MINISTERSTVO
DOPRAVY A VÝSTAVBY
SLOVENSKEJ REPUBLIKY

Long-term renovation strategy for building stock

December 2020

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1. Legal context for devising the strategy

1.1 European context

In November 2016, the European Commission ('Commission') presented the Clean energy for all Europeans initiative, a package of eight legislative acts contributing to the formation of Energy Union and the fulfilment of EU commitments within the Paris Agreement. By virtue of the initiative, the EU committed to cut CO_2 emissions by at least 40% by 2030 while modernising the EU's economy and delivering on growth and jobs for all European citizens.

The buildings sector is the biggest energy consumer in Europe. It uses almost 50% of the Union's final energy consumption for heating and cooling, 80% of which is used in buildings. Almost 75% of the buildings in Europe are not energy efficient and nearly 80% of existing buildings are expected to still be used in 2050. The existing pace of renovation of buildings in Europe is very low and insufficient for reaching the climate neutrality target by 2050.[1]

The measures adopted at the European and national levels aim to reach the long-term greenhouse gas emission reduction target and decarbonise the building stock, which is responsible for 36% of all CO_2 emissions in the Union, by 2050.

In the area of energy efficiency in the buildings sector, Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance) was adopted (Official Journal L 156/75 of 19 June 2018), (the 'Directive'), which was transposed into the Slovak laws by Act No 378/2019, as well as Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action (the 'Regulation').

In Communication Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people of 14 September 2020, the European Commission outlined a set of measures for all economic sectors and a change in key legislative instruments to achieve a more ambitious 2030 emission reduction target agreed as 55% in December 2020. However, its fulfilment in the buildings sector should be fair and balanced with a view to supporting the renovation of buildings of vulnerable groups of citizens.

One of the priorities of the European Green Deal adopted in November 2019 is the 'renovation wave' initiative aimed at improving the energy performance of buildings. The document was published by the Commission on 14 October 2020. Its aim is to double the annual rate of renovation of residential and non-residential buildings and to boost deep renovation.

The documents adopted at the European level support clean air policy, improve living conditions and the health of the population and help create jobs.

1.2 National context and legal framework

Slovakia has prepared a document titled Updated strategy for the stock of residential and non-residential buildings in the Slovak Republic (2017) in accordance with the duty

[1] JRC report: 'Achieving the cost-effective energy transformation of Europe's buildings'.

imposed by Section 9 of Act No 321/2014 on energy efficiency and amending and supplementing certain laws.

Article 2a of the Directive imposes the duty to prepare a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero energy buildings. This requirement is specified in Section 4a of Act No 555/2005 on the energy performance of buildings and amending and supplementing certain laws, as amended (the 'Act').

1.3 Strategy background

Slovakia has almost thirty years of experience with renovation of buildings, especially with thermal insulation of the vertical building envelopes and roofs and with replacing doors and windows in multi-apartment buildings. Slovakia has an appropriate legislative environment and has implemented efficient financial mechanisms in this area. We are spearheading the renovation of multi-apartment buildings in the Union. However, the ambitious targets for decarbonisation of building stock by 2050 require changing the scope of building renovation, accelerating the pace of renovation of all buildings, with an emphasis on cost-effective deep renovation of buildings, promoting renovation of technical systems and installation of building automation and management systems, introducing high-efficiency alternative systems, using passive elements and passive technologies to achieve a highly energy efficient and decarbonised building stock.

The presented document is based on the approved Updated strategy for the stock of residential and non-residential buildings in the Slovak Republic (2017) and newly includes the new requisites under the Directive. The document has a direct link to the adopted Integrated national energy and climate plan until 2030 in terms of energy efficiency ('INEKP') and to the adopted Low-carbon development strategy of the Slovak Republic until 2030 with an outlook into 2050 ('NUS SR').

1.4 Public consultation

In order to develop a long-term renovation strategy and to involve as many stakeholders as possible in its preparation, the Ministry of Transport and Construction of the Slovak Republic (the party responsible for the long-term renovation strategy for buildings) set up a working party consisting of representatives of the individual government departments, civic associations active in the field of buildings (renovation or development), representatives of research and professional associations and organisations, representatives of Slovak towns and municipalities, 32 entities in total. During the preparation of the material, the Ministry consulted, the members of the working party on the individual areas, in person or in writing depending on the respective topic and the specific part of the strategy. Within the standardised procedure concerning the materials submitted to the Government for discussion, the renovation strategy was subject to ministerial and interministerial consultation. In accordance with the rules for preparing and submitting materials to the Slovak Government for discussion, the material was also subject to public consultation exercise via the publicly accessible web portal at www.slov-lex.sk; the procedure has a standardised form as well as a standardised process for evaluating comments. Any entity, including the public, may provide a comment on any part of the submitted material, using an electronic form; the submitting party must evaluate every comment provided. Any accepted comments will be incorporated by the submitting party; as for the rest, the submitting party will provide an explanation for not having accepted them. The conclusion of the public consultation forms an annex to this document.

2. Stock of residential and non-residential buildings

2.1 Overview of the national building stock

Buildings (heated and cooled) have an impact on the final energy consumption. The estimated contribution of the buildings sector to the final energy consumption in Slovakia is approximately 40%; a large part of the energy in buildings is used mainly for heating, domestic hot water and, in recent years, also for cooling and ventilation. In view of the long renovation cycle of existing buildings, those undergoing major renovation should comply with the minimum energy performance requirements depending on the local climatic conditions and on meeting the requirements for indoor thermal comfort.

The overview of the building stock is prepared based on the following:

- results of statistical processing of the 2001 Population and housing census and the 2011 Population and housing census (‘2011 Census’),
- database of buildings maintained by Technický a skúšobný ústav stavebný, n. o. (‘TSÚS’), comprising multi-apartment buildings and non-residential buildings built up to 2003,
- annual statistical survey on non-residential buildings (new non-residential buildings and non-residential buildings having undergone major renovation after 2016),
- the INFOREG information system (records of energy performance certificates issued for new buildings and buildings having undergone major renovation).

The data characterising buildings and their thermal consumption in heating come solely from the aforementioned TSÚS database and represent a substantial part of the number of buildings contained in the 2011 Census. Such data form the basis for the overview of the national building stock to devise the building renovation strategy.

2.1.1 Residential buildings

Residential buildings are classified as multi-apartment buildings and single-family houses. Their structural and technical designs differ, especially in terms of the size, the number of floors and the number of apartments.

The properties of the building structures and their ratio to the total area of the building envelope, the ratio of the area of the building envelope to the total floor area of the building differ and, consequently, the heat and energy demand for heating in such buildings per unit of the total floor area differs accordingly. In order to determine the potential for energy demand reduction, the number of existing buildings and their age have to be taken into account. Housing development in each year of the second half of the 20th century was affected by the availability of building materials and structures as well as by the controlled process of large-scale construction of apartments using standardisation and prefabrication.

Table 1 Summary of houses and apartments based on the 2011 Census

Description	Single-family houses	Multi-apartment buildings	Total
Number of houses/buildings	969 360	64 846	1 034 206
Number of apartments	1 008 795	931 605	1 940 400
Of which Number of occupied apartments	856 147	877 993	1 734 140

Source: 2011 Census, Statistical Office of the Slovak Republic

In addition to apartments in multi-apartment buildings and single-family houses, apartments are also located in other buildings (such as ecclesiastical entities, nursing and retirement homes and others); there are 13 020 such buildings, i.e. 3.41%. There are 54 497 apartments in those buildings.

Apartment housing development peaked between 1960 and 1983. Such apartments are over 30 years old now and the buildings constructed up to 1983 had very poor thermal performance as a result of the then applicable requirements following from the generally established standard and methods of construction and level of knowledge.

2.1.1.1 Multi-apartment buildings

At present, there are no other comprehensive data in Slovakia that would match the data from the TSÚS database of multi-apartment buildings in terms of information scope. As of the end of 2004, there were 867 704 apartments in multi-apartment buildings in Slovakia. The database records of multi-apartment buildings show that 92.3% of all apartments are located in multi-apartment buildings.

Multi-apartment buildings can be characterised by the time of their construction. Between 1947 and 1992, large-scale construction dominated, with several types, structural designs and assembly systems (existing buildings), which were used especially in the panel prefabricated buildings built after 1955. After 1992, ‘tailored’ buildings (new buildings) prevail in building development. More detailed data on the development of apartments in multi-apartment buildings up to 1992 were obtained from the 2001 Census and 2011 Census, as well as from the database of the Statistical Office of the Slovak Republic.

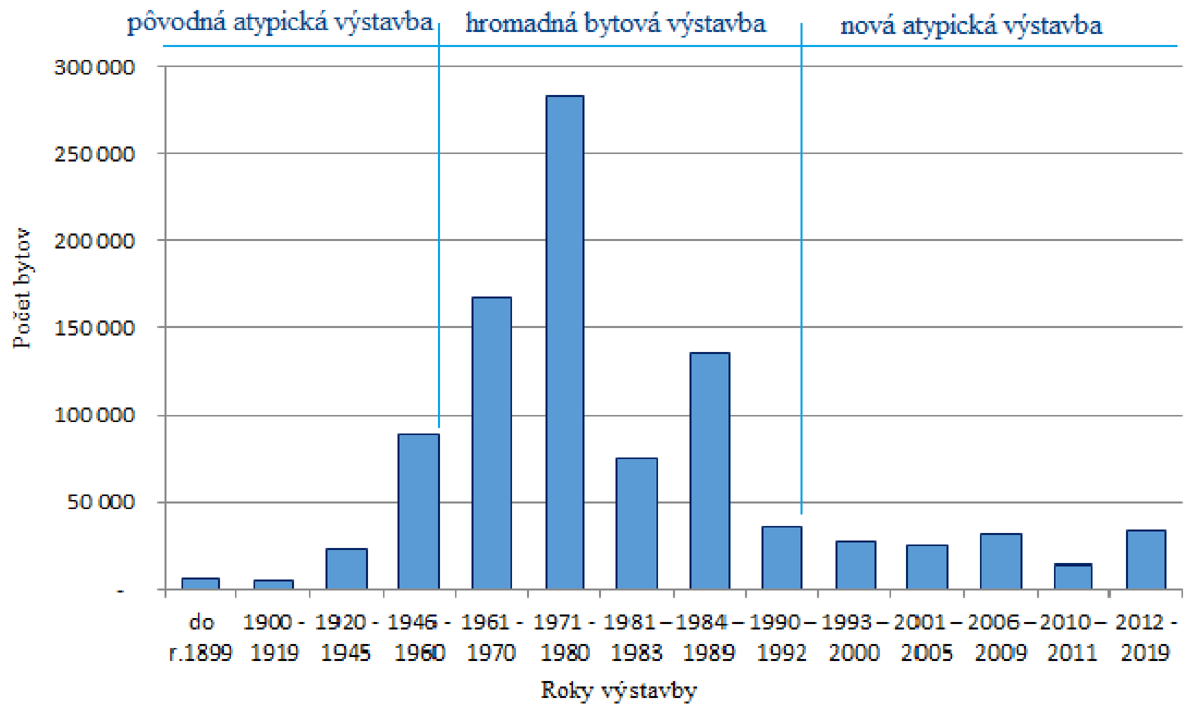

Figure 1 – Numbers of apartments in multi-apartment buildings
Source: STS – Aspects of cost-optimal measures to ensure energy performance of buildings/TSÚS (scientific and technological services, 'STS') and the database of the Statistical Office of the Slovak Republic

Key to graphic	
Original text	Translation
Počet bytov	Number of apartments
do r. 1899	up to 1899
Roky výstavby	period of construction
pôvodná atypická výstavba	original 'tailored' construction
hromadná bytová výstavba	large-scale construction
nová atypická výstavba	new 'tailored' construction

In terms of the thermal performance of the vertical building envelope as well as construction methods, multi-apartment buildings can be divided into five groups, which were also influenced by the requirements placed on the properties of building structures in each period of construction. These differ in terms of the level of thermal performance of the building envelope, in terms of the ratio of their area to the building envelope as well as in terms of the energy demand / actual consumption.

Table 2 Number of buildings, apartments, sections and specific area by groups (types, structural designs and assembly systems)

Type, structural design, assembly system	Number of buildings	Number of apartments	Number of sections	Total floor area in m^2
Brick and clay blocks buildings	6 761	133 814	14 447	10 733 966

Panel prefabricated buildings, single panel, built between 1955 and 1983	7 983	374 503	20 284	29 807 256
Panel prefabricated buildings, layered panels, built between 1971 and 1983	2 131	96 298	5 878	8 234 737
Panel prefabricated buildings built between 1983 and 1998	3 646	183 402	9 415	16 159 811
'Tailored' buildings built after 1992	65	996	117	58 776
Other, not specified	1 137	11 621	2 355	427 121
Total	21 723	800 634	52 496	65 421 666

Source: Slovakia's report for the Commission (EU). Reference buildings. Determination of cost-optimal levels of minimum energy performance requirements, 2013/STS

Multi-apartment buildings built up to 2001 are located in 567 Slovak municipalities only (buildings with more than three apartments). Multi-apartment buildings built within large-scale construction were built as terraced houses, slab blocks, point blocks and tower blocks of 61 different types, structural designs and assembly systems. 43.2% of apartments are located in multi-apartment buildings with no more than four floors; only 15% in multi-apartment buildings with more than eight floors, which has implications especially in differing renovation costs.

Most multi-apartment buildings are located in areas with winter calculation temperatures of -11 °C (308 212 apartments), -13 °C (163 195 apartments) and -15 °C (186 437 apartments). Only 23 multi-apartment buildings are located in areas with a calculation temperature of -19 °C (274 apartments). All the coldest areas with multi-apartment buildings are located in the Prešov and Žilina higher territorial units. Out of the 21 723 multi-apartment buildings, only 1 147 of them are located at an altitude exceeding 600 m above sea level and only 175 at an altitude exceeding 800 m above sea level.

According to the latest comprehensive surveys, the average annual thermal consumption in heating in multi-apartment buildings between 1994 and 2003 was as follows: in those made of bricks and clay blocks: 131.7 kWh/(m^2.a); single-panel (built between 1955 and 1983): 110.3 kWh/(m^2.a); layered panels: 119.0 kWh/(m^2.a); in panel prefabricated buildings built after 1983: 101.9 kWh/(m^2.a). The results obtained for buildings constructed between 1983 and 1992 were used in 2006 after statistical evaluation thereof to determine the upper limit of energy class D within the assessment of energy performance of buildings, expressing the reference value of average energy demand R_s for the existing building stock. The actual consumption of energy for heating is influenced by climatic conditions, which vary considerably across Slovakia. More detailed data on multi-apartment buildings are given in Annex 5.

In terms of energy consumption, the ratio of openings (they have the poorest thermal performance of all building structures) to the overall building envelope is crucial. The area of glazed parts constitutes 13–25% of the total area of the building envelope and 19–32% of the area of the vertical building envelope (facade). The openings in buildings of the original development contribute significantly to the building's thermal losses by heat transfer, but the losses occur mainly as a result of ventilation due to infiltration.

The database of buildings provides data on energy consumption for heating of multi-apartment buildings for each of the years between 1994 and 2003 for the whole housing stock. The average annual energy consumption for 1994–2003 is reported in kWh/m^2 of total floor area. Due to minimum changes to buildings up to 1994, as compared to 1990, Slovakia can take these data as inputs for determining the decrease in energy consumption by applying the proposed measures.

Statistical analysis of the parameters determining energy consumption indicates that the year when occupancy permit is obtained is the third most influential factor in terms of energy consumption. In view of the development of requirements on thermal performance of building envelope, it is appropriate to categorise existing multi-apartment buildings into buildings constructed up to 1983 and those built after 1983, when a stricter thermal performance standard entered into force, bringing about especially a change in the technologies used for vertical building envelopes and, consequently, the use of new assembly systems for large-scale construction.

Table 3 Average thermal consumption in heating by groups of assembly systems [STS]

Group by type, structural design, assembly system	Thermal consumption in heating in each year in kWh/(m^2.a)										Average annual heat consumption in 1994–2003
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
brick and clay blocks buildings	132.6	139.9	151.5	143.2	130.7	126.1	116.7	128.1	125.2	123.3	**131.7**
panel prefabricated buildings, single panel	112.9	117.6	129.4	120.5	108.4	105.1	96.0	106.5	103.2	103.0	**110.3**
panel prefabricated buildings, layered panels	123.1	128.8	137.1	128.9	117.0	114.9	104.9	114.4	110.7	110.0	**119.0**
panel prefabricated buildings	103.2	110.3	117.6	109.3	98.3	94.6	86.6	95.7	90.2	90.9	**99.7**
‘tailored’ buildings						120.0	118.4	92.8	83.5	94.7	**101.9**
other, not specified	110.2	118.5	111.3	101.2	99.5	97.8	88.9	103.5	133.5	93.7	**105.8**
Slovakia average	**116.6**	**122.9**	**134.3**	**125.8**	**113.1**	**109.8**	**100.3**	**111.6**	**107.3**	**106.3**	**114.8**

Regions with varying conditions during the winter period are among those where outdoor temperatures are a relevant factor, with an effect on the consumption of heating energy. The number of buildings, apartments, sections and the total floor area are shown for each calculation temperature of outdoor air in the table below.

Table 4 Number of buildings, apartments, sections and specific area according to the calculation temperature of outdoor air [STS]

Outdoor air calculation temperature in °C	Number of buildings	Number of apartments	Number of sections	Total floor area in m^2
-11	7 484	308 252	17 995	25 170 252
-12	1 059	36 210	2 842	2 925 353
-13	4 307	163 195	10 438	13 192 946
-14	516	21 805	1 833	1 823 699
-15	5 290	186 437	13 262	15 427 402
-16	2 409	71 320	4 937	5 804 761

-17	491	10 122	907	809 150
-18	144	3 019	252	244 078
-19	23	274	30	24 025
Slovakia total	**21 723**	**800 634**	**52 496**	**65 421 666**

2.1.1.2 Single-family houses

Single-family houses are variable in terms of their shape, achieved shape factor values and the ratio of each building structure to the heat-exchange interface of the building. No other detailed statistical data or relevant databases are available for single-family houses. The 2001 Census and the 2011 Census as well as the statistical reports published by the Statistical Office of the Slovak Republic provide an overview of the number of apartments in single-family houses built in each period.

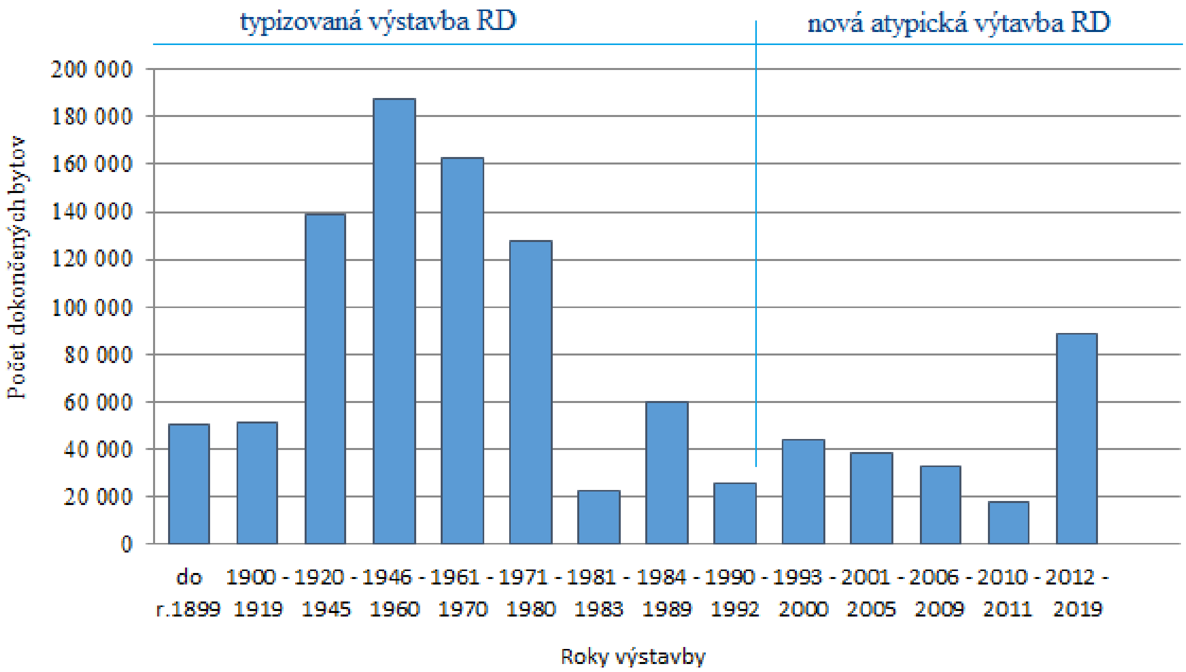

Figure 2 – Number of apartments in single-family houses according to statistical data, the Statistical Office of the Slovak Republic

Key to graphic	
Original text	Translation
Počet dokončených bytov	Number of completed apartments
do r. 1899	up to 1899
Roky výstavby	period of construction
typizovaná výstavba RD	standardised single-family houses
nová atypická výstavba RD	new ‘tailored’ construction of single-family houses

The Statistical Office of the Slovak Republic provides data on the number of completed apartments in multi-apartment buildings and single-family houses between 2012 and 2019, as indicated in Table 5.

Table 5 Number of completed apartments in residential buildings between 2012 and 2019

New apartments	2012	2013	2014	2015	2016	2017	2018	2019	Total 2012–2019
in multi-apartment buildings	4 155	2 603	2 995	3 751	4 176	3 516	6 037	6 369	**33 602**
in single-family houses	9 479	10 208	10 041	9 860	11 195	11 547	12 687	13 338	**88 355**
Apartments in residential buildings total	13 634	12 811	13 036	13 611	15 371	15 063	18 724	19 707	**121 957**

Source: Statistical Office of the Slovak Republic

Single-family houses were made mainly of bricks (later of aerated concrete blocks), the houses' shapes were simple, usually no more than two storeys high, with or without a basement. Designs were often replicated. Initially, pitched roofs were used; flat roofs began to be used in the 1950s. Wooden double-paned doors and windows were used similar to those in multi-apartment buildings.

In order to determine more detailed typical geometric characteristics of single-family houses, we can also rely on a set of representatives of single-family houses that were used for determination of the scale for energy performance certification of buildings within the Ministry's tasks in the field of science and research. The living space of single-family houses is derived from statistical data. The living space / total floor area ratio differs and depends on the layout of the house. Living space accounted for 75% of the total floor area.

Table 6 Average size of living space and total floor area of single-family houses

Single-family houses Storey	Average number of living rooms per apartment	Average living space per apartment in m^2	Average recalculated total floor area per apartment in m^2
Ground floor	3.32	60.6	80.8
Ground floor and 1st floor	4.83	87.4	116.5
1st floor	3.53	65.1	86.8
2nd floor	4.08	75.2	100.3

Source: Slovakia's report for the Commission. Reference buildings. Determination of cost-optimal levels of minimum energy performance requirements / STS

Due to the large area of the building envelope compared to the enclosed volume (shape factor), single-family houses have a greater heating demand than multi-apartment buildings. The minimum and maximum values of the shape factor in single-family houses equal 0.61 1/m and 1.11 1/m, respectively. The total floor area of single-family houses per apartment is approximately 1.5–2 times the area per apartment in a multi-apartment building.

We have no detailed data at our disposal as to energy consumption of the existing single-family houses. The assessments available suggest that the average annual thermal consumption of heating energy is 165 kWh/(m^2.a). Often, not all the rooms in a single-family house will be heated, so the actual energy consumption is lower and does not meet the requirements on indoor climate.

The minimum and maximum ratios of the area of openings to total area of the building envelope (heat-exchange interface) are 4.1% and 12.8%, respectively. Roof structures constitute a significant share in single-family houses, especially if there is an attic with a pitched roof.

2.1.2 Non-residential buildings

2.1.2.1 Buildings of central government

As laid down in Article 5 of Directive 2012/27/EU, each Member State shall ensure that, as from 1 January 2014, 3% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements that it has set in application of Article 4 of Directive 2010/31/EU.

