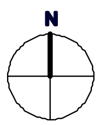
IWU 2008



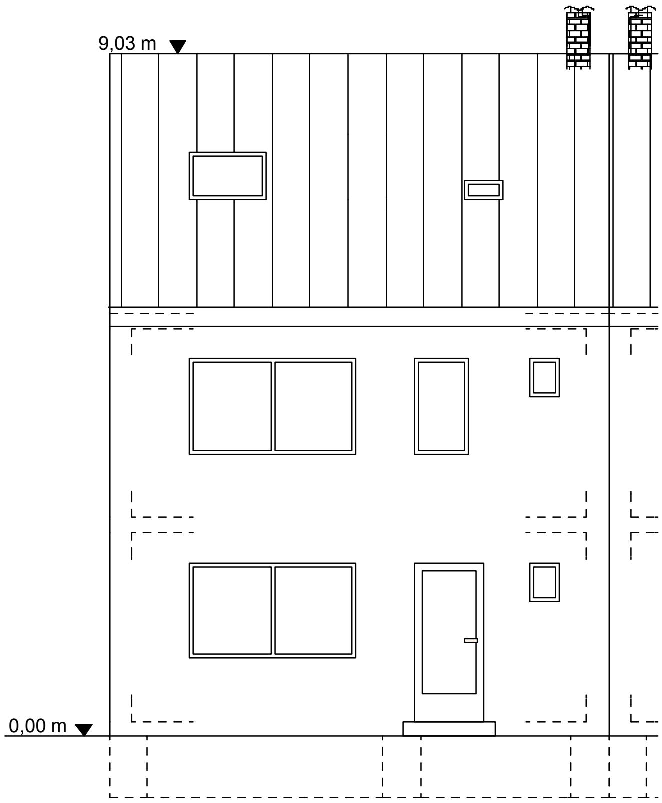
Building	END-TERRACE HOUSE
Floor Plan	**First Floor**
Scale	1:100
Date	Jan 2008



IWU 2008

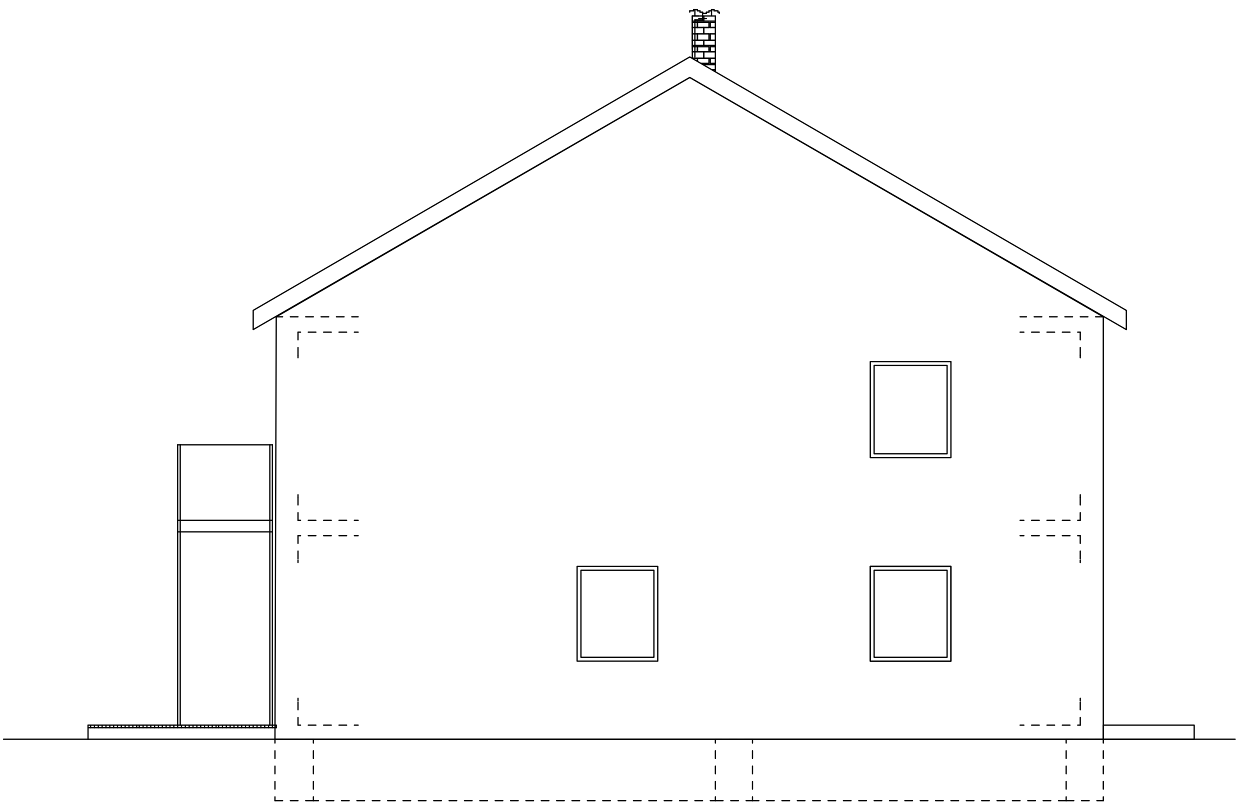


Building	END-TERRACE HOUSE
Floor Plan	**Attic Floor**
Scale	1:100
Date	Jan 2008



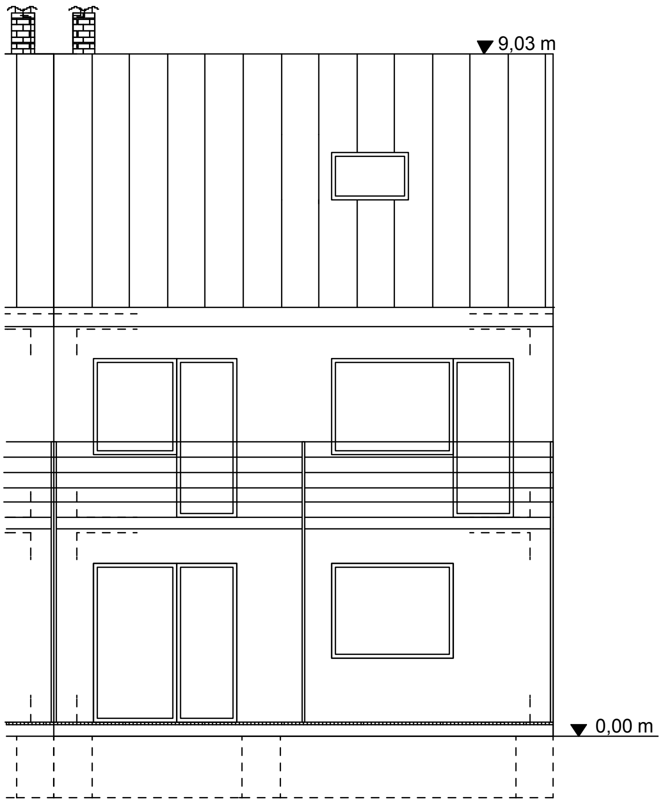
IWU 2008

Building	END-TERRACE HOUSE
Plan	**Elevation North**
Scale	1:100
Date	Jan 2008



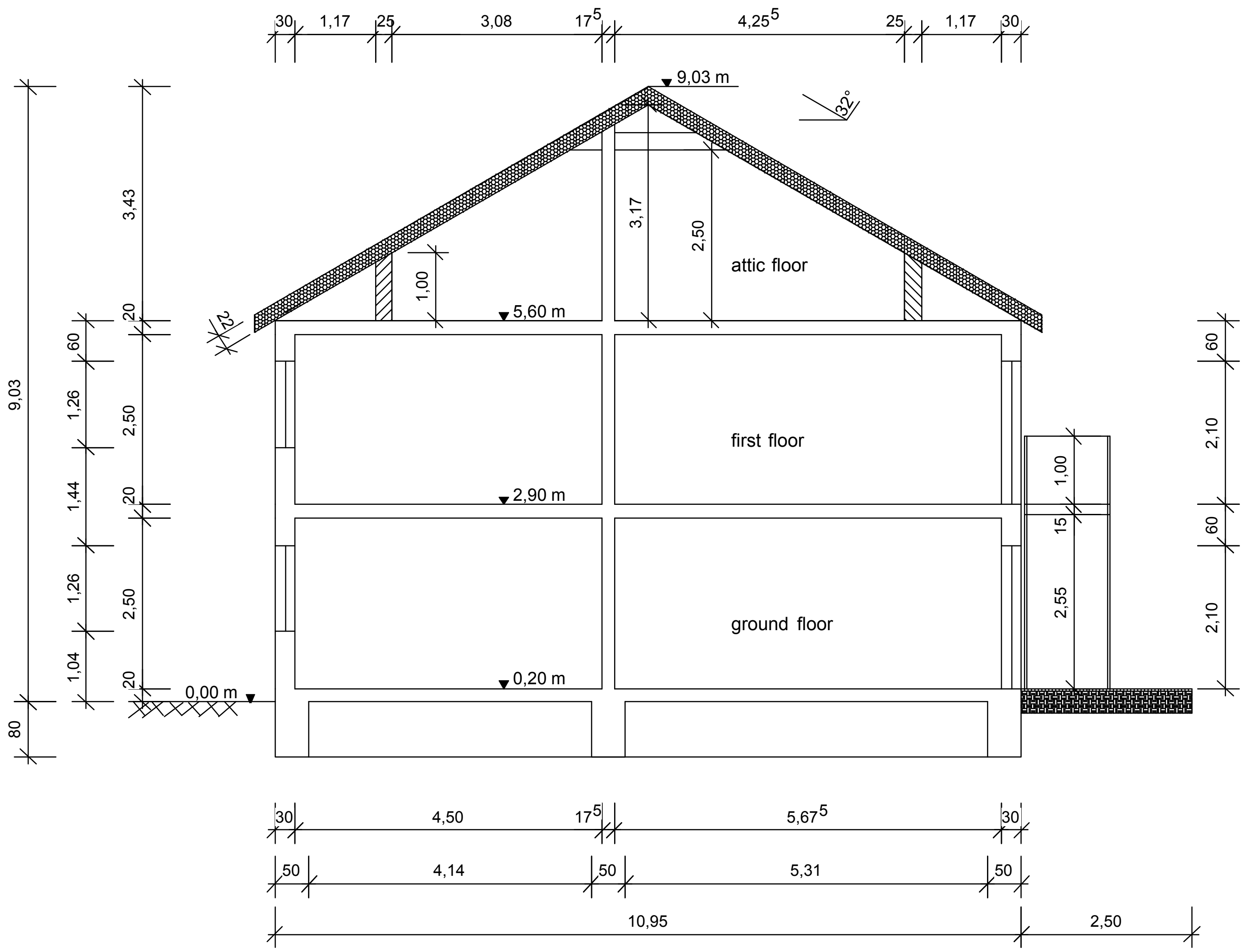
IWU 2008

Building	END-TERRACE HOUSE
Plan	**Elevation East**
Scale	1:100
Date	Jan 2008



IWU 2008

Building	END-TERRACE HOUSE
Plan	**Elevation South**
Scale	1:100
Date	Jan 2008



IWU 2008

Building	END-TERRACE HOUSE
Plan	**Section A - A**
Scale	1:100
Date	Jan 2008

Appendix 1b: Detailed envelope area calculation (external dimensions)

	name area element (free)	further specification / location	dedicated envelope area type	dedicated orientation for windows	reduction area: insert "R"	width	length	height	gross surface area	net surface area
						[m]	[m]	[m]	[m²]	[m²]
1.	floor above soil		floor			6,605	10,95			72,3
2.	wall N	front side	wall				6,605	5,86	38,7	30,0
3.	door N	front side	door		R	0,90		2,10		1,9
4.	window N 1	North / ground floor	window	N	R	2,20		1,26		2,8
5.	window N 2	North / ground floor	window	N	R	0,40		0,51		0,2
6.	window N 3	North / first floor	window	N	R	2,20		1,26		2,8
7.	window N 4	North / first floor	window	N	R	0,70		1,26		0,9
8.	window N 5	North / first floor	window	N	R	0,40		0,51		0,2
9.	wall S	South	wall				6,605	5,86	38,7	25,9
10.	window S 1	South / ground floor	window	S	R	1,90		2,10		4,0
11.	window S 2	South / ground floor	window	S	R	1,60		1,26		2,0
12.	window S 3	South / first floor	window	S	R	1,10		1,26		1,4
13.	window S 4	South / first floor	window	S	R	0,80		2,10		1,7
14.	window S 5	South / first floor	window	S	R	1,60		1,26		2,0
15.	window S 6	South / first floor	window	S	R	0,80		2,10		1,7
16.	wall E 1	East / ground floor + first floor	wall				10,95	5,86	64,2	60,1
17.	window E 1	East / ground floor	window	E	R		1,08	1,26		1,4
18.	window E 2	East / ground floor	window	E	R		1,08	1,26		1,4
19.	window E 3	East / first floor	window	E	R		1,08	1,26		1,4
20.	wall E 2	East / attic floor	wall				10,95	1,585		17,4
21.	roof N	North	roof			6,605	6,461		42,7	41,1
22.	skylight window N 1	North	window	N_45	R	0,51	0,50			0,3
23.	skylight window N 2	North	window	N_45	R	1,01	1,26			1,3
24.	roof S	South	roof			6,605	6,461		42,7	41,4
25.	skylight window S	South	window	S_45	R	1,01	1,26			1,3
									Gesamt thermische Hülle:	**316,6**

