STUDY TOP 15%
of the most energy-efficient buildings
in the Czech Republic

from the national stock of residential and non-residential buildings

EU Taxonomy - Annex 1, Activity 7.7 (Acquisition and ownership of buildings)

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Chart of the distribution of buildings energy performance in the national building stock

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Since its foundation in 1825, Česká spořitelna has been significantly involved in shaping Czech society and strengthening the country's prosperity. The bank still sees this role as its mission and key priority. The growth of prosperity must be based on sustainability, both in the environmental, social and financial/economic spheres. The Bank bases its advisory services on these values.

In autumn 2022, Česká spořitelna a.s. initiated the creation of a unified material that will be useful for the interpretation of the energy performance of all buildings within the domestic real estate stock in the Czech Republic, in relation to the application of the EU taxonomy. This will contribute to a more accurate mapping of the current situation and also create conditions for its improvement.

Prepared under the auspices of and in cooperation with:

The MIT is interested in an overall analysis of the energy performance of the building stock in the Czech Republic also with regard to the implementation of the forthcoming EPBD IV directive, where it is important to know the profile of both the most efficient and the least efficient buildings.

The CBA, as an association defending the interests of the banking market, welcomes the creation of such material as it will promote a uniform approach to the assessment of buildings in terms of Criterion 7.7.

The CZGBC is working during 2023 within the Taxonomy Working Group on a technical interpretation that will be available during 2024. The interpretation of Criterion 7.7 will be implemented through this study. ČS a.s. and CEVRE are members of the CZGBC.

FOREWORD AND AIM OF THE STUDY

The primary objective of the study is to create a reference material that can be used uniformly and transparently for assessing whether the energy performance of a building complies with the EU taxonomy. Other objectives are to identify the barriers of the current legal setting in the field of energy performance of buildings, data availability, etc. in the context of the requirement and binding nature of the EU taxonomy.

The analyses were carried out within the banking sector (Czech Banking Association) and the building sector (Czech Green Building Council), their aim was to analyse the available data from the non-public ENEX database owned by the Ministry of Industry and Trade (MIT) containing data from EPCs and to create a study that would define the TOP 15% (and also the TOP 30%) of the most energy efficient buildings for the complete building stock, residential and non-residential buildings in greater detail.

For buildings constructed before 31 December 2020, for acquisition and ownership purposes can be demonstrated the compliance with the EU taxonomy (Annex 1 - Acquisition and ownership of buildings 7.7) by meeting the alternative requirement of affiliation to the TOP 15% of the most energy efficient buildings in the national or regional building stock. This affiliation shall be expressed as operational Primary Energy Demand (PED) and demonstrated by adequate evidence, which at least compares the performance of the relevant asset to the performance of the national or regional stock built before 31 December 2020 and at least distinguishes between residential and non-residential buildings.

In this area, a basic and partial study from 2019 prepared by EnergySim is available on the Czech market, however only for the non-residential segment and with insufficient scope and granularity.

Therefore, in autumn 2022, Česká spořitelna a.s. initiated an activity with the aim of creating a uniform material that would cover the entire national building stock on a predefined division and would be applicable to the entire market.

The study also includes:

- A building stock analysis describing the average values of primary energy from non-renewable sources for each type of building (ANNEX 1),
- a building stock analysis describing the highest values of primary energy from non-renewable sources for each type of building as a basis for EPBD IV (WORST 15% and WORST 25%),
- a quantification of the percentage of new buildings meeting the conditions of the TOP 15% of buildings according to this study (ANNEX 2),
- GAP analysis highlighting the main points of concern and possible recommendations to address them (ANNEX 3),
- the representation of energy performance classes and specific primary energy from non-renewable sources in the ENEX database (ANNEX 4).

The study is expected to be updated at intervals of 3 years from the publication of this version or if conditions or the underlying data on which the study was prepared change significantly. This may be e.g. a change, addition, clarification or change in the interpretation of the EU taxonomy methodology, a change in the ENEX system records, a change in the underlying data, a change in legislation in the field of energy performance of buildings, etc. Updates may also occur based on feedback from Users of this study. The entities that supported the creation of this study (i.e. EnergySim s.r.o., CEVRE Consultants s.r.o., Česká spořitelna, a.s., Czech Banking Association, Czech Council for Green Buildings and Ministry of Industry and Trade) are not bound by the obligation to prepare such an update.

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A. EXECUTIVE SUMMARY

The study identifies the top 15% and top 30% of the building stock in terms of operational primary energy demand for the purposes of the European taxonomy.

A.1. Technical screening criteria

These criteria are based on Commission Delegated Regulation (EU) 2021/2139.

TOP 15 %
as technical screening criteria for substantial contribution to climate change mitigation :

The European Taxonomy sets out technical screening criteria for determining under which conditions an economic activity qualifies as a significant contribution to **climate change mitigation** for Section 7.7 Acquisition and ownership of buildings (Annex I of the Regulation). The criteria relating to the assessment of the energy performance of buildings are as follows:

*For buildings built **before 31 December 2020**, the building has at least an Energy Performance Certificate (EPC) class A. As an alternative, the building is within the **top 15% of the national or regional building stock** expressed as operational Primary Energy Demand (PED) and demonstrated by adequate evidence, which at least compares the performance of the relevant asset to the performance of the national or regional stock built before 31 December 2020 and at least distinguishes between residential and non-residential buildings.*

For buildings built after 31 December 2020, the building meets the criteria specified in Section 7.1 Constructions of new buildings that are relevant at the time of the acquisition. The Primary Energy Demand (PED), defining the energy performance of the building resulting from the construction, is at least 10 % lower than the threshold set for the nearly zero-energy building (NZEB) requirements in national measures implementing Directive 2010/31/EU of the European Parliament and of the Council. The energy performance is certified using an as built Energy Performance Certificate (EPC).*

TOP 30 %
as Do no significant harm ('DNSH') for Climate change adaptation:

Similarly, technical screening criteria are established to determine under which conditions an economic activity qualifies as a significant contribution to climate change adaptation for Section 7.7 Acquisition and Ownership of Buildings (Annex II of the Regulation). In addition, the principle of DNSH is established regarding the assessment of the energy performance of buildings as follows::

The building is not dedicated to extraction, storage, transport or manufacture of fossil fuels.

*For buildings built before 31 December 2020, the building has at least an Energy Performance Certificate (EPC) class C. As an alternative, **the building is within the top 30 % of the national or regional building stock** expressed as operational Primary Energy Demand (PED) and demonstrated by adequate evidence, which at least compares the performance of the relevant asset to the performance of the national or regional stock built before 31 December 2020 and at least distinguishes between residential and non-residential buildings.*

For buildings built after 31 December 2020, the Primary Energy Demand (PED) (617) defining the energy performance of the building resulting from the construction does not exceed the threshold set for the nearly zero-energy building (NZEB) requirements in national regulation implementing Directive 2010/31/EU. The energy performance is certified using an as built Energy Performance Certificate (EPC).

* For the application of the Taxonomy criteria, the date of the application for a construction permit is relevant. (according to COMMISSION NOTICE C/2023/267).

A.2. Methodology for establishing a reference sample of buildings

As a basis data for determining the top 15% and top 30% of the building stock in terms of operational primary energy demand was chosen data from ENEX, a non-public database of the Ministry of Industry and Trade. The data was provided by the Ministry for the purpose of this study. The data was provided anonymised without the possibility to identify a specific building. The database contains records of building energy performance certificates (EPC) created and registered in this database between 2016 and 2022.

A total of 322 638 records, i.e. energy performance certificates, are available.

The records were subsequently reduced by obviously incorrect or incomplete records so that the results were not skewed. After the reduction, 313 388 records remained.

Tab. 1: numbers of records in the database by the purpose of EPC

Purpose of EPC	No.	Share
New building	149 945	48%
Major renovation	52 954	17%
Sale of a building or part of a building	60 887	19%
Rental of a building or part of a building	12 008	4%
Building used by a public authority	7 974	3%
Other purpose	29 620	9%
	313 388	

Tab. 2: numbers of records in the database by building type

Building type	No.	Share
Office building	8 577	3%
Family house	227 954	73%
Apartment residential building	43 411	14%
Building for accomm. and catering	4 545	1%
Building for health care	1 356	0%
Building for education	4 224	1%
Building for sport	1 466	0%
Retail building	4 985	2%
Building for culture	1 008	0%
Other types of building, please specify:	15 762	5%
Residential unit	21	0,0%
Building for production and storage	71	0,0%
Building for social care	8	0,0%
	313 388	100%

The most widely represented by the purpose of the certificate is the New Building. It is obvious that from the point of view of the purpose of EPC, not all EPC records in ENEX can be considered as a sample representing the total building stock of the Czech Republic. For example, according to the statistics, new family house constructions in the Czech Republic account for only about 1% of the total number of buildings per year.

For further analysis, a selection of EPC purposes was made to better represent the entire building stock of the Czech Republic. The following EPC purposes were selected:

- **Sale of a building or part of a building**
- **Lease of a building or part of a building**
- **Building used by a public authority**

These purposes should include a much more even sampling of the entire building stock. It is assumed that both buildings in their original condition, major renovations and new buildings that have been built/renovated in previous years are represented in the above categories.

The verification could only be done partially, on a sample of residential buildings, where the proportional distribution according to the date of construction and reconstruction according to the Population and Housing Censuses (PHC) 2021 approximately corresponds to the proportional distribution of records according to the year of commissioning in the ENEX database. In PHC 2021, the counts by “period of construction or reconstruction” are only for occupied buildings, whereas in ENEX the counts are by year of commissioning for all, i.e. theoretically also unoccupied buildings, therefore the two data sets cannot be compared in absolute terms, but a similar distribution can be observed.

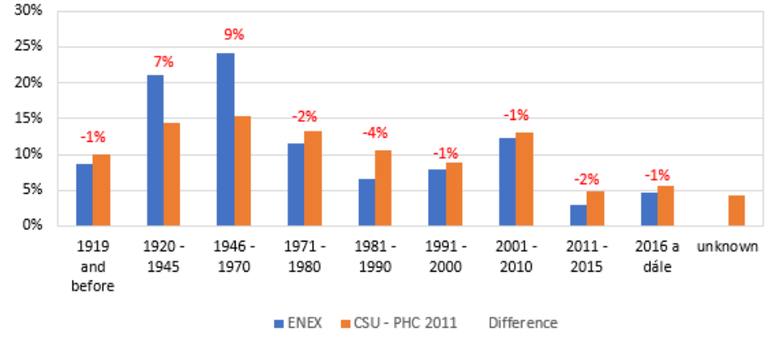


Fig. 1: proportional distribution of residential buildings according to the PHC 2021 construction and reconstruction date and ENEX commissioning date

It can be assumed that, taking the number of reconstructed buildings into account, the distribution according to the PHC should be on average more recent than the ENEX data, which is also evident from the comparison. Even given the fact that more detailed data on the energy performance of the entire residential building stock of the Czech Republic with a link to individual construction periods is not known, **the selected sample of ENEX data can be considered as**

sufficiently representative for the analysis of the TOP 15% of the building stock of the Czech Republic. On this basis, the selection of these EPC purposes is applied to other building types as well.

A.3. Specifics of energy performance assessment of buildings in the Czech Republic

The EU Taxonomy sets out an indicator that arranges a threshold for the top 15% of buildings as primary energy. In the Czech environment, this indicator is **primary energy from non-renewable energy sources**, stated as a measure of consumption per m^2 of energy reference area. This is the main assessment criterion for EPC according to the current Decree No. 264/2020 Coll. on the energy performance of buildings (hereinafter referred to as the Decree) and the value was also reported on EPC according to the previous version of the Decree from 2013.

It is important to note that the EPC assessment in the Czech Republic is based on the so-called **reference building**. For this reason, there are no fixed thresholds for specific primary energy from non-renewable energy sources set by the decree, but the thresholds of requirements and building classification are calculated for each building separately.

The total absolute amount of specific primary energy from non-renewable energy sources is influenced by various building qualitative parameters but **also significantly by mode of operation** such as time of use. Solely numerical expression of specific primary energy from non-renewable energy sources can be significantly influenced by the operation of the building, which is not related to the quality of the building.

Therefore, using only a fixed threshold could result in **energy efficient but highly used buildings being excluded** from the top 15% of the best buildings, and vice versa, less energy efficient buildings with low operational use could be included in the top 15% of the best buildings.

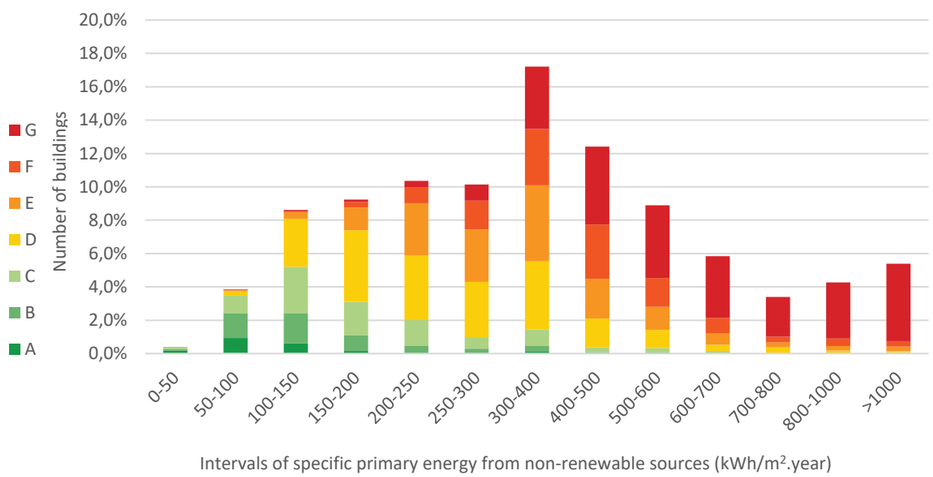


Fig 2: Example of energy class distribution for intervals of specific primary energy from non-renewable sources for office buildings

For example, if only a numerical threshold of 151 kWh/(m^2.year) of specific primary energy from non-renewable sources were used for office buildings, buildings with ratings D, E and F would be included, while a large proportion of buildings with ratings A, B, C would be excluded.

To eliminate such a fundamentally incorrect selection of energy efficient buildings, there was chosen method to select buildings primarily by energy class and only then by numerical value.

A.4. Determining the thresholds of the best buildings

According to the percentage of the primary non-renewable energy rating class for each building purpose can be determined which classes fall into the top 15% of buildings. Some classes will be included as a whole, so for example it can be said with certainty that classes A and B fall into the top 15% of buildings, but if the representation of classes A and B is less than exactly 15%, then a certain number of class C buildings will also fall into the top 15% of buildings.

However, class C cannot be included as a whole, so the numerical threshold of specific primary energy from non-renewable sources in kWh/(m^2.yr) is applied to this lowest included class only.

*Tab. 3: Percentage of primary non-renewable energy **rating class** for each building purpose:*

Building type / PNE class	A	B	C	D	E	F	G
Office building	1%	5%	11%	29%	20%	13%	21%
Family house	2%	6%	10%	16%	13%	13%	40%
Residential apartment building	2%	5%	21%	23%	18%	13%	18%
Building for culture	2%	5%	12%	21%	21%	13%	25%
Retail building	2%	4%	11%	33%	18%	13%	19%
Building for sport	3%	7%	20%	32%	15%	9%	13%
Building for accomm. And catering	1%	4%	12%	27%	20%	14%	22%
Building for education	2%	5%	17%	33%	20%	12%	11%
Building for health care	2%	7%	19%	38%	18%	9%	8%
Building for production and storage	3%	9%	16%	24%	18%	11%	20%
Other types	2%	6%	11%	23%	18%	13%	27%

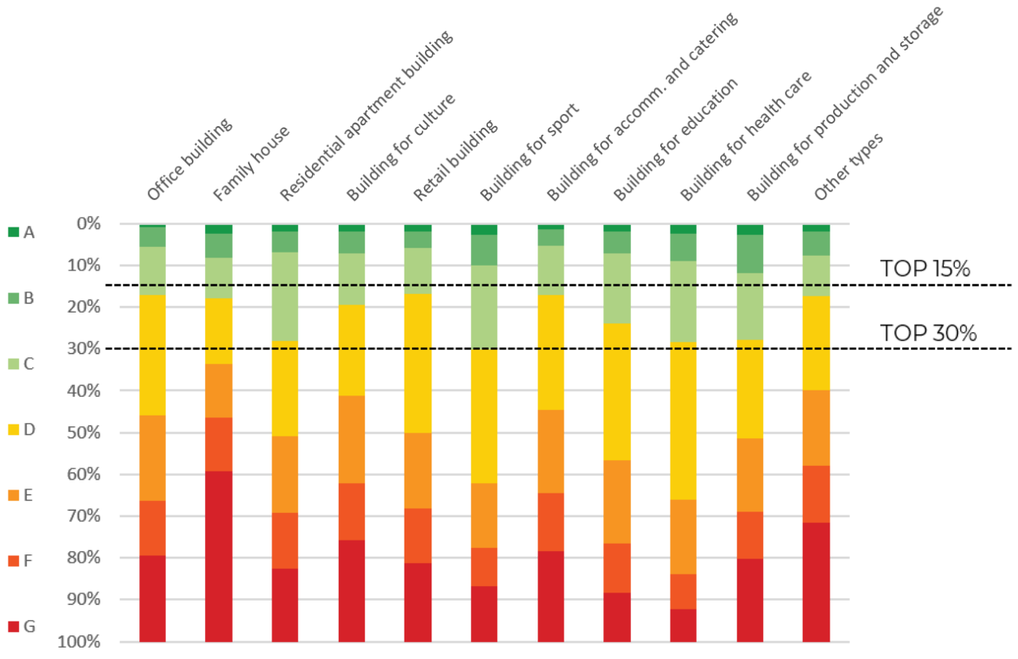


*Fig 3: Percentage of the primary non-renewable energy **rating class** for each building type and graphical representation of the TOP 15% and TOP 30% thresholds*

Comment on the final method results:

Whether a building is among the top 15% or 30% of the best buildings in the Czech Republic is determined by the classification class (for each building type). For the class C and D respectively, also the maximum value of specific primary non-renewable energy (PNE) is specified. These numerical values (thresholds) are the result of the statistical distribution of a sample of records from the ENEX database representing the building stock of the Czech Republic.

For some building types, this threshold is higher for Class C than for Class D, the reason for this can be seen in the graph in Figure 3. For example, for office buildings, the threshold is 260 kWh/(m^2.yr) because the top 15% of office buildings include up to 81% of the buildings in class C and therefore have higher PNE values, while only 45% of the number of buildings in class D have lower PNE values, specifically 208 kWh/(m^2.yr) for this building type. This is therefore not an error, but a statistical distribution of buildings across classes.

The higher values for some building types are due to the typical mode of operation and technical equipment used (e.g. generally higher values for retail buildings are due to the high usage and high proportion of air-conditioned buildings, intensive lighting, etc. for this building type).