At the same time, Directive 2012/27/EU (Article 5(6)) allows for fulfilling the duty under Article 5(1) in an alternative manner. This means that Member States may take cost-effective measures, including deep renovations and measures for behavioural change of occupants, to achieve, by 2020, an amount of energy savings in eligible buildings that is at least equivalent to that required in Article 5(1) of Directive 2012/27/EU, reported by Member States to the European Commission on an annual basis.

Table 7 Number of central government's buildings, total floor area and enclosed volume

Data	Number of buildings	Total floor area in m^2	Enclosed volume in m^3
All buildings total	3 806	4 773 344	21 678 102
All buildings total, by owners – area not specified	189	0	9 408
Buildings over 500 m^2	**1 893**	**4 370 709**	**19 571 523**
Buildings over 500 m^2, between 1947 and 1993 (including that year)	1 364	3 175 872	14 026 720
Buildings over 500 m^2 – year not specified	62	112 392	536 336
Buildings over 500 m^2 – up to 1947	135	365 202	1 860 893
Buildings over 250 m^2	**2 631**	**4 641 021**	**21 070 474**
Buildings over 250 m^2, between 1947 and 1993 (including that year)	1 938	3 386 048	15 178 299
Buildings over 250 m^2 – year not specified	1 938	3 386 048	15 178 299
Buildings over 250 m^2 – up to 1947	192	385 754	1 000 936

Source: Ministry of Transport, Construction and Regional Development of the Slovak Republic – Notification report on the alternative approach under Article 5 of Directive 2012/27/EU

The inventory of the relevant (eligible) buildings of the central government pursuant to Article 5 of Directive 2012/27/EU is published on the Ministry's website at:
https://www.mindop.sk/ministerstvo-1/vystavba-5/stavebnictvo/zoznam-budov-uoss-podla-cl-5-smernice-2012-27-eu-660

The notification report informs the European Commission of the alternative measures envisaged to achieve the 2020 energy savings target pursuant to Article 5(6) of Directive 2012/27/EU. The report includes a proposal of preliminary target pursuant to Article 5(1) of Directive 2012/27/EU, a target expressed in the form of energy savings for the purposes of application of an alternative method, as well as a list of alternative measures.

Central government buildings with total building floor area over 250 m^2 will be included in the inventory of buildings eligible for deep renovation. The annual target pursuant to Article 5 of Directive 2012/27/EU is 3% of the total floor area of the buildings included in the inventory. The total floor area of central government buildings of 445 791 m^2 suggests that, each year, 13 374 m^2 (3%) have to be renovated or yearly savings of 52.17 GWh have to be achieved.

2.1.2.2 Public buildings

The law stipulates that a public building, for the purposes of defining policies and activities within the renovation strategy, means a building owned by the state, a higher territorial unit, municipality or public law body.

The management of state-owned and central government buildings is not centralised in Slovakia. There are also no statistical surveys in terms of ownership of non-residential buildings (of any type). For the future, it is necessary to ensure the collection and better availability of data necessary for targeted planning of the renovation of public sector buildings, in particular data on the structural and technical condition of individual buildings, their energy performance or data relating to energy consumption. This would create an information source for better planning of investments in renovation in the public buildings sector. Such data will have the highest added value if they are also entered into the existing information systems for records of buildings, such as the Central Property Register ('CEM'). The Register has been created as publicly available records of immovable property owned by the Slovak Republic.[2] At the same time, when planning the use of the existing information systems, it will be necessary to assess the costs of changing the systems and provide for financing in cooperation with their operators.

Out of the total number of non-residential buildings, 15 435 buildings were identified between 1994 and 2003 as those owned by the state and local governments. In terms of the enclosed volume of those non-residential buildings, schools constituted 50.9%, healthcare institutions 13.2%, offices 12.5% and accommodation facilities 10.3%.

Table 8 Non-residential non-production state-owned buildings, categorised by purpose of use

Purpose of use	Number of buildings	Percentage of total (%)	Enclosed volume of buildings m^3	Percentage of total enclosed volume (%)
Schools	6 943	45.0	58 382 303	50.9
Shops and services	156	1.0	680 090	0.6
Healthcare institutions	1 293	8.4	15 197 903	13.2
Cultural institutions	525	3.4	3 071 713	2.7
Offices	2 556	16.6	14 365 517	12.5
Accommodation	1 317	8.5	11 814 638	10.3
Sport	126	0.8	810 218	0.7
Other	2 519	16.3	10 381 270	9.0
Total	**15 435**	**100.0**	**114 703 652**	**100.00**
of which primary schools	2 513	16.3	26 549 348	23.1

[2] Act of the National Council of the Slovak Republic No 278/1993 on the management of state-owned property as amended by Act No 324/2014.

Non-residential buildings owned by the state and local governments account for 54.8% of the enclosed volume of the non-residential buildings identified to date.

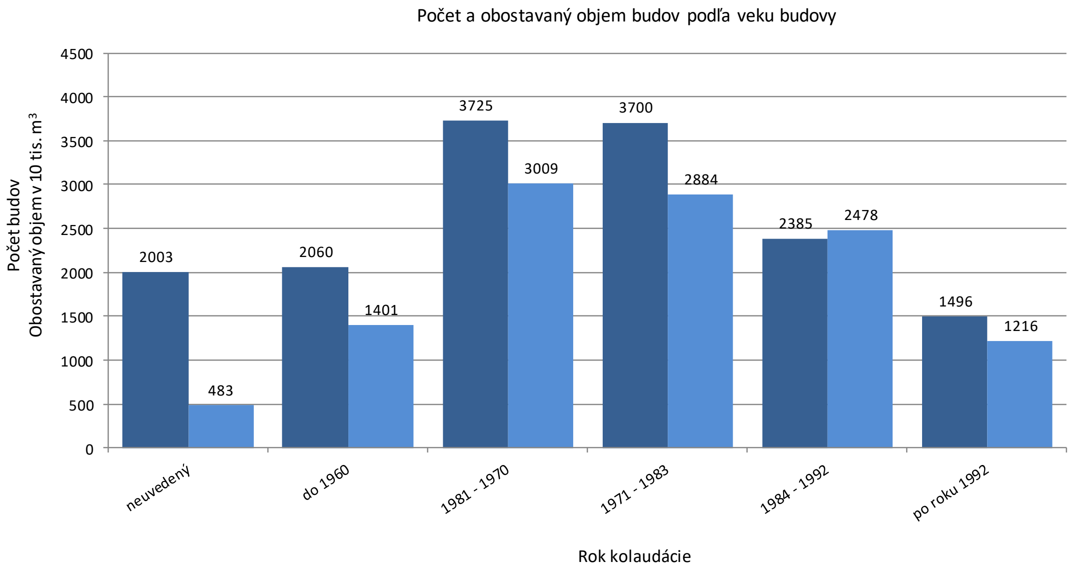

Figure 3 – Enclosed volume of non-residential buildings owned by the state or local governments and their numbers by age

Source: Slovakia's report for the Commission (EU). Reference buildings. Determination of cost-optimal levels of minimum energy performance requirements, 2013/STS

Key to graphic	
Original text	Translation
Počet budov	Number of buildings
Obostavaný objem v 10 tis. m^3	Enclosed volume in 10 thousand m^3
Počet a obostavaný objem budov podľa veku budovy	Number and enclosed volume of buildings by age of building
neuvedený	not specified
do 1960	up to 1960
po roku 1992	after 1992
Rok kolaudácie	Year of occupancy permit

Information on the average thermal consumption in heating is available for 1994 to 2003 only (Table 9), as ascertained from the TSÚS database of buildings. The average consumption of all non-residential buildings owned by the state and local governments is 55.2 kWh/(m^3.a), while it is merely 49.1 kWh/(m^3.a) in the case of primary schools. The lower annual heat consumption of primary schools compared to the average for all buildings is due to the lower average indoor air temperature in schools (on account of winter breaks) compared to, for example, offices or healthcare institutions. The highest heat consumption is 68.3 kWh/(m^3.a), in healthcare institutions; the lowest is 42.7 kWh/(m^3.a), in buildings of cultural institutions, which are often not heated throughout the heating season and only a part of the enclosed volume of the building is heated. Sporting facilities have a low heat consumption of 44.3 kWh/(m^3.a); they mostly include gymnasiums of primary and secondary schools, heated to a lower temperature.

The average thermal consumption in heating has changed in recent years as a result of replacement of windows and doors and thermal insulation of buildings. However, in more than a third of the buildings, there is no night and weekend temperature setback. In addition to heating energy consumption, most non-residential buildings have a significant energy consumption for lighting and also for domestic hot water preparation. No data are available on the actual energy consumption for those points of consumption.

Table 9 Average thermal consumption in heating by purpose of use [STS]

Purpose of use	Thermal consumption in heating in each year in kWh/(m^3.a)										Average consumption between 1994 and 2003
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Schools	51.2	51.8	53.7	52.7	51.4	50.9	46.8	51.1	49.5	50.7	51.0
Shops and services	54.5	54.3	62.6	60.4	57.3	50.2	51.5	53.0	48.4	62.9	55.5
Healthcare institutions	59.7	59.5	79.0	75.9	71.2	71.9	68.1	70.6	65.1	61.7	68.3
Cultural institutions	47.3	45.8	46.3	46.6	45.4	43.7	37.7	41.1	33.3	39.6	42.7
Offices	56.7	59.3	61.6	60.1	58.2	57.8	53.0	56.7	54.7	57.8	57.6
Accommodation	57.4	59.7	62.2	60.6	59.4	60.0	57.9	62.0	57.4	58.7	59.5
Sport	48.8	46.8	49.1	47.8	44.0	46.3	42.5	42.9	37.5	37.0	44.3
Railway stations and airports									46.2		46.2
Post offices								62.9	63.2	65.4	63.9
Other	53.7	53.8	61.4	58.8	57.5	58.0	55.4	58.3	57.5	56.3	57.1
Average for all buildings	52.8	54.0	58.3	56.9	55.2	54.9	51.1	55.4	54.7	58.3	55.2
Primary schools	49.4	49.5	50.9	50.3	48.4	47.7	42.6	46.9	47.3	58.3	49.1

Source: TSÚS database of buildings, STS

Non-residential non-production buildings can be categorised according to the time of construction, reflecting the different requirements, especially in terms of thermal performance of building structures, as well as the trends in the materials used and construction elements as follows:

- up to 1950: brick buildings, usually with pitched roofs (wooden roof framework);
- between 1951 and 1970: development of prefabrication, application of concrete with light fillers and light concrete (areated concrete), almost exclusively flat roofs, installation of double-paned windows;
- between 1971 and 1983: layered vertical structures, aluminium double-paned windows in addition to the wooden ones, flat roofs;

- after 1983: improvement of the thermal performance of building structures by demonstrating calculation values meeting the requirements of the revised thermal performance standard; the calculation methods disregarded the impact of the construction design of details, which resulted in higher thermal losses, especially in vertical building envelope through contact areas.

2.1.2.3 Other non-residential buildings

Up to 1989, non-residential buildings in Slovakia were owned by the state. In the years that followed, the development of non-residential buildings was slow at the beginning. Existing non-residential buildings gradually passed to the hands of private owners.

Since 2016, the Statistical Office of the Slovak Republic has been carrying out statistical surveys on the number of non-residential buildings completed, based on the yearly number of occupancy permits issued according to the Statistical classification of structures broken down into new and renovated non-residential buildings. The 2016–2019 surveys suggest that 1 986 new non-residential buildings were built and 662 non-residential buildings were renovated.

Table 10 Statistical survey for new and renovated non-residential buildings based on occupancy permits between 2016 and 2019

Non-residential buildings between 2016 and 2019 (based on occupancy permits)	2016	2017	2018	2019	Total
Hotels	33	59	62	51	205
Offices	80	86	89	120	375
Buildings for trade and services	258	271	241	279	1 049
Schools, universities and education buildings	42	24	34	45	145
Hospitals and healthcare institutions	35	18	23	20	96
Sports facilities	24	24	45	23	116
New total	**472**	**482**	**494**	**538**	**1 986**
Hotels	16	14	14	18	62
Offices	26	29	35	57	147
Buildings for trade and services	65	101	66	68	300
Schools, universities and education buildings	22	11	23	27	83
Hospitals and healthcare institutions	15	11	10	6	42
Sports facilities	10	6	8	4	28
Total renovated	**154**	**172**	**156**	**180**	**662**

Source: Statistical Office of the Slovak Republic

2.2 Previous approach to renovation of buildings

A systematic approach to the renovation of buildings in Slovakia was adopted in the early 1990s, when it was stated that buildings older than 30 years built within large-scale construction in Slovakia especially between 1960 and 1992 all showed inadequate thermal protection of building structures and significant wear and tear of technical equipment, which needs to be replaced as soon as possible with elements whose quality and properties will create the required safety and indoor comfort and will eliminate any public-health issues to enable a continued use of the buildings in the years to come. Another common issue were structural and technical deficiencies of the building structures, resulting from the original technical design, construction methods, but mainly inadequate maintenance and repairs.

Nearly 70% of apartments built in multi-apartment buildings during the large-scale construction period were constructed with the use of panel prefabricated structural designs and assembly systems in at least 61 different variants of point blocks, terraced houses, slab blocks and tower blocks. Each of the multi-apartment buildings exhibited one of 12 system failures.

All the residential and non-residential buildings built to a standardised design with a significant replicability potential were built up to 1992, i.e. they have been used for more than 25 years. Given the extended period of use, the lifetime of a significant portion of the building structures and technical equipment is drawing near. Renovation is also required due to amended laws, especially technical regulations related to the basic requirements in the field of structural stability, fire protection and user safety, public health, health and environmental protection, as well as acoustic protection, energy savings and thermal protection.

Renovation strategy is linked to concepts that define the extent of renovation, the proposed cost-effective measures as well as the projected costs and expected energy savings. Definitions are given in Annex 1.

The Ministry of Construction and Public Works of the Slovak Republic[3)] prepared and submitted the Framework for renovation of buildings, focusing on the renovation of the housing stock; the Framework was approved by Resolution of the Government of the Slovak Republic No 1088 of 8 December 1999. The volume of residential and non-residential buildings is given in Table 11.

Table 11 Overview of building stock

Total building stock	Up to 1950	1951–1960	1961–1970	1971–1980	1981–1990	1991–2000	Total
	millions of m^3 of enclosed volume of buildings						
Non-residential buildings	20.95	14.29	22.86	53.33	63.81	34.01	209.25
Residential buildings	44.11	29.52	47.00	88.82	87.51	32.76	329.72
Buildings, halls for production and services	55.96	41.45	64.28	117.00	143.83	58.11	480.63
Total	121.02	85.26	134.14	259.15	295.15	124.88	1 019.60

Source: The Framework for renovation of the building stock with emphasis on the housing stock, Ministry of Construction and Public Works of the Slovak Republic / VVÚPS-NOVA, 1999; supplementation of data for 1998 to 2000: ÚEOS – komercia, a.s., Bratislava

Based on the Framework for renovation of the building stock, the first step was to eliminate any system failures of multi-apartment buildings constructed within specified types, structural designs and assembly systems (‘construction systems’); this can be considered as the starting point of renovation. The number of system failures was extended from 6 in the original proposal to 11 in 2002 and 12 in 2006. The second step in the renovation process was to address any issues in terms of structural stability, public health and user comfort in multi-apartment

[3)] The Ministry of Construction and Building Industry of the Slovak Republic; the Ministry of Construction and Public Works of the Slovak Republic; the Ministry of Construction and Regional Development of the Slovak Republic; the Ministry of Transport, Construction and Regional Development of the Slovak Republic; the Ministry of Transport and Construction of the Slovak Republic (the ‘Ministry’).

buildings older than 30 years; the third step was to comprise renovations of multi-apartment buildings built less than 30 years ago. Regulation of the Slovak Government No 587/2001 amending Regulation of the Slovak Government No 137/2000 on housing programmes, as the implementing rules of the State Housing Development Fund Act, changed the eligibility criterion for support of renovation of multi-apartment buildings from 30 to 20 years. This may also have changed the number of apartments in multi-apartment buildings built within large-scale forms of construction that were eligible for the renovation programme. In addition to the age of the multi-apartment building, the eligibility criteria also included an achieved 20% reduction in heating demand as compared to the initial state.

Financial support for thermal protection of buildings by thermal insulation was linked to the conditions following from Resolution of the Government of the Slovak Republic No 493/1991, on the basis of which the Ministry prepared, in October 1991, Guidelines on procedures and technical conditions of additional thermal insulation and elimination of failures of multi-apartment buildings.

Since 1996, support from the state budget in the form of subsidies and loans has been provided for thermal insulation of residential buildings. The number of renovated residential buildings (apartments) supported through the housing development programme (a subsidy provided by the Ministry of Transport and Construction of the Slovak Republic) and the State Housing Development Fund (a loan), as well as the amount of the support provided, are shown in the table according to the purpose of use for the given period of time. Since 2000, a total of 451 100 apartments have been supported through the programme, with the amount of support reaching EUR 1.43 billion.

Table 12 The number of renovated residential buildings (apartments) supported through the Housing Development Programme (subsidy provided by the Ministry of Transport and Construction of the Slovak Republic) and the State Housing Development Fund (loan)

Purpose	Form	Time period	Support granted *(eur)*	Average yearly support *(eur)*	Number of apartments	
					Multi-apartment buildings	Single-family houses
Remedy of system failure of multi-apartment building	subsidy	2000–2019	112 342 700.08	5 617 135.00	151 949	0
	loan	2014–2019	24 076 470.00	4 012 745.00	15 484	0
Renovation of a residential building	loan	2006–2019	1 155 280 201.00	82 520 014.36	253 350	28
including - thermal insulation of a residential building		2014–2019	349 356 107.29	58 226 017.88		
Government thermal insulation programme for residential buildings	loan	2009–2014	133 779 242.54	22 296 540.42	30 317	51
Allowance for thermal	subsidy	2016–2019*	1 144 185.58	286 046.40	0	173

insulation of a single-family house						
Residential buildings total			**1 429 150 799.20**		**451 100**	**568**

Source: Ministry of Transport and Construction of the Slovak Republic, State Housing Development Fund
Note: *situation as of 31 December 2019

As early as 2000, conditions were created to support the remedy of system failures of multi-apartment buildings (system failures include issues with balconies, recessed balconies, inclining attics, specified types of vertical building envelopes, exterior staircases). Between 2000 and 2019, a total of approx. EUR 112.342 million was provided in subsidies, which represents 151 949 apartments; between 2014 and 2019, a loan of EUR 24.076 million was provided for the same purpose (15 484 apartments).

At present, the conditions governing the provision of subsidies for the remedy of system failures in multi-apartment buildings are specified by Act No 443/2010 on subsidies for housing development and on social housing, as amended.

The matter of system failures of the housing stock was very pressing and, therefore, the remedy thereof was launched as well as gradual release of financial resources for loans (through the State Housing Development Fund) for renovation of residential buildings. The remedy of system failures of a multi-apartment building was the first step in the process of the building's major renovation.

A common approach to increasing the energy performance of buildings in the European Union, and thus to a significant reduction of CO_2 emissions generated by buildings, was laid down in Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings ('Directive 2002/91/EC') and in Directive 2010/31/EU, which were transposed into Slovak laws and technical regulations; the approach was first systematically addressed in the Framework for energy performance of buildings until 2010 with outlook until 2020 (approved by Resolution the Government of the Slovak Republic No 384/2008) and, subsequently, in the Updated framework for energy performance of buildings until 2010 with outlook until 2020 approved by Resolution of the Government of the Slovak Republic No 336/2012. Many of the tasks from these frameworks for 2015–2020 were covered by the proposed renovation strategy for buildings, relying on the results of the scientific and technological services 'Technical and economic aspects of cost-optimal measures to ensure the energy performance of buildings'. These results take into consideration the conditions and procedures under Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements ('Commission Regulation (EU) No 244/2012'), supplementing Directive 2010/31/EU.

Since 1992, targeted renovation of the housing stock has been underway in Slovakia, focusing on apartments older than 20 years, especially through thermal insulation and remedy of structural deficiencies. In 1993, the construction of panel prefabricated buildings was ended. All these residential buildings should be renovated over time. This is based on the fact that building stock younger than 20 years undergoes cyclical maintenance and repairs; building stock older than 20 years requires renovation.

The individual construction works (e.g. thermal insulation of external walls) have not been statistically evaluated yet by the Statistical Office of the Slovak Republic or by any other institution. For the first time, the Statistical Office of the Slovak Republic focused on renovation (thermal insulation) of buildings in the 2011 Census, where the monitoring of the data concerning houses included new items: 'Building's thermal insulation' (thermal insulation of external walls and replacement of windows) and 'Extent of restoration'.

It should be noted that the accuracy of the data acquired is affected by the choice of words in the question asked and by the owner's subjective individual assessment of the extent of renovation / thermal insulation of the building in question. The 2011 Census data (Annex 3) suggest that, as of 21 May 2011, renovation (at least partial) had been carried out in 27% of single-family houses and 41.04% of residential buildings. The figures were distorted to some extent due to the number of unoccupied apartments and houses, specifically 15% and 5.75% of single-family houses and multi-apartment buildings, respectively.

The extent of renovation (thermal insulation) of buildings allows us to compare the results not only for Slovakia as a whole, but also to express differences among regions (Table 4 of Annex 3). While the greatest extent of renovation of single-family houses was in the Bratislava Region and the Žilina Region (41.86% and 33.08%, respectively), the smallest extent was in the Banská Bystrica Region and the Nitra Region (19.55% and 22.97%, respectively). This is also true for multi-apartment buildings, with the greatest extent of renovation in the Žilina Region (up to 53.13% of buildings), followed by the Bratislava Region (50.25%). The smallest extent of renovated multi-apartment buildings was in the Košice Region and the Nitra Region (31.21% and 32.04%, respectively). The expert estimate of renovation of buildings calculated by the Civic Association for Thermal Insulation of Buildings ('OZ ZPZ') that was obtained by a progressively refined method of monitoring consumption of thermal insulation material on vertical building envelopes until 2019 can be compared with the 2011 Census data, allowing us to determine an appropriate correction of the Association's original data (item 2 of Annex 3).

After correcting the Association's data, it was possible to calculate the extent of renovation (thermal insulation) between 2011 and late 2019 and conclude that renovation was carried out in Slovakia as a whole in more than 67.87% of apartments in multi-apartment buildings and 44.97% of apartments in single-family houses (Table 13). We assume that the number of renovated single-family houses as well as multi-apartment buildings also includes houses/buildings with partial renovation only.

Table 13 Apartments in multi-apartment buildings and single-family houses renovated until 31 December 2019

Description	Apartments in multi-apartment buildings	Apartments in single-family houses	Total
2011 Census	931 605	1 008 795	1 940 400
Renovation as of 2011 Census	382 319	272 415	654 734

Renovation as of 31 December 2019	632 301	431 864	1 064 165
Renovation as of 31 December 2019 (%)	**67.87**	**44.97**	**54.84**

Source: Data from the 2011 Census (Statistical Office of the Slovak Republic) supplemented by the Civic Association for Thermal Insulation of Buildings

The pace of renovation of non-residential buildings has been lagging significantly behind the pace of renovation of multi-apartment buildings, mainly due to the lack of any system support in the past. Nevertheless, the positive effect of introducing a support energy service has not helped putting the renovation of the non-residential building stock in motion. Energy performance contracting for the public sector provides an appropriate basis for promoting renovation; however, only the future will show how effective that measure really was.

To some extent, the scope of renovation of buildings can be deducted from the energy performance certificates ('EPCs'), processed since 2008. Since 2010, the Central Register has registered EPCs for each building category and the energy class reached. The number of EPCs suggests that, between 2010 and 2019, a total of 5 814 buildings were renovated, specifically 1 784 office buildings (31%), 1 599 schools and school institutions (28%), 867 buildings for trade services (15%), 525 hotel and accommodation buildings (9%), 150 hospital buildings (3%), 128 sports halls and other buildings intended for sport (2%) and 761 other mixed-purpose buildings (13%). More detailed results on the number of buildings renovated each year following from the database of EPCs are given in Table 14; Figure 4 shows regional distribution.