Appendix 1c: Definition of the supply system types

Explanation of table colours:

green	= basic definition of the system
blue	= to be used only if necessary; if not compatible to the national definitions or values the most similar ones were to be used

Variants basis, hg-cond, hg-pellet, hg-hp, dhw-el, dhw-sol

variant						
variant N°	**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**
variant name	**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system
short description	low temperature boiler	condensing boiler	wood pellet boiler	electric heat pump	decentral electric	thermal solar system
building						
thermal envelope						
envelope surface area	**definition see plans (+ table with outside envelope areas, if app**					
thermal bridges	no relevant constructive thermal bridges					
air-tightness	no blower door measurement	no blower door measurement	no blower door measurement	no blower door measurement	no blower door measurement	no blower door measurement
solar gains						
total solar energy transmittance (for radiation perpendicular to the gl	0,6					
external shading correction factor (all directions)	0,6					
alternatively: horizon angle	*30°*					
frame area fraction of windows	0,3					
heating system						
heat generation (heating)						
type	**low temperature boiler (not condensing)**	**condensing boiler**	**pellet boiler**	**electric heat pump (soil/water)**	**= var. 1-0**	**= var. 1-0**
energy carrier	natural gas	natural gas	wood pellets	electricity	= var. 1-0	= var. 1-0
location	central heating room (attic)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control temperature	adjusted in dependence of outdoor temperature	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
further specification	maximum values for supply / return temperature: 70°C / 55°C	= var. 1-0	= var. 1-0	maximum values for supply / return temperature: 55°C / 45°C	= var. 1-0	= var. 1-0
thermal power	18 kW	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heat distribution (heating)						
type	**water pipes**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**
location	completely inside of the thermal envelope, vertical central string	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control temperature	control of heat distribution temperature according to outdoor air temperature	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
electric consumption pump	electric power = 80 W / running time = 18 h/d x 365 d/a	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heating pipes (if detailed input required)						
string 1	main string / heating room	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 2 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	20 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,20 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 2	main string / vertical	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 6 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	20 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,20 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 3	distribution in rooms	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 60 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	-	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,40 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heat emission (heating)						
type	radiators	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control	thermostatic valves (regulation range: 2K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0

variant						
variant N°	**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**
variant name	**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**
variant type	basis	variation heat generator	variation heat generator	variation heat generator	variation hot water system	variation hot water system
short description	low temperature boiler	condensing boiler	wood pellet boiler	electric heat pump	decentral electric	thermal solar system
hot water system						
heat generation						
type	combined with heat generator for space heating (see above)	combined with heat generator for space heating (see above)	combined with heat generator for space heating (see above)	combined with heat generator for space heating (see above)	**electric water heaters**	combined with heat generator for space heating (see above) **+ additional thermal solar system**
energy carrier	(see above)	(see above)	(see above)	(see above)	**electricity**	(see above)
location	(see above)	(see above)	(see above)	(see above)	inside thermal envelope	(see above)
further specification						
heat storage						
type	**hot water storage**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**none**	**= var. 1-0**
location	central heating room (attic)	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
volume	120 liter	= var. 1-0	= var. 1-0	= var. 1-0	-	400 liter
heat loss per day	1,75 kWh/d	= var. 1-0	= var. 1-0	= var. 1-0	-	2,6 kWh/d
heat distribution						
type	**without hot water circulation**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**without hot water circulation**	**= var. 1-0**
location	completely inside of the thermal envelope, vertical central string	= var. 1-0	= var. 1-0	= var. 1-0	in the kitchen and in the bathroom	= var. 1-0
temperature	60°C	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
electric consumption pump	-	= var. 1-0	= var. 1-0	= var. 1-0	none	= var. 1-0
heating pipes (if detailed input required)						
string 1	main string / heating room	= var. 1-0	= var. 1-0	= var. 1-0	none	= var. 1-0
pipe length	2 m	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
insulation thickness	10 mm	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
alternatively: U-value	0,30 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
string 2	main string / vertical	= var. 1-0	= var. 1-0	= var. 1-0	none	= var. 1-0
pipe length	6 m	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
insulation thickness	10 mm	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
alternatively: U-value	0,30 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
string 3	distribution in kitchen and in bathroom / WC	= var. 1-0	= var. 1-0	= var. 1-0	distribution in kitchen and in bathroom / WC	= var. 1-0
pipe length	10 m	= var. 1-0	= var. 1-0	= var. 1-0	10 m	= var. 1-0
insulation thickness	-	= var. 1-0	= var. 1-0	= var. 1-0	-	= var. 1-0
alternatively: U-value	0,40 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	0,40 W/(m²K)	= var. 1-0
ventilation system						
type	none	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
specification	none	none	none	none	none	none

Variants basis, sys-el, vent-exh, vent-rec, sys-cond/sol/rec

variant					
variant N°	**1-0**	**1-31**	**1-41**	**1-42**	**1-51**
variant name	**basis**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**
variant type	basis	variation heating & hot water system	variation ventilation	variation ventilation	variation heating & hot water system
short description	low temperature boiler	electric resistance system	exhaust ventilation system	ventilation system with heat recovery	condensing boiler + solar dhw system + ventilation system with heat recovery
building					
thermal envelope					
envelope surface area	**definition see plans (+ table with outside envelope areas, if applicable)**				
thermal bridges	no relevant constructive thermal bridges				
air-tightness	no blower door measurement	no blower door measurement	blower door measurement: n50 ≤ 1,5 h^{-1}	blower door measurement: n50 ≤ 1,5 h^{-1}	blower door measurement: n50 ≤ 1,5 h^{-1}
solar gains					
total solar energy transmittance (for radiation perpendicular to the gl	0,6				
external shading correction factor (all directions)	0,6				
alternatively: horizon angle	*30°*				
frame area fraction of windows	0,3				
heating system					
heat generation (heating)					
type	**low temperature boiler (not condensing)**	**eletric heated water storage**	**= var. 1-0**	**= var. 1-0**	**condensing boiler**
energy carrier	natural gas	electricity	= var. 1-0	= var. 1-0	natural gas
location	central heating room (attic)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control temperature	adjusted in dependence of outdoor temperature	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
further specification	maximum values for supply / return temperature: 70°C / 55°C	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
thermal power	18 kW	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heat distribution (heating)					
type	**water pipes**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**
location	completely inside of the thermal envelope, vertical central string	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control temperature	control of heat distribution temperature according to outdoor air temperature	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
electric consumption pump	electric power = 80 W / running time = 18 h/d x 365 d/a	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heating pipes (if detailed input required)					
string 1	main string / heating room	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 2 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	20 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,20 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 2	main string / vertical	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 6 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	20 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,20 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 3	distribution in rooms	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 x 60 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	-	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,40 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heat emission (heating)					
type	radiators	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
control	thermostatic valves (regulation range: 2K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0

variant					
variant N°	**1-0**	**1-31**	**1-41**	**1-42**	**1-51**
variant name	**basis**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**
variant type	basis	variation heating & hot water system	variation ventilation	variation ventilation	variation heating & hot water system
short description	low temperature boiler	electric resistance system	exhaust ventilation system	ventilation system with heat recovery	condensing boiler + solar dhw system + ventilation system with heat recovery
hot water system					
heat generation					
type	combined with heat generator for space heating (see above)	combined with heat generator for space heating (see above)	= var. 1-0	= var. 1-0	combined with heat generator for space heating (see above) **+ additional thermal solar system**
energy carrier	(see above)	(see above)	= var. 1-0	= var. 1-0	(see above)
location	(see above)	(see above)	= var. 1-0	= var. 1-0	(see above)
further specification					
heat storage					
type	**hot water storage**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**
location	central heating room (attic)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
volume	120 liter	= var. 1-0	= var. 1-0	= var. 1-0	400 liter
heat loss per day	1,75 kWh/d	= var. 1-0	= var. 1-0	= var. 1-0	2,6 kWh/d
heat distribution					
type	**without hot water circulation**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**	**= var. 1-0**
location	completely inside of the thermal envelope, vertical central string	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
temperature	60°C	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
electric consumption pump	-	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
heating pipes (if detailed input required)					
string 1	main string / heating room	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	2 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	10 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,30 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 2	main string / vertical	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	6 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	10 mm	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,30 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
string 3	distribution in kitchen and in bathroom / WC	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
pipe length	10 m	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
insulation thickness	-	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
alternatively: U-value	0,40 W/(m²K)	= var. 1-0	= var. 1-0	= var. 1-0	= var. 1-0
ventilation system					
type	none	= var. 1-0	**exhaust ventilation system**	**ventilation system with heat recovery**	**ventilation system with heat recovery**
specification	none	none	DC fan	heat recovery 80%, DC fan	heat recovery 80%, DC fan

Appendix 1d: Country sheets

Applied method

Country	**Germany**
Region	**whole country**

Type of requirements / method used to proof the compliance

Calculation according to the German Energy Saving Ordinance (Energieeinsparverordnung EnEV 2007)
simplified method (EnEV vereinfachtes Verfahren)
calculation building: seasonal balance (according to DIN V 4108-6)
calculation system: table values (according to DIN V 4701-10 Annex C)

Requirements to be complied: maximum values for thermal transmittance and primary energy demand

Requirements in force since: October 2007

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond / sol / rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,18**	**0,2**	**0,33**	**0,33**	**0,18**	**0,2**	**-**	**0,18**	**0,33**	**0,33**	**[W/(m²K)]**
walls	external air	**0,4**	**0,46**	**0,5**	**0,5**	**0,35**	**0,48**	**-**	**0,35**	**0,5**	**0,5**	**[W/(m²K)]**
windows	external air	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**-**	**1,5**	**1,5**	**1,5**	**[W/(m²K)]**
door	external air	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**-**	**2,0**	**2,0**	**2,0**	**[W/(m²K)]**
floor above soil	soil	**0,35**	**0,35**	**0,5**	**0,5**	**0,3**	**0,35**	**-**	**0,35**	**0,5**	**0,5**	**[W/(m²K)]**
Restricting limit		maximum primary energy demand	maximum primary energy demand	maximum heat transfer coefficient	maximum heat transfer coefficient	maximum primary energy demand	maximum primary energy demand	-	maximum primary energy demand	maximum heat transfer coefficient	maximum heat transfer coefficient	
Remarks								realisation practically not possible (compliance only by inserting U-values < 0,10 W/(m²K))				

Mean heat transmission losses (basis for cross country comparison)

Element	Element area (external dimensions) (only for cross-country comparison)	Correction factor	**Simplified heat transfer coefficient**										
	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	14,9	16,5	27,2	27,2	14,9	16,5	-	14,9	27,2	27,2	
walls	133,4	1	53,4	61,4	66,7	66,7	46,7	64,0	-	46,7	66,7	66,7	
windows	26,5	1	39,8	39,8	39,8	39,8	39,8	39,8	-	39,8	39,8	39,8	
door	1,9	1	3,8	3,8	3,8	3,8	3,8	3,8	-	3,8	3,8	3,8	
floor above soil	72,3	0,6	15,2	15,2	21,7	21,7	13,0	15,2	-	15,2	21,7	21,7	
sum	317		127	137	159	159	118	139	0	120	159	159	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,40**	**0,43**	**0,50**	**0,50**	**0,37**	**0,44**	**-**	**0,38**	**0,50**	**0,50**	**[W/(m²K)]**

Applied method

Country	**Austria**
Region	**whole country**

Type of requirements / method used to proof the compliance

In Austria the relevant regulation is the net energy demand for heating per m² depending on the proportion of building volume to building survace (lc = V/A). The requirements are regulated in the OIB directive 6 "Energieeinsparung und Wärmeschutz" from April 2007 and are calculated with a reference climate with 3.400 degree days. The calculation method is defined in the Austrian Standard ÖNORM B 8110-6, which is based on the ISO EN 13790.. Main estimations, which were not provided: "heavy construction" (brick or concrete) and air exchange rate 0,4/h with window ventilation. The heating system has no influence on the U-Values.
The current requirement (until 31.12.2009): HWB = 26 * (1 + 2/lc).
The data of the model building: lc = 1,69m; HWB < 56,76 kWh/m²a.