*Tab. 4: Selection of the **TOP 15% buildings using the final method**:*

Building type	TOP 15% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B no limits & class C w/ max. specific PNE 260 kWh/(m^2.year)
Family house	PNE class A+B no limits & class C w/ max. specific PNE 157 kWh/(m^2.year)
Residential apartment building	PNE class A+B no limits & class C w/ max. specific PNE 102 kWh/(m^2.year)
Building for culture	PNE class A+B no limits & class C w/ max. specific PNE 222 kWh/(m^2.year)
Retail building	PNE class A+B no limits & class C w/ max. specific PNE 545 kWh/(m^2.year)
Building for sport	PNE class A+B no limits & class C w/ max. specific PNE 210 kWh/(m^2.year)
Building for accomm. and catering	PNE class A+B no limits & class C w/ max. specific PNE 375 kWh/(m^2.year)
Building for education	PNE class A+B no limits & class C w/ max. specific PNE 161 kWh/(m^2.year)
Building for health care	PNE class A+B no limits & class C w/ max. specific PNE 173 kWh/(m^2.year)
Building for production and storage	PNE class A+B no limits & class C w/ max. specific PNE 143 kWh/(m^2.year)
Other types	PNE class A+B no limits & class C w/ max. specific PNE 242 kWh/(m^2.year)

*Tab. 5: Selection of the **TOP 30% buildings using the final method**:*

Building type	TOP 30% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B+C no limits & class D w/ max. specific PNE 208 kWh/(m2.year)
Family house	PNE class A+B+C no limits & class D w/ max. specific PNE 240 kWh/(m2.year)
Residential apartment building	PNE class A+B+C no limits & class D w/ max. specific PNE 115 kWh/(m2.year)
Building for culture	PNE class A+B+C no limits & class D w/ max. specific PNE 241 kWh/(m2.year)
Retail building	PNE class A+B+C no limits & class D w/ max. specific PNE 331 kWh/(m2.year)
Building for sport	PNE class A+B+C no limits
Building for accomm. and catering	PNE class A+B+C no limits & class D w/ max. specific PNE 278 kWh/(m2.year)
Building for education	PNE class A+B+C no limits & class D w/ max. specific PNE 166 kWh/(m2.year)
Building for health care	PNE class A+B+C no limits & class D w/ max. specific PNE 145 kWh/(m2.year)
Building for production and storage	PNE class A+B+C no limits & class D w/ max. specific PNE 117 kWh/(m2.year)
Other types	PNE class A+B+C no limits & class D w/ max. specific PNE 265 kWh/(m2.year)

A.5. Result of the study TOP 15% best buildings by primary non-renewable energy

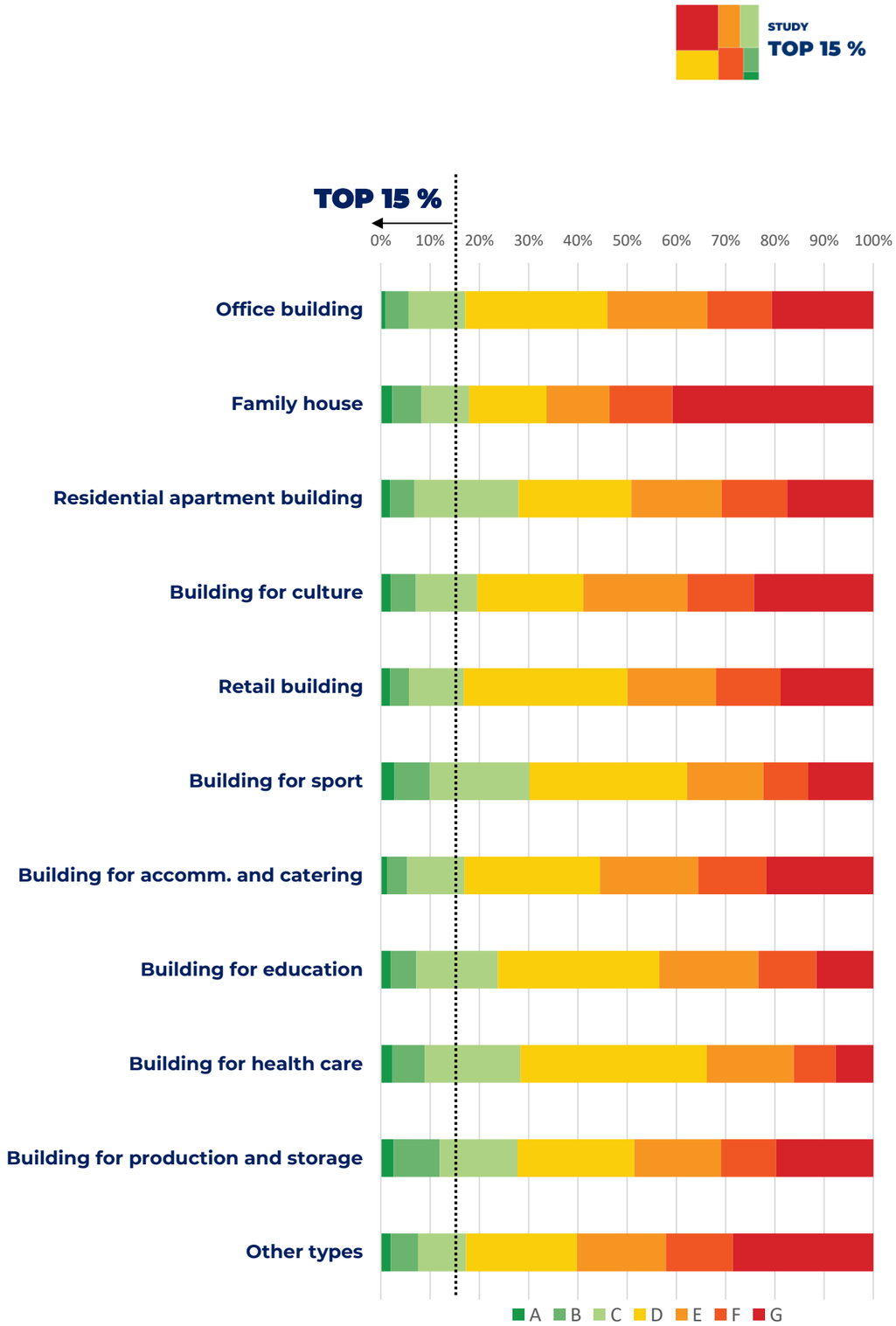


Fig. 4: graphical representation of the study results

B. SOURCE DATA

The study builds on a document prepared in 2019 (Methodology of establishing the 15% threshold of the most energy-efficient buildings in the Czech Republic (the "Methodology"), Ing. Jan Antonín, Ph.D., EnergySim). Compared to the Methodology prepared in 2019, the intention is to extend the analysis to the entire stock or all building typologies. It is also envisaged to refine or introduce new approaches in the assessment, and above all to update it in view of the significantly larger database.

B.1. Source of data

For the purposes of the methodology, data were obtained from the database of the Ministry of Industry and Trade (MIT). This is a database (called **ENEX**) consists selected data from the Energy Performance Certificates of Buildings (EPC). Energy specialists are obliged to input data for each EPC made in the Czech Republic. It is not a public database, and the data have been provided anonymised. In principle, the data is in almost the same format as the data provided in 2019. Logically, the number of records is significantly higher due to the gradual preparation of EPCs.

The database has been in operation for a long time, but only since the beginning of 2017 it has been fully operational for statistical use. This is the time when the energy performance assessment software developers allowed to **export values in a uniform structure and the possibility to import these data into the system was introduced**. Prior to this date, only some EPC data had to be saved and it have had to be done manually. Due to the lack of sufficient control and enforcement of the obligation to store the data, many records from this period either do not exist or are erroneous.

It should be noted that in 2013, the Czech Republic adopted an updated decree on the energy performance of buildings (Decree 78/2013 Coll.) and therefore changed the way of preparing EPC both in terms of calculation procedures and the way of classification of buildings. This includes, for example, the method of classification by comparison with the so-called reference building, or the introduction of the delivered energy indicator instead of energy consumption, i.e. the introduction of a different way of including non-fuel renewable sources in the main evaluation criterion.

This fact must be considered when processing. The recording of EPC data is therefore done by exporting selected data from the software to a file and then uploading the data by the energy specialist via a web interface to the database of the Ministry of Industry and Trade. It should also be emphasised that there is still the possibility to enter the data manually via the web interface instead of uploading the exported file. This option is used by some energy specialists probably due to the use of other, less widespread software that does not allow the export of the file in the given format. This is probably the reason for some of the incorrect data in the provided files.

For developing the Methodology, the Ministry of Industry and Trade provided data in an excel files. Data for this purpose were provided during 08/2023. The type of data contained in the supplied file is shown in Table 6 below. The data provided in 2023 are in the same format. The only differences from the data provided in 2019 are the lack of a record of the EPC entry in the ENEX database and the description of the building type entry (IdTypB).

Furthermore, compared to the 2019 database, 3 specific building categories have been added within the building types, namely:

- IdTypB 11 Name – Residential unit (21 records)
- IdTypB 12 Name – Building for production and storage (73 records)
- IdTypB 13 Name – Social care building (9 records)

The number of records in these categories is negligible though.

Tab. 6: a list of data contained in the file supplied by the MIT for the elaboration of the methodology – 2023

ID whole
ID
ID add
YearU
YearOfCompletion
Year
Purpose1
Purpose2
OtherPurpose
BuildingPlace
IDTypeOfBuilding
Name
OtherType
AreaEnergy
SumOfDeliverEn
SumOfDeliverEnClass
Non-renPrimEn
Non-renPrimEnClass
HeatTrCoeff
HeatTrCoeffClass
Heating
HeatingClass
Cooling
CoolingClass
Ventilation
VentilationClass
Humid
HumidClass
DHW
DHWClass
Lighting
LightingClass

In total, the database contains information (records) from **322,638** energy performance certificates. The records from individual EPCs are classified into six categories based on the purpose of EPC, the numbers are shown in Table 7:

- New Building
- Major renovation
- Sale of a building or part of a building
- Lease of a building or part of a building
- Building used by a public authority
- Other purpose

The data on building type are divided into the following thirteen categories, where the category "other building types" includes buildings that cannot be clearly classified; the numbers are shown in Table 3:

- Office building
- Family house
- Residential apartment house
- Building for accommodation and catering
- Building for health care
- Building for education
- Building for sport
- Building for commercial purposes – retail buildíngs
- Building for culture
- Other types of building
- Residential unit
- Building for production and storage
- Building for social care

Tab. 7: a summary of data from the ENEX database, broken down by purpose and date of EPC

Purpose of EPC	No.	Share
New building	152 102	47%
Major renovation	53 602	17%
Sale of a building or part of a building	62 963	20%
Rental of a building or part of a building	12 341	4%
Building used by a public authority	8 210	3%
Other purpose	33 420	10%
	322 638	100%

Year of EPC	No.	Share
2016	25 391	8%
2017	42 925	13%
2018	43 354	13%
2019	44 957	14%
2020	48 131	15%
2021	60 337	19%
2022	57 543	18%
	322 638	100%

Tab. 8: a summary of data from the ENEX database, breakdown by building type

Building type	No.	Share
Office building	8 783	3%
Family house	234 702	73%
Residential apartment building	44 871	14%
Building for accomm. and catering	4 641	1%
Building for health care	1 396	0%
Building for education	4 319	1%
Building for sport	1 506	0%
Retail building	5 097	2%
Building for culture	1 031	0%
Other types of building, please specify:	16 189	5%
Residential unit	21	0,0%
Building for production and storage	73	0,0%
Building for social care	9	0,0%
	322 638	100%

B.2. Data cleaning

Identification of erroneous records

Already during the first study in 2019, it was found that the database contained records that needed to be excluded before further analysis. These are likely to be due to the possibility of manual entry or errors in the processing of the EPC. These are records where some of the essential data are completely missing (e.g. specific consumption of primary non-renewable energy) or where more data are missing. In addition, there are records with apparently erroneous/unrealistic values.

As an example can be mentioned the specific total energy delivered with a value of 2 999 548 kWh/(m^{2}a) or the energy reference area with a value of 0.18 m^2.

Tab. 9 gives a basic overview of the database provided. The first two columns show the number of total records and number of empty records. The cells in green indicate the data that are filled in for each EPC. These are the data without which it is not possible to save the so-called report card, i.e. to register the EPC in the ENEX database and obtain a registration number for it.

Tab. 9: a summary of basic information about the ENEX data

	No. of entries	No. of empty entries	Min.	Min. (>0)	Average	Average (>0)	Percentil 99,9%	Max.	Median
ID whole	322 638	0	-	-	-	-	-	-	-
ID	322 638	0	153	-	-	-	-	480 204	-
ID add	322 638	0	0	-	-	-	-	25	-
YearU	281 968	40 670	0	194	-	1 994	-	9 999	2018
YearOfCompletion	322 638	0	01.01.2016	-	-	-	-	31.12.2022	-
Year	322 638	0	2016	-	-	-	-	2022	-
Purpose1	322 638	0	7	-	-	-	-	15	-
Purpose2	322 638	0	-	-	-	-	-	-	-
OtherPurpose	12 236	310 402	-	-	-	-	-	-	-
BuildingPlace	162 488	160 150	-	-	-	-	-	-	-
IDTypeOfBuilding	272 594	50 044	1	-	-	-	-	13	-
Name	320 511	2 127	-	-	-	-	-	-	-
OtherType	16 114	306 524	-	-	-	-	-	-	-
AreaEnergy	322 638	0	0	0,18	669	669	27 440	302 533	218
SumOfDeliverEn	322 638	0	0	0,01	248	248	1 571	2 999 548	124
SumOfDeliverEnClass	322 638	0	-	-	-	-	-	-	-
Non-renPrimEn	322 110	528	-580	0,01	295	296	2 222	3 656 813	143
Non-renPrimEnClass	321 663	975	-	-	-	-	-	-	-
HeatTrCoeff	322 638	0	0	0,02	0,51	0,51	2,17	2 012	0,30
HeatTrCoeffClass	322 638	0	-	-	-	-	-	-	-
Heating	319 959	2 679	0	0,01	183	183	1 409	2 895 545	95
HeatingClass	319 724	2 914	-	-	-	-	-	-	-
Cooling	89 885	232 753	0	0,01	5	32	115	246 343	3
CoolingClass	84 243	238 395	-	-	-	-	-	-	-
Ventilation	135 504	187 134	0	0,01	4	9	116	96 731	1
VentilationClass	130 838	191 800	-	-	-	-	-	-	-
Humid	92 695	229 943	0	0,01	1	60	40	36 667	5
HumidClass	74 677	247 961	-	-	-	-	-	-	-
DHW	318 355	4 283	0	0,01	27	28	241	227 732	21
DHWClass	318 102	4 536	-	-	-	-	-	-	-
Lighting	319 739	2 899	0	0,01	9	9	118	178 446	4
LightingClass	319 551	3 087	-	-	-	-	-	-	-

For example, for the year of commissioning, it is obvious that it is not stated for more than 40,000 records, etc. The minimum, maximum, average and median are then given for each data point. Values in red indicate obviously erroneous records. This refers to minimum values, see e.g. specific total energy delivered of 0.01 kWh/(m²a), year of commissioning 194 or average heat transfer coefficient of 0.02 W/(m²K). It also refers to maximum values, see e.g. specific non-renewable primary energy consumption of 3 656 813 kWh/(m²a), average heat transfer coefficient of 2 012 W/(m²K) or year of commissioning 9 999.

It should be noted that negative values for the specific consumption of primary non-renewable energy are not incorrect, as the building may generate a negative export of electricity (or other) energy to the grid. Furthermore, it is not an error if there are zero values for some records for partial energy supplied (e.g. for ventilation). The building may not be equipped with the system at all. However, zero values for total energy supplied for heating are questionable.

Setting the rules for discarding records

Considering the above mentioned, it was decided to exclude the non-compliant records from the database for further analysis. Records were excluded based on the following rules.

- **Exclusion of an entire record** if the value of specific non-renewable primary energy (as the main criterion) is completely missing (528 records excluded)
- **Exclusion of the highest values** for the main energy performance indicators based on the set upper percentile of the data:
  - Specific consumption of non-renewable primary energy (1599 records excluded)
  - Specific consumption of total energy supplied (1077 records excluded)
  - Average heat transfer coefficient (1164 records excluded)

In comparison with the previous version of the 2019 methodology, it has been decided that the upper limits to "crop" erroneous records will be set based on the percentile of the values. This is because the upper limit, where values are already unrealistic, is not clearly definable for each building category (in the previous version of the methodology it was set by expert estimation).

Prior to setting the upper percentile for exclusion values, the screening identified cut-off values for the percentiles of 99.00% / 99.50% / 99.75% (i.e. 1% / 0.5% / 0.25% of values to be excluded). Subsequently, it was decided to exclude setting the exclusion threshold at 99.50%, i.e. excluding the highest 0.5% of values. The following tables show the values of the exclusion thresholds for the three indicators mentioned above. The values of the cut-offs for the 99.00% and 99.75% percentiles are also given for information.

The tables on the following page show the upper limit settings for data discarding:

Tab. 10: setting upper limits for data discard - non-renewable primary energy

Building type	specific NPE (average)	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries
	průměr kWh/(m²a)	kWh/(m²a)	0,25%	kWh/(m²a)	0,5%	kWh/(m²a)	1,0%
Office building	1 146	2 500	0,25%	1 630	0,5%	1 320	1,0%
Family house	223	1 570	0,25%	1 340	0,5%	1 150	1,0%
Residential apartment building	269	1 250	0,25%	1 000	0,5%	840	1,0%
Building for accomm. and catering	431	2 494	0,24%	1 835	0,5%	1 500	1,0%
Building for health care	304	1 540	0,22%	1 400	0,5%	1 140	1,0%
Building for education	736	1 520	0,26%	1 200	0,5%	960	1,0%
Building for sport	1 145	3 500	0,40%	2 600	0,5%	1 750	1,0%
Retail building	810	3 000	0,26%	2 170	0,5%	1 650	1,0%
Building for culture	316	1 650	0,19%	1 580	0,5%	1 400	1,0%
Other types of building	590	2 900	0,25%	2 100	0,5%	1 600	1,0%

Tab. 11: setting upper limits for data discard - total energy supplied

Building type	total delivered energy (average)	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries
	průměr kWh/(m²a)	kWh/(m²a)	0,25%	kWh/(m²a)	0,5%	kWh/(m²a)	1,0%
Office building	892	1 300	0,24%	930	0,5%	690	1,0%
Family house	204	1 210	0,25%	1 050	0,5%	910	1,0%
Residential apartment building	220	790	0,25%	665	0,5%	570	1,0%
Building for accomm. and catering	411	1 650	0,24%	1 400	0,5%	1 080	1,0%
Building for health care	211	920	0,29%	850	0,5%	680	1,0%
Building for education	642	1 000	0,25%	705	0,5%	616	1,0%
Building for sport	884	3 000	0,46%	1 800	0,5%	1 100	1,0%
Retail building	480	1 650	0,24%	1 150	0,5%	920	1,0%
Building for culture	245	1 560	0,29%	1 300	0,5%	990	1,0%
Other types of building	356	1 540	0,25%	1 200	0,5%	980	1,0%

Tab. 12: setting upper limits for data discard - average heat transfer coefficient

Building type	heat tr. coeff. (average)	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries	upper limit	upper percentage of excluded entries
	průměr W/(m².K)	W/(m².K)	0,25%	W/(m².K)	0,5%	W/(m².K)	1,0%
Administrativní budova	0,69	2,00	0,24%	1,790	0,5%	1,62	1,0%
Rodinný dům	0,46	1,84	0,24%	1,680	0,5%	1,54	1,0%
Bytový dům	0,70	1,73	0,25%	1,620	0,5%	1,51	1,0%
Budova pro ubyt. a strav.	0,56	1,90	0,24%	1,660	0,5%	1,50	1,0%
Budova pro zdravotnictví	0,56	1,80	0,29%	1,660	0,5%	1,52	1,0%
Budova pro vzdělání	0,55	1,70	0,25%	1,560	0,5%	1,41	1,0%
Budova pro sport	0,46	2,30	0,27%	1,750	0,5%	1,60	1,0%
Budova pro obchodní účely	0,68	2,30	0,27%	1,950	0,5%	1,68	1,0%
Budova pro kulturu	0,61	1,89	0,29%	1,750	0,5%	1,60	1,0%
Jiné druhy budovy, uveďte:	0,57	3,30	0,25%	2,450	0,5%	1,98	1,0%

- **Exclusion of lowest values** for energy performance indicators based on a fixed threshold:
  - Specific consumption of total energy supplied (193 records excluded)
  - Average heat transfer coefficient (1569 records excluded)

In the case of specific consumption of non-renewable primary energy, **the lower limit** for the exclusion of values has not been set for the above reason, i.e. that negative values are also possible.

In the case of setting lower limits, the exclusion was not based on a percentile but on an expert estimate of the lower limit. In the case of total energy supplied, the limit was set at 20 kWh/(m²a). The benchmark for setting this limit is the specific heating demand of 15 kWh/(m²a) for passive houses. If the specific demand is at this value, the delivered energy for heating only is then higher.

The total delivered energy after taking into account other sub-components (hot water preparation, forced ventilation, lighting) then exceeds 20 kWh/(m²a). Tab. 13 shows the lower limit for data exclusion and comparison with the average value. It also indicates for each building type what proportion of the total number of buildings in a given category will be excluded from the records. These are in the hundredths to lower tenths of a percent, i.e. a very small proportion.