Table 14 Renovation of non-residential buildings by category based on the EPCs issued between 2010 and 2019

Non-residential buildings – renovation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Offices	157	197	169	157	137	168	121	163	234	281	1 784
School buildings and school institutions	247	274	139	95	78	160	76	108	198	224	1 599
Hospital buildings	17	18	16	23	14	19	13	10	9	11	150
Hotel and restaurant buildings	46	45	63	43	63	75	56	42	45	47	525
Sports halls and other buildings intended for sport	15	28	11	11	5	11	14	7	14	12	128
Buildings for wholesale and retail services	50	60	70	93	108	111	107	90	102	76	867
Other non-production buildings consuming energy	54	79	72	88	95	68	75	91	80	59	761

Total	**586**	**701**	**540**	**510**	**500**	**612**	**462**	**511**	**682**	**710**	**5 814**

Source: INFOREG information system

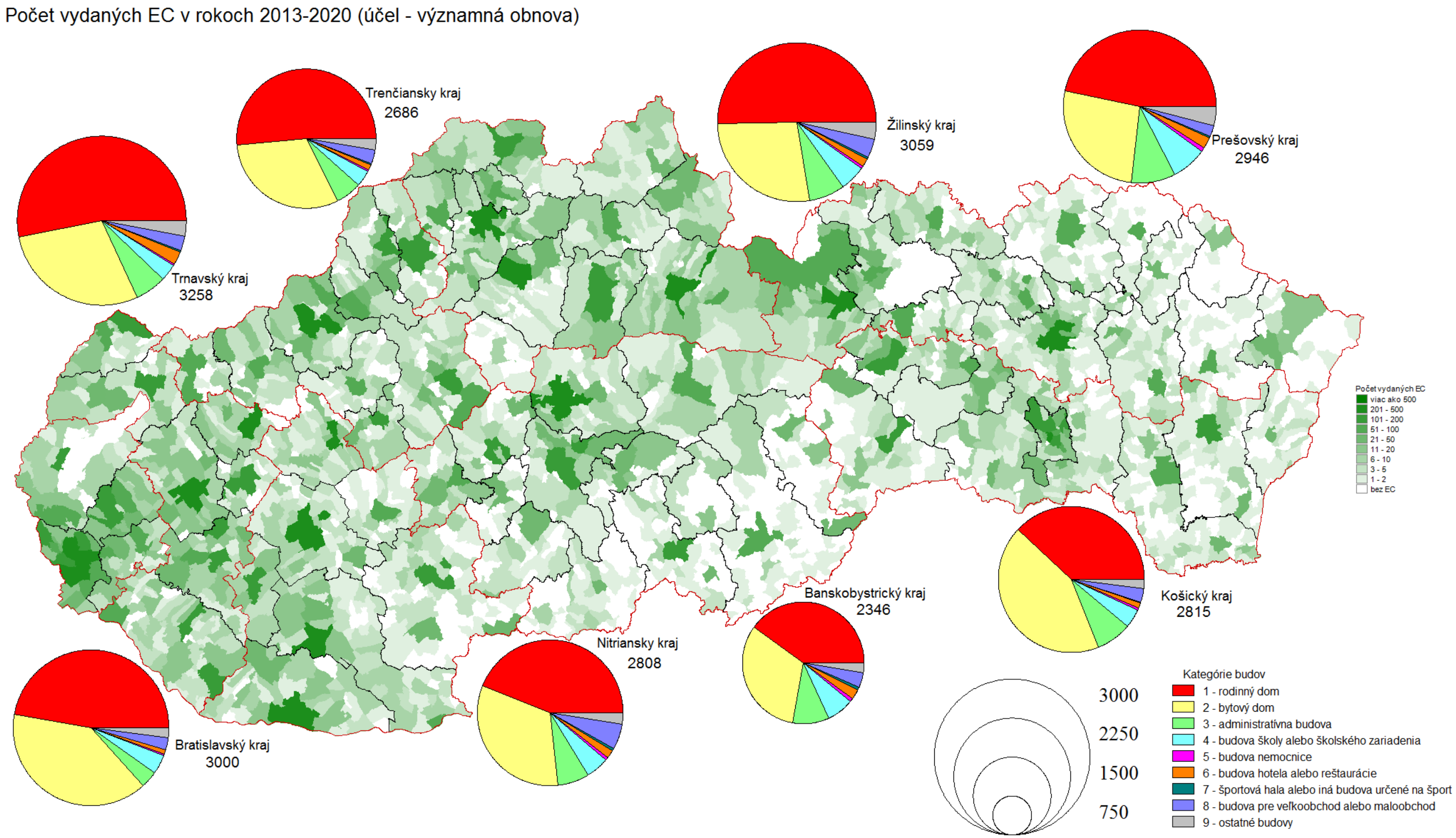

Figure 4 – Major renovations by Slovak regions between 2013 and 2020 based on the EPCs recorded
Source: INFOREG information system

Key to graphic	
Original text	Translation
Počet vydaných EC v rokoch 2013-2020 (účel - významná budova)	Number of EPCs issued between 2013 and 2020 (purpose – major renovation)
Trnavský kraj	Trnava Region
Trenčiansky kraj	Trenčín Region
Žilinský kraj	Žilina Region
Prešovský kraj	Prešov Region
Bratislavský kraj	Bratislava Region
Nitriansky kraj	Nitra Region
Banskobystrický kraj	Banská Bystrica
Košický kraj	Košice Region
Počet vydaných EC	Number of EPCs issued
viac ako 500	more than 500
bez EC	without EPC
Kategórie budov	Building category
1 – rodinný dom	1 – single-family house
2 – bytový dom	2 – multi-apartment building
3 – administrativna budova	3 – office building
4 – budova školy alebo školského zariadenia	4 – school building or school institution building
5 – budova nemocnice	5 – hospital building
6 – budova hotela alebo reštaurácie	6 – hotel or restaurant building
7 – športová hala alebo iná budova určené na šport	7 – sports hall or other building intended for sport
8 – budova pre veľkoobchod alebo maloobchod	8 – building for wholesale or retail trade
9 – ostatné budovy	9 – other buildings

2.3 Cost-effective renovation approaches by building category

The law requires determination of a cost-optimal level of minimum energy performance requirements for buildings. Pursuant to Section 4(6) of the Act, cost-optimal level means the energy performance level which leads to the lowest cost during the estimated economic lifecycle of the building. The lowest costs shall be determined taking into account energy-related investment costs as well as maintenance and operation costs by building category, including energy costs and savings in earnings from energy produced and disposal costs. The cost-optimal level shall lie within the range of energy performance levels where the cost benefit analysis calculated over the estimated economic lifecycle of the building is positive. The estimated economic lifecycle of the building is determined as follows:

(a) for the whole building, where the energy performance requirements are intended for the building as a whole; or

(b) for a separate part thereof, where energy performance requirements are intended for a separate part only.

The cost-effectiveness assessment must be based on a set of standard conditions relating to the assessment of energy savings and the current energy prices and on a preliminary estimate of investment costs according to the current usual prices of construction products and construction works on the market.

The determination of input data on construction products and technical systems, their parameters, lifetime and prices for determining measures affecting the energy performance of a building at different levels of energy performance requirements was provided for in the Draft methodology and input data for determining the cost-effectiveness of construction and renovation of buildings in terms of energy performance of buildings (TSÚS, n.o., May 2015, ISBN 978-80-971912-0-7). The data followed from the results of the scientific and technological services' task in determining the cost-optimal levels of the minimum energy performance requirements.

Cost-effective measures to improve the energy performance of buildings are classified according to the building category, taking into account the lifetime of the individual building structures and technical system elements; the lifetime should be considered in each specified calculation period. In line with the conditions following from Commission Delegated Regulation (EU) No 244/2012, a calculation period of 30 years is applied to residential buildings and public buildings, 20 years for other buildings.

Technical systems (technical equipment of a building) are influenced by the building category determining the use pattern and, consequently, the operation of a building. The size of the technical equipment is influenced by thermal performance of a building, its size, as well as the occupancy rate of the building. Investment costs therefore depend on the building category. The heat and heating energy demand influences the technical equipment for heating and domestic hot water preparation in terms of the required output / heat input as well as heat losses in distribution systems. In order to determine the investment costs of technical systems, it is therefore necessary to first determine the heat and energy demand of a building and, subsequently, to determine the heat input of the equipment.

Measures affecting the energy performance of a building at different levels of the energy performance requirements are determined within phases one and two of deriving the cost-optimal levels of the minimum energy performance requirements.

Thermal performance of the vertical building envelope of existing buildings (single-family houses, multi-apartment buildings and non-residential buildings) is improved by additional thermal protection, especially using external thermal insulation composite systems (ETICS). Various materials and construction products can be used for thermal insulation, e.g. expanded polystyrene, expanded polystyrene with graphite, extruded polystyrene (at the footing and under the terrain), stone mineral wool and phenolic foam. When selecting the appropriate type of thermal insulation material, it is necessary to take into account the thermal insulation parameters and fire safety requirements as well as mechanical properties. Among other things, full thermal insulation eliminates thermal bridges and any leaking and extends the lifetime of the building structures. The thickness of the thermal insulation material shall be determined by a detailed calculation in the design documents. In non-residential buildings, additional thermal insulation of the vertical building envelope can also be made by applying a ventilated thermal insulation system. Being costly, these systems are not applied to multi-apartment buildings.

To improve thermal performance of roofs on existing buildings (single-family houses, multi-apartment buildings and non-residential buildings), additional thermal insulation can be performed in flat roofs using various types of thermal insulation material, e.g. expanded and extruded polystyrene, stone mineral wool, polyurethane rigid foam boards. The thickness of the thermal insulation material shall be determined by a detailed calculation in the design documents. Waterproofing is performed mostly by using plasticised PVC film, modified asphalt membranes and EPDM rubber films, which are ideal for extensive green roofs. Pitched roofs usually cover unheated attics. They can be additionally insulated using various types of thermal insulation material applied to the upper side of the ceiling above the last heated floor, e.g. foam polystyrene, loose glass mineral wool on the floor or blow-in insulation materials.

Thermal performance of roof structures covering unheated spaces of existing buildings (single-family houses, multi-apartment buildings and non-residential buildings) can be improved by additional insulation from the bottom side by inserting thermal insulation material mainly on the basis of stone and glass wool. The thickness of the thermal insulation material shall be determined by a detailed calculation in the design documents.

Thermal performance of openings in existing buildings (single-family houses, multi-apartment buildings and non-residential buildings) is improved by replacing windows with uPVC windows having five- or six-chambered sections and sash stiles with double or triple insulating glazing. It is also possible to use wooden frames with glued layered sections or aluminium sections minimising thermal bridge.

Cost-effective measures vary according to building category and range from a combination of renovation of elements of the heat-exchange interface (major renovation), renovation of individual technical systems involving regulation and automation, to replacing energy sources with renewable sources. Examples that also take into account the lifetime are shown in the table below.

Table 15 Proposed measures for selected building categories

Building category	Building structure / technical system	Proposed measure	Lifetime (years)
Multi-apartment building	Vertical building envelope	Change in thermal protection by applying thermal insulation	25–30

		with ETICS thickness given by the original condition and the level of energy performance requirements as well as fire safety requirements	
	Roof covering	Change in thermal protection with thickness of insulation material given by the original condition and the level of energy performance requirements, creation of a new waterproofing layer	25
	Windows, doors	Replacement of windows and doors	30
	Ceiling above/adjacent to unheated space	Change in thermal protection and covering material	30
	Heating	Installation or replacement of thermostatic radiator valves	10
		Measuring heat consumption	10
		Reducing the temperature gradient of the heating system	
		Improvement of thermal insulation of distribution pipes	20
		Hydraulic balancing	10
		Heat-recovery systems – recuperation	20
		Replacing pumps with pumps with frequency converters	15
		Replacement of radiators	30
		New or modernised district heating	30
		Replacing boilers with condensing boilers in the case of a separate boiler room	20
		Replacing boilers with condensing boilers using solar collectors for heating and domestic hot water preparation in the case of a separate boiler room	20
	Domestic hot water preparation	Replacing taps with lever taps	15
		Replacing taps with thermostatic and automatic taps	15
		Thermal insulation of rising and horizontal pipes with max. heat losses of 10 W/m	20
		Hydraulic balancing of the distribution system	10
		Replacing pumps with pumps with frequency converters	15
		Reducing volume of storage tanks and improving their thermal insulation / replacement of tanks	15
		Installation of solar collectors	15
		Photovoltaic solar panels	10
Single-family house	Vertical building envelope	Change in thermal protection by applying thermal insulation with ETICS thickness given by the original condition and the level of energy performance requirements	30
	Roof covering	Change in thermal protection with thickness of insulation material given by the original condition and the level of energy performance requirements, creation of a new waterproofing layer	25
	Windows, doors	Replacement of windows and doors	30
	Ceiling above/adjacent to unheated space	Change in thermal protection and covering material	30
	Heating	The same measures as in the case of multi-apartment buildings except for district heating	10–20
	Domestic hot water preparation	The same measures as in the case of multi-apartment buildings	15

Office building	Vertical building envelope and roof covering, internal partition structures as well as doors and windows	The same measures as in the case of multi-apartment buildings	25
	Heating	The same measures as in the case of multi-apartment buildings except for district heating	10–20
		Installation of a zoned heating system	15
		Introduction of night and weekend temperature setback in heated rooms	5–10
	Domestic hot water preparation	The same measures as for multi-apartment buildings	15
		Potentially eliminate district domestic hot water preparation and introduce on-site domestic hot water preparation	20
	Lighting	Replacing lighting with light fittings equipped with electronic ballast and a higher zero-load efficiency	5
		Changing the arrangement of light fittings	15
		Installing motion sensors	10
		Installing brightness sensors	10
		Optimising the frequency of replacing and cleaning of light fittings	3–5

In non-residential buildings, the use of smart technologies can be a cost-effective tool to help create a healthier and more comfortable building with lower energy consumption and emissions. Introducing building automation elements and electronic monitoring of technical building systems is important as a cost-effective alternative to controls in large non-residential buildings. It is a good solution for multi-apartment buildings if the investment return is less than 3 years.

Energy performance of buildings is characterised as amount of energy needed to meet all the energy demand associated with a standardised use of a building, in particular energy used for heating, hot water, cooling, ventilation and lighting (according to Section 3(1) of the Act). In residential buildings, not all energy consumption points are evaluated. Multi-apartment buildings and single-family houses are solely assessed in terms of heating energy demand (including heating demand affected by thermal performance of building structures) and in terms of domestic hot water preparation. Heating demand depends on the efficiency and quality of the thermal protection of buildings. The calculation of heating demand to demonstrate meeting of the minimum energy performance requirement also takes into account the operation time of the heating of buildings with a specified effect on the decrease of indoor temperature in the building of the specified category. Heating demand according to STN 730540-2+Z1+Z2 Thermal protection of buildings. Thermal performance of building structures and buildings. Part 2: Functional requirements. The consolidated text is used for project and standardised energy evaluation in consideration of climate conditions according to STN 73 0540-3 Thermal protection of buildings. Thermal performance of building structures and buildings. Part 3: Characteristics of the environment and construction products for calculating the energy performance of buildings depending on the environment (Table 7 – winter period; Table 8 – summer period).

Requirements to demonstrate meeting of the minimum energy performance requirements for buildings – heating demand parameters (in kWh(m^2.a))

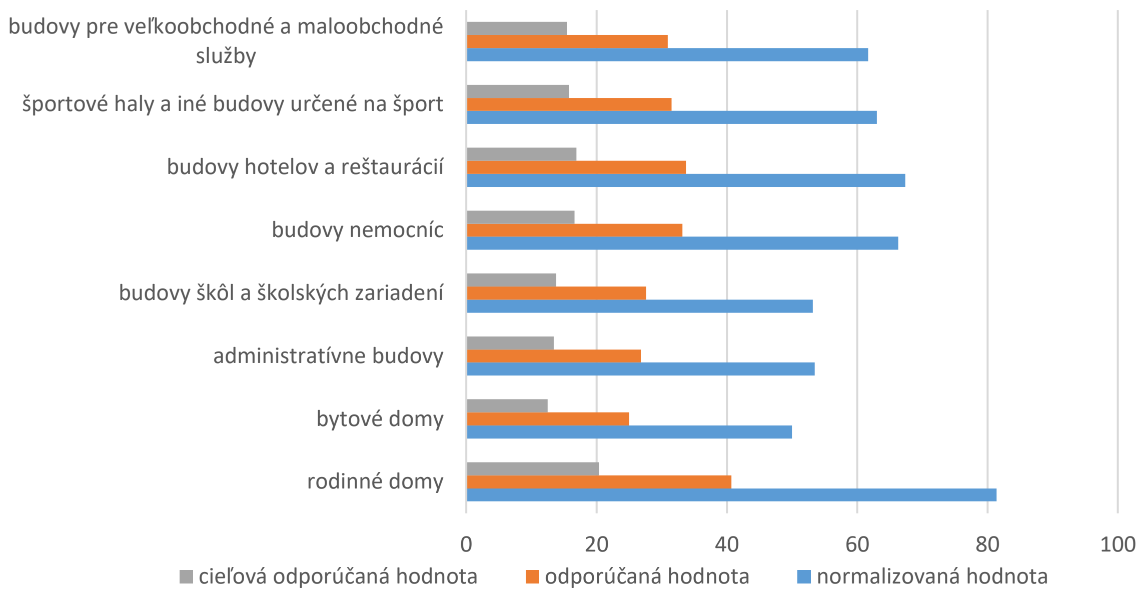

Figure 5 – Requirements to demonstrate meeting of the minimum energy performance requirements

Source: STN 730540-2+Z1+Z2 Thermal protection of buildings. Thermal performance of building structures and buildings. Part 2: Functional requirements. Consolidated version.

Key to graphic	
Original text	Translation
Požiadavky na preukázanie predpokladu splnenia minimálnych požiadaviek na energetickú hospodárnosť budov - hodnoty potreby tepla na vykurovanie (v kWh(m^2.a))	Requirements to demonstrate meeting of the minimum energy performance requirements for buildings – heating demand parameters (in kWh(m^2.a))
budovy pre veľkoobchodné a maloobchodné služby	wholesale and retail trade services buildings
športové haly a iné budovy určené na šport	sports halls and other buildings intended for sport
budovy hotelov a reštaurácií	hotel and restaurant buildings
budovy nemocníc	hospital buildings
budovy škôl a školských zariadení	school buildings and school institutions buildings
administratívne budovy	office buildings
bytové domy	multi-apartment buildings
rodinné domy	single-family houses

cieľová odporúčaná hodnota	recommended target value
odporúčaná hodnota	recommended value
normalizovaná hodnota	standardised value

The climate data for the assessment of the energy performance of a building for a season or month, e.g.: number of days of heating/cooling, average temperature, total solar energy depending on the orientation of the building. Detailed climate conditions for 2 884 towns and villages (documentation prepared by the Slovak Hydrometeorological Institute) are specified in national annex STN EN ISO 13790/NA Energy performance of buildings. Calculation of the energy demand for heating and cooling (STN 73 0703). For the purposes of calculating the heating and energy demand, Slovakia is considered as a single temperature zone. For residential buildings, the seasonal method could be used provided that uninterrupted heating exists. Currently, the monthly method is required for non-residential non-production buildings as well as residential buildings.

2.4 Expected ratio of buildings renovated after 2020

Slovakia has had a tradition of renovating multi-apartment buildings in various forms for almost 30 years now. The percentage of renovated multi-apartment buildings in Slovakia is more than 67% as of the end of 2019. The Updated strategy for the stock of residential and non-residential buildings from 2017 suggests that, at this pace of renovation, all residential buildings where renovation is possible will be renovated in Slovakia as early as 2030. It is therefore important to maintain the pace of promoting renovation of multi-apartment buildings also in the upcoming period, which requires securing sufficient financial resources for that period. It is necessary to take into account the fact that multi-apartment buildings renovated more than twenty years ago will need to undergo renovation again, as the lifetime of the building materials and structures used is coming to an end, but especially due to stricter requirements on building structures (e.g. windows). This will involve higher financial costs for carrying out deep renovation of multi-apartment buildings to comply with stricter energy-level requirements placed on development of nearly zero energy buildings to be introduced after 2020. Incentives aimed at owners will be instrumental in the increase of the costly deep renovation of buildings, which will, however, bring lower energy savings than the initial renovation.

Slovakia has more than one million single-family houses. No other detailed statistical data or databases are available for single-family houses. The development of single-family houses peaked in the 1960s; most of the houses are older than 30–70 years. Apartments in single-family houses constitute more than a half of the total number of apartments in Slovakia; they are owned by their occupants, as private parties. This fact is essential in the state's approach to incentivising its citizens to renovate their houses.

The percentage of renovated single-family houses in Slovakia as of the end of 2019 is 48.97% of occupied apartments in single-family houses; their renovation had almost exclusively been financed from the owners' private funds or in combination with a loan under a construction savings scheme or a loan provided by a commercial bank. It is a known fact that renovation costs per m^2 are substantially higher in the case of single-family houses than the renovation costs per m^2 of a multi-apartment building. In an effort to incentivise the owners of single-family houses, the state introduced a support scheme in 2016 in the form of a state-provided allowance for thermal insulation of single-family houses to improve their energy performance. The allowance covers up to 40% of the owner's eligible and expended renovation costs provided that the conditions of the allowance are observed. Based on practical experience, the allowance was revised in terms of increasing its amount, the scope of activities covered by the allowance as well as simplifying the administrative requirements to make the allowance mechanism more attractive to single-family houses' owners. The Updated strategy for the stock of residential and non-residential buildings states that, at the current pace of renovation, all occupied single-family houses will be renovated by 2040. It must be noted that in a large part of the single-family houses renovated in the past, inappropriate materials were used and the renovation was often a self-build without any expertise and understanding of the thermal insulation process. Repeated renovation will not only be much more expensive as a result of stricter minimum energy performance requirements after 2020, but especially due to the need to promote education and motivation of single-family houses' owners to renovate.

Table 16 Expected extent of renovation of residential buildings in 2020

Description	Apartments in multi-apartment buildings	Apartments in single-family houses
2011 Census	931 605	856 147[x]
Renovation as of 31 December 2019	632 301	431 864
Renovation as of 31 December 2019 (%)	**67.87**	**44.97**
Scope of renovation in 2020 (expected)	29 500	20 000
Extent of renovation as of 31 December 2020	661 801	450 665
Renovation as of 31 December 2020 (%)	**71.04**	**52.64**
Renovation to be performed between 2021 and 2030	269 804	405 482
Number of years of renovation after 2020	9.1	20.3
Number of years of renovation, including **unoccupied** apartments, in single-family houses after 2020		27.63

Source: From the data of the 2011 Census (Statistical Office of the Slovak Republic) compiled by the Civic Association for Thermal Insulation of Buildings and TSÚS

[x] Occupied single-family houses only

Setting targets for the renovation of non-residential buildings is difficult for a host of reasons. Most importantly, there are no relevant statistics and monitoring concerning the non-residential building stock allowing for analysis in this segment of buildings. Limited statistical data are available for central government buildings; no comprehensive statistics with the necessary information relevant for renovation planning are available for public sector buildings. But, in fact, public sector buildings have a considerable energy savings potential as they include a large number of buildings with the lowest energy performance. Many of the public sector buildings are historic buildings or buildings subject to heritage protection or otherwise important in terms of architecture. Such buildings require a special approach, in respect of heritage protection (their value in terms of architecture, technology, fine arts or craft). Not only the facades of these buildings, but also their windows, doors and other elements can be valuable. When decisions are made with respect to buildings that constitute national cultural heritage or are situated in heritage protection areas, the conditions of structural interventions are subject to decision of the competent regional heritage authority[4]. Such buildings are often in a poor structural and technical condition and require an array of structural interventions (such as dehumidification, repairs of roof coverings and gutter systems), which, if performed in a professional and sensitive manner, can significantly improve their user-friendliness and reduce operational costs. In terms of cost planning, it is necessary to be aware of the increased financial burden, as part of the costs has to be invested in subsequent long-term and systematic maintenance. It is necessary to rely on international experience and know-how and use any available training opportunities to improve the structural and technical condition and comprehensive energy balance of historic buildings.