Requirements in force since April 2007

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond / sol / rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**[W / (m²K)]**
walls	external air	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**[W / (m²K)]**
windows	external air	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**1,4**	**[W / (m²K)]**
door	external air	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**[W / (m²K)]**
floor above soil	soil	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**0,4**	**[W / (m²K)]**
Restricting limit		net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	net energy demand for heating	
Remarks												

Mean heat transmission losses (basis for cross country comparison)

Element	Element area (external dimensions) (only for cross-country comparison)	Correction factor	**Simplified heat transfer coefficient**										
	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	16,5	16,5	16,5	16,5	16,5	16,5	16,5	16,5	16,5	16,5	
walls	133,4	1	46,7	46,7	46,7	46,7	46,7	46,7	46,7	46,7	46,7	46,7	
windows	26,5	1	37,1	37,1	37,1	37,1	37,1	37,1	37,1	37,1	37,1	37,1	
door	1,9	1	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	
floor above soil	72,3	0,6	17,4	17,4	17,4	17,4	17,4	17,4	17,4	17,4	17,4	17,4	
sum	317		121	121	121	121	121	121	121	121	121	121	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**[W / (m²K)]**

Applied method

Country	**Czech Republic**
Region	**whole country**
Type of requirements / method used to proof the compliance	Calculation method according to the requirements of the Act no. 406/2000 Coll. on Energy Management, its amendment no. 177/2006 Coll. as amended by no. 406/2006 Coll. and the Code of Practice no. 148/2007 Coll. on Energy Demand of Buildings as amended. A specific technical regulation in this field is the Czech standard ČSN 73 0540 "Thermal Protection of Buildings" (and a set of relevant standards), which the abovementioned statutes are related to and make its requirements binding. Valid requirements for U values are set forth in the second part of the standard i.e. in ČSN 73 0540-2 as of April 2007. Two groups of U values are prescribed: recommended values and required values. Required U-values were used in this table.
Requirements in force since	April 2007

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**[W/(m²K)]**
walls	external air	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**0,38**	**[W/(m²K)]**
windows	external air	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**1,7**	**[W/(m²K)]**
door	external air	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**3,5**	**[W/(m²K)]**
floor above soil	soil	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**[W/(m²K)]**
Restricting limit		U-values	U-values	U-values	U-values	U-values	U-values	U-values	U-values	U-values	U-values	
Remarks												

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	**Simplified heat transfer coefficient**										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	19,8	19,8	19,8	19,8	19,8	19,8	19,8	19,8	19,8	19,8	
walls	133,4	1	50,7	50,7	50,7	50,7	50,7	50,7	50,7	50,7	50,7	50,7	
windows	26,5	1	45,1	45,1	45,1	45,1	45,1	45,1	45,1	45,1	45,1	45,1	
door	1,9	1	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	
floor above soil	72,3	0,6	19,5	19,5	19,5	19,5	19,5	19,5	19,5	19,5	19,5	19,5	
sum	317		142	142	142	142	142	142	142	142	142	142	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**0,45**	**[W/(m²K)]**

Applied method

Country	**Poland**
Region	**whole country**
Type of requirements / method used to proof the compliance	Values defined in "Technical conditions to be fulfilled by new and modernised buildings". There are no differences in required U values for different types of heating, but there are differences between rooms with different internal temperature. Ex. different type of living rooms that computational temperature is over 16 C, for other room (like halls, staircases, cellars) it is between 8 an 16 C.
Requirements in force since	October 2002

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**[W/(m²K)]**
walls	external air	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**	**[W/(m²K)]**
windows	external air	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**2,0**	**[W/(m²K)]**
door	external air	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**2,6**	**[W/(m²K)]**
floor above soil	soil	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**0,6**	**[W/(m²K)]**
Restricting limit												
Remarks		there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	there is no differences of required U-value in relation to the heating system	

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	24,8	24,8	24,8	24,8	24,8	24,8	24,8	24,8	24,8	24,8	
walls	133,4	1	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	
windows	26,5	1	53,0	53,0	53,0	53,0	53,0	53,0	53,0	53,0	53,0	53,0	
door	1,9	1	4,9	4,9	4,9	4,9	4,9	4,9	4,9	4,9	4,9	4,9	
floor above soil	72,3	0,6	26,0	26,0	26,0	26,0	26,0	26,0	26,0	26,0	26,0	26,0	
sum	317		149	149	149	149	149	149	149	149	149	149	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**0,47**	**[W/(m²K)]**

Applied method

Country	**Sweden**
Region	**Lund**
Type of requirements / method used to proof the compliance	From the Swedish regulation for building (Regelsamling för byggande - Boverkets byggregler, BBR, 2006) Requirements for housing Maximum specific energy consumption 110 kWh/m2 floor area (internal) in south Sweden, 130 kWh/m2 floor area (internal) in north Sweden. Household electricity is not included in the specific energy consumption. For one ore two family houses with direct-acting electric heating system is the requirement for maximum specific energy consumption 75 kWh/m2 floor area (internal) in south Sweden, 95 kWh/m2 floor area (internal) in north Sweden. Household electricity is not included in the specific energy consumption. Maximum Um for the total building 0,50 W/m2K Minimum ventilation 0,35 l/s m2
Requirements in force since	2006

Resulting U-values

		1-0	1-11	1-12	1-13	1-21	1-22	1-31	1-41	1-42	NEW	
Variant N° variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,16**	**0,16**	**0,16**	**0,3**	**0,03**	**0,3**	**0,03**	**0,3**	**0,3**	**0,3**	**[W/(m²K)]**
walls	external air	**0,21**	**0,21**	**0,21**	**0,34**	**0,04**	**0,34**	**0,04**	**0,34**	**0,34**	**0,34**	**[W/(m²K)]**
windows	external air	**1,2**	**1,2**	**1,2**	**1,5**	**0,8**	**1,5**	**0,8**	**1,5**	**1,5**	**1,5**	**[W/(m²K)]**
door	external air	**1,1**	**1,1**	**1,1**	**2,0**	**0,8**	**2,0**	**0,8**	**2,0**	**2,0**	**2,0**	**[W/(m²K)]**
floor above soil	soil	**0,16**	**0,16**	**0,16**	**0,47**	**0,01**	**0,27**	**0,01**	**0,47**	**0,47**	**0,47**	**[W/(m²K)]**
Restricting limit		Maximum specific energy consumption 110 kWh/m2 floor area			Maximum Um for the total building 0,50 W/m2K		Maximum specific energy consumption 110 kWh/m2 floor area	Electric heating system with maximum specific energy consumption requirement 75 kWh/m2 floor area	Maximum Um for the total building 0,50 W/m2K	Maximum Um for the total building 0,50 W/m2K and maximum specific energy consumption 110 kWh/m2 floor area	Maximum Um for the total building 0,50 W/m2K	
Remarks		calculated energy consumption for the building 110 kWh/m2. With exhaust ventilation system	Same as 1-0	Same as 1-0	calculated energy consumption for the building 78 kWh/m2. heat pump	Same as 1-31	Solar energy is "free" energy. Calculated energy consumption for the building 107 kWh/m2,. With exhaust ventilation system	calculated energy consumption for the building 76 kWh/m2. With exhaust ventilation system. This type of house is not realistic – it needs a heat pump for heat recovery	calculated energy consumption for the building 98 kWh/m2. With exhaust air heat pump	calculated energy consumption for the building 108 kWh/m2. With balansed ventilation, mechanical supply and exhaust ventilation		

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	13,2	13,2	13,2	24,8	2,5	24,8	2,5	24,8	24,8	24,8	
walls	133,4	1	28,0	28,0	28,0	45,4	5,3	45,4	5,3	45,4	45,4	45,4	
windows	26,5	1	31,8	31,8	31,8	39,8	21,2	39,8	21,2	39,8	39,8	39,8	
door	1,9	1	2,1	2,1	2,1	3,8	1,5	3,8	1,5	3,8	3,8	3,8	
floor above soil	72,3	0,6	6,9	6,9	6,9	20,4	0,4	11,7	0,4	20,4	20,4	20,4	
sum	317		82	82	82	134	31	125	31	134	134	134	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,26**	**0,26**	**0,26**	**0,42**	**0,10**	**0,40**	**0,10**	**0,42**	**0,42**	**0,42**	**[W/(m²K)]**

Applied method

Country	**Denmark**
Region	**whole country**

Type of requirements / method used to proof the compliance

Monthly calculation according to the SBi direction 213, Calculation of buildings energy demand.
- heating demand is based on prEN ISO 13790:2005, which elaborates on EN 832 and EN ISO 13790.
- heat loss from installations is calculated as defined in prEN 15316 part 2.3 og part 3.2.
- boilers is calculated according to prEN 15316 part 4.1 methode II and part 3.3.
- calculation tool: Be06, version 2,7,5,3

Requirements to be complied: maximum primary energy demand, maximum values for overall thermal transmittance and maximum U-values for constructions.

This new building must have an energy consumption less than 70+2200/A, having a dimensioning transmission loss less than 8 W/m² through the thermal envelope or meet maximum U-values for the constructions.

Requirements in force since: January 2006

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	-	**0,25**	**0,25**	**0,25**	**0,25**	**0,25**	**0,15**	**0,25**	**0,25**	**0,25**	**[W/(m²K)]**
walls	external air	-	**0,28**	**0,28**	**0,28**	**0,28**	**0,28**	**0,18**	**0,28**	**0,28**	**0,28**	**[W/(m²K)]**
windows	external air	-	**1,51**	**1,51**	**1,51**	**1,51**	**1,51**	**1,51**	**1,51**	**1,51**	**1,51**	**[W/(m²K)]**
door	external air	-	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**[W/(m²K)]**
floor above soil	soil	-	**0,3**	**0,3**	**0,3**	**0,2**	**0,3**	**0,17**	**0,3**	**0,3**	**0,3**	**[W/(m²K)]**
Restricting limit		-	overall dimensioning transmission loss (8 W/m² thermal envelope)	overall dimensioning transmission loss (8 W/m² thermal envelope)	overall dimensioning transmission loss (8 W/m² thermal envelope)	maximum primary energy demand	overall dimensioning transmission loss (8 W/m² thermal envelope)	maximum primary energy demand	overall dimensioning transmission loss (8 W/m² thermal envelope)	overall dimensioning transmission loss (8 W/m² thermal envelope)	overall dimensioning transmission loss (8 W/m² thermal envelope)	
Remarks		Non-condensing gas boiler is illegal in Denmark, variation 1-11 is thus used as base case for the other calculations.	Overall dimensioning transmission loss ≤ 8.0 W/m²K, incl. thermal bridges	Estimated efficiency of pellet burner is 80 % for full and part load.			Fulfills the requirement for Low Energy class 2, which is approx. 25 % better than minimum Building Regulation requirement.		Exhaust ventilation air flow of 50 l/s (2 toilets and 1 kitchen) and infiltration of 0,13 l/s m².	Heat recovery efficiency 65%. Same ventilation rate as variant 1-41	Fulfills the requirement for Low Energy class 2, which is approx. 25 % better than minimum Building Regulation requirement.	