Tab. 13: setting lower limits for data discard - total energy supplied

Building type	total delivered energy (average)	lower limit	lower percentage of excluded entries
	průměr kWh/(m²a)	kWh/(m²a)	
Office building	892	20,0	0,10%
Family house	204	20,0	0,05%
Residential apartment building	220	20,0	0,04%
Building for accomm. and catering	411	20,0	0,02%
Building for health care	211	20,0	0,07%
Building for education	642	20,0	0,07%
Building for sport	884	20,0	0,00%
Retail building	480	20,0	0,12%
Building for culture	245	20,0	0,29%
Other types of building	356	20,0	0,35%

Similarly, a lower limit was set to exclude data for the average heat transfer coefficient. The lower limit was set to 0.15 W/(m²K). Tab. 14 shows the limit settings compared to the average and the percentage of excluded records.

Tab. 14: setting lower limits for data discard - average heat transfer coefficient

Building type	heat trans. coeff (average)	lower limit	lower percentage of excluded entries
	průměr W/(m².K)	W/(m².K)	
Office building	0,69	0,150	0,15%
Family house	0,46	0,150	0,62%
Residential apartment building	0,70	0,150	0,06%
Building for accomm. and catering	0,56	0,150	0,22%
Building for health care	0,56	0,150	0,14%
Building for education	0,55	0,150	0,12%
Building for sport	0,46	0,150	0,66%
Retail building	0,68	0,150	0,20%
Building for culture	0,61	0,150	0,00%
Other types of building	0,57	0,150	0,31%

- **Exclusion of all records with a floor area of less than 25 m²**

With regard to the inclusion of “tiny-house” type buildings, a threshold of 25 m², not 50 m², was used as the EPC obligation threshold (266 records excluded)

- **Exclusion of records based on parts of text strings** (2284 records excluded)

Due to the prevalence of records that clearly relate to subsidy programme and where the EPC for a single building is typically found for the existing and proposed condition, records for the existing condition of the building were excluded with the assumption that the proposed condition is or will be implemented.

Tab. 15: an example of the purpose of EPC description for "other purpose"

Stávající stav pro NZÚ		2 Rodinný dům
Vyhodnocení výchozího stavu	Mosty u	2 Rodinný dům
NZÚ - stávající stav	Pražmo	2 Rodinný dům
Výchozí stav pro výpočet dotace	Ostrava	2 Rodinný dům
Původní stav pro NZÚ	Křinec	2 Rodinný dům
žádost NZU - stávající stav RD	Praha	2 Rodinný dům
NZÚ, původní stav	Praha	2 Rodinný dům
NOVÁ ZELENÁ ÚSPORÁM - původní	Praha	2 Rodinný dům
žádost NZU - původní stav	Roztoky	2 Rodinný dům
Vyhodnocení výchozího stavu	Nový Jičín	2 Rodinný dům
Zpracování k doložení stávajícího	Malá Morávka	2 Rodinný dům
Nová zelená úsporám - původní	Sepekov	2 Rodinný dům
žádost o dotaci NZÚ- stávající stav	Borovy	2 Rodinný dům
Stávající stav - dodatečné	Petřvald	2 Rodinný dům
Výchozí stav pro výpočet dotace	Zašová	2 Rodinný dům
Výchozí stav pro výpočet dotace	Malá Bystřice	2 Rodinný dům
stávající stav pro dotační titul NZÚ	Jičín	2 Rodinný dům
Nová zelená úsporám - původní	Milevsko	2 Rodinný dům
Stávající stav		2 Rodinný dům
Nová zelená úsporám - původní	Přistoupim	2 Rodinný dům
Nová zelené úsporám - stávající	Přerov nad Labem	2 Rodinný dům

This applies to the following items:
for IdTypB (10) - **Other building types**, specify:, JinyTypB (text note for building type)
for Purpose of elaboration (15) - **Other purpose of elaboration**, UcelJiny
(textual note on the purpose of the EPC elaboration)

For both of the records above, the following portions of the text strings were identified and subsequently discarded, presumably identifying the existing condition of the building for the purposes of the application for grants from subsidy programme.

- „stáv“ - the current state of the building
- „SS“ - the current state of the building
- „pův“ - original state of the building
- „vých“- default building condition

- **Exclusion of records with a sum of partial energy delivered greater than the total energy delivered** (570 records excluded)

Despite the data cleaning stated above, records with absurdly high values of energy supplied for heating, hot water and lighting continue to occur. For this reason, a check of the sum of the partial energy supplied and a comparison with the total energy supplied was carried out. If the sum of the sub-items is greater than the total (with a tolerance of 5 kWh/m² as the data is rounded), the record is discarded.

Duplications of registration number endings

The chapter below presents findings from an examination of duplicates in registration numbers. A unique registration number (xxx.0) is generated by ENEX for the first registered EPC on a given parcel/address. In the case of a subsequent record for a given EPC, another ending (xxx.1 / xxx.2. etc.) is assigned to the same registration number before the dot. For example, a repetition count of 3 means that there are 3 variations for the unique registration number XXX, indicated by a different digit after the dot. For example, 1000.0 / 1000.1 / 1000.2. There are 8028 such records in the database

For those registration numbers that contain xxx.0 / xxx.1 at the same time, it can be either a major change to a completed building (renovation of the original building) or an existing plus proposed condition for a subsidy programme (e.g. the New Green Savings Programme). If can be only speculated as to whether or not the refurbishment has actually taken place. However, it may also be two separate buildings on the same plot (ENEX will automatically assign the following number after

the dot to the EPC already entered on the plot). The same applies to the registration numbers xxx.1/2/3/a above. Multi-building project on the same plot.

Unfortunately, no obvious patterns can be traced in the number of repetitions of registration numbers, as the numbers after the dot occur chaotically.

Therefore, it is not possible to simply assume that in the case of a repeating EVN it is a major change to a completed building and simply consider as a unique building the one with the highest suffix of the registration number (with the assumption that the building has been reconstructed in the meantime and now this building is present in the set of buildings in the Czech Republic). Furthermore, especially for a higher number of repetitions of EVNs, it can be assumed that these are unique buildings, since the ENEX portal, when entering multiple buildings on the same parcel number or the same address, registers the unique first registration number to the first building and then assigns suffixes after the dot (e.g. development projects of multiple buildings on one parcel, complexes with multiple buildings and the same address - e.g. hospitals, industrial complexes, etc.).

Furthermore, it was considered to clean the data where there is duplication of the EVC (i.e. two variants after the dot to the unique EVC, e.g. XXX.0 / XXX.1) and at the same time it is a so-called different purpose of EPC, which is often used in the case of the New Green Savings Programme, where there is a requirement to record the EPC for the building in the existing and proposed state. The intention was to subsequently clean up the records for the existing state of the building so that only the design state of the building remains in the records (again with the assumption that most have already been or will be subsequently really renovated and will therefore correctly describe the building stock).

Unfortunately, even in this case, the data cannot be processed unambiguously, as they occur again in a completely chaotic manner and it is not possible to work with parts of text strings (except for a specific category, which is listed in the chapter Setting the rules for discarding records) for unambiguous identification due to the high number of disparate notes. The following figure gives examples of chaotic descriptions, much of which is ADDITIONALLY misclassified as "other purpose" even though it is, for example, a new building:

- Bytový dům s EVP menší než 1000 m2
- Celkové zhodnocení budovy po rekonstrukc
- Centrum Nazaret
- část budovy novostavba (garsonky) a část větší změna (dům)
- částečná úprava topného systému
- DAROVACÍ SMLOUVA
- Demolice v rámci revitalizace
- digitalizace
- dílčí posuzení pro nárůst en.vzt. plochy > 25%
- Dílčí průkaz posuzující pouze nástavbu a přístavbu s referenční
- dle § 7a odst. 4 zák. 406/2000 Sb.
- dle § 7a odst.1 písm. c), zák. 406/2000
- dle podmínek NZÚ
- dle z. 406/200 Sb.
- dle z. 406/2000 Sb.
- Dle zákona
- dle zákona 406/2000
- součást energetického auditu
- součást EP - žádost o dotaci SFŽP
- součást PD - změna užívání stavby
- součástí EP pro dotaci z OPŽP
- SP povol 9.5.2007, zkolaudován 22.6.2017
- Spáčil
- společenství vlastníků jednotek
- Stácající stav

Fig. 5: example of the purpose of EPC descriptions

B.3. Cleaned data for further analysis

Based on the above data cleaning procedure, a total of 9,250 records were discarded. The data was in this way prepared for further analysis. The following tables provide a summary of the cleaned data.

Tab. 16: numbers of records in the database by building type and purpose of EPC

Purpose of EPC	No.	Share
New building	149 945	48%
Major renovation	52 954	17%
Sale of a building or part of a building	60 887	19%
Rental of a building or part of a building	12 008	4%
Building used by a public authority	7 974	3%
Other purpose	29 620	9%
	313 388	

Year of EPC	No.	Share
2016	24 442	8%
2017	41 236	13%
2018	41 809	13%
2019	43 365	14%
2020	46 535	15%
2021	59 427	19%
2022	56 574	18%
	313 388	

It is clear that new buildings are a major contributor to the composition of ENEX records. The following largest number of records is for the purpose of sale to rent and third is major renovations of completed buildings. New buildings plus Major renovations (i.e. relatively well rated buildings) then represent almost 2/3 of the records.

Tab. 17: number of records by building type

Building type	No.	Share
Office building	8 577	3%
Family house	227 954	73%
Apartment residential building	43 411	14%
Building for accomm. and catering	4 545	1%
Building for health care	1 356	0%
Building for education	4 224	1%
Building for sport	1 466	0%
Retail building	4 985	2%
Building for culture	1 008	0%
Other types of building, please specify:	15 762	5%
Residential unit	21	0,0%
Building for production and storage	71	0,0%
Building for social care	8	0,0%
	313 388	100%

The table above shows that approximately 3/4 of the entries are for family homes. The last 3 categories that were added with the ENEX changes represent a negligible percentage of buildings.

Tab. 18: development of EPC in years by purpose

EPC Purpose	2 016	2 017	2 018	2 019	2 020	2 021	2 022	
New building	7 960	17 952	19 426	22 123	23 693	33 460	25 331	
Major renovation	4 257	7 249	6 988	7 895	9 371	9 716	7 478	
Sale of a building or part of a building	5 709	9 563	10 476	9 401	8 910	9 213	7 615	
Rental of a building or part of a building	3 314	2 266	1 973	1 275	876	1 047	1 257	
Building used by a public authority	3 086	2 081	1 037	620	617	0	533	
Other purpose	116	2 125	1 909	2 051	3 068	5 991	14 360	
Total								**313 388**

Tab. 19: development of EPC in years by building type

Building type	2 016	2 017	2 018	2 019	2 020	2 021	2 022	
Family house	13 095	28 088	30 121	32 805	34 376	47 455	42 014	**227 954**
	6%	12%	13%	14%	15%	21%	18%	100%

Building type	2 016	2 017	2 018	2 019	2 020	2 021	2 022	
Apartment residential building	5 541	6 605	5 936	5 363	6 614	5 836	7 516	**43 411**
	13%	15%	14%	12%	15%	13%	17%	100%

Building type	2 016	2 017	2 018	2 019	2 020	2 021	2 022	
Office building	1 369	2 006	1 285	1 004	1 122	959	832	
Building for accomm. and catering	443	656	669	552	710	775	740	
Building for health care	183	192	197	158	166	188	272	
Building for education	842	656	392	414	530	610	780	
Building for sport	198	237	182	175	251	225	198	
Retail building	743	756	718	809	563	665	731	
Building for culture	198	209	135	92	115	124	135	
Other types of building, please specify:	1 830	1 831	2 174	1 993	2 075	2 538	3 321	
Residential unit	0	0	0	0	3	11	7	
Building for production and storage	0	0	0	0	8	40	23	
Building for social care	0	0	0	0	2	1	5	
	5 806	6 543	5 752	5 197	5 545	6 136	7 044	**42 023**
	14%	16%	14%	12%	13%	15%	17%	100%
						total		**313 388**

Tab. 22 below shows the number of EPCs processed by purpose and building type. For family houses, a dominant part (more than half of the records) of the EPCs listed in the ENEX database is obviously represented by EPCs processed for new buildings as it is obligatory to process them for building permits. Conversely, for apartment houses, the largest number of records is represented by major renovations, as well as sales and leases of buildings (together also over half). In the case of buildings for education, for example, major renovations are significantly more represented than new buildings. The opposite is true for buildings for sport and commercial purposes.

Tab. 20: number of EPCs processed by purpose as well as by building type

	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
Family house	128 794	31 578	43 370	1 649	284	22 279
	56%	14%	19%	1%	0%	10%
Apartment residential building	7 370	11 130	11 843	6 400	1 493	5 175
	17%	26%	27%	15%	3%	12%

	7 New building	8 Major renovation	9 Sale of a building or part of a building	10 Rental of a building or part of a building	11 Building used by a public authority	15 Other purpose
Office building	2 442	2 150	1 181	1 017	1 539	248
Building for accomm. and catering	1 512	1 186	966	288	446	147
Building for health care	341	430	70	104	346	65
Building for education	854	1 501	50	73	1 509	237
Building for sport	726	318	50	64	262	46
Retail building	1 760	651	1 177	1 016	287	94
Building for culture	162	371	24	45	361	45
Other types of building, please specify:	5 947	3 617	2 124	1 346	1 447	1 281
Residential unit	1	3	15	2	0	0
Building for production and storage	31	17	17	4	0	2
Building for social care	5	2	0	0	0	1
	13 781	10 246	5 674	3 959	6 197	2 166
	33%	24%	14%	9%	15%	5%
Total all						**313 388**

Tab. 21: number of buildings in the "production and storage" category, broken down by purpose

	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
Budova pro výrobu a skladování	1 688	769	407	397	48	197

Additional selection of records for category Building for production and storage

Due to the very small number of building types in the newly introduced category “Building for production and storage”, further analysis was carried out on the records from the category “Other building types, please specify:” of which these buildings were part of before the introduction of the separate category. The following word parts were used to search for these records, so as to find buildings for production and storage (industry):”'warehouse”, “produc”, “indust”. In this way, approximately 3,500 records were separated from the category “Other building types, specify:” into the category “Production and storage building”. Due to the great variety and interconnection of the purposes of buildings for storage and for production, where these functions may change during the use of the building, a single category “Building for production and storage” is further used. This building type typically includes an office building in (building part) with sanitary facilities for production and storage.

C. DESCRIPTION OF THE METHODOLOGY FOR THE BEST BUILDINGS DETERMINATION

C.1. Selection of EPC purpose

As mentioned in the previous chapter, the representation of individual EPC records in terms of the EPC purpose is significantly uneven, see the fundamental predominance of new building purpose in family houses category. The ENEX database contains a total of approximately 322 thousand records. At the same time, it is a fact that the majority of buildings in the Czech Republic do not have EPC, and therefore not even ENEX record. The total number of buildings in the Czech Republic is around 2.5 million (approx. 1.7 million Occupied family houses, 19approx.. 0.2 million Occupied apartment houses, approx. 0.6 million approx. Non-residential buildings).

Therefore, if we want to extrapolate the values for the 15% most energy-efficient buildings determined based of the ENEX database for the whole building stock of the Czech Republic, it is not possible to work with average values for all purposes of EPC.

From this perspective is chosen as a representative sample for the Czech Republic the set of records represented in the following categories of the purpose of EPC:

- Sale of a building or part of a building
- Lease of a building or part of a building
- Building used by a public authority

It is assumed that in the above categories are represented both buildings in their original condition and major renovations and new buildings built/renovated in previous years.

The aggregate category of the above three EPC purposes is analysed collectively and then the resulting threshold of 15% of the most efficient buildings is determined from the frequency analysis.

C.2. Year of construction/renovation analysis for residential buildings - CSO vs. ENEX

In order to verify the representativeness of the selected data set (purposes: building sale + building rent + building used by public authority), a comparison of the number of records from the ENEX database with data from the Population and Housing Censuses (PHC) 2021 conducted by the Czech Statistical Office was carried out. The PHC data refer to family and apartment houses only. The comparison is therefore made between all occupied residential buildings in the Czech Republic and a selection from ENEX data of family and apartment houses and the purpose of the EPC for sale/rent/public power. The following chart shows the distribution of numbers by period of construction from the PHC 2021 data.

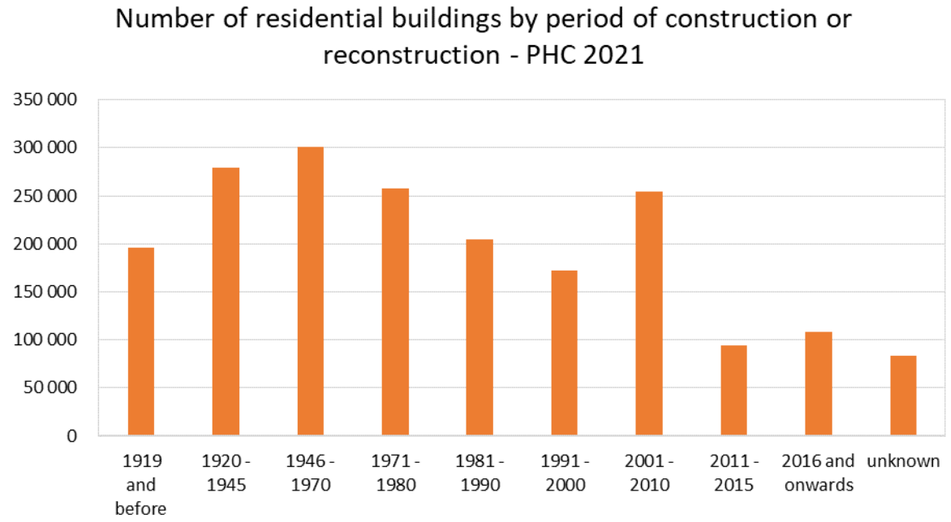


Fig. 6: distribution of the number of residential buildings by period of construction or reconstruction - PHC 2021 data, source: Období výstavby domů | Sčítání 2021 (scitani.cz)

The graph (see Fig. 6) then shows the numbers of records for residential buildings for the above purposes. It should be noted here that within the “cleaned data”, out of a total of 313,388 records, the year of commissioning is only given for about 273 thousand records. Thus, for about 40 records it is missing. However, it is not assumed that the data is missing for any specific "time" group, but that the error is evenly spread over all records and therefore the proportional distribution can be considered correct.

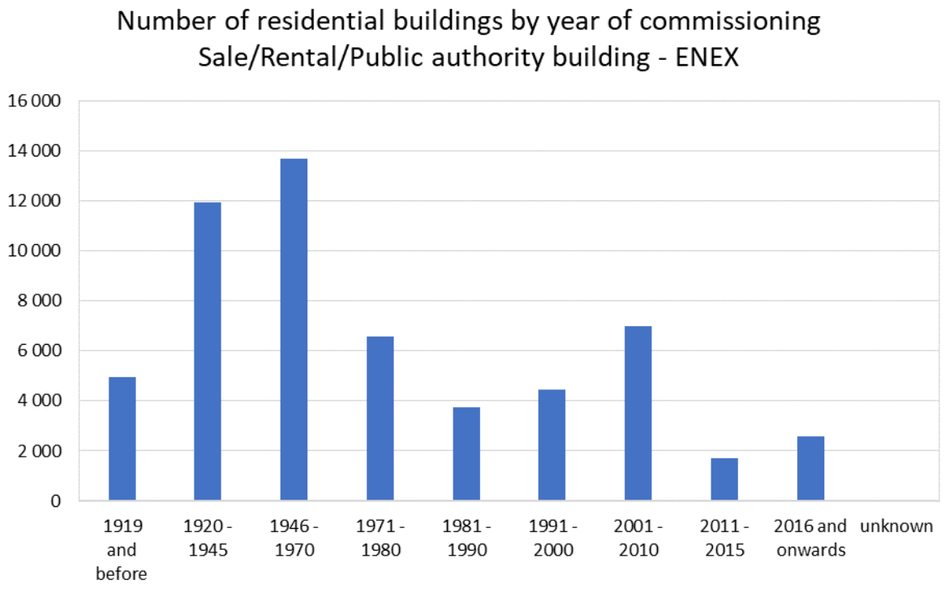


Fig. 7: distribution of the number of residential buildings by year of commissioning - ENEX data for Sale of a building or part of a building, Lease of a building or part of a building and Building used by a public authority

The following table and chart show the total number of residential buildings/entries by period of construction/refurbishment more precisely date of commissioning according to EPC.

