CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

Implementation of the EPBD Hungary

Status in 2020

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NATIONAL WEBSITES
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1. Introduction

In Hungary, most of the articles of the EPBD (Directive 2010/31/EU) were implemented between 2012 and 2015. For buildings that receive public funding, the energy performance requirements were upgraded to the cost-optimal level at the beginning of 2015. The cost-optimal requirements have been introduced as mandatory requirements in 2018, whereas NZEB requirements came into force in 2019 for buildings used by authorities, and in 2021 for all new buildings, respectively[1].

Due to several changes in administration, the EPBD transposition, originally the responsibility of the Ministry for National Development, was later moved to the Prime Minister's Office and lately to the Ministry of Innovation and Technology. The office updated the national rulebook in 2015 thereby introducing significant changes. The new version is in force since the beginning of 2016. It has introduced new energy labelling ranges resulting in all existing EPCs having been reclassified. Further, it has provided an exact definition of the NZEB requirements, having an impact on the EPCs issued since 2016.

The National Building Energy Strategy adopted in 2015 envisaged very ambitious renovation goals until 2020 and, in particular, an exemplary role for public buildings. Hungary has adopted alternative measures for inspection of heating and AC systems. Support programmes have rather focused on public buildings, except for the non-refundable funds of the '*Warmth of Home Programme'* focusing on reconstruction of residential buildings (approximately 10 billion HUF per year since 2015 by the Ministry of National Development[2]). The '*GINOP 8'* programme[3] offers a favourable loan for retrofitting the residential stock with a budget of more than 100 billion HUF[4]. Information campaigns have been carried out with special attention to cost-optimal renovation solutions.

[1] Based on the published country report 2016 by Tamás Csoknyai, Ákos Lakatos, Ilona Soltész, András Zöld

2. Current Status of Implementation of the EPBD

2.I. Energy performance requirements: NEW BUILDINGS

2.I.i. Progress and current status of new buildings (regulation overall performance)

The first ministerial order (7/2006. (V. 24) Decree about Determination of Energy Efficiency of Buildings) to transpose Directive 2002/91/EC was issued in May 2006 and has been in force since 1 September 2006, with several modifications having taken place since. For buildings supported by public funds and for any construction projects financed by the state budget, cost-optimal requirements are applicable since the beginning of 2015. The same requirements were introduced for all new buildings (with exceptions allowed by the EPBD) and those undergoing major renovations as of 2018. The fulfilment of the cost-optimal level requirements is a precondition for any subsidy. Commissioning of such a building could be realised by the end of 2020.

An amendment entered into force on 29 November 2019 with the aim to assess the real energy characteristics of district heating. Thus, during the energy calculations, each district heating system is evaluated according to its own characteristics. Goal of this amendment was to improve the energy performance of the domestic building stock, while also promoting the energy and climate protection benefits of district heating in line with other energy strategy goals.

With effect from 1 January 2021, the Decree has again been amended, in order to replace the 25% renewable share on one hand and to promote electromobility on the other.

The amendment allows the builder, if justified, to replace the requirement for the share of renewable energy as defined in Directive 2010/31/EU by meeting an increased cost-effectiveness requirement. The amendment thus demonstrably retains the requirement to encourage the use of renewable energy, but also provides acceptable alternative requirements for buildings where the share of renewable energy cannot be reasonably (technically, economically, or environmentally) met.

Regarding the promotion of electromobility, as a result of the modification of the Decree, in accordance with the EU Directive, in the case of a new building or a major renovation or extension of an existing building where the extension exceeds 100% of the useful floor area of the building to be extended, the building must meet the new requirements for electromobility. This means that new non-residential buildings with more than ten parking spaces (e.g., office buildings) must be equipped with an electrical charging point at every five parking spaces. For new residential buildings, any tenth parking space must also be equipped with electrical cables. For other existing non-residential buildings with more than twenty parking spaces, an electric charging point is required from 1 January 2025.

NZEB requirements, defined by the 7/2006. (V. 24) Decree since 2016, were introduced in 2019 for public buildings and will be mandatory from 2021 for all new buildings. The NZEB threshold of the specific primary energy consumption for residential buildings is 100 kWh/m^{2}year. For educational buildings the NZEB levels are 85kWh/m^{2}year and for office buildings 90 kWh/m^2.