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient									
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]
roof	82,5	1	-	20,6	20,6	20,6	20,6	20,6	12,4	20,6	20,6	20,6
walls	133,4	1	-	37,4	37,4	37,4	37,4	37,4	24,0	37,4	37,4	37,4
windows	26,5	1	-	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0
door	1,9	1	-	2,9	2,9	2,9	2,9	2,9	2,9	2,9	2,9	2,9
floor above soil	72,3	0,6	-	13,0	13,0	13,0	8,7	13,0	7,4	13,0	13,0	13,0
sum	317		0	114	114	114	110	114	87	114	114	114
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**-**	**0,36**	**0,36**	**0,36**	**0,35**	**0,36**	**0,27**	**0,36**	**0,36**	**0,36**

[W/(m²K)]

Applied method

Country	**UK**
Region	**England & Wales**
Type of requirements / method used to proof the compliance	SAP 2005 (www.bre.co.uk/sap2005) Seasonal energy balance Requirements to be complied with: maximum CO2 emissions, maximum U-values, minimum heating efficiency
Requirements in force since	2005

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	-	**0,16**	**0,25**	**0,25**	**0,16**	**0,25**	**0,16**	**0,2**	**0,25**	**0,25**	**[W/(m²K)]**
walls	external air	-	**0,33**	**0,35**	**0,35**	**0,22**	**0,35**	**0,21**	**0,35**	**0,35**	**0,35**	**[W/(m²K)]**
windows	external air	-	**1,8**	**2,2**	**2,2**	**1,5**	**2,2**	**1,5**	**1,8**	**2,2**	**2,2**	**[W/(m²K)]**
door	external air	-	**2,0**	**2,2**	**2,2**	**0,8**	**2,2**	**2,0**	**2,0**	**2,2**	**2,2**	**[W/(m²K)]**
floor above soil	external air	-	**0,22**	**0,25**	**0,25**	**0,2**	**0,25**	**0,2**	**0,23**	**0,25**	**0,25**	**[W/(m²K)]**
Restricting limit			maximum CO2 emissions	maximum U-values of elements	maximum U-values of elements	maximum CO2 emissions	maximum U-values of elements (although only small margin left on CO2 emissions)	maximum CO2 emissions	maximum CO2 emissions	maximum U-values of elements	maximum U-values of elements	
Remarks		not possible - minimum boiler efficiency is 86% (condensing)				condensing boiler; improved thermal bridging	condensing boiler	improved thermal bridging	condensing boiler	condensing boiler	condensing boiler	

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	-	13,2	20,6	20,6	13,2	20,6	13,2	16,5	20,6	20,6	
walls	133,4	1	-	44,0	46,7	46,7	29,3	46,7	28,0	46,7	46,7	46,7	
windows	26,5	1	-	47,7	58,3	58,3	39,8	58,3	39,8	47,7	58,3	58,3	
door	1,9	1	-	3,8	4,2	4,2	1,5	4,2	3,8	3,8	4,2	4,2	
floor above soil	72,3	1	-	15,9	18,1	18,1	14,5	18,1	14,5	16,6	18,1	18,1	
sum	317		0	125	148	148	98	148	99	131	148	148	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**-**	**0,39**	**0,47**	**0,47**	**0,31**	**0,47**	**0,31**	**0,41**	**0,47**	**0,47**	**[W/(m²K)]**

Applied method

Country	**The Netherlands**
Region	**whole country**

Type of requirements / method used to proof the compliance

Energy use calculations for the heating season (October 1 - April 30) according to (for building as well as system):
* Dutch Standard NEN 5128: Energy performance of residential functions and residential buildings - Determination method (NNI, March 2004).
* Dutch Guideline NPR 5129: Energy performance of residential functions and residential buildings - Calculation program (EPW) with handbook (NNI, April 2005).
* EPW for Windows Version 2.02 (NNI, 2006)

Requirements to be met:
* EPC <= 0,8 (EPC = Energy Performance Coefficient, based on primary energy demand), and
* Minimum Rc values (heat resistance) for thermal envelope

Requirements in force since: 2006 (EPC <=0,8), 1992 (Rc >= 2,5 W/(m²K))

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	-	-	-	**0,24**	-	-	-	-	-	**0,24**	**[W/(m²K)]**
walls	external air	-	-	-	**0,24**	-	-	-	-	-	**0,27**	**[W/(m²K)]**
windows	external air	-	-	-	**1,3**	-	-	-	-	-	**1,8**	**[W/(m²K)]**
door	external air	-	-	-	**2,0**	-	-	-	-	-	**2,0**	**[W/(m²K)]**
floor above soil	soil	-	-	-	**0,23**	-	-	-	-	-	**0,23**	**[W/(m²K)]**
Restricting limit		-	-	-	EPC<=0,80	-	-	-	-	-	EPC<=0,80	
Remarks		Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Wood pellet boiler is no option in Dutch calculation software (except for complicated procedure using 'declaration of quality'). Wood pellet boiler not used as primary heat generator in new		Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	Not possible to meet EPC<=0,8. The effect of low performance of heating and ventilation system can not be compensated by improved U-values.	condensing boiler (97,5%) radiators mech. Ventilation + heat recovery (80%) solar collector (2,7 m2) default pipe lengths	

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	-	-	-	19,8	-	-	-	-	-	19,8	
walls	133,4	1	-	-	-	32,0	-	-	-	-	-	36,0	
windows	26,5	1	-	-	-	34,5	-	-	-	-	-	47,7	
door	1,9	1	-	-	-	3,8	-	-	-	-	-	3,8	
floor above soil	72,3	0,6	-	-	-	10,0	-	-	-	-	-	10,0	
sum	317		0	0	0	100	0	0	0	0	0	117	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**-**	**-**	**-**	**0,32**	**-**	**-**	**-**	**-**	**-**	**0,37**	**[W/(m²K)]**

Applied method

Country	**Belgium**
Region	**Flanders**
Type of requirements / method used to proof the compliance	Method described in the decree of the 5th of march 2005. Three requirements are imposed : one limits the annual characteristic primary energy use, a second one limits the average thermal transmitance, and a third one gives the maximal values of the thermal transmittance.
Requirements in force since	2005

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond / sol / rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,19**	**0,4**	**0,09**	**0,4**	**0,11**	**0,31**	**-**	**0,19**	**0,21**	**0,46**	**[W/(m²K)]**
walls	external air	**0,19**	**0,39**	**0,09**	**0,47**	**0,11**	**0,31**	**-**	**0,19**	**0,21**	**0,45**	**[W/(m²K)]**
windows	external air	**1,76**	**1,76**	**1,76**	**1,76**	**1,76**	**1,76**	**-**	**1,76**	**1,76**	**1,76**	**[W/(m²K)]**
door	external air	**2,9**	**2,9**	**2,9**	**2,9**	**2,9**	**2,9**	**-**	**2,9**	**2,9**	**2,9**	**[W/(m²K)]**
floor above soil	external air	**0,35**	**0,35**	**0,35**	**0,4**	**0,35**	**0,35**	**-**	**0,35**	**0,35**	**0,35**	**[W/(m²K)]**
Restricting limit		Primary energy consumption	Primary energy consumption	Primary energy consumption	Average thermal transmitance	Primary energy consumption	Primary energy consumption	Primary energy consumption	Primary energy consumption	Primary energy consumption	Average thermal transmitance	
Remarks		in addition: exhaust air ventilation system (mandatory)	in addition: exhaust air ventilation system (mandatory)	in addition: exhaust air ventilation system (mandatory)	in addition: exhaust air ventilation system (mandatory)	in addition: exhaust air ventilation system (mandatory)	in addition: exhaust air ventilation system (mandatory)	It is not possible to use this system and fullfil requirements , even with a zero average thermal transmitance.	This variant is the same as variant 1-0			

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient										
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	15,7	33,0	7,4	33,0	9,1	25,6	-	15,7	17,3	38,0	
walls	133,4	1	25,3	52,0	12,0	62,7	14,7	41,4	-	25,3	28,0	60,0	
windows	26,5	1	46,6	46,6	46,6	46,6	46,6	46,6	-	46,6	46,6	46,6	
door	1,9	1	5,5	5,5	5,5	5,5	5,5	5,5	-	5,5	5,5	5,5	
floor above soil	72,3	1	25,3	25,3	25,3	28,9	25,3	25,3	-	25,3	25,3	25,3	
sum	317		118	162	97	177	101	144	0	118	123	175	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,37**	**0,51**	**0,31**	**0,56**	**0,32**	**0,46**	**-**	**0,37**	**0,39**	**0,55**	**[W/(m²K)]**

Applied method

Country	**Luxembourg**
Region	**whole country**

Type of requirements / method used to proof the compliance

The calculation has been done according to the Luxembourg "Règlement grand-ducal" (short: RGD) from 30.11.2007 (LuxEeB).
The RDG gives minimum requirements for U-Values, air-tightness, thermal bridges, summer requirements, insulation of pipes for heat transfer / hot water transfer and specific fan power for ventilation. Additionally there are main requirements for the heating and primary energy consumption.

Requirements in force since 2008

Resulting U-values

Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,2**	**0,21**	**0,21**	**0,21**	**0,15**	**0,21**	**-**	**0,21**	**0,25**	**0,25**	**[W/(m²K)]**
walls	external air	**0,24**	**0,25**	**0,25**	**0,25**	**0,19**	**0,25**	**-**	**0,26**	**0,32**	**0,32**	**[W/(m²K)]**
windows	external air	**1,35**	**1,35**	**1,35**	**1,35**	**1,2**	**1,35**	**-**	**1,5**	**1,5**	**1,5**	**[W/(m²K)]**
door	external air	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**-**	**1,5**	**2,0**	**2,0**	**[W/(m²K)]**
floor above soil	external air	**0,3**	**0,3**	**0,3**	**0,3**	**0,25**	**0,3**	**-**	**0,3**	**0,35**	**0,4**	**[W/(m²K)]**
Restricting limit		maximum primery energy demand	maximum heat energy demand	maximum heat energy demand	maximum heat energy demand	maximum primery energy demand	maximum heat energy demand	maximum primery energy demand	maximum primery energy demand	maximum heat transfer coefficient		
Remarks								realisation not possible, only with U-Values < 0,02				

Mean heat transmission losses (basis for cross country comparison)

	Element area (external dimensions) (only for cross-country comparison)	Correction factor	Simplified heat transfer coefficient									
Element	[m²]	[-]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]
roof	82,5	1	16,5	17,3	17,3	17,3	12,4	17,3	-	17,3	20,6	20,6
walls	133,4	1	32,0	33,4	33,4	33,4	25,3	33,4	-	34,7	42,7	42,7
windows	26,5	1	35,8	35,8	35,8	35,8	31,8	35,8	-	39,8	39,8	39,8
door	1,9	1	2,9	2,9	2,9	2,9	2,9	2,9	-	2,9	3,8	3,8
floor above soil	72,3	1	21,7	21,7	21,7	21,7	18,1	21,7	-	21,7	25,3	28,9
sum	317		109	111	111	111	90	111	0	116	132	136
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,34**	**0,35**	**0,35**	**0,35**	**0,29**	**0,35**	**-**	**0,37**	**0,42**	**0,43**

[W/(m²K)]

Applied method

Country	**France**
Region	**Alsace (H1b)**

Type of requirements / method used to proof the compliance

The used method is based on several steps:1) use the "reference" U values of each building fabric component to calculate the building overall Uvalue Ubat 2) make sure the result is lower than 1,2 x the "refrence" Ubat 3) calculate the project consumption (C in kWh/m2 primary energy) and the reference consumption Cref 4) Check compliance in having C < Cref and C < Cepmax which is an absolute figure depending only on the energy and the location 5) depending on the result, iterate by modifying some Uvalues to comply with the "lowest" effort.