Tab. 22: comparison of the number of PHC 2021 records and ENEX data - numbers of buildings by period of construction/renovation/commissioning

	1919 and before	1920 - 1945	1946 - 1970	1971 - 1980	1981 - 1990	1991 - 2000	2001 - 2010	2011 - 2015	2016 and onwards	unknown
PHC 2021	195 896	279 456	300 552	257 936	205 033	171 954	254 774	94 761	108 849	83 457
PHC 2021	10%	14%	15%	13%	11%	9%	13%	5%	6%	4%
ENEX	4 963	11 945	13 675	6 583	3 755	4 450	6 974	1 716	2 590	0
ENEX	9%	21%	24%	12%	7%	8%	12%	3%	5%	-

It is clear from the results that the distributions match each other reasonably well. The differences across periods are in units of percents, with only the 1920-1970 period having a greater representation of buildings in the ENEX data compared to the PHC 2021 data. However, the PHC data additionally contains an "undetected" entry, a portion of which may fall within this period. It should also be noted that based on the previous version of the study have been found inaccuracies in the EPC records when individual specialists often estimate and “round” the date to the nearest decade.

For PHC 2021, the records by "period of construction or reconstruction" are only for occupied buildings, while in the ENEX database the records are for the year of commissioning for all, i.e. theoretically also unoccupied, buildings, therefore the two data sets cannot be compared absolutely, but a similar distribution can be observed. It can be assumed that, taking into account also the number of renovated buildings, the distribution according to the PHC should on average be more recent than the ENEX data, which is also evident from the comparison.

Even though it is a fact that more detailed data on the energy performance of the entire residential building stock of the Czech Republic connected to individual construction periods is not known, the selected sample of data from ENEX can be considered sufficiently representative for the analysis of the TOP 15% of the building stock of the Czech Republic.

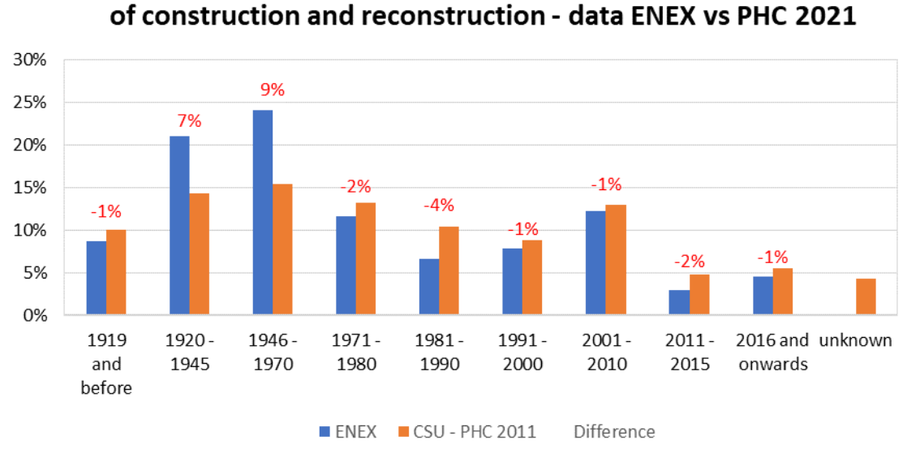


Fig. 8: comparison of the number of PHC 2021 records - number of buildings by period of construction/reconstruction and ENEX data - number of buildings by period of commissioning

On this basis, a selection of these EPC purposes is also applied to other building types.

C.3. Analysis of buildings classification

For the purposes of the contracting authority a frequency distribution analysis by classification for residential buildings was performed. The following tables show one by one the breakdown for family and apartment houses across all EPC purposes. Subsequently, the analysis for the aggregated group of purposes - sales, leases and public authority building aggregated for residential buildings (family and apartment houses) is then presented.

Tab. 23: analysis of the classification of primary non-renewable energy - family houses, all purposes

Family house					
New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
7	8	9	10	11	15

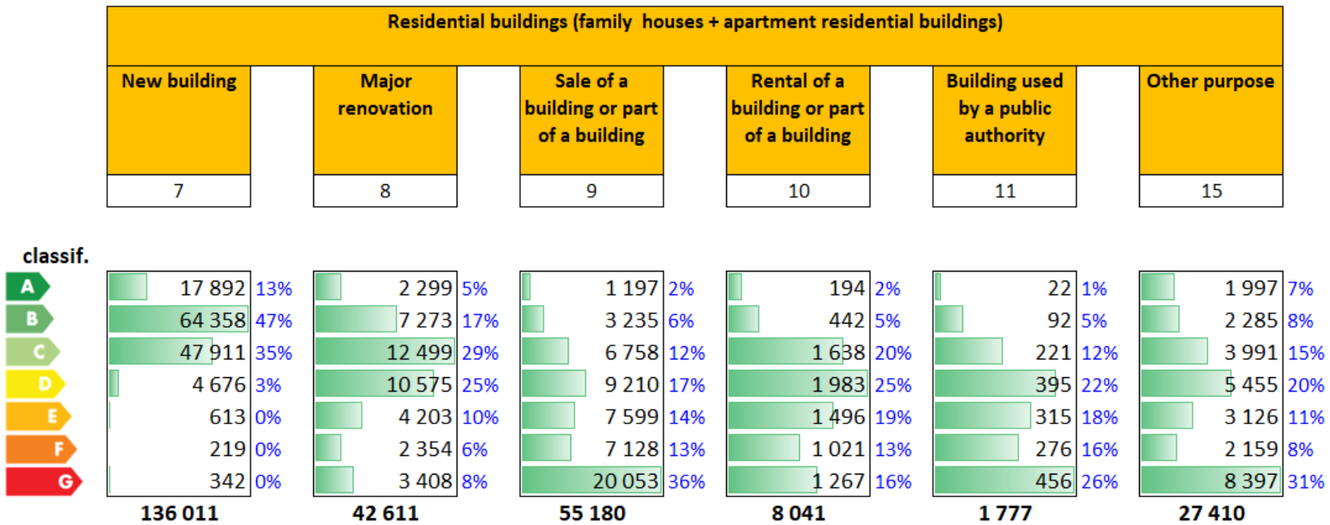
classif.												
A	17 366	13%	2 038	6%	981	2%	48	3%	9	3%	1 887	8%
B	59 686	46%	5 602	18%	2 628	6%	125	8%	31	11%	2 020	9%
C	46 101	36%	8 405	27%	4 182	10%	249	15%	19	7%	2 967	13%
D	4 478	3%	7 546	24%	6 597	15%	425	26%	53	19%	3 926	18%
E	533	0%	3 161	10%	5 529	13%	236	14%	28	10%	2 318	10%
F	184	0%	1 852	6%	5 582	13%	195	12%	36	13%	1 693	8%
G	307	0%	2 918	9%	17 849	41%	371	22%	108	38%	7 435	33%
	128 655		31 522		43 348		1 649		284		22 246	

Tab. 24: analysis of the classification of primary non-renewable energy - apartment houses, all purposes

Apartment residential building					
New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
7	8	9	10	11	15

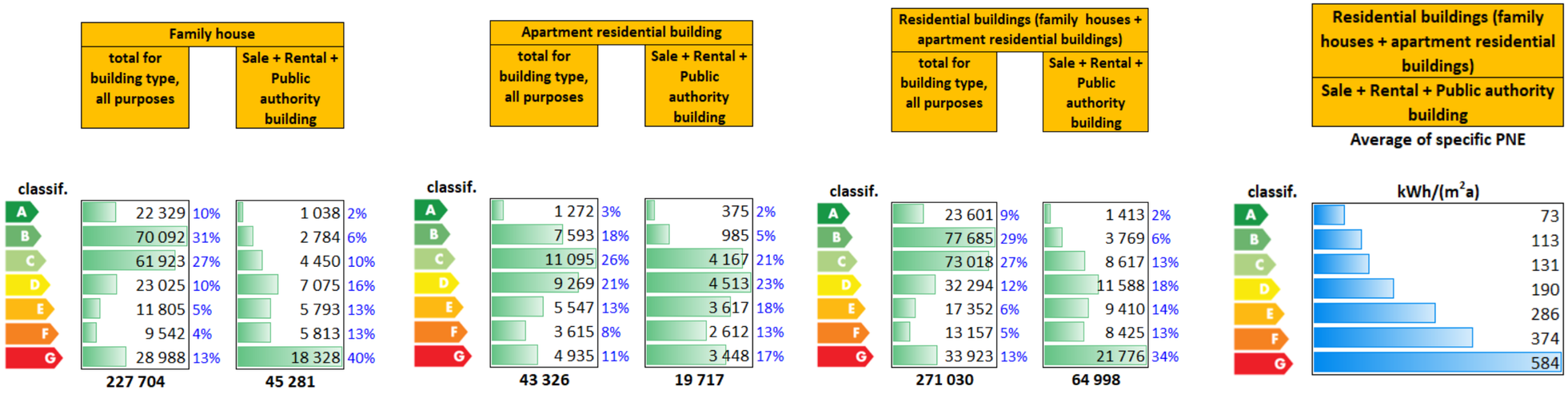
classif.												
A	526	7%	261	2%	216	2%	146	2%	13	1%	110	2%
B	4 672	64%	1 671	15%	607	5%	317	5%	61	4%	265	5%
C	1 810	25%	4 094	37%	2 576	22%	1 389	22%	202	14%	1 024	20%
D	198	3%	3 029	27%	2 613	22%	1 558	24%	342	23%	1 529	30%
E	80	1%	1 042	9%	2 070	17%	1 260	20%	287	19%	808	16%
F	35	0%	502	5%	1 546	13%	826	13%	240	16%	466	9%
G	35	0%	490	4%	2 204	19%	896	14%	348	23%	962	19%
	7 356		11 089		11 832		6 392		1 493		5 164	

Tab. 25: analysis of the classification of primary non-renewable energy – residential buildings (family + apartment houses), all purposes



The table below shows the frequencies for selected categories of use. The bottom right, the average consumption of primary non-renewable energy in kWh/(m²a) is also evaluated for each class.

Tab. 26: analysis of the classification of primary non-renewable energy – residential buildings – all purposes and selected purposes (sales, leases and public authority building)



C.4. Selection of an indicator as the threshold for the best buildings

The EU Taxonomy sets out an indicator for threshold determination for the top 15% of buildings as primary energy. In the Czech environment, this indicator is primary energy from non-renewable energy sources, reported as a specific value per m^2 of energy reference area. This is the main assessment criterion for the EPC under the current decree and the value was also reported on the EPC under the previous version of the decree in 2013.

It is important to note that the PENB assessment in the Czech Republic is based on the so-called reference building. For this reason, there are no fixed limits for specific primary energy from non-renewable energy sources set by the decree, but the limits of requirements and building classification are calculated for each building separately. The total absolute amount of specific primary energy from non-renewable energy sources is influenced by various parameters of the building such as its use. The current decree on the energy performance of buildings stipulates that For residential zones a uniform profile of typical building use according to EN 730331-1 must be used, with only very limited modifications possible. For non-residential zones, the adjustment of the values of the typical building use profile can be made more freely, even though the rules are defined by the decree. So by adjusting the profile the absolute value of the specific primary energy from non-renewable energy sources can be different. However, the classification of a building changes with a change in the absolute value of specific primary energy from non-renewable energy sources only minimally.

This means that the absolute value of specific primary energy from non-renewable energy sources may not be the best indicator of the quality (energy performance) of a building, especially for non-residential buildings. A better indicator in these cases is the classification of the building according to the reference building.

For this reason, the study to determine the threshold for determining the top 15% of buildings by energy performance is carried out using 2 alternative methods:

- **Method 1:** the fixed value of specific primary energy from non-renewable sources
- **Method 2**: the relative value of specific primary energy from non-renewable sources determined on the basis of the EPC class

Both methods will be described below.

Method 1: The fixed value of specific primary energy from non-renewable sources

For the assessment, sets of individual building types and purposes of EPC are defined. For defined groups of buildings, the analysis of the specific non-renewable primary energy (NPE) indicator as the main evaluation criterion is performed. The representation of the number of buildings by type and at the same time the purposes of EPC is evaluated according to the NPE value in the resolution of certain consumption limits. Thus, in practice, an analysis of the frequency distribution according to the resulting value of the NPE parameter in kWh/(m^2.year) is performed.

From this statistical analysis, the bottom 15% percentile is then created and the final threshold of the 15% most energy efficient buildings in terms of NPE consumption is determined. In this way, the threshold is set for all EPC purposes and building types.

Advantages of the method:

- A fixed benchmark value is sufficient, especially for residential buildings for which it is not possible to specify other than a standardised use of the building in the EPC valid for the current version of the decree).

Disadvantages of the method:

- The fixed value takes into account not only the quality of the building, but also the way the building is operated as specified in the EPC calculation.
- A problematic indicator especially for non-residential buildings, where the decree for the calculation of EPC does not strictly standardise the building operation.

Method 2: The relative value of specific primary energy from non-renewable sources determined on the basis of the EPC

According to the percentage of the primary non-renewable energy rating class for each building purpose can be determined which classes fall into the top 15% of buildings. Some classes will be included as a whole, so for example it can be said with certainty that classes A and B definitely fall into the top 15% of buildings, but if the representation of classes A and B is less than 15%, then a certain number of class C buildings will also fall into the top 15% of buildings.

In practice, this can then be applied to a specific building in a simplified way so that if the building class is in class A or B, it automatically falls into the top 15% of buildings; if it falls into class C, a closer analysis is required.

For a particular building in Class C, it is then possible to see if it is in the percentage of Class C that would still fall into the top 15% of buildings. The simplification used is that the percentage of the number of buildings represented in the “better” part of Class C corresponds to the percentage of Class C for the particular building being assessed.

Advantages of the method:

- The main advantage is that it is a relative value that assesses the quality of the building but does not penalise or favour buildings with a different use profile from the standardised one.
- For buildings in the higher NPE classes (typically A and B), it is possible to assess compliance with the top 15% condition based on the knowledge of a class alone.

Disadvantages of the method:

- For lower classes, a simple calculation is required to determine if the building falls into the top 15% and it is necessary to use the correct NPE parameter from the graphical part of the EPC

D. FINAL SELECTION OF THE TOP BUILDINGS THRESHOLD

D.1. Method 1: The fixed value of specific primary energy from non-renewable sources

The following table provides an illustrative distribution of frequency (histogram) of records by specific primary non-renewable energy consumption value for the entire ENEX dataset. At the same time, the cumulative frequency of records is shown (right column). The table then shows the boundaries between which the 15% frequency limit is located (black box, blue text). The exact limit is then stated at the bottom left. If we were to look for the limit for the whole ENEX dataset, it would specifically be 78.5 kWh/(m²a).

Tab. 27: histogram by NPE for the entire ENEX dataset

total of all entries		
frequency distribution of non-renewable primary energy		
thershold kWh/(m²a)	frequency for a given value range	cumulative frequency
0	503	0,2%
25	1 364	0,6%
50	7 195	2,9%
75	32 455	13,2%
100	45 356	27,7%
125	46 090	42,4%
150	35 604	53,8%
175	25 692	62,0%
200	19 758	68,3%
225	14 735	73,0%
250	10 764	76,4%
275	7 951	79,0%
300	6 622	81,1%
325	5 931	83,0%
350	5 105	84,6%
375	4 726	86,1%
400	4 223	87,5%
425	3 863	88,7%
450	3 369	89,8%
475	3 049	90,7%
500	2 686	91,6%
525	2 652	92,4%
550	2 324	93,2%
575	2 107	93,9%
600	1 965	94,5%
625	1 793	95,1%
>625	15 506	100,0%
SUM	**313 388**	
TOP 15 threshold		
78,50	46 630	**15%**

The frequency is similarly analysed for all purposes and building types. The tables below show an example for a family house and two EPC purposes - New Building and sale and lease of the building.

The threshold of 15% of the most energy-efficient new buildings of family houses is set at 67 kWh/(m²a). Similarly, the threshold for sales and lease of family houses is set at 137 kWh/(m²a).

Tab. 28: frequency distribution of NPEs for family houses - new building and sales/leases

Family house New building		
thershold kWh/(m2a)	frequency for a given value range	cumulative frequency
0,0	269	0,2%
25,0	751	0,8%
50,0	4 371	4,2%
75,0	23 433	22,4%
100,0	27 639	43,8%
125,0	25 468	63,6%
	16 997	76,8%
	11 037	85,4%
	8 224	91,8%
	5 430	96,0%
	2 550	98,0%
	996	98,7%
	494	99,1%
	293	99,3%
	196	99,5%
	125	99,6%
	98	99,7%
	73	99,7%
	61	99,8%
	48	99,8%
	38	99,8%
	24	99,9%
	27	99,9%
	14	99,9%
	20	99,9%
	19	99,9%
	99	100,0%
	128 794	
ld		
	19 149	**15%**

Family house Sale of a building or part of a building		
thershold kWh/(m2a)	frequency for a given value range	cumulative frequency
0,0	3	0,0%
25,0	34	0,1%
50,0	173	0,5%
75,0	716	2,1%
100,0	1 622	5,9%
125,0	2 553	11,8%
	2 886	18,4%
	2 562	24,3%
	2 250	29,5%
	1 836	33,7%
	1 824	38,0%
	1 666	41,8%
	1 589	45,5%
	1 529	49,0%
	1 443	52,3%
	1 525	55,8%
	1 448	59,2%
	1 398	62,4%
	1 252	65,3%
	1 159	67,9%
	1 104	70,5%
	1 162	73,2%
	1 101	75,7%
	1 018	78,1%
	982	80,3%
	826	82,2%
	7 709	100,0%
	43 370	
ld		
	6 512	**15%**

The threshold for other uses and building types is set in a similar manner. The resulting threshold for the TOP 15% is shown in the following table (Tab. 31).

Tab. 29: setting a fixed limit of TOP 15% for individual building types and EPC purposes

VALUE TOP 15%	Range	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
		kWh/(m²a)					
Office building	84 - 166	84	95	166	140	152	103
Family house	67 - 145	67	92	137	118,5	145	86
Apartment residential building	67,5 - 133	67,5	87,5	102,5	103	133	99
Building for accomm. and catering	77 - 205	77	110	199	205	155	118
Building for health care	100 - 230	100	113	230	180	183	100
Building for education	78 - 225	78	103	225	170	145	83,5
Building for sport	105 - 220	117	142	220	200	205	105
Retail building	96 - 264	96	116	240	190	264	174
Building for culture	80 - 175	80	103	175	130	161	90
Other types of building, please specify:	70,5 - 169,5	70,5	94	169,5	148	152	83

The table above is for informative and comparison purposes. As mentioned previously, the following categories have been identified as characteristic of Czech building-stock : **sale** of a building or part of a building / **lease** of a building or part of a building / **building used by a public authority**. These 3 categories are therefore aggregated into one set and the TOP 15% threshold is then evaluated on this set.

The aggregated ratings for office buildings and buildings for education are shown in Tab.25. Here it is clearly evident that the TOP 15% threshold for office buildings is set at **152 kWh/(m²a)** and for buildings for education at **146.5 kWh/(m²a)**. A similarly is threshold then set for all other categories,

Tab. 30: example of frequency distribution of NPEs for the aggregated groups sale/lease/public authority building

Office building Sale + Rental + Public authority building		
thershold kWh/(m2a)	frequency for a given value range	cumulative frequency
0,0	0	0,00%
25,0	2	0,05%
50,0	7	0,24%
75,0	22	0,83%
100,0	96	3,40%
125,0	174	8,05%
150,0	241	14,5%
175,0	250	21,2%
200,0	236	27,51%
225,0	233	33,74%
250,0	223	39,71%
275,0	227	45,79%
300,0	195	51,00%
325,0	176	55,71%
350,0	155	59,86%
375,0	151	63,90%
400,0	153	68,00%
425,0	145	71,88%
450,0	121	75,11%
475,0	103	77,87%
500,0	76	79,90%
525,0	77	81,96%
550,0	68	83,78%
575,0	49	85,09%
600,0	48	86,38%
625,0	66	88,15%
>625	443	100,00%
SUM	**3 737**	
TOP 15 threshold		
152	559	**15%**

The conclusion of Method 1 of the fixed values selection, a table of the resulting values of the TOP 15% threshold can be presented for an overview, followed by the TOP 30% boundary for comparison, as well as the 15% and 25% of "worst buildings" in terms of primary non-renewable energy consumption WORST 25% and WORST 15% boundaries for the 15% and 25% "worst buildings" in terms of primary non-renewable energy consumption.

The final selection of the TOP 15% and TOP 30% thresholds is presented in chapter D.3.