Since 2016, a regular statistical survey has been carried out concerning the number of new and renovated non-residential buildings (both public and private), which may partially contribute to a greater awareness in this buildings sector. Some information on non-residential buildings can also be found in the database of energy performance certificates.

Renovations in the non-residential buildings sector have been slow. They have mostly been financed by the Structural Funds (ESIF) and by private funding. The Eurostat guidance adopted in May 2018 does have some potential to promote the extension of guaranteed energy services in public buildings, but the real potential to prevent the lock-in effect lies in deep renovation exclusively.

Up to 2020, especially major renovations were carried out in the area of building renovation, without any renovation of technical systems except for replacement of solid fuel boilers. Only in recent years, the use of renewable sources of energy has been promoted (photovoltaic panels, solar collectors, heat pumps, biomass boilers, etc.).

3. A roadmap with measurable progress indicators

3.1 Backgrounds for setting the plan in line with the headline target

After the industry sector, the buildings sector in Slovakia generates the second largest contribution to the fulfilment of the binding energy efficiency target according to Article 7 of Directive 2012/27/EU and of the binding energy savings target for public buildings pursuant to Article 5 of Directive 2012/27/EU established in accordance with the notification report.

The revision of the Directive has brought a clear intention to accelerate the renovation rate with an increased number of buildings undergoing deep renovation supported by targeted measures and financial instruments for achieving a stock of low to zero carbon buildings by 2050.

Indicative milestones followed from the definition of a baseline of energy consumption for the buildings sector and the related CO_2 emissions, calculated at the level of 2016. In order

[4]Act No 49/2002 on heritage protection, as amended.

to determine the total emissions for the buildings sector, direct energy consumption was determined based on the data of the Slovak Hydrometeorological Institute (available on an annual basis); the Eurostat data (available until 2016 only) were used to determine indirect energy consumption. For this reason, 2016 was established as a baseline. Both data sources keep separate records for residential buildings. Non-residential buildings are listed as the 'services' sub-category in the Eurostat database; however, in the data of the Slovak Hydrometeorological Institute, they form part of a sub-category which also includes other emissions that cannot be categorised any further. For the purpose of determining the baseline CO_2 emissions in the buildings sector in Slovakia, valid conversion factors of CO_2 emissions were used in calculations for each energy carrier.[5]

Table 17 CO_2 emissions in the sector of residential buildings in 2016

Residential buildings	Total energy consumption (TWh/a)	Emission factor (tCO_2/MWh)	$MtCO_2$	Percentage (%)
Solid fuels	0.7	0.360	0.27	2.4
Liquefied petroleum gas	0.1	0.248	0.03	0.3
Natural gas	13.7	0.220	3.2	43.9
Heating supplied	5.2	0.220	1.15	16.7
Solar thermal energy	0.1	0.000	0.00	0.2
Solid biofuels	6.3	0.020	0.13	20.2
Electrical energy	5.1	0.167	0.85	16.3
Total	**31.2**		**5.43**	**100.0**

Source: BPIE, Assistance with development of long-term renovation strategy for buildings in Slovakia

In view of the availability of relevant data sources for non-residential buildings, the reported energy consumption can be slightly overestimated.

Table 18 CO_2 emissions in the sector of non-residential buildings in 2016

Non-residential buildings	Total energy consumption (TWh/a)	Emission factor (tCO_2/MWh)	$MtCO_2$	Percentage (%)
Solid fuels	0.6	0.360	0.23	8.0
Liquefied petroleum gas	0.1	0.248	0.02	0.6
Gas oil / diesel fuel	0.0	0.290	0.01	0.4
Natural gas	6.5	0.220	1.42	44.8
Heating supplied	1.1	0.220	0.24	7.8
Solar thermal energy	0.0	0.000	0.00	0.0
Solid biofuels	0.7	0.020	0.01	0.0
Biogas	0.1	0.020	0.00	0.1
Geothermal energy	0.0	0.000	0.00	0.0
Electrical energy	6.9	0.167	1.16	38.1
Waste (non-renewable)	0.0	0.303	0.01	0.2
Total	**16.1**		**3.11**	**100.0**

Source: BPIE, Assistance with development of long-term renovation strategy for buildings in Slovakia

Total emissions in the buildings sector in Slovakia in 2016 were 8.54 $MtCO_2$, which represents 28% of the energy sector. As regards the type of energy carrier in terms of energy

[5]Annex 2 to Decree No 364/2012.

consumption and CO_2 emissions in residential buildings, more than three quarters are constituted by natural gas, electricity and district heating; the percentage is even higher for non-residential buildings (90%).

3.2 Setting indicative milestones for 2030, 2040 and 2050 and their contribution to the Union's targets

Directive (EU) 2018/844 of the European Parliament and of the Council on the energy performance of buildings, amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency introduces an obligation for each Member State to set indicative milestones for 2030, 2040 and 2050, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990.

Indicative milestones for Slovakia are set to reflect the ambitions of the Energy Performance of Buildings Directive in Article 2a) on long-term renovation strategy as well as more ambitious 2030 climate targets for Europe, respecting the framework for defining milestones6. They also take into account the fact that Slovakia has the highest decarbonisation targets, which foresee a reduction of at least 90% compared to 1990, which would mean achieving climate neutrality in 2050.7 Their fulfilment will require an increase in current efforts aimed at reducing emissions by rigorous implementation of additional energy efficiency measures outlined in the NUS SR as NEUTRAL measures as well as a consistent application of existing energy efficiency measures and policies specified in the adopted INEKP.

The same methodology as for the 2016 level was used to determine the baseline emissions in the buildings sector in 1990. Total CO_2 emissions in the buildings sector were set for 1990 at around 14.2 $MtCO_2$, which represents a 40% reduction compared to emissions of 8.54 $MtCO_2$ in 2016.

To achieve the Union's long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990, the national target for the buildings sector has to be set at 0.7–2.8 $MtCO_2$. For the purpose of determining the national trajectory, a mean range of 1.8 $MtCO_2$ has been applied.

The contribution of each type of fuel to the energy consumption in buildings as well as the amount of CO_2 emissions are presented in the following charts.

[6] Commission Recommendation (EU) 2019/786 of 8 May 2019 on building renovation.
[7] NUS SR, p. 5.

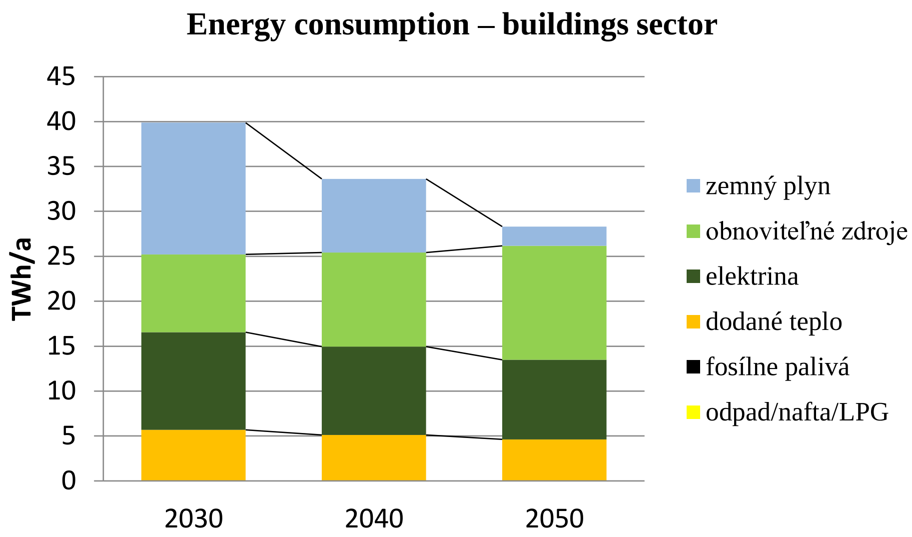

Figure 6 Buildings sector – estimated energy consumption (TWh)

Key to graphic	
Original text	Translation
Spotreba energie - sektor budov	Energy consumption – buildings sector
TWh/a	TWh/a
zemný plyn	natural gas
obnoviteľné zdroje	renewables
elektrina	electricity
dodané teplo	heating supplied
fosílne palivá	fossil fuels
odpad/nafta/LPG	waste/diesel/LPG

Table 19 Buildings sector – estimated energy consumption (TWh) – indicative milestones

Energy consumption (TWh)	2030	2040	2050
waste/diesel/LPG	0.0		
solid fossil fuels	0.0		
heating supplied	5.7	5.1	4.6
electricity	10.9	9.8	8.9
renewables	8.7	10.5	12.7
natural gas	14.7	8.2	2.1
TOTAL	**39.9**	**33.6**	**28.3**
% compared to 1990	57%	47%	40%

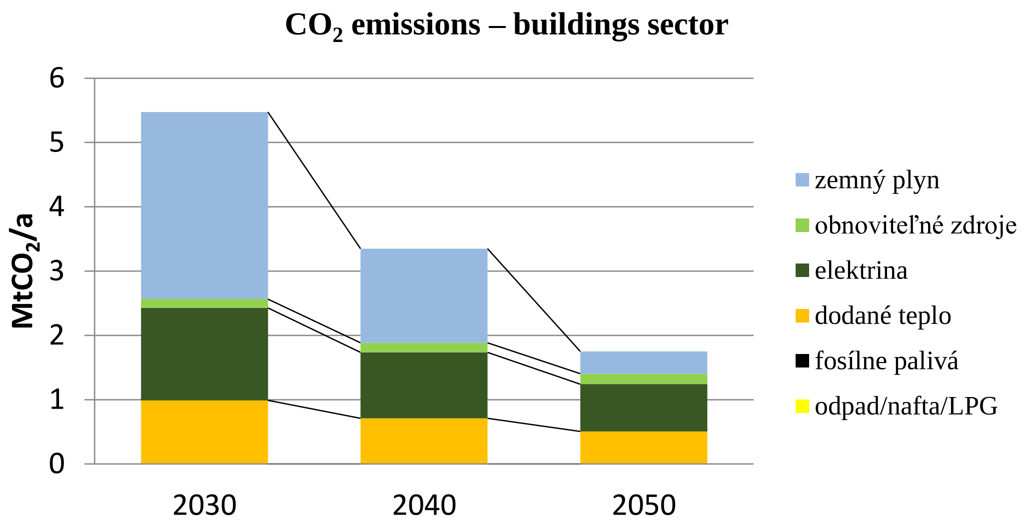

Figure 7 Buildings sector – estimated CO_2 emissions ($MtCO_2$)

Key to graphic	
Original text	Translation
Emisie CO_2 - sektor budov	CO_2 emissions – buildings sector
$MtCO_2$/a	$MtCO_2$/a
zemný plyn	natural gas
obnoviteľné zdroje	renewables
elektrina	electricity
dodané teplo	heating supplied
fosílne palivá	fossil fuels
odpad/nafta/LPG	waste/diesel/LPG

Table 20 Buildings sector – estimated CO_2 emissions ($MtCO_2$) – indicative milestones

CO_2 emissions	2030	2040	2050
waste/diesel/LPG	0.0		
solid fossil fuels	0.0	0.0	0.0
heating supplied	1.0	0.7	0.5
electricity	1.4	1.0	0.7
renewables	0.1	0.1	0.2
natural gas	2.9	1.5	0.3
TOTAL	**5.5**	**3.4**	**1.8**
% compared to 1990	39%	24%	13%

Source: The Buildings Performance Institute Europe (BPIE), Assistance with development of long-term renovation strategy for buildings in Slovakia

Energy consumption in buildings should be reduced by 40% by 2050 compared to 2020; emissions will fall by 79% and 87% compared to 2020 and 1990, respectively.

The model for trajectory determination is based on several assumptions, the most important of which are the following:

- electricity and heat supply will be decarbonised by 50% by 2050;
- direct consumption of solid fossil fuels, waste, LPG and gas oil and diesel will be phased out by 2030;
- carbon emissions in gas will be reduced by 25% by 2050;
- renewable energy sources in buildings will increase by 10% every 5 years;
- the net impact of new buildings on emission levels will be zero by 2050.

Slovakia is the leader in electricity generation with low-carbon technologies already, with nuclear energy constituting the highest share.[8]

The model for determining the trajectory of estimated CO_2 emissions is based on the available data sources and presents one of the possible development scenarios, relying on the information provided in the Slovak relevant strategy documents adopted. Any amendments thereto as well as the adoption of any additional strategic materials will be taken into account when updating this strategy. Achieving the thus-defined ambitious objectives will require increased efforts to intensify building stock renovation, both in terms of emphasising deep renovation and significantly increasing the renovation pace.

The renovation scenario in line with the defined milestones requires a significant shift from partial renovation of buildings (light/shallow and medium forms of renovation) towards deep renovation (also in a gradual fashion) so that the ratio of deep renovation to renovations of building carried out in 2050 is 40% (Figure 8).

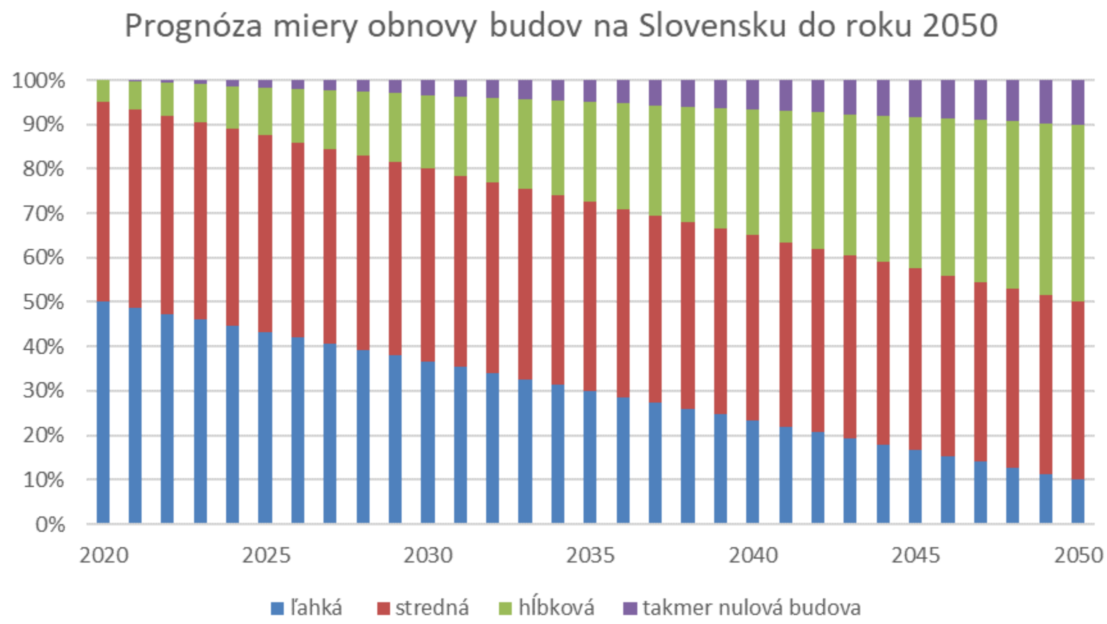

Figure 8 Forecast of building renovation rates in Slovakia until 2050
Source: BPIE, Final report

[8] https://www.mhsr.sk/energetika/navrh-integrovaneho-narodneho-energetickeho-a-klimatickeho-planu, p. 261.

Key to graphic	
Original text	Translation
Prognóza miery obnovy budov na Slovensku do roku 2050	Forecast of building renovation rates in Slovakia until 2050
ľahká	light
stredná	medium
hĺbková	deep
takmer nulová budova	nearly zero energy building

The type of renovation can be categorised according to the amount of primary energy savings achieved.

Table 21 Types of renovation by the amount of primary energy savings achieved.

	Type of renovation		
	Light, shallow	Medium	Deep
Primary energy savings (%)	3–30	30–60	over 60

3.3 Measurable progress indicators and evidence-based estimate of energy savings

Measurable progress indicators were defined based on the available data sources, qualified estimates of the total floor area of residential and non-residential buildings in Slovakia, the current pace of renovation in the buildings sector, taking into account the scenario of renovation with regard to the growing pace of building renovation over the next twenty years with emphasis on deep renovations.

The estimated energy savings as well as the investments required to achieve these savings were calculated using a calculation model, based on a number of variables. Account is taken of the categorisation of the buildings sector into residential and non-residential buildings, with regard to the differing internal rate of return on investment for the given buildings segment, the pace of renovation, the different levels of building renovation carried out and the related rate of savings and investments, energy prices in the sector (including inflation factor) and others. All the buildings are expected to be renovated by 2050. By 2030, more than a half of non-residential buildings should undergo medium renovation; residential buildings should undergo deep renovation, gradually achieving 29% of such renovations in 2030, with this percentage then increasing until 2041, when all the buildings should be renovated.

The results in the table constitute cumulative data for the entire buildings sector in Slovakia. The estimated cumulative energy savings rate in the buildings sector in Slovakia is 10 518 GWh in 2030, growing to 18 368 GWh in 2040 and reaching 19 006 GWh in 2050. These values are in line with the indicative milestones set for energy consumption and carbon emissions in the buildings sector and in line with the objectives of the Directive.

Table 22 Indicative milestones at national level

Indicative milestones	2030	2040	2050

Cumulative energy savings (GWh)	10 518	18 368	19 006
CO_2 savings	61%	76%	87%

Source: BPIE Model (EPBD scenario)

The cumulative volume of energy savings for the final consumer between 2021 and 2030 is 47 877.5 GWh. On an annual basis, the contribution is 870.5 GWh.[9] The estimated annual energy savings in the buildings sector represent 22% of this value.

When making a forecast for a period longer than 30 years, it should be taken into account that the results achieved will be influenced by a number of factors that cannot be anticipated at this point. The renovation pace and rate achieved, the sufficient amount and availability of funds for renovation, technological developments as well as behavioural change of occupants, demographic factors and many others will be of great importance.

4. Measures to fulfil the renovation plan

4.1 Policies and measures to promote cost-effective deep renovation of buildings

The Directive emphasises deep renovation of buildings, which will reduce both the energy supplied and the final energy consumption of buildings compared to the pre-renovation level. The proposals for cost-effective measures to improve the energy performance of buildings relate to deep renovation of buildings. The Act defines major renovation of a building and substantial refurbishment of a building's technical equipment, as well as deep renovation of a building (see Annex 1).

Owners of buildings decide to carry out a renovation mainly for the following reasons:

- poor, unsatisfactory condition of certain building structures;
- in extreme cases, state of serious disrepair (structural defects, damaged roofing);
- poor hygiene conditions inside the building (leaks, formation of mould, moisture);
- insufficient thermal protection and low thermal performance of building structures (heat loss and overheating of the interior of the building in summer);
- poor lighting and poor light conditions.

Besides major renovation, deep renovation of a building also requires substantial refurbishment of its technical system. Besides heating and domestic hot water systems for residential and non-residential buildings, this also concerns ventilation (including heat recovery – recuperation), cooling and lighting of non-residential buildings and the use of control and automation systems.

For residential and non-residential buildings undergoing major renovation, the Directive establishes a new duty to install the infrastructure necessary for charging electric vehicles. By increasing the energy efficiency of buildings, this measure contributes to the decarbonisation of the economy.

Energy efficiency gains in buildings are also dependent on the energy efficiency of heating and cooling. Slovakia is characterised by a developed district heating system, which covers more than 30% of total heat consumption (approximately 16 100 multi-apartment

[9] INEKP, p. 55.

buildings). More than 74% of multi-apartment buildings are connected to district heating systems. Most of the heat generators and heat distribution systems were installed before 1990. Boilers used in the district heating systems are very diverse in terms of age, technical parameters as well as type of fuels. After some old boilers have been replaced, most of the boilers operated are currently less than 15 years old. In terms of installed capacity, boilers older than 20 years predominate. Water and hot water distribution predominates in the district heating systems. The majority of heat distribution systems is 20 to 30 years old, with corresponding technical condition. Given that the expected lifetime of the said generators and distribution systems is 25 to 30 years, substantial refurbishment of a building's technical equipment also concerns the production and distribution of heat and domestic hot water.

Ensuring a functioning support for reducing the energy intensity of heat distribution is part of the policies to improve energy efficiency in the heating and cooling sector, as set out in the Integrated national energy and climate plan for 2021–2030. A new measure is introduced to support the construction of new district heating and cooling systems and the transition of existing district heating and cooling systems to efficient district heating and cooling systems.

A significant increase in the energy efficiency of district heating and cooling systems and an increase in the share of renewable energy in these systems is, in view of the above, one of the preconditions for achieving the milestones identified in the buildings sector, which is in line with the measures specified in Chapter 3.2 of the INEKP in the section on 'Measures planned in the heating and cooling sector'.

Therefore, deep renovation, i.e. renovation of building envelopes and necessary interventions in the technical systems for heating, domestic hot water, including renovation of the distribution systems in the prefabricated service/sanitary cores of multi-apartment buildings, is necessary in order to meet the basic requirements for construction works, and in particular to meet the minimum energy performance requirements.

The measures to be implemented in the process of deep renovation can be phased or performed as a one-off process of major renovation of the building (building structures) and substantial refurbishment of its technical systems. Deep renovation can also be carried out in one single phase, applying all the necessary measures at once.

The draft measures are distinguished according to:

a) the objectives for energy performance of buildings set out by the Act and Decree No 364/2012;
b) building categories (residential and non-residential buildings);
c) construction periods (before 1983, before 2002, after 2002);
d) the original state of the building structures (openings including shielding, vertical building envelope, roof covering and internal partition structures between heated and unheated rooms);
e) the original state of technical systems in the building (heating, domestic hot water preparation, ventilation (including heat recovery), cooling, lighting);
f) the age and technical condition of heat generators, domestic hot water preparation and cooling equipment and distribution systems in and outside the building;
g) the scope of the options for introducing automation and management;
h) the scope of the deployment of renewable heat, domestic hot water and electricity sources.

The procedures for assessing cost efficiency are determined by STN EN 15459-1 Energy performance of buildings. Procedures for economic evaluation of energy systems in buildings. Part 1: Calculation procedures, module M1-14.These procedures have also been used to establish cost-optimal levels of minimum energy performance requirements in accordance with Commission Regulation (EU) No 244/2012, complemented by national parameters.

Intermediate targets for achieving individual energy levels of construction are set out in Decree No 364/2012, which implements the Act in three phases as follows:

a) low-energy construction level for both new and renovated buildings from 1 January 2013 onwards (up to the upper limit of the B energy class for individual building categories);

b) ultralow-energy construction level for all new buildings from 1 January 2016 (up to the upper limit of the A1 energy class for renovated buildings, provided that the cost-efficiency conditions are met);

c) nearly zero energy construction level for new buildings owned and managed by public bodies from 1 January 2019 and for all new buildings from 1 January 2021 (up to the upper limit of the A0 energy class for the global indicator (primary energy)).

The values set for the ranges of energy classes for different building categories take into account the results of calculations from the second phase of deriving the cost-optimal levels of the minimum energy performance requirements for nearly zero energy buildings published in 2018.

New buildings must meet standardised requirements for the thermal performance of building structures and elements determined by the STN 73 0540-2+Z1+Z2 Slovak technical standard. The standardised requirements must also be met by buildings subject to major renovation. If this is not functionally, technically and economically feasible, all building structures and elements subject to major renovation must comply with at least the thermal performance determined by a technical standard (e.g. STN 73 0540-2+Z1+Z2).

Achieving almost zero-energy demand for all new buildings and buildings subject to major renovation requires efficient use of renewable energy sources.

A significant part of the total number of renovated multi-apartment buildings and single-family houses consists in apartments renovated partly through thermal insulation of the vertical envelope and roof covering and replacement of the original doors/windows. In this way, more than 60% of the building’s energy consumption was saved in the past. The multi-apartment buildings and single-family houses already renovated will require another renovation due to the phasing-out of the lifetime of building elements and structures; however, this renovation will save less energy and will require higher investment costs necessary to achieve the nearly zero energy level after 2020, as long as this is economically, functionally and technically feasible.