Requirements in force since September 2006

Resulting U-values

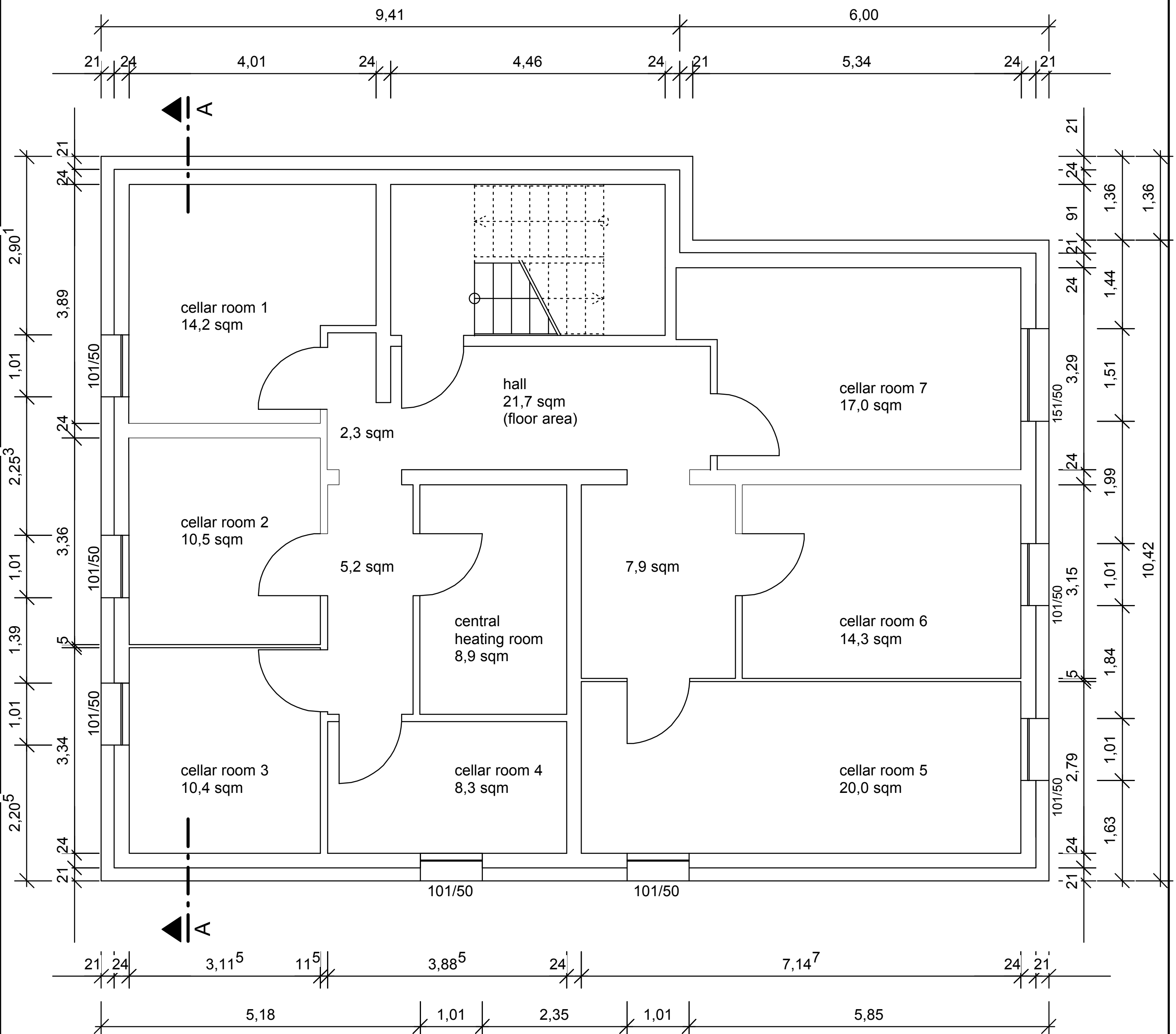
Variant N°		**1-0**	**1-11**	**1-12**	**1-13**	**1-21**	**1-22**	**1-31**	**1-41**	**1-42**	**NEW**	
variant name		**basis**	**hg-cond**	**hg-pellet**	**hg-hp**	**dhw-el**	**dhw-sol**	**sys-el**	**vent-exh**	**vent-rec**	**sys-cond/sol/rec**	
U-values	U-value defined for temperature difference between room and ...											
roof	external air	**0,2**	**0,3**	**0,2**	**0,3**	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**	**0,3**	**[W/(m²K)]**
walls	external air	**0,36**	**0,45**	**0,36**	**0,45**	**0,2**	**0,36**	**0,36**	**0,36**	**0,36**	**0,45**	**[W/(m²K)]**
windows	external air	**1,8**	**1,8**	**1,8**	**2,1**	**1,8**	**1,8**	**1,8**	**1,8**	**1,8**	**2,1**	**[W/(m²K)]**
door	external air	**1,5**	**1,5**	**1,5**	**1,5**	**1,3**	**1,5**	**1,5**	**1,5**	**1,5**	**1,5**	**[W/(m²K)]**
floor above soil	external air	**0,27**	**0,3**	**0,27**	**0,3**	**0,2**	**0,27**	**0,27**	**0,27**	**0,27**	**0,3**	**[W/(m²K)]**
Restricting limit		Cref	Cref	Cref	Ubat ref	Cep max	Cref	Cref	Cref	Cref	Ubat ref	
Remarks						with special treatment of thermal bridges in the case of interior insulation						

Mean heat transmission losses (basis for cross country comparison)

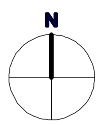
Element	**Element area (external dimensions)** [m²]	**Correction factor** (only for cross-country comparison) [-]	**Simplified heat transfer coefficient** [W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	[W/K]	
roof	82,5	1	16,5	24,8	16,5	24,8	16,5	16,5	16,5	16,5	16,5	24,8	
walls	133,4	1	48,0	60,0	48,0	60,0	26,7	48,0	48,0	48,0	48,0	60,0	
windows	26,5	1	47,7	47,7	47,7	55,7	47,7	47,7	47,7	47,7	47,7	55,7	
door	1,9	1	2,9	2,9	2,9	2,9	2,5	2,9	2,9	2,9	2,9	2,9	
floor above soil	72,3	1	19,5	21,7	19,5	21,7	14,5	19,5	19,5	19,5	19,5	21,7	
sum	317		135	157	135	165	108	135	135	135	135	165	
Mean heat transmission losses per m² envelope (basis: external dimensions, not considering thermal bridges)			**0,43**	**0,50**	**0,43**	**0,52**	**0,34**	**0,43**	**0,43**	**0,43**	**0,43**	**0,52**	**[W/(m²K)]**