Tab. 31: frequency distribution of NPEs for aggregated groups sale/lease/public authority building using ***method 1 - the fixed value of specific primary energy from non-renewable sources***

	TOP 15% kWh/(m²a)	TOP 30% kWh/(m²a)	WORST 25% kWh/(m²a)	WORST 15% kWh/(m²a)
Office building	152	208	449	572
Family house	137	200	539	660
Apartment residential building	104	137	328	403
Building for accomm. and catering	185	257	535	685
Building for health care	185	244	480	575
Building for education	147	197	398	475
Building for sport	207	284	581	743
Retail building	214	301	640	750
Building for culture	159	242	525	640
Building for production and storage	146	206	506	649
Other types of building, please specify:	157	229	525	665

D.2. Method 2: The relative value of specific primary energy from non-renewable sources determined on the basis of the EPC class

*Tab. 32: Percentage of primary non-renewable energy **rating class** for each building purpose*

Building type / PNE class	A	B	C	D	E	F	G
Office building	1%	5%	11%	29%	20%	13%	21%
Family house	2%	6%	10%	16%	13%	13%	40%
Residential apartment building	2%	5%	21%	23%	18%	13%	18%
Building for culture	2%	5%	12%	21%	21%	13%	25%
Retail building	2%	4%	11%	33%	18%	13%	19%
Building for sport	3%	7%	20%	32%	15%	9%	13%
Building for accomm. and catering	1%	4%	12%	27%	20%	14%	22%
Building for education	2%	5%	17%	33%	20%	12%	11%
Building for health care	2%	7%	19%	38%	18%	9%	8%
Building for product. and storage	3%	9%	16%	24%	18%	11%	20%
Other types	2%	6%	11%	23%	18%	13%	27%

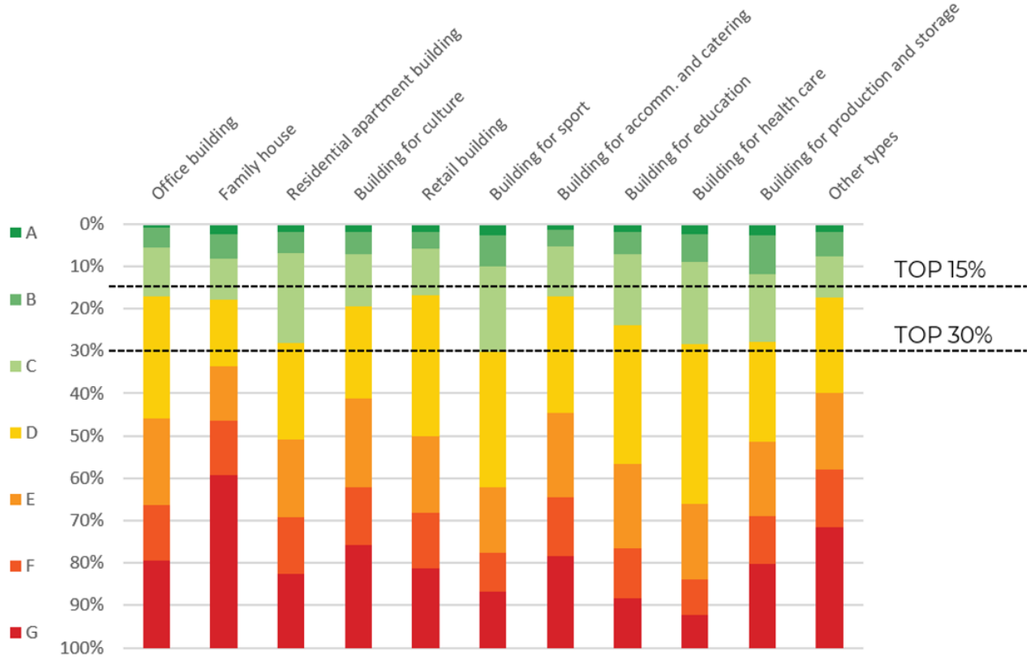


Fig. 9: Thresholds of TOP 15% and TOP 30% in the graph of EPC class distribution by specific PNE

*Tab. 33: Selection of the **top 15% of buildings using the PNE building classification method**:*

Building type	Classification by non-renewable primary energy (PNE) class in the EPC falling into the TOP 15% of the buildings
Office building	Class A, B and 81% of class C
Family house	Class A, B and 67% of class C
Residential apartment building	Class A, B and 38% of class C
Building for culture	Class A, B and 62% of class C
Retail building	Class A, B and 83% of class C
Building for sport	Class A, B and 26% of class C
Building for accomm. and catering	Class A, B and 83% of class C
Building for education	Class A, B and 46% of class C
Building for health care	Class A, B and 31% of class C
Building for production and storage	Class A, B and 20% of class C
Other types	Class A, B and 74% of class C

*Tab. 34: Selection of the **top 30% of buildings using the PNE building classification method**:*

Building type	Classification by non-renewable primary energy (PNE) class in the EPC falling into the TOP 30% of the buildings
Office building	Class A, B, C and 45% of class D
Family house	Class A, B, C and 77% of class D
Residential apartment building	Class A, B, C and 9% of class D
Building for culture	Class A, B, C and 48% of class D
Retail building	Class A, B, C and 40% of class D
Building for sport	Class A, B and C
Building for accomm. and catering	Class A, B, C and 47% of class D
Building for education	Class A, B, C and 19% of class D
Building for health care	Class A, B, C and 4% of class D
Building for production and storage	Class A, B, C and 10% of class D
Other types	Class A, B, C and 56% of class D

D.3. Final method: Selection based on energy class with a limit value of specific primary energy from non-renewable sources for the lowest included class

The final method **uses the advantages of both methods and eliminates their disadvantages.** The best of TOP 15% and TOP 30% of buildings are determined by the EPC class, and for the lowest included class a fixed limit of specific primary energy from non-renewable sources is also set.

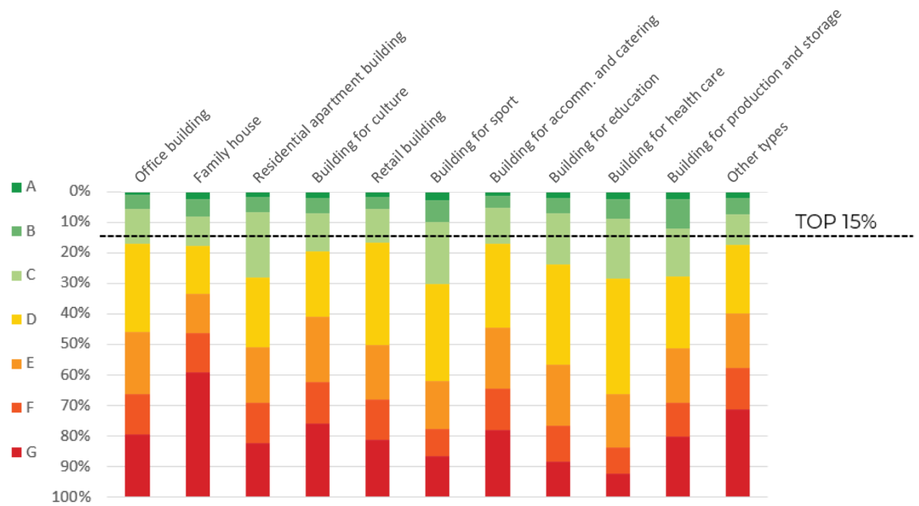
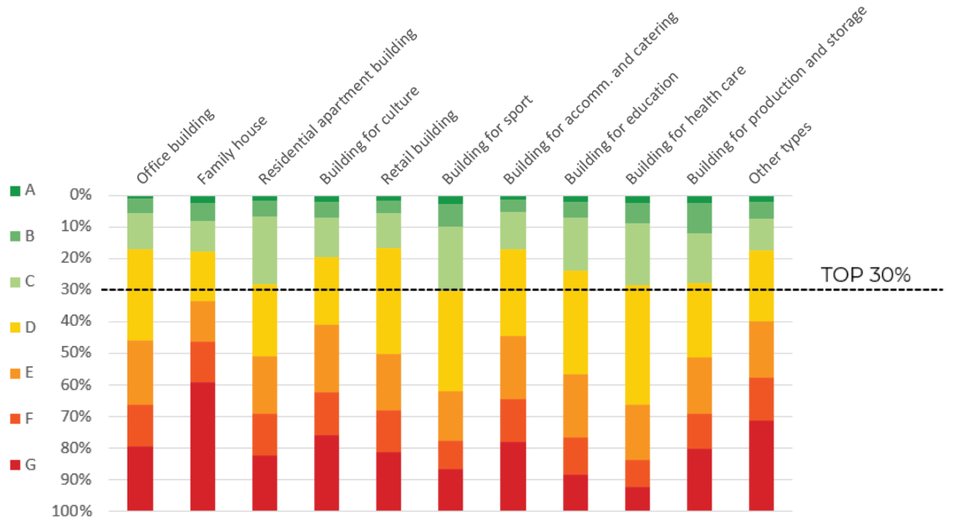


Fig. 10: Threshold of TOP 15% in the graph of EPC class distribution by specific PNE

Tab. 35: ***Selecting the top 15% of buildings using the final method:***

Building type	TOP 15% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B no limits & class C w/ max. specific PNE 260 kWh/(m^2.year)
Family house	PNE class A+B no limits & class C w/ max. specific PNE 157 kWh/(m^2.year)
Residential apartment building	PNE class A+B no limits & class C w/ max. specific PNE 102 kWh/(m^2.year)
Building for culture	PNE class A+B no limits & class C w/ max. specific PNE 222 kWh/(m^2.year)
Retail building	PNE class A+B no limits & class C w/ max. specific PNE 545 kWh/(m^2.year)
Building for sport	PNE class A+B no limits & class C w/ max. specific PNE 210 kWh/(m^2.year)
Building for accomm. and catering	PNE class A+B no limits & class C w/ max. specific PNE 375 kWh/(m^2.year)
Building for education	PNE class A+B no limits & class C w/ max. specific PNE 161 kWh/(m^2.year)
Building for health care	PNE class A+B no limits & class C w/ max. specific PNE 173 kWh/(m^2.year)
Building for production and storage	PNE class A+B no limits & class C w/ max. specific PNE 143 kWh/(m^2.year)
Other types	PNE class A+B no limits & class C w/ max. specific PNE 242 kWh/(m^2.year)



Obr. 11: Threshold of TOP 30% in the graph of EPC class distribution by specific PNE

Tab. 36: ***Selecting the top 30% of buildings using the final method:***

Building type	TOP 30% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B+C no limits & class D w/ max. specific PNE 208 kWh/(m2.year)
Family house	PNE class A+B+C no limits & class D w/ max. specific PNE 240 kWh/(m2.year)
Residential apartment building	PNE class A+B+C no limits & class D w/ max. specific PNE 115 kWh/(m2.year)
Building for culture	PNE class A+B+C no limits & class D w/ max. specific PNE 241 kWh/(m2.year)
Retail building	PNE class A+B+C no limits & class D w/ max. specific PNE 331 kWh/(m2.year)
Building for sport	PNE class A+B+C no limits
Building for accomm. and catering	PNE class A+B+C no limits & class D w/ max. specific PNE 278 kWh/(m2.year)
Building for education	PNE class A+B+C no limits & class D w/ max. specific PNE 166 kWh/(m2.year)
Building for health care	PNE class A+B+C no limits & class D w/ max. specific PNE 145 kWh/(m2.year)
Building for production and storage	PNE class A+B+C no limits & class D w/ max. specific PNE 117 kWh/(m2.year)
Other types	PNE class A+B+C no limits & class D w/ max. specific PNE 265 kWh/(m2.year)

E. PRACTICAL APPLICATION OF THE TOP BUILDING THRESHOLD

This chapter describes how the assessment of whether a particular building is in the top 15% of the best buildings according to the alternative procedure for Section 7.7 Acquisition and ownership of buildings will be made in practice.

E.1. Time specification

This study applies to buildings in Section 7.7 Acquisition and ownership of buildings built prior to 31 December 2020. For time specification purposes, the date of the building permit application shall be considered the time of construction.

For the assessment **can be used** data from the EPC, where the class and value of non-renewable primary energy according to **Decree 78/2013 Coll.** (valid from 1 April 2013 to 31 August 2020) or the class and value of primary energy from non-renewable energy sources of the EPC according to **Decree 264/2020 Coll.** (valid from 1 September 2020).

The EPC according to **Decree 148/2007 Coll.** (valid from 1 July 2007 to 31 March 2013) **cannot be used** for this purpose.

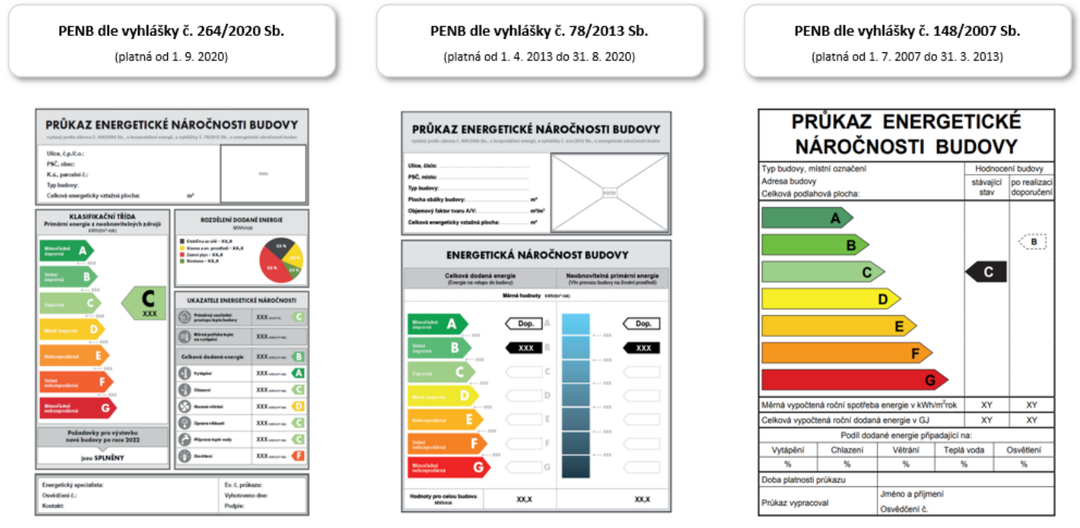


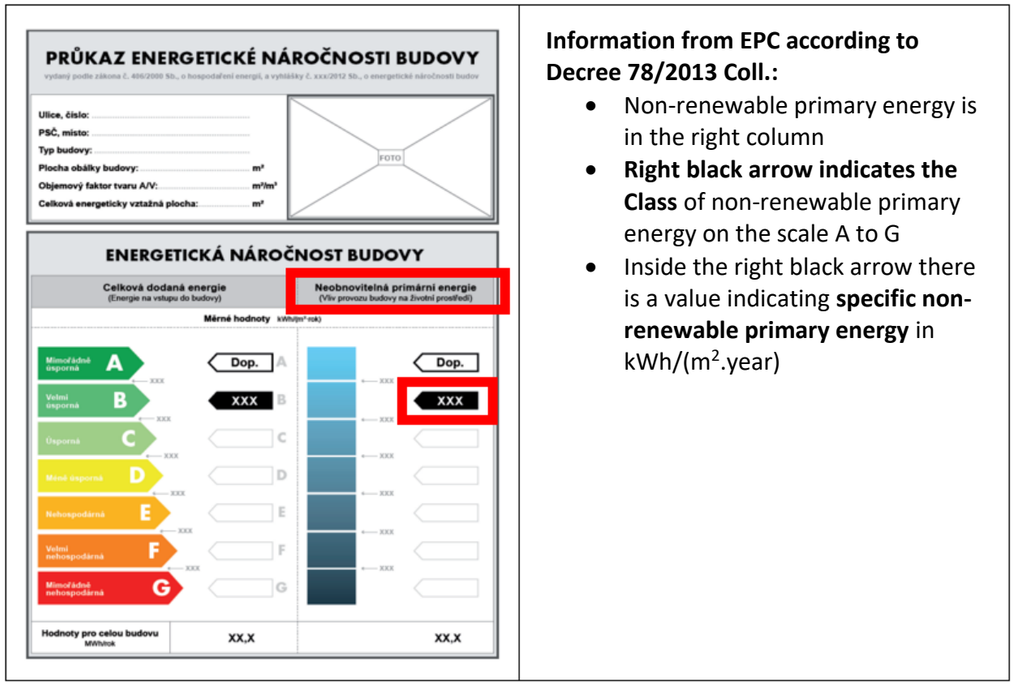
Fig. 12: Graphical representation of EPCs according to the individual Decrees in force in the Czech Republic from 2007 to the present day

E.2. Data from EPC according to Decree 148/2007 Coll. (valid from 1 July 2007 to 31 March 2013)

Data from EPC according to Decree 148/2007 Coll. cannot be used, they do not contain data on primary energy. Moreover, the EPCs drawn up in accordance with this Decree are no longer valid at this time, the EPCs are valid for 10 years, i.e. the EPCs under this Decree expired 31 March 2023 at the latest.

E.3. Data from EPC according to Decree 78/2013 Sb. (valid from 1 April 2013 to 31 August 2020)

The data for assessment can be found on the first page of the graphical part of the EPC according to Decree 78/2013 Coll. In this Decree, the indicator non-renewable primary energy is just a complementary assessment.



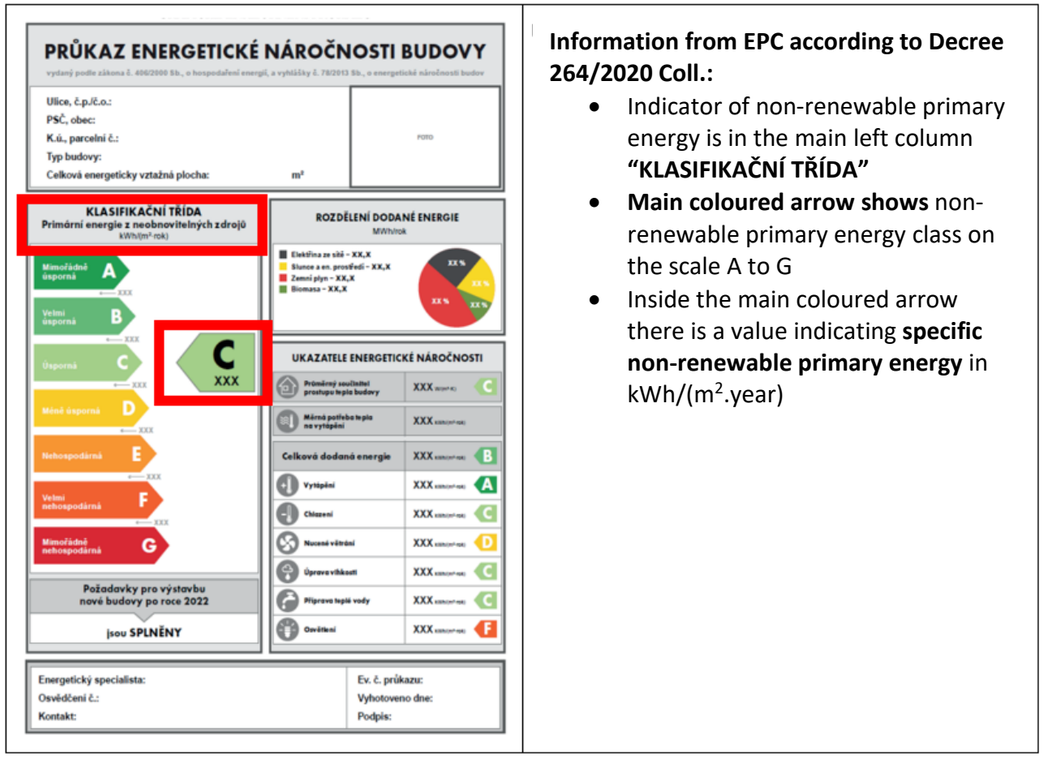
Information from EPC according to Decree 78/2013 Coll.:

- Non-renewable primary energy is in the right column
- **Right black arrow indicates the Class** of non-renewable primary energy on the scale A to G
- Inside the right black arrow there is a value indicating **specific non-renewable primary energy** in kWh/(m^2.year)

Fig. 13: Graphical representation of EPC according to Decree 78/2013 Coll. with description of data relevant for the purpose of this study

E.4. Data from EPC according to Decree 264/2020 Sb. (valid from 1 September 2020)

The data for assessment can be found in the graphical part of the EPC according to Decree 264/2020 Coll. In this Decree, the primary energy from non-renewable sources indicator is the main indicator - the EPC classification class.