The average investment costs for the renovation of a single-family house range from EUR 180 to 220/m^2, the average investment costs for renovation of a multi-apartment building range from EUR 150 to 180/m^2. Depending on the extent of the previous renovation, the average investment costs of EUR 100/m^2 (both for single-family houses and multi-apartment buildings) are expected for the new renovation.

It must be taken into account that the owners who already have repaid a 15- or 20-year loan for the renovation (although partial) of their multi-apartment building may be reluctant to vote for another 20-year loan for a deep renovation of their building (and tolerate the associated increase of payments to the obligatory fund for operation, maintenance and repairs). In the forecasts of multi-apartment building stock renovation and its pace, it is necessary to take into account the ageing population that owns apartments in multi-apartment buildings and that owns single-family houses[10]. A significant portion of middle-aged owners will reach retirement age in about twenty years, which will mean a considerable reduction in their disposable income. Thus, an important factor to be considered is the retired owners' declining interest and motivation for renovations, which can be expected due to changes in their personal preferences and life circumstances. Another group influencing the renovation rate are owners who are single parents with a single income.

4.2 Policies and activities targeting the least energy efficient buildings and energy poverty

The buildings considered the least energy efficient are those with the worst energy performance, which is mainly reflected in high thermal consumption in heating and domestic hot water. However, the actual energy consumption of a building is significantly influenced by a number of factors: energy consumption for heating and domestic hot water (depending on the very different climate conditions across Slovakia), ratio of openings to the heat-exchange envelope of the building, and the requirements for the thermal performance of the envelope structures valid during the construction period. From this point of view, we consider buildings built before 1983, when a stricter thermal performance standard came into force, to be the least energy efficient. In Slovakia, more than 64% of apartments in multi-apartment buildings and more than 48% of apartments in single-family houses have been renovated (including partial renovation) and, therefore, it can be assumed that the number of the least energy efficient multi-apartment buildings and single-family houses is significantly lower than twenty years ago when the renovation started and buildings with the lowest energy efficiency were renovated first. Data from the monitoring system of the Slovak Innovation and Energy Agency, which collects data on real savings made by thermally insulating multi-apartment buildings with the support of renovation loans from the State Housing Development Fund, show a decreasing average percentage of thermal consumption saved for heating in thermally insulated multi-apartment buildings[11]. This also implies the need to increase incentives for owners to renovate buildings not yet thermally insulated. As private ownership predominates in Slovakia (more than 90.5% of the occupied apartments are privately owned), the motivation of owners is a fundamental element on the path to renovation.

The existing laws stipulating the duty for owners to maintain a fund for operation, maintenance and renovation is a good prerequisite for creating an environment motivating owners of apartments in multi-apartment buildings and owners of non-residential premises, supported by incentivising and available financial mechanisms, as well as support from the state. The application of various tax mechanisms to support renovation of buildings in Slovakia seems unrealistic in the future.

[10]Source: B. Bleha, B. Šprocha and B. Vaňo, 2013: *A Forecast of the Population Development in the Slovak Republic until 2060*.
[11]Source: Slovak Innovation and Energy Agency, indicative numbers in the energy industry.

Interested and capable real estate owners as well as educated building managers and owners' representatives are an important factor determining the extent of renovation. Deep renovation, especially for buildings with the worst energy performance, is essential, as it can not only maximise the energy savings achieved, but also significantly extend the lifetime of the building and significantly affect the quality of the indoor climate for occupants.

The least energy efficient buildings, i.e. those buildings from the Slovak building stock with the greatest energy demand, are non-residential buildings. Hospitals, schools (mainly primary schools), school facilities and hotels have the greatest heating demand for heating and domestic hot water, which is due to the condition of the buildings as well as the higher requirements for indoor parameters.

Public buildings and renovation measures are addressed in a separate section of this document. Privately owned non-residential buildings account for a less significant share of the total number of non-residential buildings but show a high energy demand. However, the state has few effective tools to motivate the owners in this building segment to renovate their property.

Due to a significant share of privately owned apartments (in multi-apartment buildings as well as single-family houses) compared to a very small share of real estate rented (approx. 6%), Slovakia does not face the problem of inconsistent motivation following from the owner-tenant relationship. Given this significant share of privately owned real estate, motivating owners to renovate their property and raising their awareness becomes an important element and measure of renovation policies. Lease of residential space is regulated in the Civil Code and other acts, e.g. Act No 98/2014 on short-term lease of apartments and lease of non-residential premises and Act No 116/1990 on lease and sub-lease of non-residential premises. These acts govern the rights and obligations of the lessor and the tenant and their contractual relationship.

Rented real estate (mostly apartments in multi-apartment buildings) gains value by renovation, and the owners prefer lower operating costs since mostly they themselves pay the monthly advances for utilities, the amount of which is specified in the lease agreement as a part of the total rental price.

More than 25 years of practical experience with thermal insulation of buildings and raising awareness of real estate owners in the field of energy performance of buildings has led to the development of an efficient market for investments in building renovation in Slovakia. However, given the need to achieve the strict minimum energy performance requirements after 2020 and the associated need for deep renovation and implementation of smart technologies, the financial mechanisms for the support of renovation, which have been effective and sufficient so far, need to be appropriately complemented.

In fulfilling the duty to achieve energy savings, vulnerable households and households affected by energy poverty need to be taken into account.

According to Act No 250/2012 on regulation in network industries, a 'vulnerable customer' means a household or small business customer, and 'energy poverty' means that the household's average monthly expenditure on consumption of electricity, gas and heat for heating and domestic hot water represents a significant share of the household's average monthly income.

Slovakia sees energy poverty as part of poverty in general. In all income categories, the share of expenditure on energy in the total household budget is higher in Slovakia than in most EU countries. Therefore, the adopted national programmes and strategies support measures in particular in the areas of employment (employment support programmes), education (skilling), social policy aimed at activation of people with low socioeconomic backgrounds, and regional development.

To date, a number of strategic and conceptual documents have been adopted in this area:

- National Reform Programme of the Slovak Republic 2020,
- National Employment Strategy of the Slovak Republic until 2020 – a cross-departmental document which, with the contribution of social partners, local governments and civil society, identified mechanisms supporting employment development,
- National framework strategy for promoting social inclusion and combating poverty,
- Networking and development of public employment services,
- Strategy of the Slovak Republic for Roma integration until 2020,
- Updated action plans of the Strategy of the Slovak Republic for Roma integration until 2020 for 2019–2020.

Energy poverty is also addressed separately in Chapters 2.4.4 and 3.4.4 of the INEKP.

The final electricity and gas prices for household customers are below the average of the European Union countries in Slovakia, but from the point of view of purchasing power parity, given the lower income and the cost of other goods and services, electricity and gas prices for the population in Slovakia are above the EU average.

In the housing sector, the housing benefit is a targeted form of support (Section 14 of Act No 417/2013), which is intended to partially reimburse the costs associated with housing, including utilities. The benefit is provided as part of the benefit in material need pursuant to Act No 417/2013 on assistance in material need and amending and supplementing certain acts. The housing benefit represents a significant proportion of the income claimable by people in material need and is EUR 55.80 per month for households with one member or EUR 89.20 per month for households with several members or apartments shared by several tenants.

It is important to note that any contributions made under social policy support schemes address the acute problem of the current low disposable income of vulnerable households, but do not constitute a systemic approach to tackling energy poverty in the future. Reducing the energy costs of low-income households and supporting similar measures appears to be an effective approach to solving this issue. A possible approach is to set up the existing support mechanisms in the field of energy performance of buildings so as to incentivise specifically the vulnerable households in the future, in particular in relation to the implementation of family-housing support measures funded in the context of the Modern and Successful Slovakia plan.

Slovakia has implemented effective system support mechanisms in the field of energy performance of buildings, which are not directly linked to income levels but to meeting energy criteria and serve to prevent energy poverty in the future.

They are the following:

- allowance for thermal insulation of single-family houses;
- allowance for the installation of small devices for the use of renewable energy sources in households (both single-family houses and multi-apartment buildings);

- subsidies granted for the elimination of system failures of multi-apartment buildings;
- state bonus on construction savings schemes (provided to natural persons and legal persons, e.g. associations of owners).

The European Commission is paying particular attention to tackling energy poverty and empowering vulnerable consumers. Energy poverty indicators have been developed at the European level to assess and monitor energy poverty[12] in order to better quantify the number of households affected and analyse potential causes. Various specific instruments, measures and policies of the Member States that could serve as an inspiration for Slovakia are also available in the framework of the European Commission's initiative 'Energy Poverty Observatory'[13], along with various energy poverty indicators.

4.3 Policies and activities targeting public buildings

For the purpose of the strategy, public buildings are all buildings used by local or regional authorities as well as buildings owned but not necessarily used by central government or local authorities. Renovation of public buildings in Slovakia lags significantly behind the pace of renovation of residential buildings, especially multi-apartment buildings. Slovakia has not implemented any comprehensive programmes of support for the renovation of these buildings, as is the case for housing construction. Until now, public buildings have been renovated with support from the ESI Funds, the state budget, private funds (EkoFond), the International Fund to Support the Decommissioning of Bohunice VI Power Plant. Between 2015 and late 2019, 3 423 buildings were supported by EUR 433.83 million of Envirofond subsidies for improving the energy efficiency of existing public buildings, including thermal insulation.

Energy audits in public buildings help to identify the renovation measures with the greatest saving potential and partially fulfil the function of building passports.

Since February 2019, public administration bodies in Slovakia may engage in energy performance contracting for the public sector pursuant to Act No 321/2014 on energy efficiency, providing for improvement of the energy efficiency of buildings or equipment without consequences on the level of government debt, following a single methodology applicable to the European Union.[14] Thus, public bodies may draft and finance projects through the mobilisation of private capital. Energy services allow private finance to be mobilised not only during investment, but especially during subsequent purchase of receivables, which may increase the renovation pace (maximum leverage, minimum market distortion). Technical assistance in project drafting is carried out by the Slovak Innovation and Energy Agency.

This measure is expected to stimulate the renovation of public buildings significantly, but, at the same time, poses a risk of most renovations being partial with a short return period, and thus mainly focused solely on the renovation of technical equipment of the building, which is not in line with the objectives of the Energy Performance of Buildings Directive, which puts an emphasis on deep renovation of buildings and preventing the lock-in effect. The use of financial instruments or a combination of grant funding with repayable funding will be crucial

[12] Annex to Commission Recommendation of 14 October 2020 on energy poverty.
[13] https://www.energypoverty.eu/
[14] https://www.mfsr.sk/sk/financie/ppp-projekty/garantovane-energeticke-sluzby/metodika-vzorova-zmluva.html

in order to avoid the lock-in effect and to carry out deep renovation of buildings using guaranteed energy services.

4.4 Incentives for the use of smart technologies and skills

Smart-ready buildings provide the basis for the digitisation of the buildings sector as part of the EU Digital Single Market. Building systems ready for the deployment of smart technologies present new opportunities for energy savings, as they provide information on the impact of consumer behaviour on energy consumption. Under Slovak law, the buildings' owners and designers are obliged to use smart technologies. When carrying out major renovations, buildings' owners are obliged to apply new or renovated technical systems, to deploy smart metering systems and to install automated control, regulating and monitoring systems aimed at energy saving, where technically, functionally and economically feasible. Under the Construction Code, the designer is obliged to design new buildings and major renovations of existing buildings using appropriate building structures, alternative energy systems based on renewable energy sources and automated control, regulating and monitoring systems within technical, functional and economic conditions of the building.

A more widespread application of smart technologies in existing buildings is significantly limited by the technical parameters of built-in technical building systems, as well as by the technical possibilities within the building and the mutual compatibility of technical building systems. The introduction of modern control technologies will require the education of occupants about their benefits for everyday life and the use of information as an incentive for a change in the occupants' behaviour in the building after its renovation. The application of smart technologies, especially in non-residential buildings, will allow the integration of renewable energy sources into future energy systems.

Deep renovation is a complex process and one of the factors significantly affecting the achieved quality and user benefit is the quality of the construction and craft work in the process of renovation. The participants in the process of renovation of residential and non-residential buildings (stakeholders) are: central government, local governments, private owners as investors (also represented by building managers), manufacturers of building materials and systems of technical equipment of buildings, designers (architects and construction engineers represented by professional chambers), contractors (represented by employers' associations and professional associations), research and development sites. Lifelong learning of selected professions and continuous education and skills acquisition for craftsmen are essential to ensure renovation not only of the required quality, but also with the application of new methods of construction and innovative technologies and elements of adaptation to climate change, so as to achieve the minimum energy performance requirements applicable to the construction of nearly zero energy buildings where technically, economically and functionally possible.

Approximately 15 professions with expert skills participate in the process of deep renovation of buildings. In the area of renovation of the heat-exchange envelope, licenses are issued for special construction works, such as the licence for thermal insulation works (for the application of the external thermal insulation composite system (ETICS)), license for the construction of thermal insulation and waterproofing systems of flat roofs, license to incorporate external openings into the building. Where an entity holds such a license, it demonstrates its ability to perform special construction works, the quality of which, together with the certified components, guarantees the design parameters and durability of the work.

In the field of education and expert training, the StavEdu project set up a national system for deepening the qualification and further training of craftsmen and construction workers in the buildings sector with focus on energy efficiency and the use of renewable energy sources in buildings. This mainly concerns craftsmen and workers with secondary vocational technical training. The aim is to expand knowledge of the types, characteristics and use of building materials necessary to reduce the energy intensity of buildings, including technical regulations, to know the work activities accompanying technological processes, to be able to install facade thermal insulation systems including covering material, to know innovative technological processes and new materials, and to be able to use smart energy solutions, measurement methods and new technologies.

The StavEdu system offers nine cross-cutting programmes for 32 crafts and professions – expert training of craftsmen and construction workers in the field of energy efficiency and the use of renewable energy sources in buildings.

The training programmes for individual professions are as follows:

- mason (structural works)
- mason (associated works)
- installer of concrete and steel structures and vertical building envelope
- roofer, hydro-insulator, carpenter, plumber, roof tiler
- finishing of construction works – painter, wallpaper-hanger
- installer of technical equipment of buildings – plumber, installer of sanitation, heating and cooling systems
- operator of construction machinery
- lighting system technician
- energy equipment of buildings

StavEdu also facilitated a dialogue with the social partner organisations and stakeholders on proposals for supporting instruments for financing further training and promoting investment in skills and knowledge of craftsmen and construction workers, as well as proposals for financial and other instruments to step up the renovation of buildings, including renovation of single-family houses and housing units. These instruments stimulate demand for intelligent energy solutions in buildings. StavEdu became the cornerstone for other initiatives such as Build Up Skills and subsequently ingRES, which helped to create national qualifications frameworks, an education and training system and other measures to ensure the development of energy efficiency skills in the construction sector. The main target group of the ingRES project included five professions of construction sector experts at the middle and senior management level: construction managers, construction supervisors, construction engineers and architects, building sustainability consultants and persons qualified for energy certification of buildings. The CraftEdu project (2018 to 2021) builds on StavEdu with the aim of establishing certified programmes for further training of craftsmen and construction workers in the field of energy efficiency and the use of renewable energy sources in buildings. The purpose of the training is to create a new generation of qualified construction workers who know the basic principles, have the skills and awareness of the construction of nearly zero energy buildings and are able to apply these principles and knowledge in their professional practice when constructing or renovating nearly zero energy buildings. The Build Up Skills project continues under the title LIFE programme. To support the Horizon2020 programme, the SEEtheSkills project will be implemented over the upcoming years, building seamlessly on ingRES themes to promote energy efficiency in buildings, in particular with regard to the use of information and communication technologies and raising awareness of renewable energy solutions. Slovak professional organisations and educational institutions are part of these projects, which allow, among other things, to gain knowledge from the best applied approaches to renovation in practice, especially when it comes to the use of innovative technologies and equipment and the construction of nearly zero or plus energy buildings. In view of the anticipated increased demand for skilled craftsmen in the context of the required increase in renovation rates under the European Green Deal, the European Social Fund ESF+ will support major re-training of craftsmen in the buildings sector within its focus on green professions and green economy; this will follow up on the projects financed within the Horizon 2020 programme. In the next period, a continuous strengthening of the skills and know-how of workers in the construction sector is envisaged, as well as a re-training of new workforce, supported through the Skills Agenda and the upcoming Pact for Skills tool.

Almost 7% of the total number of workers in the Slovak economy is employed in the construction sector. The qualifications, education and expertise of the employees in the sector are considered to be one of the key attributes of further development of the construction sector. Qualifications are an important factor in labour productivity growth. Improving the qualification of green professions is necessary for a rapid introduction and a mass distribution and application of green solutions in the construction industry. 'Green' workers are those who have undergone the relevant training and apply the environmental know-how acquired. Green professions include the following: masons, plasterers, roofers and installers of building structures providing construction works related to the thermal insulation of vertical building envelopes and roof covering, the installation and replacement of doors/windows, electricians installing solar panels, plumbers installing solar collectors for domestic hot water, construction workers building energy efficient buildings and wind power plants, or other workers involved in the sustainable development of clean and renewable energy of the future, as well as experts verifying the functioning of the energy efficient buildings' systems and facility managers of energy efficient buildings. These are professions associated with the sector of reducing energy consumption in buildings, with the use of renewable energy sources and with energy efficiency.

Recognising the importance of improving qualifications in the green professions, new Act No 61/2015 on vocational education and training and on amendments to certain acts entered into effect on 1 April 2015 in order to facilitate a smooth transition of students from education to the labour market and to increase the employability of secondary vocational school graduates. From the 2015/2016 academic year, the Act on vocational education and training introduces the possibility of a dual education system, which allows employers to prepare students specifically for the profession or position according to their needs and requirements.

Dual education is a vocational education and training system that allows students to acquire the knowledge, competence and skills necessary for the profession. In particular, it is characterised by a close link between general and vocational theoretical education at a secondary vocational school combined with practical training with a particular employer. In the dual education system, the employer is not only allowed to enter the vocational training process but is given full responsibility for the organisation, content and quality of practical training and, to this end, reimburses all the costs associated with the financing of practical training. In order to ensure a uniform scope and content of practical training in the different fields of study, practical training will follow model study plans and curricula drawn up in cooperation with the relevant professional and employers' associations, which are binding on employers operating in the dual education system.

Dual education provides the following advantages:

- a highly skilled workforce, a smooth transition from education to the labour market;
- acquisition of qualifications and experience directly with the employer;
- acquisition of work habits directly in the production process with the employer;
- acquisition of knowledge of new technologies directly with the employer;
- employers responsible for the practical part of vocational training;
- employers are able to influence the content of vocational training;
- up-to-dateness of vocational training programmes and their content, flexibility in their adaptation;
- verification of the graduates' knowledge and skills by the employer upon graduation;
- students themselves choose the professions and employers to provide them with practical training;
- students are selected for dual education directly by employers and are admitted to school with the employers' consent;
- the dual education system is supervised by employers' associations;
- employers provide students with financial and material security;
- close cooperation between enterprises, schools and students;
- practically targeted curricula for each field;
- development of professions linked to the needs of the market;
- high probability of obtaining an employment contract with the employer.

Competitions of construction trades are a very efficient and practically verified tool supporting the development of skills of secondary vocational schools' students; such competitions are organised mainly by schools and employers' associations.The aim of the competitions is to support the development of students' manual professional skills, support their own creativity and develop their talents. The winners of the Mason, Young Builder, Young Craftsman competitions and of Slovak Roof Crafts Championships for students at vocational schools are awarded prizes from the Ministry (EUR 200 vouchers for the purchase of electronics).

In addition to the manual professional skills, it is important to develop students' entrepreneurial skills. Besides the basics of entrepreneurship taught within the curriculum, students have the opportunity to undergo short supplementary educational programmes to improve their entrepreneurial skills.

Despite the existence of programmes at various levels linked to the formal education and dual education systems, the option of acquiring new knowledge and skills in the process of further education remains to have little appeal, especially for the worker and craft construction trades. This may also be due to the fact that there is no system supporting workers' motivation, promoting the attractiveness of the construction sector and supporting the trainings financially.

4.5 Further measures to address the energy performance of buildings

By renovation of buildings, changes are made to their building structures and technical equipment in order to meet the basic requirements for construction works and to extend the lifetime of the building or parts thereof before the end of the lifetime. During the lifetime of the building, its condition is regularly inspected and necessary repairs and maintenance are carried out, as well as regular mandatory inspections and checks of the relevant equipment (electrical, gas, pressure vessels, lifts, etc.). Wet and dry risers (Decree No 699/2004), portable fire extinguishers (Decree No 719/2002), fire doors (Decree No 478/2008), lightning conductors, chimneys (Decree No 401/2007) and boilers (Act No 314/2012), if present in the building, are subject to regular inspections required by law. The president of the association of owners of apartments and non-residential premises or the building manager is responsible for ensuring the implementation of the statutory checks and inspections.

Owners of multi-apartment buildings, associations of owners of apartments and non-residential premises and building managers are responsible for the fulfilment of the fire protection tasks relating to the common parts and the common equipment of the multi-apartment building.

Buildings must meet the basic requirements for construction works as defined in Annex I to Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, in particular with regard to human health and safety, throughout their life cycle.

High-quality renovation is the basis for achieving the planned energy savings and other benefits. An emphasis on high-quality renovation is one of the main pillars of the state policies in the field of construction and housing. In order to achieve the full benefits of the renovation, it is necessary to ensure compliance with the principles of proper use of the renovated building by educating its occupants.

Numerous specialised publications provide managers of multi-apartment buildings with a comprehensive overview of how to ensure a high-quality and comprehensive renovation, including available financing options and the subsequent use of the renovated building by its occupants. Ongoing activities promoting awareness-raising on the new knowledge and benefits of deep renovation targeted at both professional and lay public is one of the pillars of achieving the necessary renovation rate.

Well-established conferences devoted to renovation and thermal insulation are held several times a year to inform managers of residential and non-residential buildings about legislative changes, new technologies, products, innovative processes and trends in the construction industry. The conferences are organised with the active participation of the Ministry of Transport and Construction of the Slovak Republic and are attended by building managers, business and professional associations, manufacturers, companies carrying out construction works related to building renovation (e.g. the Thermal Building Protection, Complex Renovation of Multi-Apartment Buildings, Sustainability in Architecture and

Construction conferences). Professional seminars and symposiums are regularly organised in the regions in order to educate managers of residential and non-residential buildings on the correct renovation procedure from the initial design of the renovation project to high-quality implementation.

A television show entitled ‘Energy’ broadcast on a monthly basis on public television has proved successful. It is focused on energy efficiency, up-to-date information on improving energy performance, and effectively provides the necessary information to owners in all areas related to renovation, maintenance and management. The episodes are archived and after the broadcast, they are available at: https://www.rtvs.sk/televizia/archiv/14113/205463.

Each year, the largest international construction fair in Slovakia is held under the auspices of the Ministry of Transport and Construction of the Slovak Republic. The fair includes professional events for experts such as architects, designers and contractors of buildings, as well as for the general public (e.g. Thermal Insulation Alphabet).

The activities of the Ministry are also aimed at supporting high-quality construction as well as renovation of buildings. The annual ‘Construction of the Year’ contest has been held for 25 years now, whose results in various categories are announced on a prime-time show on public television. In addition to urban and architectural design, the competition assesses the structural and technical approach, the functionality of the building and its environmental impact, the quality of the construction work and, last but not least, its benefit for the community. New buildings as well as renovated buildings, applied innovative construction methods, progressive construction products, the application of science and research in the design and construction of the building and the quality of the construction work are evaluated.

From 1998, the Ministry organised the annual ‘Progressive, Affordable Housing’ competition, which aimed at supporting the construction of progressive and affordable apartments, presenting positive examples of procurement and promoting development of affordable housing in Slovakia.

Since 2010, a nationwide competition entitled ‘The Best Renovated Multi-Apartment Building’ has been held every year with the emphasis on the comprehensive approach to the renovation of the multi-apartment buildings, the results of which are announced at the construction fair in Bratislava.