Appendix 2: Definition of Model Building 2 – multi-family house

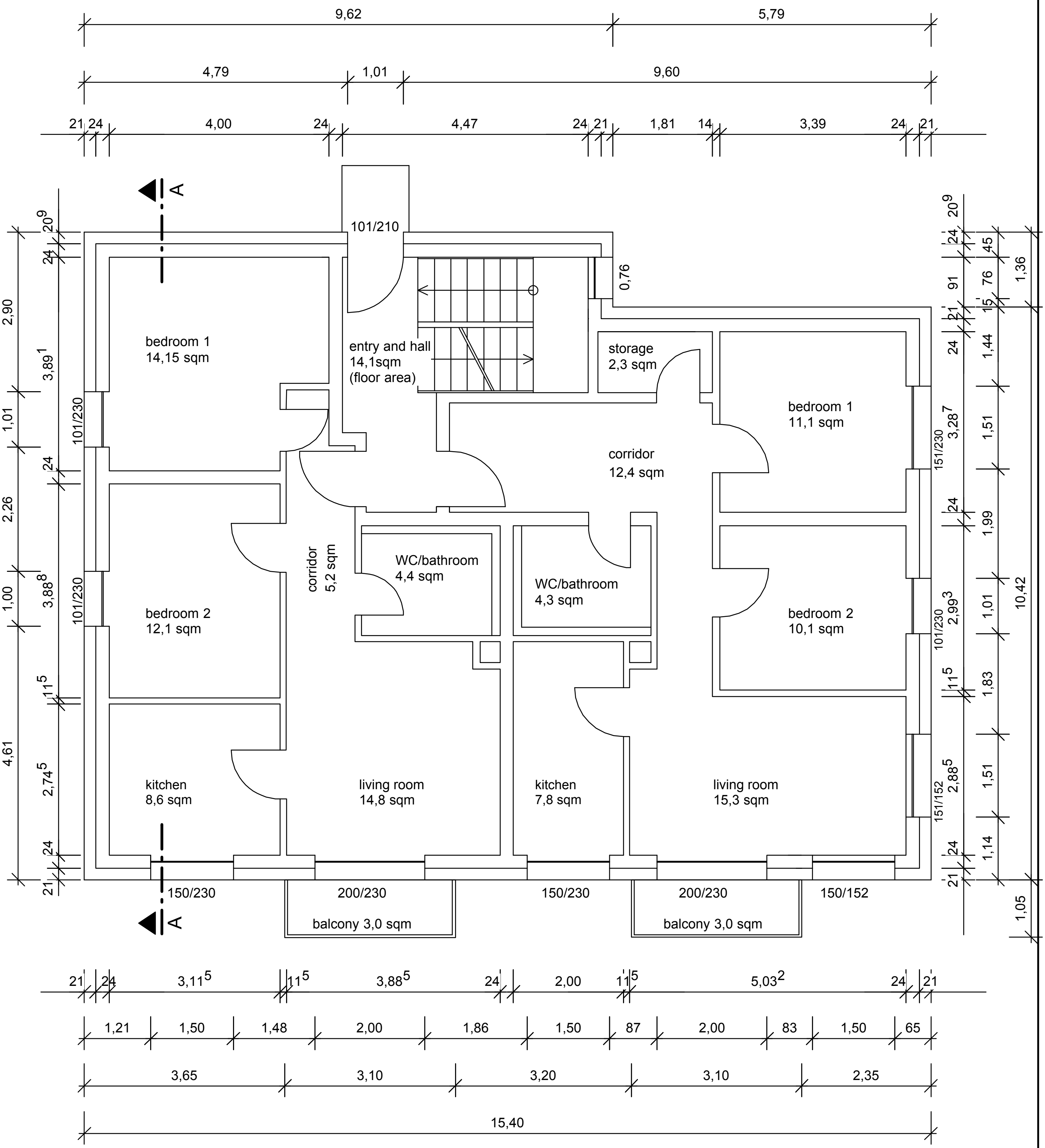
Appendix 2a: Plans



IWU 2008



Building	APARTMENT HOUSE
Floor Plan	**Basement Floor**
Scale	1:100
Date	Jan 2008



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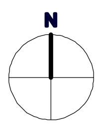
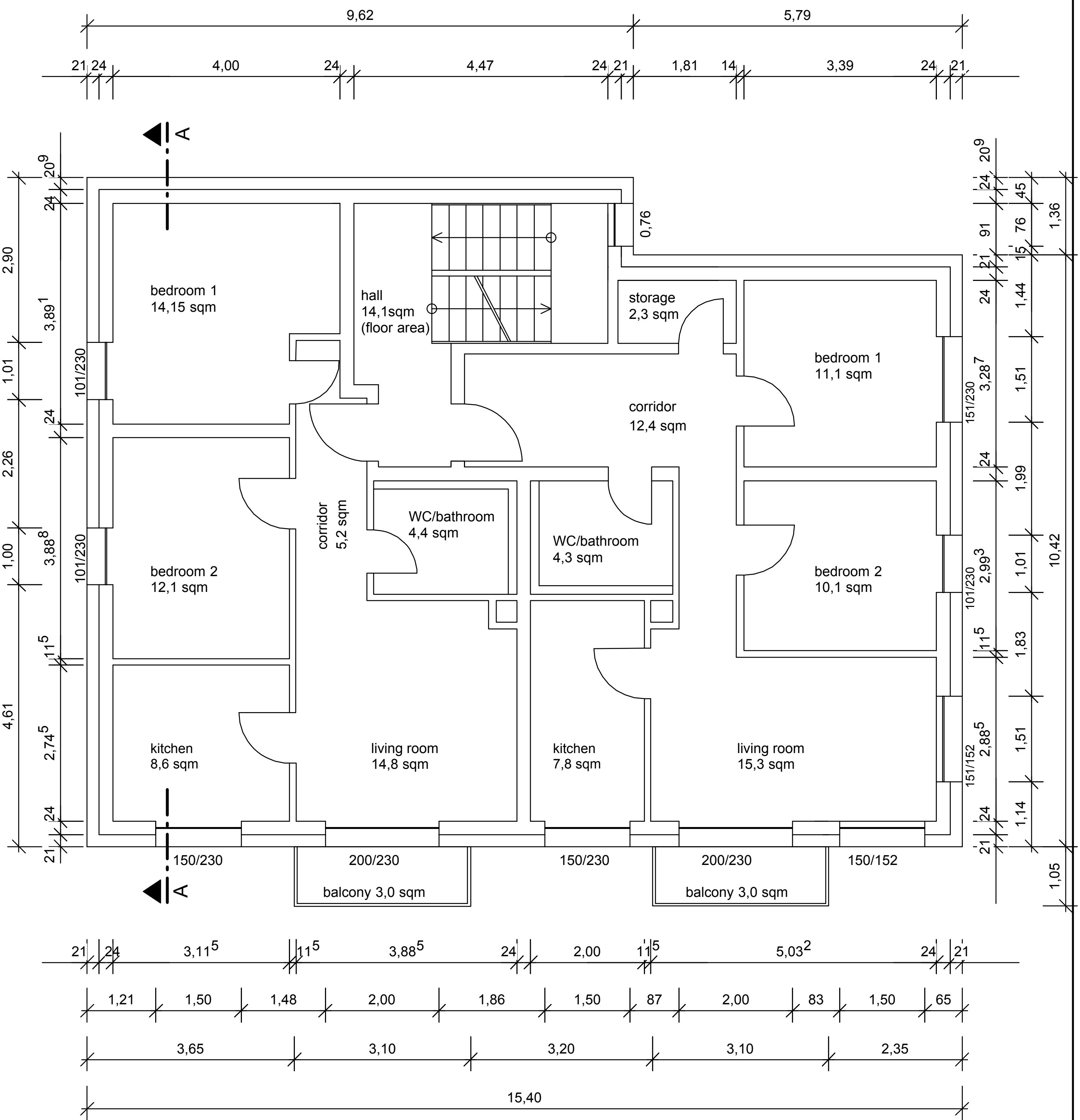


Building	APARTMENT HOUSE
Floor Plan	**Ground Floor**
Scale	1:100
Date	Jan 2008



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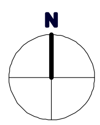
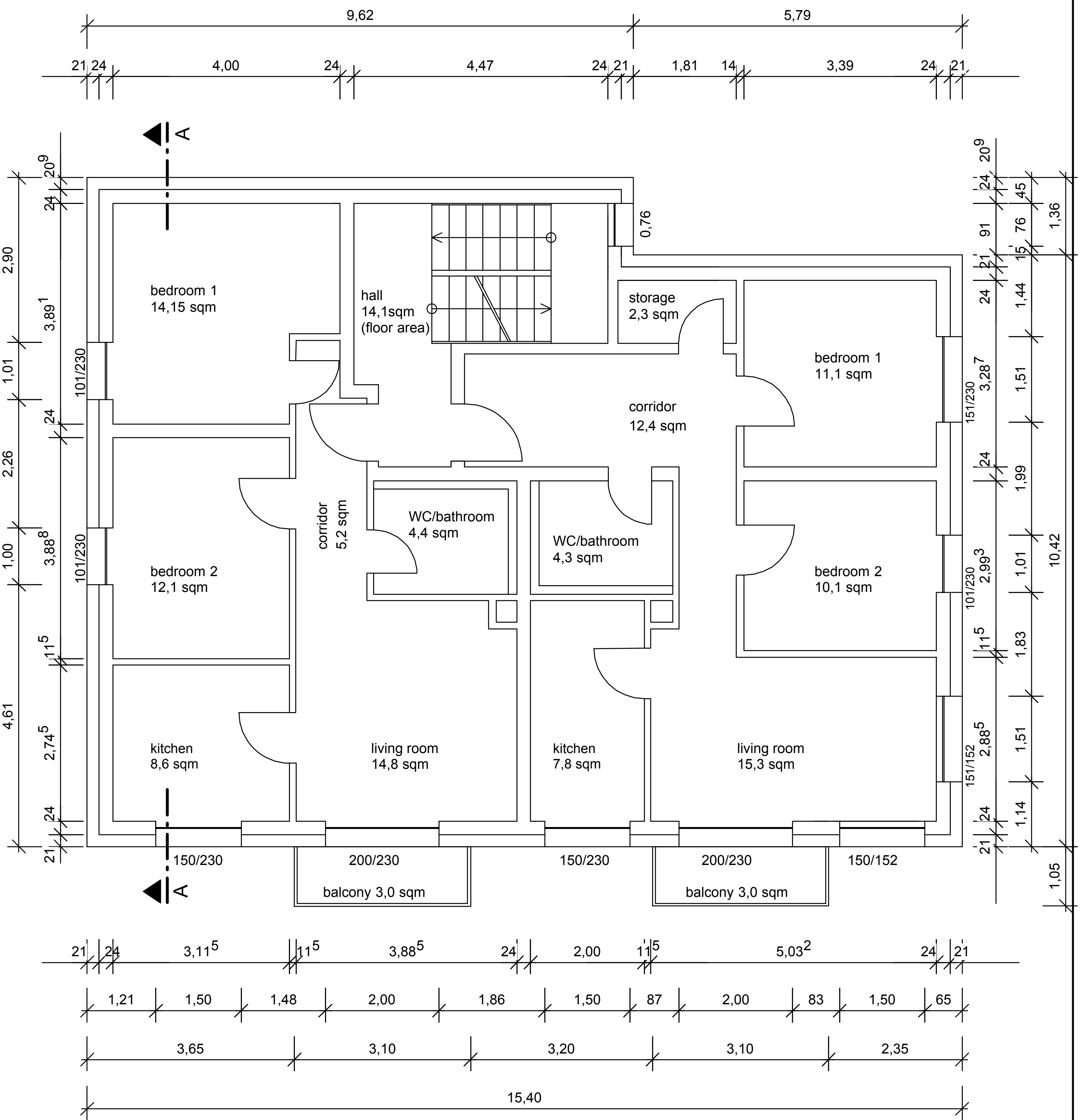


Building	APARTMENT HOUSE
Floor Plan	**First Floor**
Scale	1:100
Date	Jan 2008



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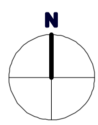
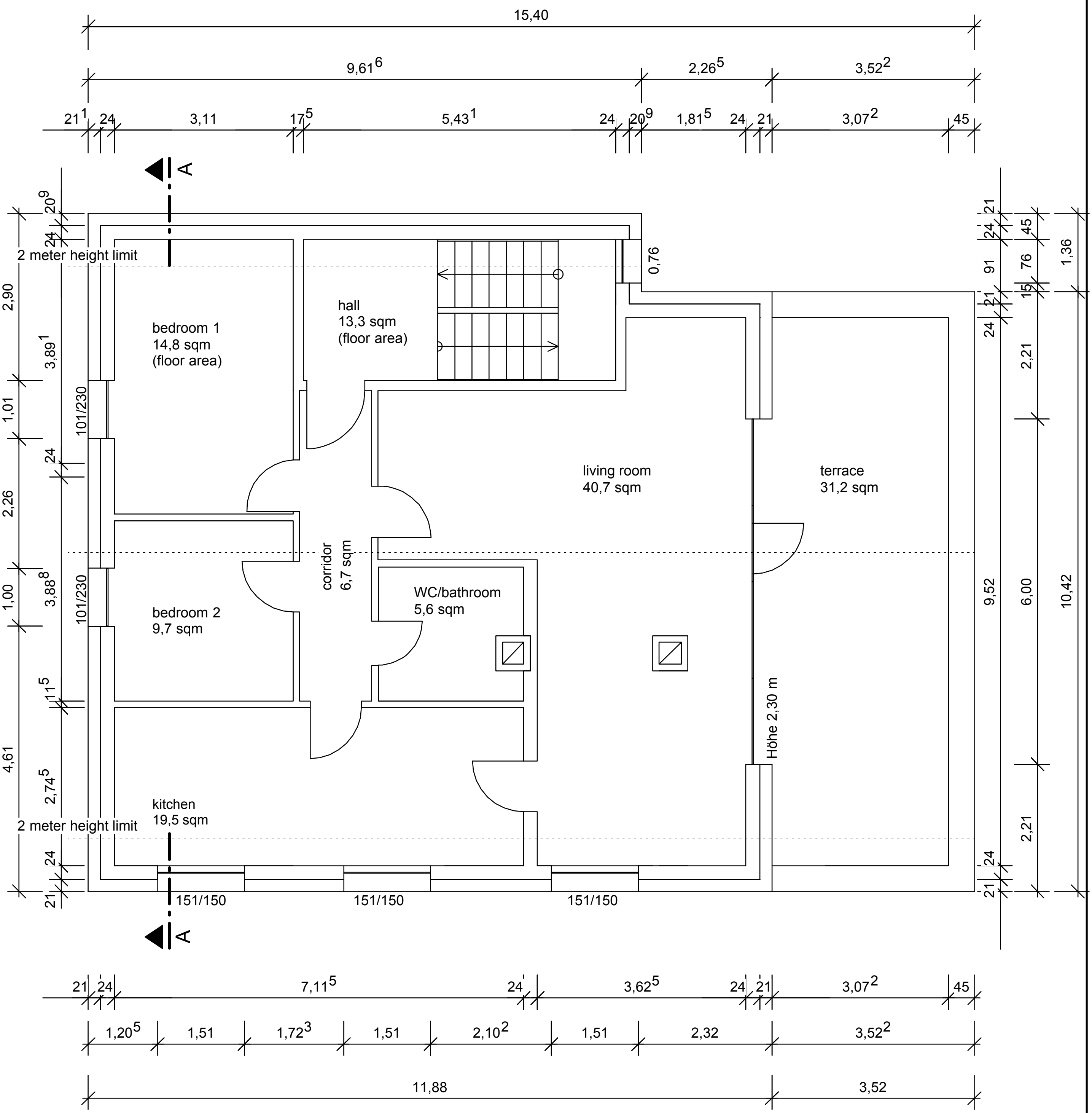