Information from EPC according to Decree 264/2020 Coll.:

- Indicator of non-renewable primary energy is in the main left column **"KLASIFIKAČNÍ TŘÍDA"**
- **Main coloured arrow shows** non-renewable primary energy class on the scale A to G
- Inside the main coloured arrow there is a value indicating **specific non-renewable primary energy** in kWh/(m^2.year)

Fig. 14: Graphical representation of EPC according to Decree 264/2020 Coll. with description of data relevant for the purpose of this study

E.5. Practical application

The data obtained from the EPC shall be compared with the results of this study as follows:

TOP 15%:

- If the **class (the letter indicator)** of non-renewable primary energy or primary energy from non-renewable sources is **A or B**, the building belongs to the TOP15% of buildings according to this study.
- If the **class (the letter indicator)** of non-renewable primary energy or primary energy from non-renewable sources is **C,** the building belongs to the TOP15% of buildings according to this study **only if the numerical value of specific non-renewable primary energy** or specific primary energy from non-renewable sources in kWh/(m^2.year) **is lower than the one indicated for the specific building type in the conclusion of this study.**

TOP 30%:

- If the **class (the letter indicator)** of non-renewable primary energy or primary energy from non-renewable sources is **A, B or C** the building belongs to the TOP30% of buildings according to this study.
- If the **class (the letter indicator)** of non-renewable primary energy or primary energy from non-renewable sources is **D**, the building belongs to the TOP30% of buildings according to this study **only if the numerical value of specific non-renewable primary energy** or specific primary energy from non-renewable sources in kWh/(m^2.year) **is lower than the one indicated for the specific building type in the conclusion of this study.**

E.6. Data from EPC not available

The assessment of whether a particular building belongs to the TOP 15% or TOP 30% of buildings according to this study can only be made in the case of availability of data from PENB according to Decree No. 78/2013 Coll. or Decree No. 264/2020 Coll.

An analysis of the number of New Buildings meeting the conditions for the TOP 15% was carried out and no significant correlation was found to determine with certainty whether a building meets these conditions based only on the date of the EPC preparation for the New Building.

The results of this analysis are presented in Annex 2 and can be used, for example, to estimate the number of compliant buildings in a portfolio of buildings of the same type.

The EU Taxonomy FAQs do not recommend using assumptions such as the year of construction of a building to determine if a building qualifies for the TOP 15% of the best buildings:

151. ***Is it permissible to use a weighted requirement value based on the valid new building regulations of the last 15 years for the definition of the necessary requirement value for 'the best 15 % of the stock' as referred to in substantial contribution criteria of the activity 'Acquisition and ownership of buildings' in Section 7.7?***

The technical screening criteria require ' adequate evidence, which at least compares the performance of the relevant asset to the performance of the national or regional stock built before 31 December 2020 and at least distinguishes between residential and non-residential buildings' if the option of the ' top 15 % of the national or regional building stock' is used. ***It is not possible to use proxies, such as the year of the construction of the building.***

F. CONCLUSION

The study determined the top 15% and top 30% of the building stock in terms of operational primary energy demand (primary energy from non-renewable sources).

A sample of buildings representing the whole building stock of the Czech Republic was selected from the ENEX database (database of building energy performance certificates (EPC)). The purposes of EPC were selected to represent best the whole building stock: EPCs for sale, lease and public authority buildings.

Obviously erroneous and incomplete records were removed from the data. Subsequently, an analysis of the representation of each class of primary energy from non-renewable sources in the total number of records for each building type was carried out.

In this way, it was possible to determine which classes fall within the top 15% and top 30% of the building stock. If the whole class was not included, a threshold of specific primary energy from non-renewable sources was quantified so that the percentage of the selected sample corresponded exactly to the 15% and 30% respectively for the building types.

The results can be interpreted using the following graph and tables:

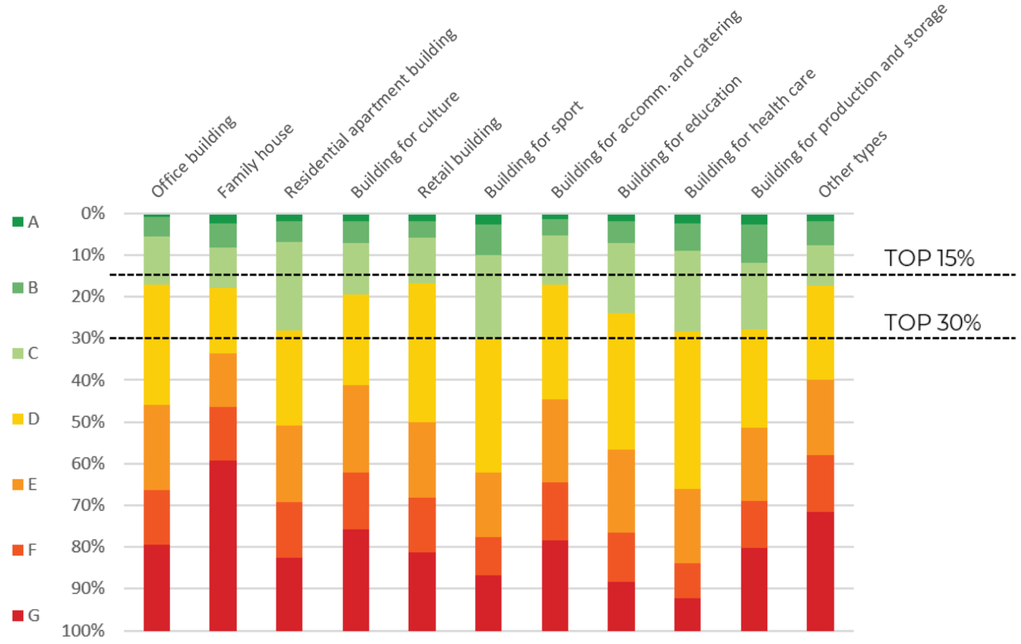


Fig.. 15: Thresholds of TOP 15% and TOP 30% in the chart of EPC class distribution by specific PNE

Tab. 37: ***Selection of the top 15% of buildings using the final method:***

Building type	TOP 15% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B no limits & class C w/ max. specific PNE 260 kWh/(m^2.year)
Family house	PNE class A+B no limits & class C w/ max. specific PNE 157 kWh/(m^2.year)
Residential apartment building	PNE class A+B no limits & class C w/ max. specific PNE 102 kWh/(m^2.year)
Building for culture	PNE class A+B no limits & class C w/ max. specific PNE 222 kWh/(m^2.year)
Retail building	PNE class A+B no limits & class C w/ max. specific PNE 545 kWh/(m^2.year)
Building for sport	PNE class A+B no limits & class C w/ max. specific PNE 210 kWh/(m^2.year)
Building for accomm. and catering	PNE class A+B no limits & class C w/ max. specific PNE 375 kWh/(m^2.year)
Building for education	PNE class A+B no limits & class C w/ max. specific PNE 161 kWh/(m^2.year)
Building for health care	PNE class A+B no limits & class C w/ max. specific PNE 173 kWh/(m^2.year)
Building for production and storage	PNE class A+B no limits & class C w/ max. specific PNE 143 kWh/(m^2.year)
Other types	PNE class A+B no limits & class C w/ max. specific PNE 242 kWh/(m^2.year)

Tab. 38: ***Selection of the top 30% of buildings using the final method:***

Building type	TOP 30% buildings by primary non-renewable energy (PNE) class in the EPC and an additional specific PNE threshold for the lowest included class
Office building	PNE class A+B+C no limits & class D w/ max. specific PNE 208 kWh/(m2.year)
Family house	PNE class A+B+C no limits & class D w/ max. specific PNE 240 kWh/(m2.year)
Residential apartment building	PNE class A+B+C no limits & class D w/ max. specific PNE 115 kWh/(m2.year)
Building for culture	PNE class A+B+C no limits & class D w/ max. specific PNE 241 kWh/(m2.year)
Retail building	PNE class A+B+C no limits & class D w/ max. specific PNE 331 kWh/(m2.year)
Building for sport	PNE class A+B+C no limits
Building for accomm. and catering	PNE class A+B+C no limits & class D w/ max. specific PNE 278 kWh/(m2.year)
Building for education	PNE class A+B+C no limits & class D w/ max. specific PNE 166 kWh/(m2.year)
Building for health care	PNE class A+B+C no limits & class D w/ max. specific PNE 145 kWh/(m2.year)
Building for production and storage	PNE class A+B+C no limits & class D w/ max. specific PNE 117 kWh/(m2.year)
Other types	PNE class A+B+C no limits & class D w/ max. specific PNE 265 kWh/(m2.year)

ANNEX 1 – DETERMINATION OF AVERAGE VALUES

For the purposes of the contracting authority (the need to report the positive impact of investments in energy efficient buildings), an analysis of the average and median values of primary non-renewable and total delivered energy consumption was carried out. The values given (compared to the fixed TOP 15%) for each building type and processing purpose are presented in the tables below.

Tab. 39: average values of non-renewable primary energy consumption by building type and purpose of EPC processing

NON-RENEWABLE PRIMARY ENERGY AVERAGE	TOP15	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
				kWh/(m²a)			
Office building	152	170	199	360	306	397	258
Family house	136,5	119	197	390	302	424	284
Apartment residential building	104	103	160	245	239	322	205
Building for accomm. and catering	184,5	187	255	455	417	381	348
Building for health care	185	220	251	459	351	360	312
Building for education	146,5	164	201	396	358	305	197
Building for sport	207	242	328	459	509	485	360
Retail building	214	223	268	525	414	596	357
Building for culture	159	191	252	380	370	414	220
Other types of building, please specify:	156,5	175	231	440	363	416	289

Tab. 40: median value of non-renewable primary energy consumption by building type and purpose of EPC processing

NON-RENEWABLE PRIMARY ENERGY MEDIAN	TOP15	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
				kWh/(m²a)			
Office building	152	137	155	302	252	326	204
Family house	136,5	108	151	333	229	392	191
Apartment residential building	104	91	131	200	201	284	161
Building for accomm. and catering	184,5	143	193	388	342	323	261
Building for health care	185	170	208	450	298	311	276
Building for education	146,5	142	172	363	310	254	148
Building for sport	207	203	224	390	458	360	269
Retail building	214	172	208	467	371	530	291
Building for culture	159	153	194	386	360	351	143
Other types of building, please specify:	156,5	131	174	365	289	326	199

Tab. 41: average values of total delivered energy consumption by building type and purpose of EPC processing

TOTAL DELIVERED ENERGY AVERAGE	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
			kWh/(m²a)			
Office building	114	135	238	205	249	169
Family house	109	172	363	276	413	266
Apartment residential building	85	124	194	189	243	171
Building for accomm. and catering	143	188	329	287	281	241
Building for health care	144	178	320	239	260	211
Building for education	119	153	275	241	213	142
Building for sport	177	230	340	390	329	257
Retail building	142	175	340	246	373	224
Building for culture	133	181	317	360	322	184
Other types of building, please specify:	129	169	330	271	284	233

Tab. 42: median value of total delivered energy consumption by building type and purpose of EPC processing

TOTAL DELIVERED ENERGY MEDIAN	New building	Major renovation	Sale of a building or part of a building	Rental of a building or part of a building	Building used by a public authority	Other purpose
			kWh/(m²a)			
Office building	95	111	208	174	221	140
Family house	105	134	325	208	393	181
Apartment residential building	78	108	162	161	219	139
Building for accomm. and catering	113	156	276	246	246	208
Building for health care	119	152	314	209	238	186
Building for education	107	129	248	225	184	112
Building for sport	147	177	321	288	279	194
Retail building	112	139	318	222	339	182
Building for culture	110	145	283	301	289	111
Other types of building, please specify:	104	133	286	222	242	165

The table below then shows the mean and median values for a representative set of processing purposes sales, leases and public authority building for total delivered and non-renewable primary energy.

Tab. 43: mean and median values of total delivered and primary non-renewable energy for the selected sample of buildings

For all buildings	Sale + Rental + Public authority building			
	non-renewable primary energy		total delivered energy	
	AVERAFE	MEDIAN	AVERAGE	MEDIAN
	kWh/(m²a)			
Office building	360	296	234	203
Family house	387	328	360	320
Apartment residential building	249	206	196	166
Building for accomm. and catering	429	365	309	264
Building for health care	372	319	264	239
Building for education	311	261	216	187
Building for sport	486	380	341	290
Retail building	488	428	305	276
Building for culture	408	356	325	291
Other types of building, please specify:	412	333	301	256
Building for production and storage	389	308	292	241

Tab. 44: mean and median values of total delivered and primary non-renewable energy for a selected sample of buildings, ***only for buildings in the top 15% of the best buildings as determined by the final method***

For TOP 15 % buildings only according to the Final method	Sale + Rental + Public authority building			
	non-renewable primary energy		total delivered energy	
	AVERAFE	MEDIAN	AVERAGE	MEDIAN
	kWh/(m²a)			
Office building	157	141	140	110
Family house	112	111	266	142
Apartment residential building	87	89	99	85
Building for accomm. and catering	193	164	226	170
Building for health care	206	160	167	130
Building for education	139	131	115	102
Building for sport	226	176	233	156
Retail building	237	208	209	156
Building for culture	167	145	279	149
Other types of building, please specify:	151	137	210	130
Building for production and storage	156	131	159	100

For buildings in the top 15% of the best buildings determined by the final method, it can be observed that the values for non-renewable primary energy are sometimes lower than for delivered energy. This may be due to the fact that low primary energy can be achieved for a particular building by using renewable sources such as a photovoltaic system, a heat pump, or for example a heat source fired by wood or other biomass with a low non-renewable primary energy factor. In this case, the resulting class and value of the primary non-renewable energy will be favourable, while the total energy delivered will be high. This is a consequence of using primary **non-renewable energy** as a criterion for selecting the TOP 15% and TOP 30% of the best buildings respectively.

ANNEX 2 –NUMBER OF NEW BUILDINGS MEETING THE TOP 15% THRESHOLD IN 2016-2019

The additional analysis tracks the development of the portion of new buildings meeting the TOP 15% criterion in the individual years 2016, 2017, 2018, 2019. The analysis is performed to estimate the probability that a new building put into operation in a given year (the year of EPC processing and therefore the year of building permit submission) will meet the TOP 15% threshold. The analysis can be used, for example, to estimate what proportion of new buildings in a given portfolio will meet the TOP 15% threshold.

The data shows that the aggregate for the years in question is 69%. For 2016 it is 66% and for the following years up to 2019 it is almost identically 69% and 70%. This reflects some improvement in building quality from 2017 onwards.

Tab. 45: number of new buildings meeting the TOP 15% threshold in individual years

2016	No. of New buildings	No. of buildings that fall to given Class (for "C" Class threshold applies)			Buildings in TOP 15%
		A	B	C	suma
Office building	211	12	58	73	143
Family house	6 649	711	2 594	994	4 299
Residential apartment building	319	16	135	31	182
Building for accomm. and catering	80	6	20	38	64
Building for health care	29	1	6	6	13
Building for education	99	15	36	21	72
Building for sport	37	3	13	5	21
Retail building	122	16	38	50	104
Building for culture	8	1	3	3	7
Other types of building	406	44	162	115	321
	7 960	**825**	**3 065**	**1 336**	**5 226**

2017	No. of New buildings	No. of buildings that fall to given Class (for "C" Class threshold applies)			Buildings in TOP 15%
		A	B	C	suma
Office building	539	65	188	205	458
Family house	15 654	1 935	6 455	2 305	10 695
Residential apartment building	725	52	424	41	517
Building for accomm. and catering	146	11	55	62	128
Building for health care	34	2	12	5	19
Building for education	104	17	40	12	69
Building for sport	81	9	36	9	54
Retail building	220	33	79	94	206
Building for culture	23	1	9	5	15
Other types of building	426	42	187	112	341
	17 952	**2 167**	**7 485**	**2 850**	**12 502**

2018	No. of New buildings	No. of buildings that fall to given Class (for "C" Class threshold applies)			Buildings in TOP 15%
		A	B	C	suma
Office building	364	43	165	126	334
Family house	16 776	2 169	6 673	2 492	11 334
Residential apartment building	898	53	513	51	617
Building for accomm. and catering	160	13	65	54	132
Building for health care	46	7	15	6	28
Building for education	90	16	45	7	68
Building for sport	109	14	51	11	76
Retail building	223	46	90	72	208
Building for culture	22	2	12	3	17
Other types of building	738	97	342	181	620
	19 426	**2 460**	**7 971**	**3 003**	**13 434**

2019	No. of New buildings	No. of buildings that fall to given Class (for "C" Class threshold applies)			Buildings in TOP 15%
		A	B	C	suma
Office building	292	34	114	126	274
Family house	19 501	2 710	8 235	2 492	13 437
Residential apartment building	819	49	534	51	634
Building for accomm. and catering	187	19	65	54	138
Building for health care	38	5	19	6	30
Building for education	80	17	34	7	58
Building for sport	107	16	57	11	84
Retail building	242	51	96	72	219
Building for culture	15	3	6	3	12
Other types of building	842	121	359	181	661
	22 123	**3 025**	**9 519**	**3 003**	**15 547**

Tab. 46: aggregate number of buildings meeting the TOP 15% threshold in 2016-2019

2016-2019	No. of New buildings	No. of buildings that fall to given Class (for "C" Class threshold applies)			Buildings in TOP 15%
		A	B	C	suma
Office building	1 406	154	525	530	1 209
Family house	58 580	7 525	23 957	8 283	39 765
Residential apartment building	2 761	170	1 606	174	1 950
Building for accomm. and catering	573	49	205	208	462
Building for health care	147	15	52	23	90
Building for education	373	65	155	47	267
Building for sport	334	42	157	36	235
Retail building	807	146	303	288	737
Building for culture	68	7	30	14	51
Other types of building	2 412	304	1 050	589	1 943
	67 461	**8 477**	**28 040**	**10 192**	**46 709**

Tab. 47: aggregate number of buildings meeting the TOP 15% threshold in 2016-2019 and the portion in each year

		2016	2017	2018	2019	
	2016-2019					2016-2019
Office building	1 209	68%	85%	92%	94%	86%
Family house	39 765	65%	68%	68%	69%	68%
Residential apartment building	1 950	57%	71%	69%	77%	71%
Building for accomm. and catering	462	80%	88%	83%	74%	81%
Building for health care	90	45%	56%	61%	79%	61%
Building for education	267	73%	66%	76%	73%	72%
Building for sport	235	57%	67%	70%	79%	70%
Retail building	737	85%	94%	93%	90%	91%
Building for culture	51	88%	65%	77%	80%	75%
Other types of building	1 943	79%	80%	84%	79%	81%
	46 709	**66%**	**70%**	**69%**	**70%**	**69%**

ANNEX 3 – GAP ANALYSIS

This annex to the study highlights the main points of concern and potential recommendations to address them.

Methodology for establishing a reference sample of buildings

- The methodology described in Section A.2 aimed to select records from the ENEX database to represent the distribution of the building stock of the Czech Republic as accurately as possible in terms of the energy performance parameters which are evaluated in this study. Given the unavailability of comparable statistical data with the ENEX records, this is only an attempt to get closer to this goal, but it was not possible to verify the accuracy more precisely.
- In the event of more suitable data becoming available, or a more appropriate methodology for selecting records to more accurately represent the actual building stock is found, an update to this study is recommended.

Low number of records of some EPC processing purposes in the ENEX database

- This is a systemic problem where, unlike for new buildings (inspection is carried out by the building authority), there is no effective instrument in place to guarantee the enforceability and controllability of EPC processing for the purposes of sale and lease of real estate.
- If EPC were mandatory at least for the sale of real estate at the time of the transfer of the property owner in the land register, a much higher number of such processed and registered EPCs could be expected.

Unavailability of data on delivered energy by energy carrier

- The ENEX database shows the total delivered energy and the partial delivered energy for each category of consumption (heating, TV heating, lighting...), but not by individual energy carriers.
- Due to these data missing, it was not possible to process any statistical data on CO_2 emissions because it is not possible to distinguish which energy carrier was used in the building, the values on primary energy from non-renewable energy sources cannot be easily converted to CO_2 emissions because it is not known by which factors primary energy from non-renewable energy sources was calculated.
- In case it would be necessary to prepare not only statistics on primary energy from non-renewable energy sources but also statistics on total primary energy for the purpose of determining the worst buildings for the implementation of EPBD 4, the data basis for this will not be available, so it would be advisable to consider adding data on delivered energy broken down by energy carrier to the ENEX system immediately, even before the possible introduction of a completely new version of the energy specialist recording system.