4.6 Summary of policies and measures aimed at improving the energy performance of buildings

Slovakia has set up functional policies for the improvement of the energy performance of buildings, which cover the whole building stock and include measures that are appropriately complemented by a system of functioning economic instruments. However, the new more ambitious climate objectives of the Commission represent a challenge in terms of increased ambition for building renovation. This can only be attained if the existing forms of support are complemented by new forms with sufficient funding and a focus on areas requiring increased efforts to improve energy performance.

Achieving the indicative milestones by 2030 will require a consistent application of the existing policies and the application of the existing as well as the planned forms of support.

The policies for the improvement of the energy performance of buildings are as follows:

a) the identification and application of minimum energy performance requirements for new buildings, major renovations of existing buildings, building structures and elements, technical systems for heating, domestic hot water, ventilation, cooling and lighting of buildings and combinations thereof, established on the basis of cost-optimal levels of minimum energy performance requirements (law, implementing rule, technical specifications);
b) policies specifically aimed at improving the energy performance in multi-apartment buildings, single-family houses, public buildings and private non-residential buildings.

The existing as well as the planned measures, supported by appropriate economic instruments, are given in the following overview.

Table 23 Existing measures for improving energy performance of buildings

1. Improvement of energy performance: multi-apartment buildings		
Measures	Activities	Source of funding
Subsidy for the remedy of system failures of multi-apartment buildings	Remedy of the system failure: - protruding structures of the stairway area, - covered balconies with coffered ceiling, - covered balconies with hollow-core ceiling panels, - balconies and recessed balconies, - attics, - covered balcony and associated vertical building envelope of tensioned areated concrete blocks.	**Subsidy of the Ministry of Transport and Construction of the Slovak Republic** (Act No 443/2010, Annex 1 – list of failures)
Renovation of multi-apartment building	Form of renovation: - modernisation or restoration of the common parts and facilities of the multi-apartment building, - remedy of a system failure of the multi-apartment building, - structural alterations of an existing multi-apartment building, a separately used part of a multi-apartment building or of a single-family house with an intervention in the thermal protection by insulating the vertical building envelope, the roof covering and replacing the original doors/windows of the multi-apartment building (‘thermal insulation of residential building’), - construction modifications of an apartment in a multi-apartment building.	**State Housing Development Fund** (Section 6c of Act No 150/2013) **ESI Funds**
Support for renewable energy installations in a residential building	Procurement of heat generators covering the energy demand of households in a multi-apartment building (the complete supply and installation of the system is financed): - solar collectors (EUR 400/kW, max. 1 kW/apartment) - biomass boiler (EUR 80/kW, max. 7 kW/apartment)	**Green Households II** *(Zelená domácnostiam II)* (part of the OP QE, measure 4.1.1, except BOD, until 31 December 2023 or until exhaustion)
2. Improvement of energy performance: single-family houses		

Measures	Activities	Source of funding
Allowance for thermal insulation of a single-family house	Thermal insulation of a single-family house: - thermal insulation of the vertical building envelope, - thermal insulation of the roof covering, - thermal insulation of partition structures between heated and unheated space, - replacement of original doors/windows. *Including:* - regulation of the heating system, - structural alterations relating to the renovation of entrances, lightning conductor and extending parts of the building – recessed balconies, balconies and entrance roofing, - exchanges of heat generators, - thermal insulation of newly built building structures and newly built openings.	**Ministry of Transport and Construction of the Slovak Republic** (Section 9c of Act No 555/2005)
Renovation of a single-family house	Form of renovation: - construction modifications of an existing single-family house with an intervention in the thermal protection by insulating the vertical building envelope, the roof covering and replacing the original doors/windows of the single-family house, - construction modifications of an apartment in a single-family house.	**State Housing Development Fund** (Section 6c(3) of Act No 150/2013)
Support for renewable energy installations in single-family houses	Procurement of small electricity generation plants of up to 10 kW output: - photovoltaic panel (support: EUR 500/kW, max. EUR 1 500) - solar collector (support: EUR 400/kW, max. EUR 1 400) Procurement of heat generators covering the energy demand of households in a multi-apartment building (the complete supply and installation of the system is financed): - single-family house biomass boiler (max. EUR 1 200) - single-family house heat pump (max. EUR 2 720)	**Green Households II** *(Zelená domácnostiam II)* (part of the OP QE, measure 4.1.1, except BOD, until 31 December 2023 or until exhaustion)
Measure to reduce dust particulate emissions – replacement of obsolete domestic solid fuel heaters	Projects to replace obsolete domestic combustion heaters with low-emission and more energy efficient combustion heaters with conversion to a low-emission fuel, with the exception of biomass and other renewable energy sources. (‘boiler subsidies’)	**Ministry of the Environment** (managing authority) OP QE (1.4.1)

3. Improvement of energy performance: public buildings		
Improving energy efficiency of public buildings or equipment	Promoting energy efficiency improvements in the public sector on the basis of energy performance contracting for the public sector. The public sector is the recipient of the guaranteed energy service.	**Private sector** **ESI Funds 2021–2027**
Improving energy efficiency of existing public	Eligible actions: (a) thermal insulation of external walls and vertical building envelope;	**Environmental Fund**

buildings, including thermal insulation	(b) roof thermal insulation/replacement; (c) thermal insulation of the lowest and highest floors; (d) replacement of windows, doors; (e) modernisation/replacement of heat generator (including the use of renewable energy sources, excluding biomass in air quality management areas) and associated heat and/or domestic hot water distribution; (f) works and supplies in connection with the implementation of measures intended to preserve nesting, breeding or resting sites of a protected animal, insofar as those sites are affected by the activity supported; or works and supplies in connection with the implementation of measures intended to establish nesting, breeding or resting sites of a protected animal, insofar as those sites are affected by the activity supported; (g) application of innovative technologies for the use of waste heat (heat recovery, heat exchangers for the use of waste heat, etc.); (h) a combination of the above activities.	(specification of subsidy support activities, L category)

4. Improvement of energy performance: <u>private non-residential buildings</u>

The renovation of private non-residential buildings is financed exclusively from private sources. An appropriate instrument for implementing measures to improve the energy performance of these buildings consists in the use of an *energy service pursuant to Act* No 321/2014 (Section 15), with the possibility to use a support energy service (Section 16) or an energy service with guaranteed energy savings (Section 17).

The support energy service includes, for example: advisory and information activities on the possibilities of energy savings for the recipient of the support energy service, education and training of the recipient's employees, optimisation of operation and costs of equipment or buildings owned by the recipient, energy management in addition to the established energy management system.

An energy service with guaranteed energy savings is provided under energy performance contracting. The energy service provider is remunerated on the basis of whether it has actually achieved the contracted energy efficiency improvement values. It includes, for example: preparation of an energy analysis and implementation of the measures proposed therein, execution of an energy audit and implementation of the measures proposed therein, planning and preparation of a coherent project focused on energy efficiency, operation and maintenance of energy equipment including user training, monitoring and operation of the system, supply of energy equipment.

Table 24 Planned forms of support for improving energy performance in the buildings sector

Reducing the energy intensity of buildings – public buildings	Support for deep renovation of **public** buildings by: (a) thermal insulation of external walls and vertical building envelope; (b) thermal insulation of the roof covering; (c) replacement of the original windows, doors; (d) hydraulic balancing of the heating system after thermal insulation or replacement of the technical building system; (e) substantial refurbishment of a building's technical equipment, including the deployment of smart metering systems and	**ESI Funds 2021–2027 GES**

	installation of building automation and management, including energy saving monitoring systems; (f) application of elements to protect biodiversity and elements supporting adaptation to climate change. *Cost-effective deep renovation of buildings will be encouraged, including the installation of RES, where relevant and feasible.*	
Reducing the energy intensity of buildings – residential buildings (multi-apartment buildings and single-family houses)	Support for deep renovation of **residential** buildings by: (a) thermal insulation of the vertical building envelope; (b) thermal insulation of the roof covering; (c) replacement of the original windows, doors; (d) remedy of system failure of multi-apartment building; (e) hydraulic balancing of the heating system after thermal insulation or replacement of the technical building system; (f) replacement or modernising of technical systems including deployment of smart metering systems and installation of building automation and management including energy saving monitoring systems (SMART technologies); (g) installation of self-regulatory devices for individual control of the indoor temperature of the heated rooms. *Building renovation projects will be addressed in a comprehensive manner, including the use of elements to protect biodiversity and green infrastructure to support adaptation to climate change. Cost-effective deep renovation of buildings will be encouraged, including the installation of RES, where relevant and feasible.*	**ESI Funds 2021–2027**
Improving energy performance of public buildings	Renovation of state-owned public buildings with the worst energy performance, including the application of elements of climate change adaptation measures, protection of biodiversity and green infrastructure, and integration of RES where relevant.	**Recovery plan**
Improving energy performance of single-family houses	Support for the renovation of single-family houses, especially for poorer households, reducing utilities costs to prevent energy poverty and improving the quality of housing.	**Recovery plan**
Renovation of historic public buildings and public buildings subject to heritage protection	Support for renovation in order to improve the structural and technical condition of public buildings subject to heritage protection in order to improve the possibilities of their use and reduce operating costs.	**Recovery plan**
Improving energy efficiency in enterprises (buildings)	Support for energy efficiency measures in enterprises following from energy audits. (thermal insulation of commercial buildings)	**ESI Funds 2021–2027**
Promoting increased use of RES in households based on RES self-consumption and renewable energy communities (innovation of the Green Households project)	Support for the installation of small equipment for the use of RES in heat/cold production (self-consumers of heat and energy communities), including the modernisation of heating systems and installation/modernisation of air-conditioning systems by way of allowance in the form of vouchers. Support for the installation of RES equipment (for electricity generation) for self-consumers and energy communities, possibly in combination with the use of financial instruments for the procurement of energy-efficient white goods.	**ESI Funds 2021–2027**

Supporting the development of regional and local energy industry	Support for the creation of regional energy centres and the creation of regional sustainable energy centres to ensure coordinated and optimised planning of energy consumption at regional level. The energy centres' agenda will also include activities to promote public awareness in the field of energy efficiency and the use of renewable energy.	**ESI Funds 2021–2027**
Improving energy efficiency of energy supply infrastructure	Supporting the modernisation, restoration and construction of heating and cooling infrastructure and the deployment of technologies to improve energy efficiency in energy supply; support for smart district heating and cooling systems, deployment of measurement and control systems (including SMART solutions). (measures with impact on residential buildings connected to district heating systems)	**ESI Funds 2021–2027**
Promoting the use of RES in energy supply systems	Supporting the transition to efficient district heating systems through the use of RES in heating and cooling. (measures with impact on residential buildings connected to district heating systems)	**ESI Funds 2021–2027**

5. Mobilising investments in the renovation of the public and private building stock

5.1 Time-tested forms of support for renovation of residential and non-residential buildings to date

5.1.1. Renovation of residential buildings

The state housing policies adopted after 1990 defined a clear role of the state in the field of housing quality, namely its task to improve the technical condition of the existing housing stock and, using appropriate renovation tools, to contribute to extending its lifetime, safety in use and increasing the energy performance of buildings. These state housing policies were followed by the Framework for renovation of buildings, focusing on the renovation of the housing stock, which was adopted in 1999 and is still in force to date. This framework set up a systemic solution for the renovation of the housing stock to ensure the objectives of the housing policy framework in terms of renovation of residential and non-residential buildings.

Currently, the state applies a system of economic instruments in the form of direct and indirect support in the area of housing policy to expand and enhance the housing stock.

(a) **Direct state support** for tasks related to building renovation is provided in the following forms:

- subsidies under the housing development programme provided by the Ministry to remedy system failures of multi-apartment buildings;
- an allowance for thermal insulation of single-family houses for natural persons – owners of single-family houses (statutory allowance of EUR 8 000 and a further increase of EUR 800);
- preferential loans provided through the State Housing Development Fund to natural persons as well as legal persons upon fulfilment of statutory conditions.

(b) **Indirect state support** is provided through:

- mortgage financing in the form of a state mortgage contribution and a state allowance for mortgage for young citizens (contracts concluded before 31 December 2017) and a tax bonus (contracts concluded after 1 January 2018) – natural persons only;
- a construction savings scheme with state support provided in the form of a state premium for construction savings for natural persons and for the associations of owners of apartments and non-residential premises;
- the Programme of state support for the renovation of the housing stock in the form of the provision of bank guarantees for loans (the 'bank guarantees programme') adopted by the Slovak government to boost housing construction and create conditions enabling the renovation of the housing stock, which is currently not used due to the availability of other favourable support instruments.

A summary of the results of the state support for renovation of residential buildings is as follows:

(a) remedy of system failures of multi-apartment buildings:
  - EUR 112.3 million of subsidies granted (Ministry of Transport and Construction of the Slovak Republic), corresponding to the renovation of 151 949 apartments between 2000 and 2019,
  - EUR 24.1 million loan granted (State Housing Development Fund), corresponding to the renovation of 15 484 apartments;

(b) 5 calls for thermal insulation of single-family houses announced since 2016 (Ministry of Transport and Construction of the Slovak Republic):
  - allowance granted for 173 single-family houses in the total amount of EUR 1.14 million after completing the insulation,
  - allowance reserved for 169 single-family houses in the total amount of EUR 1 487 200 before completing the insulation; and

(c) loans in the amount of EUR 1 155.28 million provided for the renovation of the residential buildings from the State Housing Development Fund between 2006 and 2019, corresponding to 253 350 apartments in multi-apartment buildings and 28 apartments in single-family houses, of which EUR 348.85 million were used for thermal insulation of multi-apartment buildings and EUR 510 059 for thermal insulation of single-family houses;

(d) loans in the amount of EUR 132.9 million for the renovation of 30 317 apartments in multi-apartment buildings and EUR 879 446 for the renovation of 51 single-family houses provided for thermal insulation of residential buildings from the State Housing Development Fund under the corresponding government programme between 2009 and 2014;

(e) bank guarantees for loans were provided for 26 852 apartments in the total amount of EUR 43.019 million. Since 2013, no bank guarantee has been granted for loans financing the renovation of the housing stock.

An overview of the support provided is given in Annex 2.

Data on direct support for renovation of residential buildings show that owners of buildings are aware of the need to remedy system failures before renovating the building, either as a standalone process or as the first step of the renovation, as evidenced by the share of apartments with system failures remedied (153 007 apartments).

Support of the renovation of residential buildings including thermal insulation constitutes a significant share of the resources allocated to housing development. In the long term, the demand for renovation of multi-apartment buildings has been much higher than the demand for the support for single-family house renovation. When it comes to the renovation of a single-family house, it is necessary to note that the area of the building envelope structures and openings (vertical building envelope, roof covering, windows) of a single-family house is at least four to six times larger than that of an apartment, which also requires higher investment costs than in the case of an apartment in a multi-apartment building, but the resulting energy savings per apartment are greater, with a greater share of CO_2 emissions reduced per apartment.

The forms of state support for single-family houses have been re-evaluated. The introduction of new types of support for single-family houses since 2016 has significantly increased the interest of the owners of single-family houses in thermal insulation.

In terms of the state's support for the renovation of single-family houses, statutory conditions have been laid down for providing allowances for thermal insulation of single-family houses in order to improve their energy performance.[15]In connection with the additional proposed financial support under the Modern and Successful Slovakia plan (the Recovery plan), a re-evaluation of the tool will be considered so as to incentivise vulnerable groups of the population owning real estate to renovate it. The model for setting indicative CO_2 savings milestones is based on the expected increase in the use of RES in buildings by 10% every 5 years. The Slovak Innovation and Energy Agency provides information to owners of both multi-apartment buildings and single-family houses about the possibilities of acquiring and installing RES production equipment, including financial support, through free consultancy within the LIVE ENERGY (*ŽIŤ ENERGIOU*) project. The Green Households II national project supports the use of RES in households, with a further 21 thousand RES installations to be supported by 2023. Under the project, it is possible to support the installation of five types of equipment, including small electricity generation plants of up to 10 kW output (photovoltaic panels, wind turbines) and heat generating plants, which cover the need for domestic energy (solar collectors, biomass boilers, heat pumps). A household may receive support for one device of each type only. Single-family houses are eligible for all five types of equipment and, as such, they can receive support of more than one type. Multi-apartment buildings can only receive support for solar collectors and biomass boilers.[16]

An important energy efficiency measure in the sector of individual heating and cooling is the one aimed at reducing emissions of dust particles from household heating by replacing boilers with low-emission heat generators. In specific areas of Slovakia with a high share of dust particles in the air, a transitional option of replacing solid fuel boilers with natural gas boilers will be possible, as it is the fastest and cheapest solution.

It is important to note that the support of the installation of RES should be preceded by major renovation of the given multi-apartment building (or single-family house). After major renovation, the remaining small energy demand of the building should be covered to a significant extent by energy from RES generated locally or nearby.

[15] Section 9c of the Act.

[16] https://zelenadomacnostiam.sk/sk/domacnosti/podporovane-zariadenia/

Pursuant to Act No 150/2013 on the State Housing Development Fund, as amended, the State Housing Development Fund provides support for renovation of residential buildings in the form of favourable loans for modernisation, thermal insulation and remedy of system failures.

The loan for the renovation of multi-apartment buildings from this source can be granted to achieve a comprehensive renovation of existing multi-apartment buildings to enable their systematic renovation. In the context of the main principles governing the selection of operations applicable to the specific objective of the IROP in question, the scope of the eligible activities is also defined in such a way as to enable the supported projects to achieve energy saving measures beyond meeting the minimum energy performance requirements under the generally applicable legislation, so as to reduce the energy demand to the level of low-energy, ultralow-energy and nearly zero energy buildings.

The system of economic instruments applied so far, in the form of direct and indirect support, is considered within state support for the renovation of residential buildings beyond 2019 as well. As energy performance requirements are gradually becoming stricter, energy requirements for construction works must become more demanding as well, which translates into the modified requirements for obtaining appropriate financial support. The intention of the state is to continue to create optimal conditions and provide support in the area of renovation of the housing stock.

5.1.2. Renovation of non-residential buildings

The current forms of support for the renovation of non-residential buildings in Slovakia have not produced the desired results. In the case of renovation of public buildings, public debt generated by financing the renovation proved to be the main obstacle. Until now, public buildings have been largely renovated in the framework of pilot projects, energy audits have been carried out in buildings and certain lines of credit such as SlovSEFF and MunSEFF have been used. The basic financial sources consisted in the ESI Funds, the state budget and, to a very limited extent, private resources of financial institutions. No relevant information is available on the sources of financing for the renovation of private non-residential buildings. In the past, Slovakia lagged behind in the use of the ESI Funds as well as other international projects (e.g. InvestEU) mainly due to insufficient preparedness of renovation financing projects. The appropriate measures taken have led to a significant increase in utilisation of the means.

Slovakia is fully aware of the need to devote increased efforts to the renovation of non-residential buildings – both public and private. Amended laws have facilitated access to the financing of the renovation of non-residential buildings without increasing public debt. Therefore, the setting of project requirements in order to successfully meet the funding criteria of these funds will be crucial in the coming period. However, the provision of generous non-repayable funds may also prove problematic, as they crowd out other financing instruments. The use of guaranteed energy services is a promising tool to support the renovation of non-residential buildings and is expected to be used increasingly in the short term. However, it should be stressed that in order to carry out deep renovation of a non-residential building in line with the new requirements of the Energy Performance of Buildings Directive and with a view to a longer period of return on such investment, it is necessary to consider a combination of financing using repayable and non- repayable funds and guaranteed energy services. A combination of grant funding with repayable assistance in a single financial operation is possible under the proposed new CPR regulation, which will make it possible to substantially simplify the whole process of utilising financial instruments to support guaranteed energy services[17]. In the case of a financial instrument combined with non- repayable public funds for the renovation of public buildings, it is important to take into account and support voluntary certification schemes developed with the use of public sources[18], which go beyond the minimum energy performance requirements, and also assess ancillary aspects of renovation (e.g. indoor climate, impact on market value, renovation passport for gradual financing of the renovation, digitisation, automation (SRI)). Such approach will significantly contribute to fulfilling the exemplary role of the central government buildings.

Slovakia notified the fulfilment of the binding energy savings target in public buildings pursuant to Article 5 in an alternative manner pursuant to Article 5(6) of Directive 2012/27/EU. When assessing the achievement of the target using the cumulative method, it can be concluded that by 31 December 2019, the target has been met at 129%. In 2019, we record a balance difference of + 90.77 GWh, which can be used to meet the 2020 target, i.e. 174% of the savings needed to meet the target in 2020.[19]The savings were mainly achieved by improving the thermal performance of public buildings by means of major renovation according to the law or beyond the minimum energy performance requirements for a major renovation of the building when using the ESI Funds.

5.2 Requirements for forms of support after 2020

In accordance with Article 2a of the Energy Performance of Buildings Directive, the Slovak Republic has committed itself to the objective of achieving a highly energy-efficient and decarbonised building stock by 2050. Accession to the Paris agreement on climate change also entails the commitment to achieve the objective of reducing greenhouse gas emissions at national level and to achieve climate neutrality by 2050.

However, these objectives cannot be achieved without a strong and consistent political support, and without pursuing highly ambitious policies and measures to support building renovation in terms of volume, as well as substantial improvements in energy performance. In the upcoming period, appropriate combinations of financing through repayable and non-repayable forms of support also need to be sought to increase the renovation pace in order to reduce any perceived risks of the activities for investors. It is essential that policy instruments and national incentives mobilise private financial resources and create a suitable environment for a much greater private capital input than has been the case so far. The set binding climate and energy targets require investment far beyond the current levels of funding.

The successful implementation of the renovation strategy will be underpinned by rigorous application of the Energy Efficiency First principle in energy policy and the alignment

[17] Article 52(5) of the Proposal for a Regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund and the European Maritime and Fisheries Fund and financial rules for those and for the Asylum and Migration Fund, the Internal Security Fund and the Border Management and Visa Instrument.

[18] e.g. https://aldren.eu/european-voluntary-certificate-evc/

[19] https://www.siea.sk/wp-content/uploads/2020/07/Sprava_efektivnost_2019.pdf.

of national programmes and policies in order to achieve their synergies and avoid fragmentation and inconsistencies of action.

5.3 Estimated investment intensity of building renovation after 2020

The current total annual rate of investment in building renovation in Slovakia amounts to EUR 900 million.

The model of investment needs for renovation of the building stock in Slovakia in accordance with the established milestones points to the annual absorption capacity of EUR 1.1 billion to EUR 1.2 billion, with the highest absorption capacity of EUR 1.3 billion per year expected between 2026 and 2031. If the renovation pace and the expected time of completion of the building stock renovation are met, the cumulative investment needs for those years should be as set out in the following table:

Table 25 Estimated cumulative investments in the buildings sector until 2050

Buildings sector	2030	2040	2050
Residential buildings (EUR b)	8.2	16.7	17.3
Non-residential buildings (EUR bn)	4.9	5.5	5.5
Cumulative investments (EUR bn)	13.2	22.2	22.8

Source: BPIE model

The existing forms of support for renovation form a solid basis for the development of other financial platforms. Loans at a preferential interest rate granted over a long period (about 20 years) will continue to be the main pillar of financing building renovation projects. These loans, combined with government subsidies and private capital, constitute a proven and effective tool for renovation in the residential buildings segment.

In the segment of non-residential public buildings, the ESI Funds resources (both repayable and non- repayable) will continue to be the main source of funding combined with the state budget and private capital from guaranteed energy services. The renovation of private non-residential buildings will be carried out in particular with the support of financial institutions and one's own resources. The most appropriate manner to use those is to combine the ESI Funds operating as guarantees and the private resources of providers to allow for deep renovation of a building.

To mobilise efforts to achieve the outlined ambitions, additional financial resources will have to be used from the 2021 to 2027 multiannual financial framework of EUR 750 million and EUR 367.5 million for residential buildings and public buildings, respectively. Other additional financial resources should be used from the Recovery and Resilience Facility (NextGenerationEU tool) within the policies set out in the Green Economy section of the Modern and Successful Slovakia plan concerning energy efficiency, where resources of EUR 300 million are proposed for improving the energy performance of single-family houses, EUR 130 million for renovation of historic public buildings and public buildings subject to heritage protection, and EUR 200 million for the improvement of the energy performance of public buildings.