Building	APARTMENT HOUSE
Floor Plan	**Second Floor**
Scale	1:100
Date	Jan 2008



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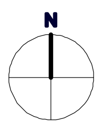
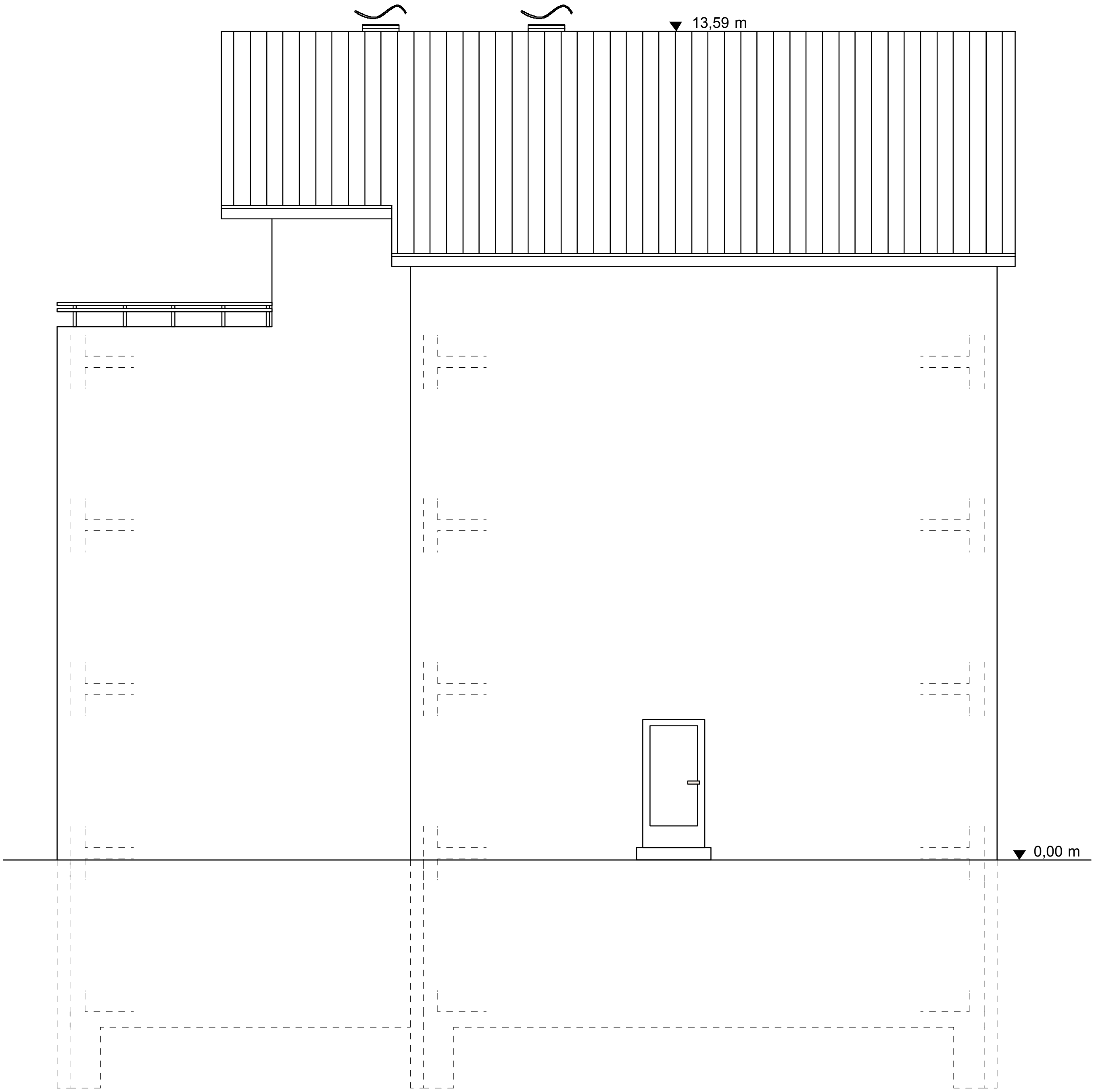
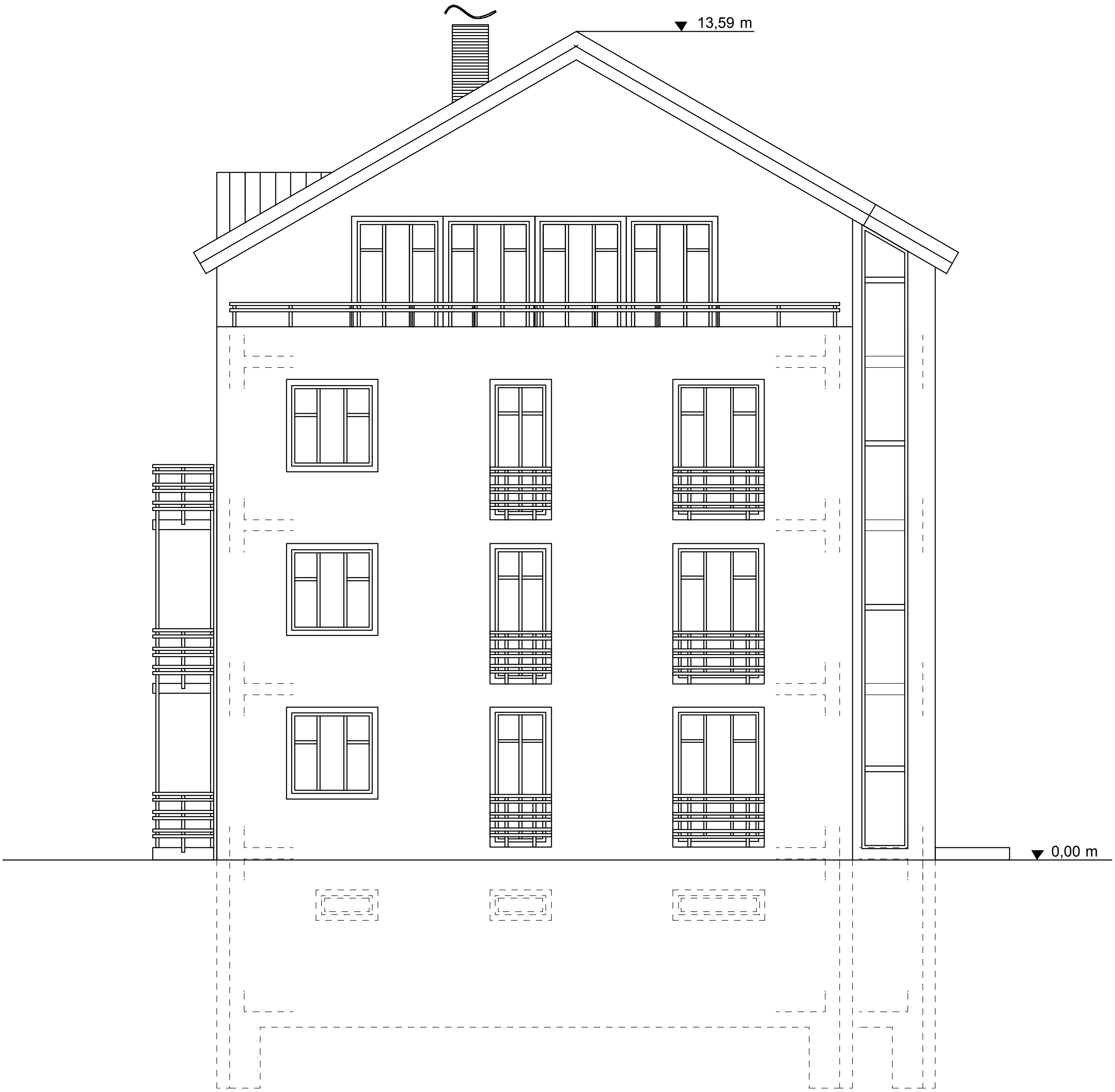