Use of primary energy from non-renewable energy sources in Czechia

- The superior EU regulations mostly assume the use of total primary energy (primary energy from non-renewable and renewable energy sources), but in the Czech Republic the current version of the Decree deals only with primary energy from non-renewable energy sources.
- With the transposition of EPBD 4, it is likely that total primary energy will have to be (re)introduced in the energy assessment of buildings, however, at the moment there is no other option than to work only with the indicator of primary energy from non-renewable energy sources, as this is the main energy performance indicator and only data on primary energy from non-renewable energy sources are available in the ENEX database even from the period of the previous decree.

Erroneous records in the ENEX database

- Erroneous or missing records are the subject of an entire chapter on cleaning and preparing ENEX data for this study
- It can be considered to introduce some measures to control the values entered into ENEX, such as warning of a value that is outside the expected range of values.

Buildings with missing EPC

- Buildings without EPC cannot currently be individually assessed e.g. based only on the year of construction (building permit), see chapter E.6 of the study for more details, however, the study at least determined the percentage of new buildings from 2016 to 2019 that would meet the TOP 15% threshold according to this study (ANNEX 1) e.g. to estimate what percentage of buildings in a certain portfolio meet this threshold.

Precise identification of the building EPC

- In the future, a more precise identification of EPC in relation to existing building information systems, e.g. RUIAN, or linking of these databases so that energy performance information can be unambiguously assigned can be recommended.

ANNEX 4 – CLASSES AND PNE DISTRIBUTION IN THE ENEX DATABASE

The annex provides an overview of the data for each building type and category of the representative sample (Sale of a building or part of a building, Lease of a building or part of a building, Building used by a public authority) from the ENEX database.

From the distribution of classes in each interval of specific primary energy from non-renewable sources (kWh/m².year), the characteristics of each building type can be observed.

The distribution shows why the resulting method of selecting the top 15% and 30% of the building stock was chosen. The reference building method allows even buildings with higher consumption to achieve a good rating, i.e. a PNE class, because it is the quality of the building design that is assessed, not the number of technical systems and operating time. Conversely, even buildings with very low specific primary energy from non-renewable sources can be in a worse class if the building is inefficiently designed yet only the EPC assumes that the building operation will be low.

The chosen method prioritises high quality building design in terms of the building envelope, technical systems and/or the use of renewable energy sources. It does not penalise buildings with a high level of operation, such as commercial buildings, hospitals, etc., if they have a good class rating, i.e. are well designed. On the contrary, it penalises buildings that are not well designed despite low consumption as the low consumption is due to low operational use.

In general, the emphasis is on the quality of the building (envelope and technical systems) and the use of renewable energy sources, factors that can be influenced by the design, regardless of the operational use of the building, which is determined by the type of building and cannot be influenced. The disadvantage of the method is that in certain circumstances the selection of efficient technical systems and renewable energy sources may be preferred to passive design. In general, however, this method is more suitable for a rating system using a reference building.

*Tab. 48: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **office buildings***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,2%	0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,3%	1,0%	1,0%	0,5%	0,2%	0,1%	0,0%	**3%**
100-150	0,1%	1,3%	4,3%	4,6%	0,6%	0,2%	0,0%	**11%**
150-200	0,1%	1,0%	2,5%	6,8%	2,0%	0,6%	0,3%	**13%**
200-250	0,1%	0,6%	1,2%	4,9%	4,0%	1,1%	0,5%	**12%**
250-300	0,0%	0,3%	0,9%	2,8%	4,5%	1,9%	0,9%	**11%**
300-400	0,1%	0,3%	1,1%	4,0%	4,4%	4,0%	2,9%	**17%**
400-500	0,0%	0,2%	0,4%	3,2%	1,9%	2,4%	3,7%	**12%**
500-600	0,0%	0,0%	0,0%	1,3%	1,0%	1,3%	3,0%	**6%**
600-700	0,0%	0,0%	0,0%	0,3%	0,9%	0,5%	2,4%	**4%**
700-800	0,0%	0,0%	0,0%	0,3%	0,5%	0,4%	2,1%	**3%**
800-1000	0,0%	0,0%	0,0%	0,2%	0,2%	0,5%	2,4%	**3%**
>1000	0,0%	0,0%	0,0%	0,1%	0,1%	0,1%	2,6%	**3%**
Totals	**1%**	**5%**	**11%**	**29%**	**20%**	**13%**	**21%**	**100%**

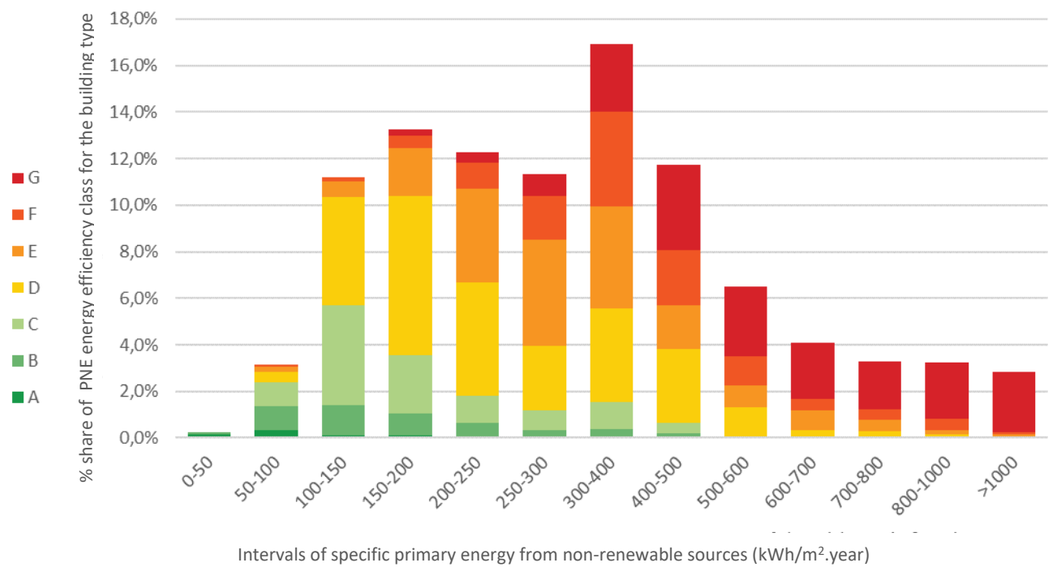


*Fig. 16: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **office buildings***

*Tab. 49: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **family houses***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,4%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
100-150	1,4%	2,2%	1,7%	0,1%	0,0%	0,0%	0,0%	**5%**
150-200	0,4%	2,8%	4,4%	4,8%	0,3%	0,0%	0,0%	**13%**
200-250	0,1%	1,0%	2,6%	4,5%	2,7%	0,4%	0,0%	**11%**
250-300	0,0%	0,1%	0,8%	3,2%	1,9%	2,1%	0,4%	**9%**
300-400	0,0%	0,0%	0,2%	1,6%	2,3%	1,3%	2,1%	**8%**
400-500	0,0%	0,0%	0,1%	1,1%	3,4%	3,4%	5,6%	**14%**
500-600	0,0%	0,0%	0,0%	0,2%	1,5%	2,9%	6,8%	**11%**
600-700	0,0%	0,0%	0,0%	0,0%	0,5%	1,7%	7,4%	**10%**
700-800	0,0%	0,0%	0,0%	0,0%	0,1%	0,7%	5,9%	**7%**
800-1000	0,0%	0,0%	0,0%	0,0%	0,1%	0,2%	4,5%	**5%**
>1000	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	4,9%	**5%**
Totals	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	2,7%	**3%**

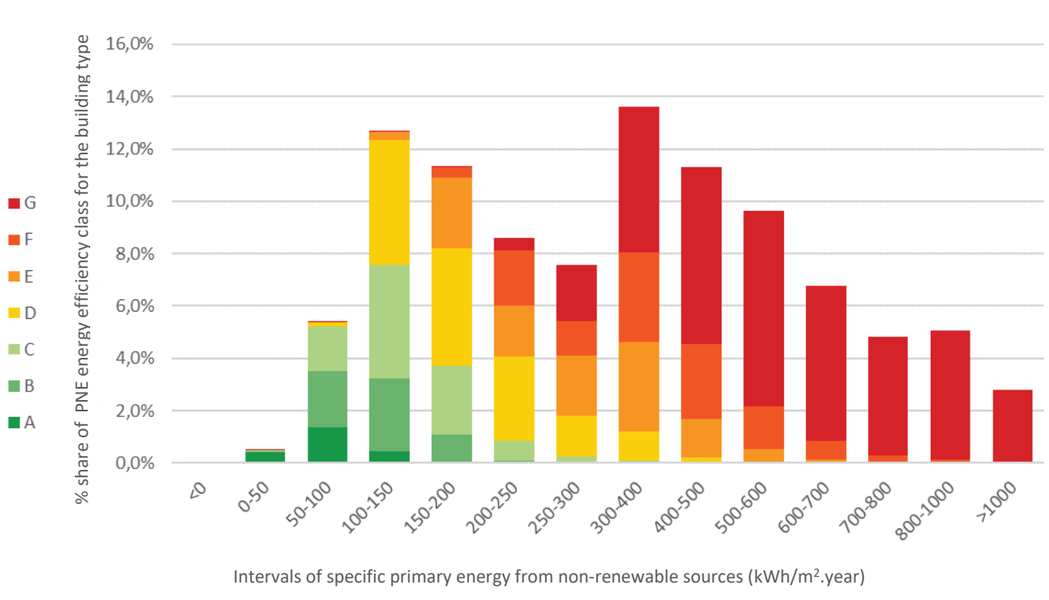


*Fig. 17: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **family houses***

*Tab. 50: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **residential apartment buildings***

Building type	A	B	C	D	E	F	G	Totals
0-50	1,3%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**1%**
50-100	0,5%	3,1%	7,2%	0,6%	0,0%	0,0%	0,0%	**11%**
100-150	0,0%	1,6%	11,2%	8,6%	0,4%	0,0%	0,0%	**22%**
150-200	0,0%	0,2%	2,2%	7,6%	3,6%	0,4%	0,0%	**14%**
200-250	0,0%	0,0%	0,4%	3,7%	5,0%	2,2%	0,3%	**12%**
250-300	0,0%	0,0%	0,1%	1,3%	4,1%	2,7%	1,6%	**10%**
300-400	0,0%	0,0%	0,0%	0,8%	3,9%	5,2%	4,7%	**15%**
400-500	0,0%	0,0%	0,0%	0,2%	0,9%	2,0%	4,0%	**7%**
500-600	0,0%	0,0%	0,0%	0,1%	0,3%	0,6%	3,0%	**4%**
600-700	0,0%	0,0%	0,0%	0,0%	0,1%	0,2%	1,8%	**2%**
700-800	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	1,1%	**1%**
800-1000	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,9%	**1%**
Totals	**2%**	**5%**	**21%**	**23%**	**18%**	**13%**	**18%**	**100%**

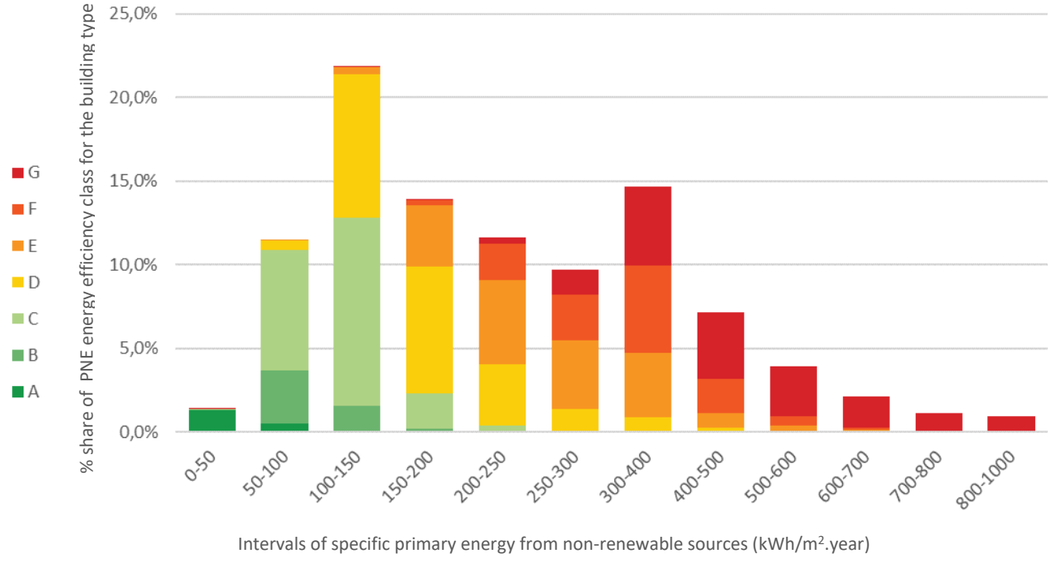


*Fig. 18: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **apartment houses***

Tab. 51: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for ***buildings for culture***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,0%	0,2%	0,2%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	1,3%	1,1%	0,9%	0,7%	0,4%	0,0%	0,0%	**4%**
100-150	0,2%	1,1%	2,9%	2,9%	0,4%	0,2%	0,4%	**8%**
150-200	0,2%	0,7%	2,4%	5,1%	2,0%	0,2%	0,0%	**11%**
200-250	0,4%	0,2%	2,6%	2,4%	2,6%	0,2%	0,2%	**9%**
250-300	0,0%	0,0%	1,3%	2,2%	3,1%	0,7%	0,9%	**8%**
300-400	0,0%	1,1%	1,1%	2,9%	5,7%	3,5%	2,6%	**17%**
400-500	0,0%	0,0%	0,2%	1,1%	2,9%	4,4%	4,9%	**13%**
500-600	0,0%	0,4%	0,2%	0,9%	1,8%	2,4%	5,5%	**11%**
600-700	0,0%	0,2%	0,2%	0,7%	0,7%	0,7%	4,2%	**7%**
700-800	0,0%	0,0%	0,2%	0,7%	0,7%	0,7%	0,9%	**3%**
800-1000	0,0%	0,0%	0,0%	1,3%	0,2%	0,2%	2,6%	**4%**
>1000	0,0%	0,0%	0,0%	0,7%	0,4%	0,2%	2,2%	**4%**
Totals	**2%**	**5%**	**12%**	**21%**	**21%**	**13%**	**25%**	**100%**

Tab. 52: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for ***buildings for commercial purposes***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,6%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**1%**
50-100	0,4%	0,4%	0,2%	0,1%	0,0%	0,0%	0,0%	**1%**
100-150	0,3%	0,7%	1,6%	0,8%	0,0%	0,0%	0,0%	**3%**
150-200	0,4%	0,8%	1,8%	2,9%	0,6%	0,4%	0,1%	**7%**
200-250	0,3%	0,4%	1,6%	4,4%	2,3%	0,6%	0,2%	**10%**
250-300	0,0%	0,6%	0,9%	3,3%	1,8%	0,8%	0,3%	**8%**
300-400	0,0%	0,5%	1,4%	5,3%	3,7%	3,0%	1,8%	**16%**
400-500	0,0%	0,2%	1,3%	4,1%	2,6%	3,0%	3,1%	**14%**
500-600	0,0%	0,2%	1,1%	2,8%	2,0%	1,2%	2,7%	**10%**
600-700	0,0%	0,0%	0,9%	4,4%	1,9%	1,7%	3,1%	**12%**
700-800	0,0%	0,0%	0,1%	2,9%	1,0%	0,5%	1,6%	**6%**
800-1000	0,0%	0,0%	0,0%	2,1%	1,6%	0,8%	2,4%	**7%**
>1000	0,0%	0,0%	0,2%	0,3%	0,4%	1,0%	3,5%	**5%**
Totals	**2%**	**4%**	**11%**	**33%**	**18%**	**13%**	**19%**	**100%**

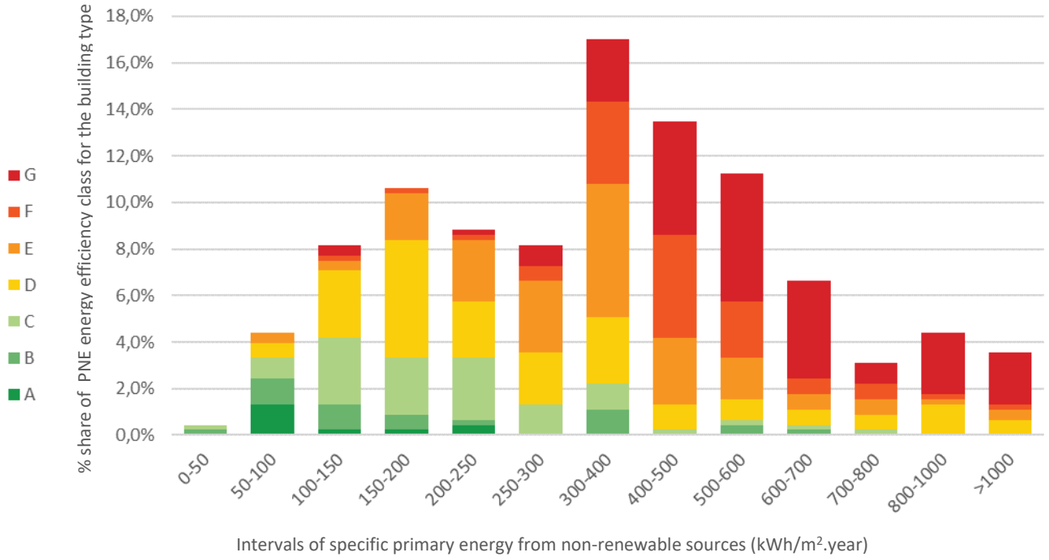


Fig. 19: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for ***buildings for culture***

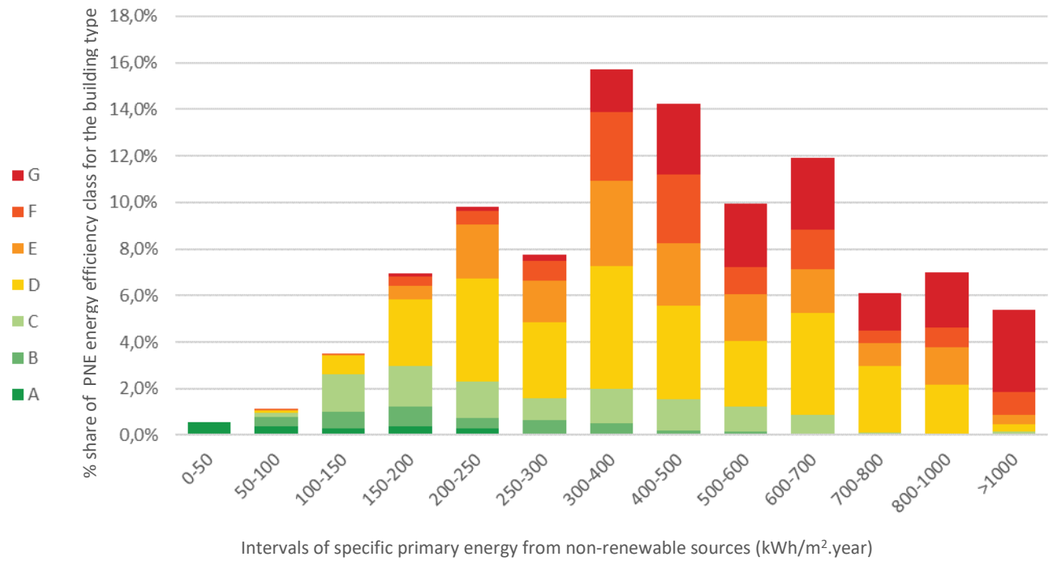


Fig. 20: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for ***buildings for commercial purposes***