6. Obstacles and barriers

Despite the progress made in removing the obstacles and barriers identified in the first renovation strategy, most of them remain, albeit less intense. At that time, the key task of the renovation strategy was to ensure, within the very short period from 2015 to 2020, the achievement of the required energy performance of buildings, with a gradual imposition of stricter requirements of the three energy levels of construction. This required amendments to the legal and technical regulations, development of new forms of support and sufficient awareness of all participants in buildings renovation (stakeholders).

Barriers occurring in construction also apply to the renovation of buildings, such as:

- low energy and legal awareness of owners;
- a large number of owners of one real estate (mainly multi-apartment buildings);
- mixed ownership of buildings (e.g. residential and non-residential parts);
- public procurement and tenders taking into account in particular the lowest price;
- poor quality of the works, affected also by the predominant low-cost offer;
- poor quality of the preparation of energy performance certificate, affected also by the predominant low-cost offer;
- lack of awareness of new requirements, measures, construction products, etc. among construction participants;
- unsatisfactory education and skills acquisition systems for green professions;
- lack of lifelong learning of selected professions (e.g. designers);
- lack of implementation of deep renovation (including refurbishment of a buildings' technical equipment);
- inefficient informing about support by providers;
- bureaucratic process relating to the submission and approval of applications;
- lengthy public procurement;
- lengthy construction proceedings (also in the case of renovation of buildings);
- the need to restructure companies and the need to re-train the staff of building renovation companies;
- lack of refurbishment of technical systems excludes the installation of buildings' automation and management systems;
- lack of renovation of heat distribution systems and heat and domestic hot water generators.

Low price affects the quality and completeness of the design documents and thus adversely affects the quality of the work produced. The low price of energy performance certificates compromises an objective preparation thereof, and, consequently, does not allow to acquire objective information on the real quality, the impact of the measures applied, and proposals for measures recommended for future application. The first strategy and its update set out the key tasks aimed at removing these barriers which have led to their mitigation or elimination.

The public procurement process for building renovation continues to be affected by insufficient professional and technical competence in setting the individual conditions, requirements and criteria, as well as the application of a cost-effective approach, taking into account the best price/quality/cost ratio over the lifetime of a building, resulting in procurement at the lowest price.

7. Other benefits of buildings' renovation

Renovation changes the thermal performance parameters of the building, increases user comfort (better thermal comfort in winter and summer, higher quality of indoor climate, elimination of hygiene deficiencies), prolongs the lifetime of the building as well as the safety of its use, decreases maintenance and energy expenditure, improves the appearance of the building, increases the market value of the real estate. Once the renovation has been carried out, it is equally important to influence the behaviour of the occupants and owners of the renovated building in order to achieve the full potential of the expected renovation savings.

In terms of the safety of using multi-apartment buildings, elimination of system failures of balconies and recessed balconies is crucial. Defects and failures of these structures are manifested by cracks and loss of concrete mass, corrosion of railings, rainwater leaking due to missing or broken waterproofing, which has an adverse impact on the length of lifetime of buildings but especially on safety. Multi-apartment buildings built within large-scale construction have several system failures, which can be eliminated by thermal insulation during renovation. This prevents leaking through cracks, corrosion of reinforcement elements with an impact on increased user safety and prolongation of lifetime.

Many physical factors such as temperature, humidity, airflow speed, air quality, lighting quality, noise, are affected in the process of deep renovation of a building. A very important effect of renovation is the benefit to the occupant's health. On average, 80–90% of the day is spent indoors. The renovation measures will contribute to a better quality of the indoor climate, thereby providing occupants with a higher level of well-being and comfort and improving their health. Healthy indoor climate is proven to have a direct impact on the health of occupants and contributes significantly to reducing the state's healthcare expenditure.

Elimination of structural deficiencies such as thermal bridges, insufficient and low surface temperature, which has an impact on preventing the emergence of moulds in critical places, has a positive impact on the health of the occupants. We spend a lot of time indoors, which naturally increases the need to ensure healthy indoor spaces. Air exchange – maintaining a healthy indoor climate by providing a clean, harmless air supply to the interior. Due to high air pollution, especially in urban areas, the requirement to rid the air of impurities and small dust particles, e.g. by heat recovery, is becoming more and more important.

Renovation of the building's vertical envelope can improve the occupants' quality of life and user comfort thanks to other properties of the building structures as well, e.g. a better soundproofing. Sufficient thermal insulation with built-in shielding systems of the openings enables better thermal comfort even in summer as it eliminates excessive overheating of the interior parts of the building.

Certain adaptation measures to mitigate the negative impacts of climate change are also implemented in the renovation. Suitable measures include vegetation (green) roofs and green facades, measures promoting a sustainable rainwater economy, bioretention systems for rainwater retention. Window blinds and climbing greenery can be used to shield the building against overheating. Additional measures and new shading elements such as pergolas, shelters or shading sails are used. Some suitable and easy-to-use measures linked to architecture include bright facade colours and high greenery to provide shade.

Renovation of buildings increases the occupants' well-being, subjectively perceived as the possibility to achieve maximum physical or mental work performance or effective rest.

A number of benefits from building renovation can be observed at the macroeconomic level, in particular in terms of employment growth, workforce mobilisation linked to the need for upskilling, an increase in the use of innovative construction methods and technologies, as well as the use of construction products with advanced properties. Meeting the minimum energy performance requirements of nearly zero energy demand for all buildings after 31 December 2020 requires a significant change in the construction process, the structure and profile of construction companies compared to the past, as well as the application of new innovative elements and solutions in the industry.

8. Summary

The strategy has created a framework for expressing public priorities in the field of energy efficiency of buildings and has given a signal to the business sector in the energy and construction industries about the state's long-term vision, thus contributing to a better planning of their investments and further steps.

The legislative environment creates sufficient and good conditions for further progress of the renovation of the building stock supported by qualified workforce. The active cooperation of the Ministry with educational institutions, employers' organisations, professional and civic associations ensures continuous exchange of information and thus creates a well-prepared environment in practice.

The policies and measures set out in the long-term strategy for the renovation of the building stock are intended to fulfil the vision of decarbonisation of the building stock by 2050 through the indicative milestones determined. Energy savings from the renovation of buildings make an important contribution to the final energy efficiency target of achieving savings for the final consumer. It is therefore important that the proposed action plans in the buildings sector, as set out in the 2021–2030 Integrated national energy and climate plan[20], are implemented consistently. The renovation of building structures (major renovation) consistently ensured at the nearly zero building construction level and the introduction of technical systems using renewable energy sources, automation and management systems will create the prerequisites for fulfilling the vision.

The Slovak Republic is aware that it has set ambitious targets in the renovation of buildings, especially for the period until 2030. Their implementation will depend in particular on the sufficient volume and availability of national sources of financing allocated to the renovations, as well as the degree of interest and commitment of the real estate owners to carry out renovations.

It is essential to ensure that the setting up of public-supported financial instruments also takes into account the additional benefits of renovation. Only strict compliance with the requirements of the law enables to invest in energy efficiency measures and achieve the necessary energy savings in the buildings sector, which will ensure continuous implementation of the renovation milestones.

[20] INEKP, pp. 118–122.

Annex 1

Terms and definitions related to the renovation of residential and non-residential buildings

The long-term strategy uses terms related to the renovation of buildings which are being introduced into the legal and technical regulations of the Slovak Republic following the recast of Directives 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) and 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC:

Energy performance of a building: amount of energy needed to meet all the energy demand associated with a standardised use of a building, in particular energy used for heating, hot water, cooling, ventilation and lighting (according to Section 3(1) of the Act).

The energy performance of a building is determined by calculation or by calculation using measured energy consumption, and is expressed in numerical indicators of the energy demand of the building and of primary energy. Primary energy means energy from renewable and non-renewable sources which has not undergone any conversion or transformation process (according to Section 3(2) of the Act).

Building: a roofed construction having walls for which energy is used to condition the indoor climate; the term ‘building’ refers to a building as a whole or its part which has been designed or altered to be used separately (according to Section 2(3) of the Act).

Energy intensity of a public building: the ratio of measured annual energy consumption in a public building to the total floor area of the public building (according to Section 10(8) of Act No 321/2014 on energy efficiency and amending and supplementing certain laws).

Energy efficiency: a process that contributes to increasing energy efficiency or reducing the energy intensity of conversion, distribution or consumption of energy, taking into account technical, economic or operational changes, or changes in the behaviour of final customers and final consumers (according to Section 2(f) of Act No 321/2014 on energy efficiency and amending and supplementing certain laws).

Public building: building owned by the state, higher territorial unit, municipality or public law body (according to Section 4c(3) of the Act).

Relevant building: building according to a special regulation, managed by the central government, which does not meet the minimum energy performance requirements under a special regulation as of 1 January of the given calendar year and whose total floor area exceeds 250 m^2 (under Section 10(2) of Act No 321/2014 on energy efficiency and amending and supplementing certain laws).

Renovated building: an existing building where changes have been made to the building structures and technical equipment of the building to ensure that the basic requirements for construction works are met before the end of their lifetime and which extend the lifetime of the building or parts of the building, usually without interrupting the building’s use; a renovation may be complete or partial in terms of its scope (according to STN 73 0540-

2+Z1+Z2 Thermal protection of buildings. Thermal performance of building structures and buildings. Part 2: Functional requirements (73 0540), No 3.5).

Major renovation of a building: building modifications to an existing building which interfere with its envelope to an extent exceeding 25% of its surface, especially thermal insulation of the vertical envelope and roof covering, and replacement of the original windows and doors (according to Section 2(7) of the Act).
Major renovation of a building can be carried out by means of its one-off construction modification or gradual partial modifications.

Substantial refurbishment of a building's technical equipment: refurbishment of the technical system of a building whose investment cost exceeds 50% of the investment cost for the acquisition of new comparable technical equipment of the building. (according to Section 2(9) of the Act).

Deep renovation of a building: is a major renovation of a building and substantial refurbishment of a building's technical equipment to achieve the inclusion of the given building in the energy class required for the building category, taking into account the life cycle of the individual building elements. Building elements include, in particular, the technical system of the building or the building structure forming a part of the building's envelope (according to Section 2(8) of the Act).

Total floor area: floor area of a storey with a modified indoor climate, determined based on the external dimensions of the building without taking into account any local extended structures, such as columns, ledges, pilasters, local reduction of the envelope's thickness, area of balconies, recessed balconies and terraces. (according to STN 73 0540-2+Z1+Z2 Thermal protection of buildings. Thermal performance of building structures and buildings. Part 2: Functional requirements (73 0540), No 3.11). Consolidated version.

Annex 2

Table 1 The number of renovated residential buildings (apartments) supported through the Housing Development Programme (subsidy provided by the Ministry of Transport and Construction of the Slovak Republic) and the State Housing Development Fund (loan)

Purpose	**Form**	**Time period**	**Support granted** in euro	**Average yearly support** in euro	**Number of apartments**	
					Multi-apartment buildings	Single-family houses
Remedy of system failure of multi-apartment building	subsidy	2000–2019	112 342 700.08	5 617 135.00	151 949	0
	loan	2014–2019	24 076 470.00	4 012 745.00	15 484	0
Renovation of a residential building including	loan	2006–2019	1 155 280 201.00	82 520 014.36	253 350	28
- thermal insulation of a residential building		2014–2019	349 356 107.29	58 226 017.88		
Government thermal insulation programme for residential buildings	loan	2009–2014	133 779 242.54	22 296 540.42	30 317	51
Allowance for thermal insulation of a single-family house	subsidy	2016–2019	1 144 185.58	286 046.40	0	173
Residential buildings total			**1 426 622 799,20**	**-**	**451 100**	**252**

Source: Ministry of Transport and Construction of the Slovak Republic, State Housing Development Fund

Table 2 Scope and analysis of the renovation of a multi-apartment building using resources from the State Housing Development Fund

Years	**Renovation of a multi-apartment building**				**Thermal insulation of a multi-apartment building** (Government programme)		
	Loans granted in euro	of which: thermal insulation* in euro	Number of apartments	Average loan amount per apartment	Loans granted in euro	Number of apartments	Average loan amount per apartment
2006	22 874 959	-	4 636	4 934	0	0	0
2007	31 562 531	-	8 219	3 840	0	0	0
2008	24 909 945	-	6 474	3 848	0	0	0
2009	26 090 530	-	7 208	3 620	70 242 012	14 740	4 765
2010	32 232 110	-	9 199	3 504	0	0	0
2011	52 036 646	-	12 537	4 151	16 542 296	3 735	4 429
2012	68 828 561	-	16 690	4 124	20 863 521	4 892	4 265
2013	82 146 773	-	18 993	4 325	24 002 665	6 618	3 627

2014	111 692 809	54 862 586.11	24 948	4 468	1 249 302.54	332	3 763
2015	109 369 420	53 086 350.13	22 828	4 791	0	0	0
2016	194 034 450	82 605 955.05	41 150	4 715	0	0	0
2017	128 975 570	56 697 999.00	27 466	4 696	0	0	0
2018	140 720 020	53 106 948.00	29 190	4 821	0	0	0
2019	128 023 735	48 486 210.00	23 812	5 376	0	0	0
Total	**1 154 770 142**	**348 846 048,29**	**253 350**	**-**	**132 899 796,54**	**30 317**	**-**

Source: Ministry of Transport and Construction of the Slovak Republic, State Housing Development Fund
Note: *data were not separately recorded until 2013 for the sub-purpose Thermal protection of buildings.

Table 3 Scope and analysis of the renovation of a single-family house using resources from the State Housing Development Fund

Years	**Renovation of a single-family house**				**Thermal insulation of a single-family house** (Government programme)		
	Loans granted in euro	of which: Thermal insulation in euro	Number of apartments	Average support per apartment	Support provided, in euro	Number of apartments	Average support per apartment
2006	143 597	143 597	8	17 950	0	0	0
2007	196 043	196 043	12	16 337	0	0	0
2008	22 937	22 937	1	22 937	0	0	0
2009	46 674	46 674	2	23 337	645 396	36	17 928
2010	0	0	0	0	0	0	0
2011	54 938	54 938	2	27 469	139 038	10	13 904
2012	0	0	0	0	76 476	4	19 119
2013	0	0	0	0	18 536	1	18 536
2014	0	0	0	0	0	0	0
2015	23 090	23 090	2	11 545	0	0	0
2016	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0
2018	22 780	22 780	1	22 780	0	0	0
2019	0	0	0	0	0	0	0
Total	**510 059**	**510 059**	**28**	**-**	**879 446**	**51**	**-**

Source: Ministry of Transport and Construction of the Slovak Republic, State Housing Development Fund

Annex 3

1. Underlying data from the 2011 Population and housing census (the '2011 Census') regarding the extent of renovation of multi-apartment buildings and single-family houses

The 2011 Census sought a number of new data allowing for their comparison with data obtained in other previous surveys. A total of twelve items were determined in the form C. DATA ON THE HOUSE:

1. type of building (Single-family house; multi-apartment building; accommodation facility without apartments);
2. occupancy status of the building;
3. type of ownership of the building;
4. period of construction;
5. period of restoration;
6. number of storeys in the building;
7. number of apartments in the building;
8. material of the building's bearing structure;
9. type of water system connection;
10. type of sewerage system;
11. building's thermal insulation;
12. gas connection.

The item 'Building's thermal insulation' was important for comparison purposes, as the explanatory notes to the census form indicated that a building is deemed insulated if it has an insulated vertical envelope and, at the same time, the windows and doors are adjusted to prevent heat losses. Thermal insulation of a building may also be only **partial**; this had to be indicated if only certain parts or walls of the building were insulated. The data were to be completed by the building's owner or manager, user or the census commissioner.

The data on a building under the heading 'Period of restoration were to comprise specification of the period when the last restoration of the building, such as extension, superstructure or conversion, was completed. According to the explanatory notes to the form, thermal insulation of a building was also deemed (contrary to construction regulations) to constitute a restoration. Restoration is not considered to include common maintenance works, such as repairs of the facade, repairs and replacement of roofing, repairs and replacement of minor building structures, such as partition walls, replacement of equipment, replacement of windows, and similar modifications. If a building had not been restored (renovated), this fact had to be indicated.

Table 1 Thermal insulation – single-family houses

Slovakia, regions	**Thermal insulation – single-family houses**				**Total**
	yes	**partial**	**no**	**not ascertained**	

Slovakia	145 470	116 273	509 548	198 069	969 360
Bratislava Region	20 009	8 132	25 014	14 068	67 223
Trnava Region	21 197	15 122	62 713	20 907	119 939
Trenčín Region	15 656	12 759	57 882	26 205	112 502
Nitra Region	20 329	16 573	91 478	32 239	160 619
Žilina Region	25 698	18 491	61 233	28 170	133 592
Banská Bystrica Region	11 710	13 085	70 253	31 751	126 799
Prešov Region	17 337	17 032	72 881	22 222	129 472
Košice Region	13 534	15 079	68 094	22 507	119 214

Source: 2011 Census, Statistical Office of the Slovak Republic

Table 2 Thermal insulation – multi-apartment buildings

Slovakia, regions	**Thermal insulation – multi-apartment buildings**				**Total**
	yes	**partial**	**no**	**Not ascertained**	
Slovakia	18 416	8 196	36 280	1 954	64 846
Bratislava Region	4 070	1 280	4 745	551	10 646
Trnava Region	1 619	586	3 949	189	6 343
Trenčín Region	1 912	1 043	5 263	222	8 440
Nitra Region	1 662	859	5 097	248	7 866
Žilina Region	2 763	1 102	3 238	171	7 274
Banská Bystrica Region	2 964	1 338	4 155	239	8 696
Prešov Region	1 804	1 111	4 500	159	7 574
Košice Region	1 622	877	5 333	175	8 007

Source: 2011 Census, Statistical Office of the Slovak Republic

Aggregated data on houses/buildings and apartments determined as of 21 May 2011 were needed so that the percentage of major renovation of single-family houses and multi-apartment buildings and many other data could be expressed based on Tables 1 and 2:

Table 3

Numbers of houses/buildings and apartments	**Single-family houses**	**Multi-apartment buildings**
houses/buildings	969 360	64 846
total apartments	1 008 795	931 605
occupied apartments	856 147	877 993

Source: Civic Association for Thermal Insulation of Buildings, from the data obtained in the 2011 Census

A clear benefit lies in the data obtained from Tables 1 and 2. These are the first statistical data proving the extent of renovation of single-family houses in Slovakia. At the same time, the two tables provide data that make it possible to determine the extent of renovation of buildings in each region.

Table 4

Region	Renovation percentage for houses/buildings (%)	
	Single-family houses	Multi-apartment buildings
Slovakia	**27.00**	**41.04**
Bratislava Region	41.86	50.25
Trnava Region	30.28	34.76
Trenčín Region	25.26	35.01
Nitra Region	22.97	32.04
Žilina Region	33.08	53.13
Banská Bystrica Region	19.55	49.47
Prešov Region	26.55	38.49
Košice Region	24.00	31.21

Source: Civic Association for Thermal Insulation of Buildings, from the data obtained in the 2011 Census, Statistical Office of the Slovak Republic

2. Scope of ETICS used in housing construction until 2018.

The Civic Association for Thermal Insulation of Buildings monitors the scope of ETICS used in the Slovakia in the long term. The ratio of thermal insulation based on EPS and mineral wool (MW) in ETICS remained basically stable until 2015. This changed in 2016; since then the vertical building envelope has to be designed at an ultralow energy level, not only for new buildings, but also in renovation, provided that this is functionally, technically and economically feasible.

Only ETICS contractors can provide the necessary data on the use of specific ETICS compositions. Aggregated data were collected from 190 licence holders for ETICS for the year 2018. Of the number mentioned above, 41 licensed firms reported that they had not used ETICS in 2018. The remaining 149 ETICS contractors produced **827 500 m^2** of ETICS in 2018, with the following percentages of individual ETICS compositions:

1. EPS-based ETICS up to 100 mm 7.42%
2. EPS-based ETICS over 100 mm, with MW fire barriers 22.41%
3. MW-based ETICS up to 100 mm 14.71%
4. MW-based ETICS over 100 mm 53.16%
5. ETICS using some other TI material 2.30%

Data on the annual production of thermal insulation materials used in ETICS are important for the calculation of the total annual use of ETICS. This is a matter of determining the ratio of thermal insulation consumption in individual building structures, determining the increase in the thickness of the thermal insulation material, and also the volume weight of the thermal insulation material in individual building structures.

Based on calculations and expert estimates, we obtained data on the scope of ETICS renovation in housing construction for 2018 and also the overall results of the scope of ETICS implementation in Slovakia.

Data on the overall state of the housing stock were taken from the 2011 population and housing census data (the 2011 Census). The extent of thermal insulation between 2012 and 2018 is linked to the basic data on the extent of thermal insulation of multi-apartment buildings obtained from the 2011 Census.