Building	APARTMENT HOUSE
Floor Plan	**Attic Floor**
Scale	1:100
Date	Jan 2008



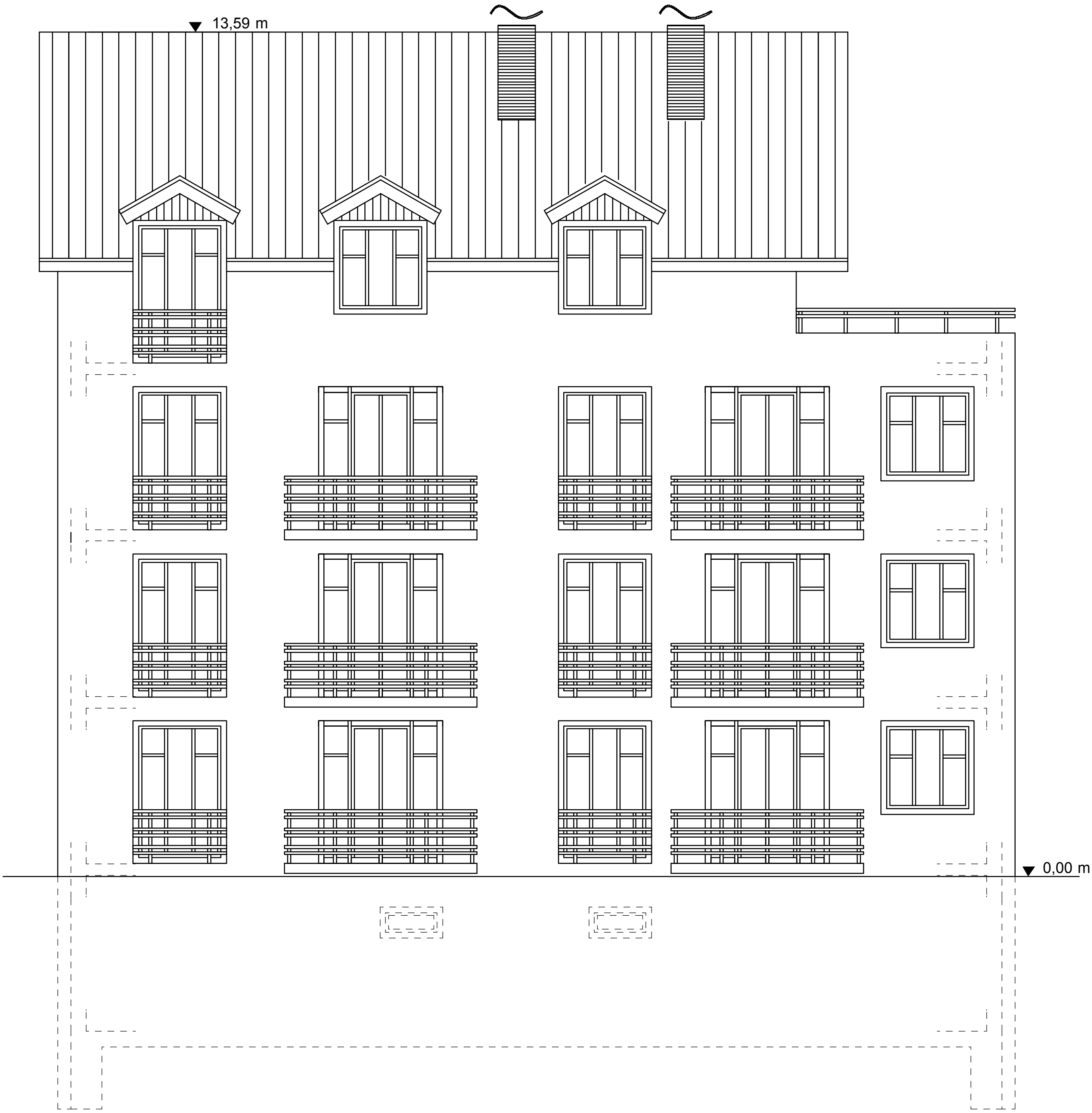
IWU 2008

Building	APARTMENT HOUSE
Plan	**Elevation North**
Scale	1:100
Date	Jan 2008



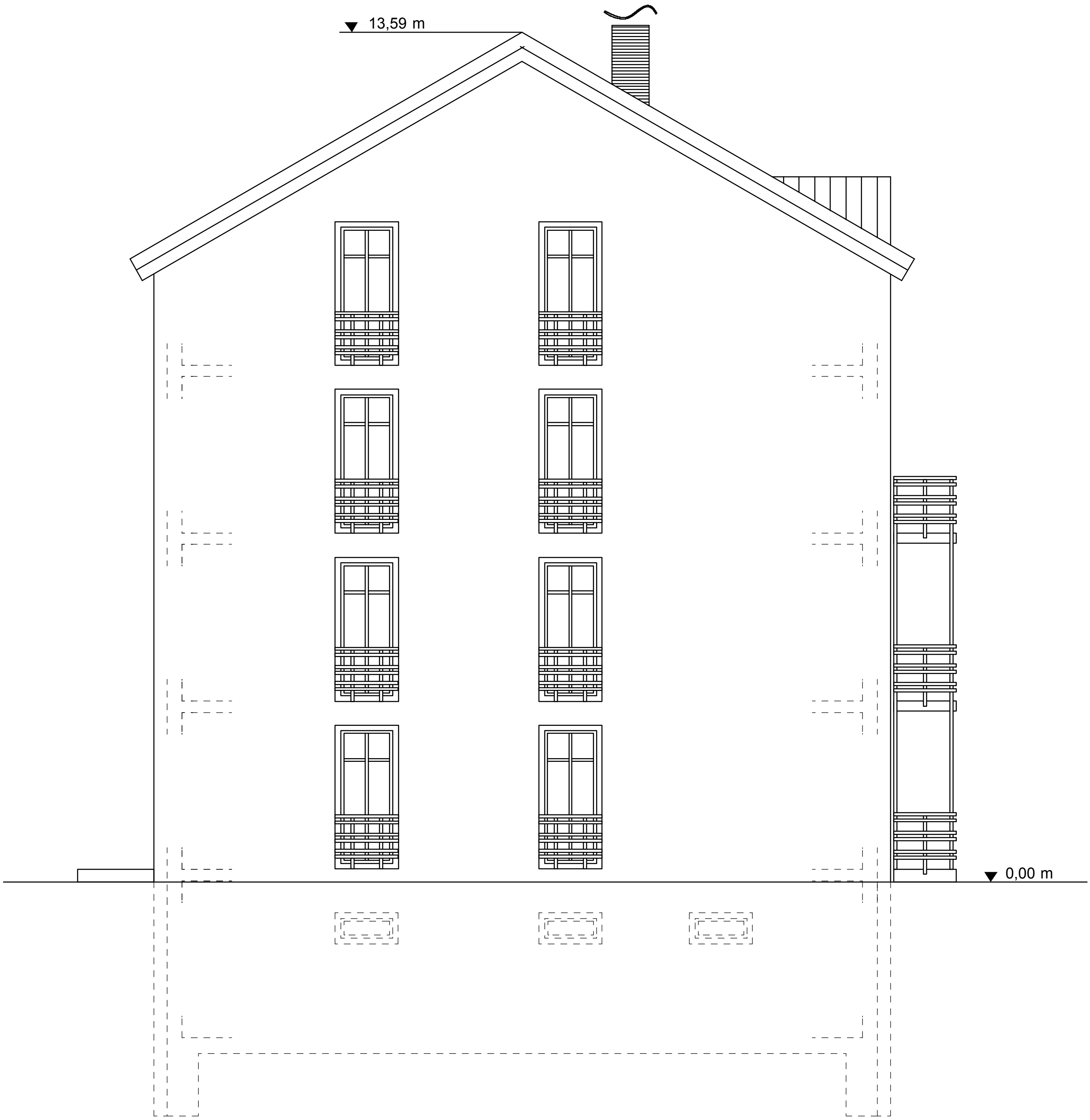
IWU 2008

Building	APARTMENT HOUSE
Plan	**Elevation East**
Scale	1:100
Date	Jan 2008



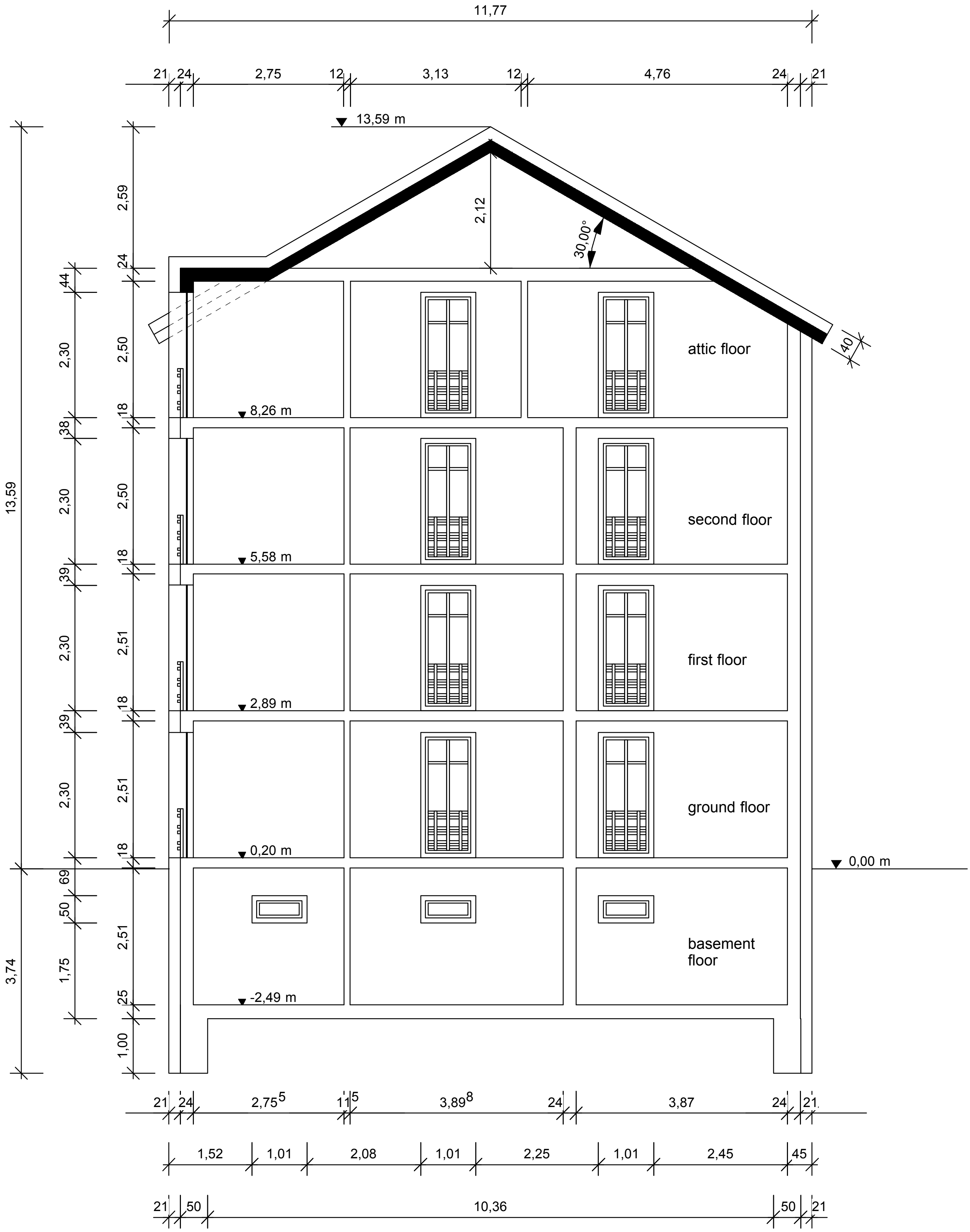
IWU 2008

Building	APARTMENT HOUSE
Plan	**Elevation South**
Scale	1:100
Date	Jan 2008



IWU 2008

Building	APARTMENT HOUSE
Floor Plan	**Elevation West**
Scale	1:100
Date	Jan 2008



IWU 2008

Building	APARTMENT HOUSE
Plan	**Section A - A**
Scale	1:100
Date	Jan 2008

Appendix 2b: Detailed envelope area calculation (external dimensions)

	name area element (free)	further specification / location	dedicated envelope area type	dedicated orientation for windows	reduction area: insert "R"	width	length	height	number (if <> 1)	additional area	gross surface area	net surface area	specific loss
						[m]	[m]	[m]		[m²]	[m²]	[m²]	[W/K]
1.	cellar ceiling		floor to cellar			10,42	15,40			13,083	173,6	158,2	0,0
2.	staircase floor basement		floor to soil		R	3,10	4,94					15,3	0,0
3.	staircase wall to basement West		wall to cellar				3,10	2,76				8,6	0,0
4.	staircase wall to basement East		wall to cellar				1,74	2,76				4,8	0,0
5.	staircase wall to basement South		wall to cellar				4,90	2,76			13,5	11,5	0,0
6.	staircase door to basement		door to cellar		R		1,01	2,00				2,0	0,0
7.	staircase wall to soil North		wall to soil				5,15	2,76				14,2	0,0
8.	staircase wall to soil East		wall to soil				1,36	2,76				3,8	0,0
9.	wall North ground floor		wall				15,40	2,87			44,2	42,1	0,0
10.	entrance door North		door		R		1,01	2,10				2,1	0,0
11.	wall North first + second floor		wall				15,40	2,69	2			82,9	0,0
12.	wall North attic floor		wall				11,88	1,95		1,816		25,0	0,0
13.	wall East ground floor		wall				11,78	2,87			33,8	23,7	0,0
14.	window East staircase ground floor		window	E	R		0,76	2,69				2,0	0,0
15.	window East ground floor 1		window	E	R		1,51	2,30				3,5	0,0
16.	window East ground floor 2		window	E	R		1,01	2,30				2,3	0,0
17.	window East ground floor 3		window	E	R		1,51	1,52				2,3	0,0
18.	wall East first + second floor		wall				11,78	2,69	2		63,4	43,1	0,0
19.	window East staircase first + second floor		window	E	R		0,76	2,69	2			4,1	0,0
20.	window East first + second floor 1		window	E	R		1,51	2,30	2			6,9	0,0
21.	window East first + second floor 2		window	E	R		1,01	2,30	2			4,6	0,0
22.	window East first + second floor 3		window	E	R		1,51	1,52	2			4,6	0,0
23.	wall East attic floor		wall				11,78	1,95		19,908	42,9	27,6	0,0
24.	window East staircase attic floor		window	E	R		0,76	2,00				1,5	0,0
25.	windows East attic floor		window	E	R		6,00	2,30				13,8	0,0
26.	wall South ground floor		wall				15,40	2,87			44,2	25,8	0,0
27.	window South ground floor 1		window	S	R		1,50	1,52				2,3	0,0
28.	window South ground floor 2		window	S	R		2,00	2,30	2			9,2	0,0
29.	window South ground floor 3		window	S	R		1,50	2,30	2			6,9	0,0
30.	wall South first + second floor		wall				15,40	2,69	2		82,9	46,1	0,0
31.	window South first + second floor 1		window	S	R		1,50	1,52	2			4,6	0,0
32.	window South first + second floor 2		window	S	R		2,00	2,30	4			18,4	0,0
33.	window South first + second floor 3		window	S	R		1,50	2,30	4			13,8	0,0
34.	wall South attic floor		wall				11,88	1,95		1,575	24,7	16,8	0,0
35.	window South attic floor 1		window	S	R		1,50	2,30				3,5	0,0
36.	window South attic floor 2		window	S	R		1,50	1,50	2			4,5	0,0
37.	gable dormers		dormer wall				1,50	0,50	3			2,3	0,0
38.	side wall dormers		dormer wall				1,10	0,325	6			2,1	0,0
39.	wall West ground floor		wall				11,78	2,87			33,8	29,2	0,0
40.	window West ground floor		window	W	R		1,01	2,30	2			4,6	0,0
41.	wall West first + second floor		wall				11,78	2,69	2		63,4	54,1	0,0
42.	window West first + second floor		window	W	R		1,01	2,30	4			9,3	0,0
43.	wall West attic floor		wall				11,78	3,64			42,9	38,2	0,0
44.	window West attic floor		window	W	R		1,01	2,30	2			4,6	0,0
45.	ceiling second floor (balcony floor attic)		flat roof			3,52	10,42					36,7	0,0
46.	tilted roof North		tilted roof			6,801	11,88			-3,565		77,2	0,0
47.	tilted roof South		tilted roof			6,801	11,88			-7,65		73,1	0,0
48.	tilted roof dormers		dormer roof			1,732	1,45		3			7,5	0,0
49.												0,0	0,0
50.												0,0	0,0
											Gesamt thermische Hülle:	**1001,3**	**0,0**

Appendix 2c: Definition of the supply system types

Explanation of table colours:

green	= basic definition of the system
blue	= to be used only if necessary; if not compatible to the national definitions or values the most similar ones were to be used