*Tab. 53: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **buildings for sport***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,5%	0,3%	0,0%	0,0%	0,0%	0,0%	0,0%	**1%**
50-100	0,8%	0,3%	0,0%	0,0%	0,0%	0,0%	0,0%	**1%**
100-150	0,5%	1,0%	1,0%	0,0%	0,0%	0,0%	0,0%	**3%**
150-200	0,5%	1,8%	4,3%	3,0%	0,3%	0,3%	0,0%	**10%**
200-250	0,0%	1,3%	3,3%	2,0%	1,0%	0,0%	0,0%	**8%**
250-300	0,0%	0,5%	2,5%	6,5%	0,8%	0,3%	0,3%	**11%**
300-400	0,0%	1,3%	3,3%	9,5%	4,3%	1,5%	0,3%	**20%**
400-500	0,0%	0,0%	2,8%	4,3%	2,8%	2,0%	0,5%	**12%**
500-600	0,3%	0,3%	2,3%	1,5%	2,8%	2,3%	1,0%	**10%**
600-700	0,0%	0,0%	0,3%	2,3%	0,8%	1,3%	3,0%	**8%**
700-800	0,0%	0,0%	0,0%	1,0%	1,0%	0,3%	1,0%	**3%**
800-1000	0,3%	0,0%	0,5%	0,8%	1,0%	0,5%	1,8%	**5%**
>1000	0,0%	0,5%	0,3%	1,3%	0,8%	0,8%	5,5%	**9%**
Totals	**3%**	**7%**	**20%**	**32%**	**15%**	**9%**	**13%**	**100%**

*Tab. 54: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **buildings for accomodation and catering***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,2%	0,1%	0,1%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,5%	0,6%	1,3%	0,6%	0,1%	0,1%	0,0%	**3%**
100-150	0,3%	1,4%	2,1%	1,9%	0,1%	0,1%	0,0%	**6%**
150-200	0,1%	0,9%	1,8%	3,7%	0,9%	0,1%	0,3%	**8%**
200-250	0,1%	0,2%	1,7%	4,9%	3,8%	0,7%	0,1%	**11%**
250-300	0,1%	0,3%	1,6%	3,1%	3,0%	1,3%	0,6%	**10%**
300-400	0,1%	0,1%	1,7%	6,0%	4,3%	3,3%	2,5%	**18%**
400-500	0,0%	0,2%	0,7%	2,5%	3,3%	2,6%	3,9%	**13%**
500-600	0,0%	0,1%	0,3%	1,9%	2,5%	2,3%	3,5%	**11%**
600-700	0,0%	0,1%	0,1%	0,6%	0,7%	1,3%	2,9%	**6%**
700-800	0,0%	0,0%	0,1%	0,7%	0,4%	0,8%	2,6%	**5%**
800-1000	0,0%	0,1%	0,1%	0,6%	0,5%	0,4%	2,6%	**4%**
>1000	0,0%	0,1%	0,1%	0,8%	0,7%	0,7%	2,6%	**5%**
Totals	**1%**	**4%**	**12%**	**27%**	**20%**	**14%**	**22%**	**100%**

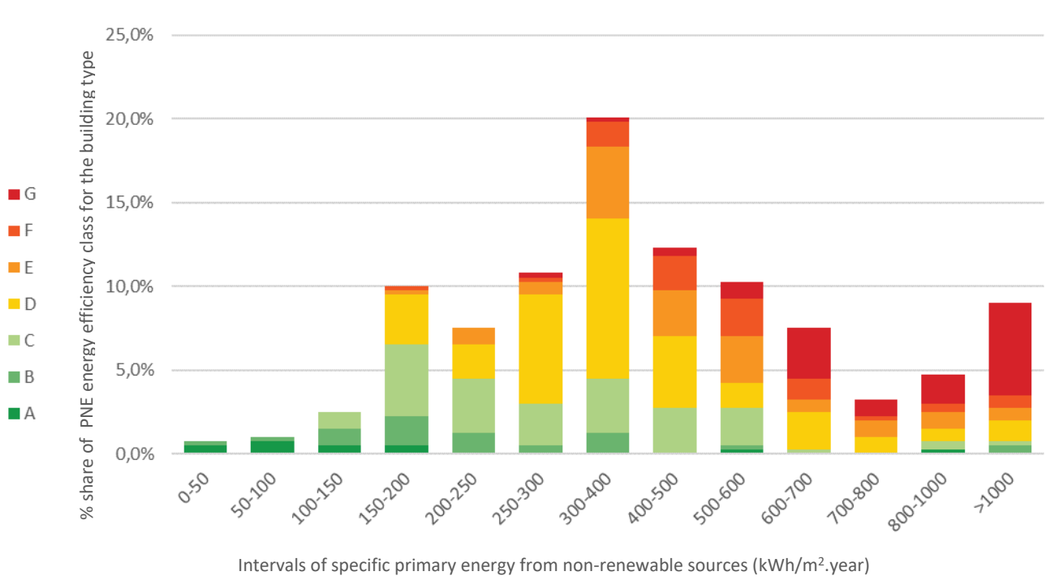


*Fig. 21: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **buildings for sport***

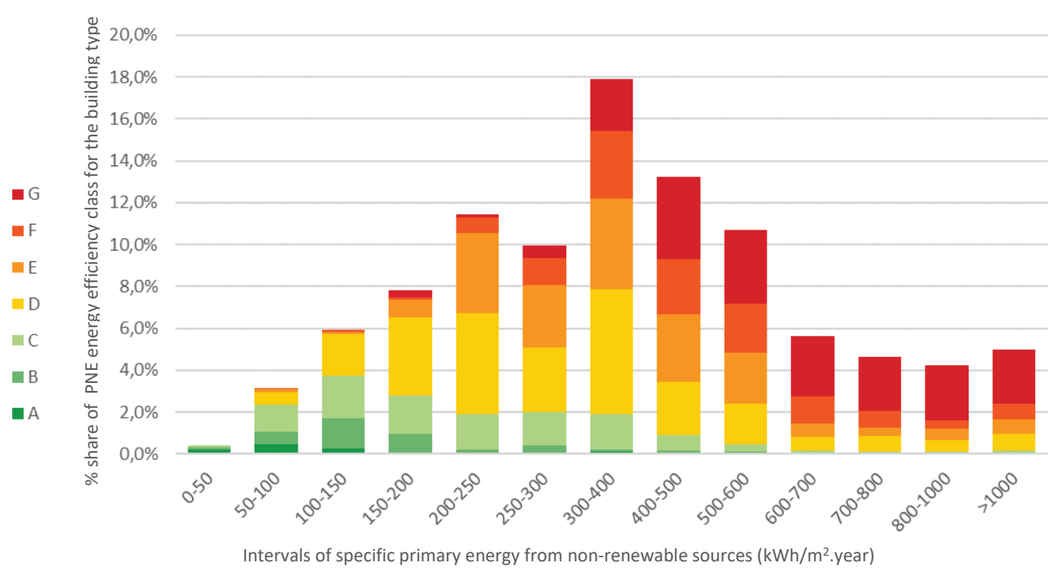


*Fig. 22: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **buildings for accomodation and catering***

*Tab. 55: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **buildings for education***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,2%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,7%	0,7%	1,3%	0,5%	0,0%	0,0%	0,1%	**3%**
100-150	0,7%	1,7%	5,2%	4,4%	0,6%	0,2%	0,0%	**13%**
150-200	0,4%	1,3%	5,0%	6,3%	1,5%	0,2%	0,1%	**15%**
200-250	0,1%	1,0%	1,7%	8,3%	3,3%	1,2%	0,3%	**16%**
250-300	0,0%	0,3%	1,2%	4,5%	4,3%	0,9%	0,3%	**11%**
300-400	0,0%	0,2%	2,0%	4,5%	5,6%	3,6%	1,3%	**17%**
400-500	0,0%	0,1%	0,1%	2,8%	2,7%	3,2%	2,6%	**11%**
500-600	0,0%	0,1%	0,1%	0,7%	1,2%	1,1%	2,1%	**5%**
600-700	0,0%	0,0%	0,0%	0,4%	0,7%	0,6%	2,0%	**4%**
700-800	0,0%	0,0%	0,1%	0,2%	0,1%	0,3%	1,0%	**2%**
800-1000	0,0%	0,0%	0,0%	0,1%	0,1%	0,4%	1,1%	**2%**
>1000	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	0,7%	**1%**
Totals	**2%**	**5%**	**17%**	**33%**	**20%**	**12%**	**11%**	**100%**

*Tab. 56: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **buildings for health care***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,2%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,5%	0,0%	0,5%	0,9%	0,0%	0,0%	0,0%	**2%**
100-150	0,7%	1,1%	3,6%	0,7%	0,0%	0,0%	0,0%	**6%**
150-200	0,2%	0,5%	4,0%	4,0%	0,9%	0,0%	0,0%	**10%**
200-250	0,7%	1,3%	2,7%	7,4%	1,1%	0,0%	0,2%	**13%**
250-300	0,0%	0,9%	2,4%	6,5%	2,5%	0,9%	0,4%	**14%**
300-400	0,0%	1,3%	1,8%	6,9%	5,4%	2,2%	1,3%	**19%**
400-500	0,0%	1,1%	1,1%	5,1%	3,6%	2,7%	2,4%	**16%**
500-600	0,0%	0,0%	1,3%	2,2%	1,5%	2,2%	0,7%	**8%**
600-700	0,0%	0,4%	1,1%	2,0%	1,3%	0,2%	0,4%	**5%**
700-800	0,0%	0,0%	0,5%	1,5%	1,1%	0,4%	0,4%	**4%**
800-1000	0,0%	0,0%	0,2%	0,4%	0,0%	0,0%	1,1%	**2%**
>1000	0,0%	0,0%	0,2%	0,2%	0,2%	0,0%	1,1%	**2%**
Totals	**2%**	**7%**	**19%**	**38%**	**18%**	**9%**	**8%**	**100%**

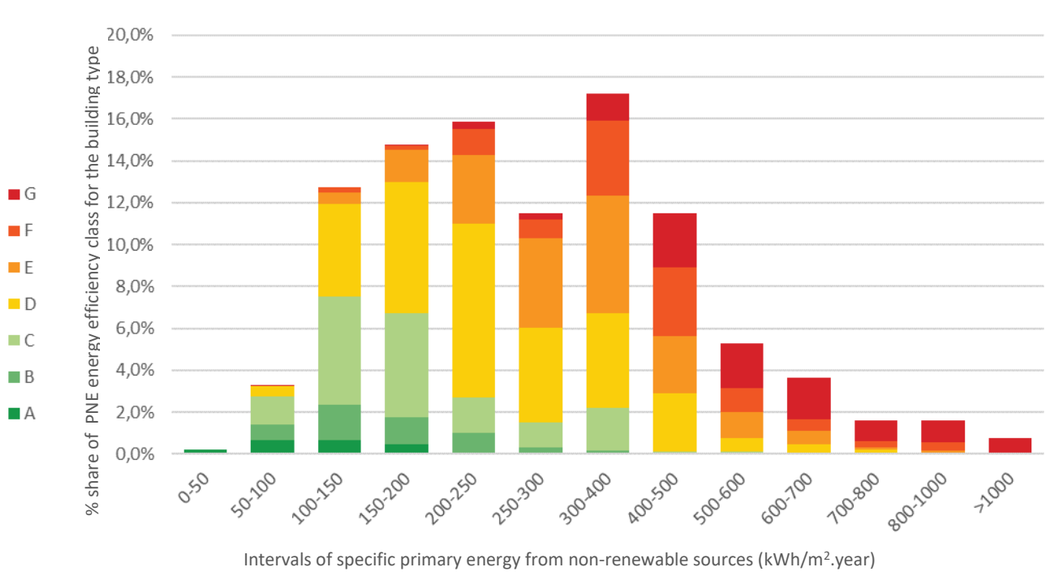


*Fig. 23: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **buildings for education***

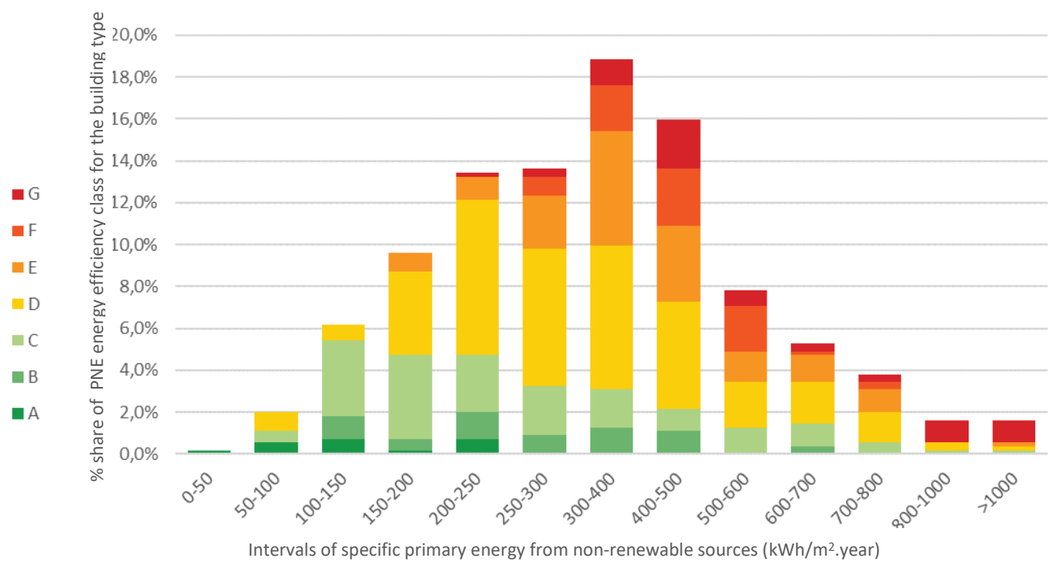


*Fig. 24: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **buildings for health care***

*Tab. 57: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **buildings for production and storage***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,4%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	1,2%	1,5%	0,7%	1,6%	0,0%	0,0%	0,4%	**5%**
100-150	0,5%	3,2%	3,3%	3,1%	0,2%	0,1%	0,2%	**11%**
150-200	0,2%	2,2%	4,0%	3,5%	1,5%	0,5%	0,4%	**12%**
200-250	0,0%	1,1%	2,8%	3,6%	2,2%	0,7%	0,8%	**11%**
250-300	0,2%	0,4%	0,9%	2,9%	2,8%	1,2%	0,5%	**9%**
300-400	0,1%	0,4%	1,9%	4,0%	4,2%	4,1%	3,3%	**18%**
400-500	0,0%	0,2%	1,2%	1,5%	1,6%	1,3%	1,6%	**8%**
500-600	0,0%	0,2%	0,8%	1,6%	1,8%	1,3%	2,2%	**8%**
600-700	0,0%	0,0%	0,0%	0,5%	1,3%	0,2%	3,5%	**6%**
700-800	0,0%	0,1%	0,0%	0,6%	0,7%	0,6%	0,9%	**3%**
800-1000	0,0%	0,0%	0,1%	0,6%	0,8%	0,8%	2,3%	**5%**
>1000	0,0%	0,0%	0,2%	0,2%	0,4%	0,4%	3,4%	**5%**
Totals	**3%**	**9%**	**16%**	**24%**	**18%**	**11%**	**20%**	**100%**

*Tab. 58: number of buildings by class and specific primary non-renewable energy value (kWh/m².year) for **other buildings types***

Building type	A	B	C	D	E	F	G	Totals
0-50	0,2%	0,1%	0,1%	0,0%	0,0%	0,0%	0,0%	**0%**
50-100	0,9%	1,5%	1,1%	0,3%	0,0%	0,0%	0,0%	**4%**
100-150	0,6%	1,8%	2,8%	2,9%	0,4%	0,1%	0,1%	**9%**
150-200	0,2%	0,9%	2,0%	4,3%	1,4%	0,3%	0,1%	**9%**
200-250	0,0%	0,5%	1,5%	3,9%	3,1%	1,0%	0,4%	**10%**
250-300	0,0%	0,3%	0,7%	3,3%	3,1%	1,7%	1,0%	**10%**
300-400	0,1%	0,3%	1,0%	4,1%	4,6%	3,4%	3,7%	**17%**
400-500	0,0%	0,1%	0,3%	1,7%	2,4%	3,3%	4,7%	**12%**
500-600	0,0%	0,1%	0,2%	1,1%	1,4%	1,7%	4,4%	**9%**
600-700	0,0%	0,1%	0,1%	0,4%	0,7%	0,9%	3,7%	**6%**
700-800	0,0%	0,0%	0,0%	0,4%	0,3%	0,3%	2,4%	**3%**
800-1000	0,0%	0,0%	0,1%	0,1%	0,3%	0,5%	3,4%	**4%**
>1000	0,0%	0,0%	0,1%	0,1%	0,3%	0,3%	4,6%	**5%**
Totals	**2%**	**6%**	**10%**	**22%**	**18%**	**14%**	**28%**	**100%**

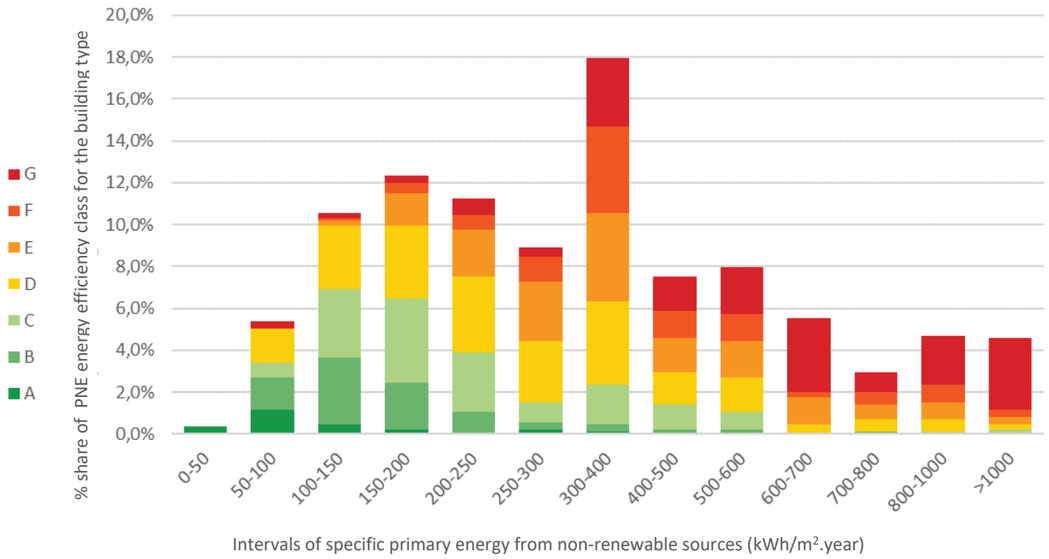


*Fig. 25: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **buildings for production and storage***

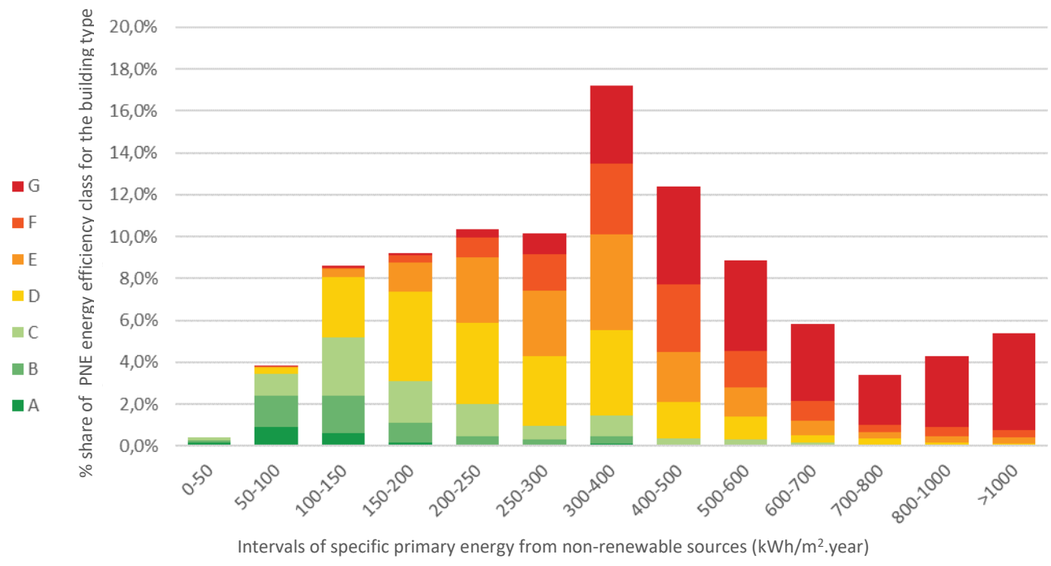


*Fig. 26: graph of the distribution of buildings by class and specific specific primary non-renewable value (kWh/m².year) for **other buildings types***

REFERENCES OF THE AUTHORS

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