Annex 4:

Numbers of energy performance certificates ('EPCs') issued for major renovations of buildings between 2010 and 2019

Table 1 EPCs by building category and energy class for 2010

Building category	Energy class							Total
	A	B	C	D	E	F	G	
Single-family houses	8	372	248	55	20	8	9	**720**
Multi-apartment buildings	0	356	350	29	4	1	0	**740**
Office buildings	1	58	62	21	6	6	3	**157**
School buildings and school institution buildings	0	51	121	52	18	4	1	**247**
Hospital buildings	0	9	6	2	0	0	0	**17**
Hotel and restaurant buildings	1	32	8	4	0	1	0	**46**
Sports halls and other buildings intended for sport	0	3	6	4	2	0	0	**15**
Wholesale and retail trade services buildings	0	26	13	5	5	0	1	**50**
Other buildings with mixed purpose	1	25	21	5	2	0	0	**54**
Total	**11**	**932**	**835**	**177**	**57**	**20**	**14**	**2 046**

Table 2 EPCs by building category and energy class for 2011

Building category	Energy class							Total
	A	B	C	D	E	F	G	
Single-family houses	8	540	295	77	24	6	9	**959**
Multi-apartment buildings	1	606	455	20	3	1	0	**1 086**
Office buildings	1	100	67	17	5	4	3	**197**
School buildings and school institution buildings	1	48	142	55	15	8	5	**274**
Hospital buildings	0	13	5	0	0	0	0	**18**
Hotel and restaurant buildings	1	33	6	3	2	0	0	**45**
Sports halls and other buildings intended for sport	1	9	7	7	3	1	0	**28**
Wholesale and retail trade services buildings	2	28	18	5	2	3	2	**60**
Other buildings with mixed purpose	1	40	27	8	2	0	1	**79**
Total	**16**	**1 417**	**1 022**	**192**	**56**	**23**	**20**	**2 746**

Table 3 EPCs by building category and energy class for 2012

Building category	Energy class							Total
	A	B	C	D	E	F	G	
Single-family houses	22	535	321	101	20	10	11	**1 020**
Multi-apartment buildings	1	843	429	20	4	0	0	**1 297**
Office buildings	1	93	58	14	2	1	0	**169**
School buildings and school institution buildings	0	36	78	16	3	2	4	**139**
Hospital buildings	0	11	5	0	0	0	0	**16**
Hotel and restaurant buildings	2	48	9	3	1	0	0	**63**
Sports halls and other buildings intended for sport	0	3	6	2	0	0	0	**11**
Wholesale and retail trade services buildings	3	42	18	4	1	2	0	**70**
Other buildings with mixed purpose	0	41	25	5	0	0	1	**72**
Total	**29**	**1 652**	**949**	**165**	**31**	**15**	**16**	**2 857**

Table 4 EPCs by building category and energy class for 2013

Building category	Energy class							Total
	A	B	C	D	E	F	G	
Single-family houses	27	638	391	108	32	12	17	**1 225**
Multi-apartment buildings	1	641	379	30	2	0	0	**1 053**
Office buildings	2	50	68	24	7	4	2	**157**
School buildings and school institution buildings	1	26	43	17	2	4	2	**95**
Hospital buildings	1	12	6	3	1	0	0	**23**
Hotel and restaurant buildings	1	25	15	1	1	0	0	**43**
Sports halls and other buildings intended for sport	1	3	3	3	0	0	1	**11**
Wholesale and retail trade services buildings	2	39	33	14	2	3	0	**93**
Other buildings with mixed purpose	4	39	36	8	1	0	0	**88**
Total	**40**	**1 473**	**974**	**208**	**48**	**23**	**22**	**2 788**

Table 5 EPCs by building category and energy class for 2014

Building category	Energy class								Total
	A0	A1	B	C	D	E	F	G	
Single-family houses	139	244	668	129	31	14	4	4	**1 233**
Multi-apartment buildings	77	41	791	158	22	9	1	1	**1 100**
Office buildings	2	4	75	38	12	3	1	1	**136**
School buildings and school institution buildings	1	3	27	33	12	2			**78**
Hospital buildings			10	4	1				**15**
Hotel and restaurant buildings	2	6	32	15	3	4	1		**63**
Sports halls and other buildings intended for sport			1	2	1			1	**5**
Wholesale and retail trade services buildings	1	9	52	32	9	3	2		**108**
Other buildings with mixed purpose	2	6	54	27	4	1	1		**95**
Total	**224**	**313**	**1 710**	**438**	**95**	**36**	**10**	**7**	**2 833**

Table 6 EPCs by building category and energy class for 2015

Building category	Energy class								Total
	A0	A1	B	C	D	E	F	G	
Single-family houses	150	284	693	123	40	10	6	3	**1 309**
Multi-apartment buildings	72	49	699	119	15	3	1	4	**962**
Office buildings	1	12	83	52	9	6		5	**168**
School buildings and school institution buildings	1		50	66	22	9	6	6	**160**
Hospital buildings			13	5	1				**19**
Hotel and restaurant buildings	2	9	42	14	5	2		1	**75**
Sports halls and other buildings intended for sport			1	8	1	1			**11**
Wholesale and retail trade services buildings		3	58	33	8	3	3	3	**111**
Other buildings with mixed purpose	1	4	46	14	1	2			**68**
Total	**227**	**361**	**1 685**	**434**	**102**	**36**	**16**	**22**	**2 883**

Table 7 EPCs by building category and energy class for 2016

Building category	Energy class								Total
	A0	A1	B	C	D	E	F	G	
Single-family houses	168	391	656	126	37	9	7	2	**1 396**
Multi-apartment buildings	80	69	820	121	19	8	4		**1 121**
Office buildings	4	8		37	2	1		2	**121**
School buildings and school institution buildings	1	2	37	26	6	3	1		**76**
Hospital buildings	1	2	9	1					**13**
Hotel and restaurant buildings	2	5	35	9	3	2			**56**
Sports halls and other buildings intended for sport		1	5	4	3	1			**14**
Wholesale and retail trade services buildings		7	52	32	12	2		2	**107**
Other buildings with mixed purpose	1	8	49	13	1	3			**75**
Total	**257**	**493**	**1 730**	**369**	**83**	**29**	**12**	**6**	**2 979**

Table 8 EPCs by building category and energy class for 2017

Kategória budovy	Energetická trieda								Spolu 2017
	A0	A1	B	C	D	E	F	G	
Rodinné domy	200	626	440	53	16	5		1	**1 341**
Bytové domy	101	338	545	42	5				**1 031**
Administratívne budovy	14	71	60	11	3	1	2		**162**
Budovy škôl a školských zariadení	6	38	46	13	3	1	1	1	**109**
Budovy nemocníc	1	3	5	1					**10**
Budovy hotelov a reštaurácií	3	9	24	5		1			**42**
Športové haly a iné budovy určené na šport		2	4	1					**7**
Budovy pre veľkoobchodné a maloobchodné služby	14	37	34	5					**90**
Ostatné budovy so zmiešaným účelom	5	40	42	3	1				**91**
Spolu	**344**	**1 164**	**1 200**	**134**	**28**	**8**	**3**	**2**	**2 883**

Table 9 EPCs by building category and energy class for 2018

Kategória budovy	Energetická trieda								Spolu 2018
	A0	A1	B	C	D	E	F	G	
Rodinné domy	244	681	370	73	8	2	1		**1 379**
Bytové domy	163	315	334	22	2			1	**837**
Administratívne budovy	32	116	79	6	1				**234**
Budovy škôl a školských zariadení	10	70	85	24	7	2			**198**
Budovy nemocníc		2	6	1					**9**
Budovy hotelov a reštaurácií	5	20	18	2					**45**
Športové haly a iné budovy určené na šport	1	2	9	1	1				**14**
Budovy pre veľkoobchodné a maloobchodné služby	10	55	31	4	2				**102**
Ostatné budovy so zmiešaným účelom	4	44	27	4	1				**80**
Spolu	**469**	**1 305**	**959**	**137**	**22**	**4**	**1**	**1**	**2 898**

Table 9 *[sic]* EPCs by building category and energy class for 2019

Kategória budovy	Energetická trieda								Spolu 2019
	A0	A1	B	C	D	E	F	G	
Rodinné domy	223	718	350	50	9	3			**1 353**
Bytové domy	138	290	238	18	1				**685**
Administratívne budovy	43	167	65	4	1	1			**281**
Budovy škôl a školských zariadení	14	115	76	14	4		1		**224**
Budovy nemocníc		6	5						**11**
Budovy hotelov a reštaurácií	3	25	15	2	1			1	**47**
Športové haly a iné budovy určené na šport		6	6						**12**
Budovy pre veľkoobchodné a maloobchodné služby	8	53	14	1					**76**
Ostatné budovy so zmiešaným účelom	5	32	20	2					**59**
Spolu	**434**	**1 412**	**789**	**91**	**16**	**4**	**1**	**1**	**2 748**

Source: INFOREG information system

Annex 5

Data on the stock of residential and non-residential buildings

1. Data on existing multi-apartment buildings

Data were taken from the database of multi-apartment buildings, as there are currently no other comprehensive data in Slovakia whose extent in terms of the information provided would match the data from the mentioned database. As of the end of 2004, there were 867 704 apartments in multi-apartment buildings in Slovakia. The database records of multi-apartment buildings show that 92.3% of all apartments are located in multi-apartment buildings.

The database of multi-apartment buildings provides data on energy consumption for heating for each of the years between 1994 and 2003 for the whole housing stock. The average annual energy consumption for 1994–2003 is reported in kWh/m2 of total floor area.

A total of 24 different construction technologies were used in housing construction; however, when regional variances and different types, including MS 5 and MS 11, are considered, this number rises to 39, and if terraced houses, point blocks and tower blocks are included, the number increases to 60 different technologies (not including T 20 and 22, VNB, B70/R and brick houses). Given that a renovation (thermal insulation) had already been carried out for the sole multi-apartment building built as a whole in the P 1.24 assembly system in Bratislava and also one section in Spišská Nová Ves, where the same construction principles were followed as for multi-apartment buildings P 1.14-7.5RP, this construction was no longer included in the number of technologies employed in housing construction. Within individual inspections, different solutions were also found in some multi-apartment buildings, such as T 06 B Žilina with extended staircases, recessed balconies ending with an attic, T 06B Nitra on footing, etc.

Table 1 Breakdown of housing construction according to the vertical envelope technology

Group of multi-apartment buildings	Period of construction	Types, structural design, assembly system
1	up to 1955, 1956–1970	T 11-16, T 01-03 PV-2
2	1956–1970	BA, G 57, LB (MB), MS 5, MS 11, T 06 B (KE, NA, BA, BB, ŽA), T 08 B, K 61, NMB (VMB), PD-62
3	1971–1983	ZT, ZTB, BA-BC, B-70, BA-NKS
4	1984–1992	P 1.14-6.5RP, P 1.14-7.5RP, PS-82 (TT, PP, ŽA, BB) U-65, P 1.15, BA NKS-S, P 1.24

Table 2 Basic geometric data on multi-apartment buildings

	Shape factor	Enclosed volume	Total floor area	Area of the building envelope	Window area	Window area	Area of the vertical building envelope	Area of the vertical building envelope	Roof area	Roof area
	1/m	m^3	m^2	m^2	m^2	%	m^2	%	m^2	%

Average	0.7968	762	251	579	47	8.1	217	38.7	162	27.2
Median	0.7536	696	228	508	41	7.7	216	37.4	141	27.5
Minimum	0.6149	260	87	279	15	4.1	94	17.8	69	18.2
Maximum	1.1115	1 907	530	1 500	125	12.8	449	57.7	574	38.3

Statistical analysis of the parameters determining energy consumption indicates that the year when occupancy permit is obtained is the third most influential factor in terms of energy consumption. In view of the development of requirements on thermal performance of building envelope, it is appropriate to categorise existing multi-apartment buildings into buildings constructed up to 1983 and those built after 1983, when a stricter thermal performance standard entered into force, bringing about a change in the technologies used for vertical building envelopes.

Table 3 Average thermal consumption in heating by groups of assembly systems

Group by type, structural design, assembly system	**Thermal consumption in heating in each year in kWh/(m^2.a)**										**Average annual heat consumption in 1994–2003**
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
brick and clay blocks buildings	132.6	139.9	151.5	143.2	130.7	126.1	116.7	128.1	125.2	123.3	**131.7**
panel prefabricated buildings, single panel	112.9	117.6	129.4	120.5	108.4	105.1	96.0	106.5	103.2	103.0	**110.3**
panel prefabricated buildings, layered panels	123.1	128.8	137.1	128.9	117.0	114.9	104.9	114.4	110.7	110.0	**119.0**
panel prefabricated buildings	103.2	110.3	117.6	109.3	98.3	94.6	86.6	95.7	90.2	90.9	**99.7**
'tailored' buildings						120.0	118.4	92.8	83.5	94.7	**101.9**
other, not specified	110.2	118.5	111.3	101.2	99.5	97.8	88.9	103.5	133.5	93.7	**105.8**
Slovakia average	**116.6**	**122.9**	**134.3**	**125.8**	**113.1**	**109.8**	**100.3**	**111.6**	**107.3**	**106.3**	**114.8**

Regions with varying conditions during the winter period are among those where outdoor temperatures are a relevant factor, with an effect on the consumption of heating energy. The number of buildings, apartments, sections and the total floor area are shown for each calculation temperature of outdoor air in the table below.

Table 4 Number of buildings, apartments, sections and specific area according to the calculation temperature of outdoor air

Outdoor air calculation temperature in °C	**Number of houses/buildings**	**Number of apartments**	**Number of sections**	**Total floor area in m²**
-11	7 484	308 252	17 995	25 170 252
-12	1 059	36 210	2 842	2 925 353
-13	4 307	163 195	10 438	13 192 946
-14	516	21 805	1 833	1 823 699
-15	5 290	186 437	13 262	15 427 402

-16	2 409	71 320	4 937	5 804 761
-17	491	10 122	907	809 150
-18	144	3 019	252	244 078
-19	23	274	30	24 025
Slovakia total	**21 723**	**800 634**	**52 496**	**65 421 666**

2. Data on existing single-family houses

According to Act No 50/1976 on land-use planning and the construction procedure (the Construction Code), as amended, single-family houses may comprise no more than three apartments. Residential buildings with a larger number of apartments are considered multi-apartment buildings. These data were published by the Statistical Office of the Slovak Republic according to the results of the 2011 Population and housing census.

Table 5 Permanently occupied single-family houses comprising apartments by the period of construction and number of apartments

Permanently occupied single-family houses and their technical equipment	**Houses with the total number of apartments**			
	1	**2**	**3**	**Total**
Up to 1899	18 849	747	211	19 807
1900–1919	26 707	831	208	27 746
1920–1945	85 367	2 726	384	88 478
1946–1960	161 136	4 590	292	166 018
1961–1970	159 149	7 042	278	166 469
1971–1980	127 451	8 699	354	136 504
1981–1985	54 101	2 253	113	56 467
1986–1990	47 837	1 353	43	49 233
1991–1995	33 118	1 045	42	34 205
1998–1999	22 643	953	78	23 674
2000 and later	7 315	311	17	7 643
N/A	15 441	802	68	16 311
Total permanently occupied houses	**759 114**	**31 352**	**2 088**	**792 555**

Table 6 Number of newly built single-family houses between 2012 and 2019

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
New single-family houses	7 729	9 274	9 381	9 649	11 380	11 576	12 672	13 330	**84 991**

Thermal losses in single-family houses are influenced by their geometrical design. The data are indicated in the table below.

Table 7 Average values of geometric data on single-family houses

Subcategory	Shape factor	Enclosed volume	Total floor area	Area of the envelope	Window area	Area of the vertical building envelope	Roof area
	1/m	m^3	m^2	m^2	m^2	m^2	m^2
All single-family houses	0.7536	696	228	508	41	216	141
One-storey single-family houses	0.9879	459	138	448	30	139	138
Two- and multi-storey single-family houses	0.7293	730	256	539	48	226	145

3. Data on existing non-residential buildings

Data are currently available only from a database comprising more detailed characteristics of non-residential buildings owned by the state and by local governments.

Table 8 Non-residential non-production state-owned buildings, categorised by purpose of use

Purpose of use	Number of buildings	Percentage of the total number %	Enclosed volume of buildings m^3	Percentage of total enclosed volume (%)
Schools	6 943	45.0	58 382 303	50.9
Shops and services	156	1.0	680 090	0.6
Healthcare institutions	1 293	8.4	15 197 903	13.2
Cultural institutions	525	3.4	3 071 713	2.7
Office buildings	2 556	16.6	14 365 517	12.5
Accommodation	1 317	8.5	11 814 638	10.3
Sport	126	0.8	810 218	0.7
Railway stations and airports	7	0.0	92 991	0.1
Post offices	440	2.9	966 192	0.8
Other	2 072	13.4	9 322 087	8.1
Total	**15 435**	**100.0**	**114 703 652**	**100.00**
of which primary schools	**2 513**	**16.3**	**26 549 348**	**23.1**

Table 9 Average thermal consumption in heating by purpose of use

Purpose of use	Energy consumption for heating in each year in kWh/(m^3.a)										Average consumption between 1994 and 2003
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Schools	51.2	51.8	53.7	52.7	51.4	50.9	46.8	51.1	49.5	50.7	51.0
Shops and services	54.5	54.3	62.6	60.4	57.3	50.2	51.5	53.0	48.4	62.9	55.5
Healthcare institutions	59.7	59.5	79.0	75.9	71.2	71.9	68.1	70.6	65.1	61.7	68.3
Cultural institutions	47.3	45.8	46.3	46.6	45.4	43.7	37.7	41.1	33.3	39.6	42.7
Office buildings	56.7	59.3	61.6	60.1	58.2	57.8	53.0	56.7	54.7	57.8	57.6
Accommodation	57.4	59.7	62.2	60.6	59.4	60.0	57.9	62.0	57.4	58.7	59.5

Sport	48.8	46.8	49.1	47.8	44.0	46.3	42.5	42.9	37.5	37.0	44.3
Railway stations and airports									46.2		46.2
Post offices								62.9	63.2	65.4	63.9
Other	53.7	53.8	61.4	58.8	57.5	58.0	55.4	58.3	57.5	56.3	57.1
Average for all buildings	52.8	54.0	58.3	56.9	55.2	54.9	51.1	55.4	54.7	58.3	55.2
Primary schools	49.4	49.5	50.9	50.3	48.4	47.7	42.6	46.9	47.3	58.3	49.1

Non-residential non-production buildings can be categorised according to the time of construction, reflecting the different requirements, especially in terms of thermal performance of building structures, as well as the trends in the materials used and construction elements as follows:

- up to 1950: brick buildings, usually with pitched roofs (wooden roof framework);
- between 1951 and 1970: development of prefabrication, application of concrete with light fillers and light concrete (areated concrete), almost exclusively flat roofs, installation of double-paned windows;
- between 1971 and 1983: layered vertical structures, aluminium double-paned windows in addition to the wooden ones, flat roofs;
- after 1983: improvement of the thermal performance of building structures by demonstrating calculation values meeting the requirements of the revised thermal performance standard; the calculation methods disregarded the impact of the construction design of details, which resulted in higher thermal losses, especially in vertical building envelope through contact areas.

Table 10 Average annual thermal consumption in heating by period of construction

Year of occupancy permit for the building	**Thermal consumption in heating in each year in kWh/(m^3.a)**										**Average consumption between 1994 and 2003**
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
Not specified	66.0	65.1	69.6	69.0	70.4	74.5	65.0	73.6	59.6	73.3	68.6
Up to 1950	49.2	50.8	56.1	55.2	53.3	53.7	50.0	53.6	52.5	55.6	53.0
1951–1970	54.0	54.8	59.3	57.5	55.0	54.2	51.0	55.9	56.1	60.0	55.8
1971–1983	54.7	55.5	59.1	57.5	56.0	54.9	50.8	55.4	55.1	58.6	55.8
1984–1992	49.7	52.1	55.8	53.9	52.2	52.9	49.5	52.5	52.7	56.3	52.8
After 1992	47.9	50.6	57.7	56.6	55.3	54.6	51.5	55.0	55.0	56.0	54.0
Average for all buildings	52.8	54.0	58.3	56.9	55.2	54.9	51.1	55.4	54.7	58.3	55.2

Thermal consumption in heating in individual years is influenced by the frequency of low outdoor air temperatures during the heating season as well as the total number of heating degree days (HDD).

Table 11 Average annual thermal consumption in heating of buildings according to the calculation temperature of the outdoor air

Outdoor air calculation temperature in °C	Thermal consumption in heating in each year in kWh/(m^3.a)										Average consumption between 1994 and 2003
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
From -11 to -13	52.1	53.8	57.8	56.4	54.9	55.0	51.3	55.3	53.8	56.7	**54.7**
From -14 to -16	52.7	53.4	57.8	56.3	54.5	53.5	49.4	54.0	54.1	58.6	**54.4**
-17 and lower	63.3	63.1	69.5	67.9	65.6	67.7	63.3	69.4	72.4	75.7	**67.8**
average	**52.8**	**54.0**	**58.3**	**56.9**	**55.2**	**54.9**	**51.1**	**55.4**	**54.7**	**58.3**	**55.2**

4. Data on new residential and non-residential buildings

Table 12 New residential and non-residential buildings from the records of energy performance certificates

NEW BUILDINGS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2009–2019
single-family house	6 205	6 818	7 729	9 250	9 381	9 649	11 381	11 576	12 672	13 330	**97 991**
multi-apartment building	369	249	253	339	370	289	303	266	299,	331	**3 068**
total residential buildings	6 574	7 067	7 982	9 589	9 751	9 938	11 684	11 842	12 971	13 661	**101 059**
office building	116	139	123	145	192	150	157	132	174	185	**1 513**
school building	15	13	10	18	25	27	31	31	30	51	**251**
hospital building	12	16	19	9	10	8	9	8	6	11	**108**
hotel or restaurant building	40	72	47	57	74	71	46	62	67	56	**592**
sports hall	15	18	16	10	21	21	13	21	22	20	**177**
wholesale and retail trade building	156	147	165	189	166	188	222	163	166	193	**1 755**
other buildings including buildings with mixed purpose of use	101	99	96	111	116	100	112	77	104	91	**1 007**
total non-residential buildings	455	504	476	539	604	565	590	494	569	607	**5 403**
TOTAL NEW BUILDINGS	**7 029**	**7 571**	**8 458**	**10 128**	**10 355**	**10 503**	**12 274**	**12 336**	**13 540**	**14 268**	**106 462**

Source: INFOREG information system

Annex 6

Cost-optimal levels of the minimum energy performance requirements on buildings

A total of 11 reference buildings were identified in the first phase of determining the cost-optimal levels of the minimum energy performance requirements on buildings in 2013 based on statistical analysis methods according to the set criteria (building category, period of construction, size, availability of design documents), with the use of a database of residential and non-residential buildings. One reference building representing school buildings was identified beyond the set duty to identify two existing reference buildings and one new reference building for each of the categories of multi-apartment buildings, single-family houses and office buildings.A total of 5 to 12 sets/variants of measures are applied to each reference building. Separate sets of measures pertain to a reference case characterised by the original condition for existing buildings and to the valid requirements applicable to new buildings. Variant solutions were suggested for the individual levels of thermal protection of building structures (e.g. 12 variants for thermal protection of the vertical building envelope with the thickness of the thermal insulation material varying between 40 mm and 240 mm in terms of additional thermal protection using a contact thermal-insulation system). The value of the heat transfer coefficient reflected the original quality of the vertical envelope, roof covering and internal partition structures between heated and unheated spaces. Products characterised by the heat transfer coefficient for the frame and glazing (U_f, U_g, U_w in W/(m^2.K)), permeability for solar energy g (-) and the linear loss coefficient of the glazing space bar were chosen for the individual variant changes of thermal performance properties of the windows and doors. Heat production variants were also considered (seven variants, e.g. district heating using natural gas, woodchips, cogeneration of heat and electricity, gas condensing boiler, wood pellet boiler, air-to-water heat pump, ground-to-air heat pump), along with variant solutions for the production of hot water and cold. The variants were used in the framework of the five assessed packages of measures, of which package 3 was analysed using the characteristics of building structures with defined cost-optimal values. For lighting, a cost-optimal analysis of the measures was carried out separately as compared to energy demands. The option chosen was applied in all the packages of proposed measures when establishing the net value.

The second phase of the assessment of the minimum energy performance requirements on buildings in 2018 was concerned with the calculation of the cost-optimal level of the minimum energy performance requirements on nearly zero energy buildings, while the baseline assessment was linked to then applicable requirements on ultralow-energy construction, for which reference buildings were also reassessed. The assessment of the cost-optimal levels of the minimum energy performance requirements on buildings included nine reference buildings (three multi-apartment buildings, three single-family houses, three office buildings). In view of the changes in the calculation inputs, level 3 (ultralow-energy), level 4 (nearly zero energy buildings) and level 5 were reassessed based on the proposed optimal properties of building structures of the building’s heat-exchange interface.

Table 1 Resulting cost-optimal values for the minimum requirements on thermal performance properties of building structures – maximum values of the heat transfer coefficient for the structure (U)

Type of building structure	Heat transfer coefficient for the structure W/(m^2.K)		
	Ultralow-energy level of construction U_{r1} standardised (required) from 1 January 2016	Level of construction of nearly zero energy buildings U_{r2}	
		standardised (required) from 1 January 2021	recommended from 1 January 2021
Outer wall and pitched roof over living space with a slope of > 45°	**0.22**	**0.22**	**0.15**
Flat and pitched roof with a slope of ≤ 45°	**0.15**	**0.15**	**0.10**
Ceiling above outdoor environment [a)]	**0.15**	**0.15**	**0.10**
Ceiling below unheated space [b)]	**0.20**	**0.20**	**0.15**
Windows, doors, glazed parts of glazed walls in the vertical envelope	**1.00**	**0.85**	**0.65**

Heat transfer resistance on the outer surface of the structure is R_{se} = 0.04 m^2.K/W.

a) Heat transfer resistance on the inner surface of the structure is R_{si} = 0.17 m^2.K/W (top to bottom heat flux).

b) Heat transfer resistance on the inner surface of the structure is R_{si} = 0.10 m^2.K/W (bottom to top heat flux).

c) Heat transfer resistance on the inner surface of the structure is R_{si} = 0.13 m^2.K/W (horizontal heat flux).

Table 2 Resulting cost-optimal values for the minimum energy performance requirements – primary energy

Building category	Cost selection optimum kWh/(m².a)	Reference building requirements after 2015 kWh/(m^2.a)	Requirements after 2020 kWh/(m².a)
Residential buildings	86	63	32
Difference from the requirement		-27%	63%
Single-family houses	131	108	54
Difference from the requirement		17%	59%
Office buildings – without cooling	94	77	61
Difference from the requirement		18%	35%
Office buildings – with cooling	137	120	
Difference from the requirement		12%	

School buildings	85	68	34
Difference from the requirement		20%	60%
Sports facilities	104	76	46
Difference from the requirement		27%	56%