In addition, after entry into force, on 1 January 2022, of the amendment of Act LVII/2015 on energy efficiency, the previous Hungarian regulatory environment for the on-site inspection of heating and air-conditioning systems will also undergo a significant modification. An IT system supporting the performance and control of the energy review is currently being developed.

Also, in order to properly transpose Article 20 of the EPBD, the Hungarian Chamber of Engineers has been appointed to carry out tasks related to informing the retail and business sectors.

2.I.ii. Format of national transposition and implementation of existing regulations

The requirement system has three levels, as far as new buildings and major renovations are concerned. Maximum permitted U-values are set for elements, as is a specific heat loss coefficient (W/m^3K) as function of the surface to volume ratio. Also considered are losses from thermal bridges (using either the simplified or the detailed procedure), passive solar gains and the effects of shading devices. Finally, the specific yearly primary energy must not exceed the set limit depending on the type and use of the building. In Table 1 maximum permitted values are given for a few typical uses (residential, school, office), whilst in the case of mixed or other use, comparison with a reference building is to be used[5]. The requirement of the specific yearly primary energy need for NZEB will not depend on the surface to volume ratio anymore, only on the building function.

Function of the building	Ep, Specific yearly primary energy need ($kWh/m^2.year$)
Residential (without lighting)	100
Office (including lighting)	90*
Educational (including lighting)	85
* If mechanical cooling is applied, additional 10 kWh/m^2.year can be counted.	

Table 1. The maximum values of the yearly E_p's as function of the building.

The primary energy needs include heating, domestic hot water, cooling and ventilation, and for non-residential buildings also lighting needs. Airtightness measurements are not required, but the quality of windows is examined visually by experts on-site and the estimated infiltration is taken into account in the calculation. For new buildings and major renovations, thermal comfort and minimum requirements on fresh air supply are set, but relevant values are not included in the calculation procedure for certification. The calculation procedure refers to several European standards. NZEB level requirements are presented below in detail and the method of calculations is the following:

- At least 25% of the energy need of the building should be covered from RES, that is, compared to the calculated value of the specific yearly primary energy need. The '*renewable share*' is defined as the quotient of renewable/non-renewable energy. During the calculation of the value of the energy need, the renewable primary energy need is not taken into account. Even if the specific primary energy consumption is less (e.g., half) than the threshold value, the building is not approved as NZEB unless the above 25% is fulfilled, which leads to extra measures in order to further decrease the non-renewable energy consumption;

- Regarding primary energy factors of district heating systems, the RES factors calculated by the heat distribution companies are published each year by the Lechner Nonprofit Knowledge Center[6]. If there is no data provided, the value e_{distr}=1.26 kWh/kWh is to be used.

- For the calculation of the renewable share, the following RES factors should be used: e_{RES}=0.1 if the national electric grid is used; e_{RES}=1 if firewood, biomass, biogas, pellets or agripellets as well as solar, wind, water, geothermal, hydrothermal energies are used.

For NZEB, detailed calculation or dynamic simulation is compulsory – these match the already available CEN standards.

The most detailed and comprehensive technical guidance document for energy experts is the book '*Building Energetics*'[7]. This book is a step-by-step guide for professionals including legislative background, the calculation process of the asset method, the certification process and an analysis of existing buildings. A new up-to-date version of the book has been published in early 2017. In addition, the Prime Minister's Office publishes technical guidance documents[8].

Mains gas	LPG	Oil - general	Diesel or heating oil	Fuel oil	Coal - general	Biomass - general	Wood - general	Wood pellets	Grid Electricity	District heating - general
1		1	1	1	1	0.6	0.6	0.6	2.5	according to data published by the Lechner Nonprofit Knowledge Center

Table 2. The primary energy factors in Hungary.

2.I.iii. Action plan for progression to NZEB for new buildings

Since 2016, new energy labels have been introduced in the certification scheme: '*BB*' means NZEB, and there are three even more ambitious levels. The NZEB requirements become obligatory after 2019 -2020.

The national plan on NZEB was adopted in 2015 by the Prime Minister's Office. It contains the NZEB requirements that were later transposed by the national rulebook on the energy efficiency of buildings (Decree 7/2006). It envisages initiatives on the improvement of energy efficiency of the existing building stock, but also on renewable energy systems that can be applied in new buildings. Since 1 January 2017, a new system to support the use of renewables is valid in Hungary, which is called '*Renewable support system*' (*METÁR*)[9]. It is a new support system for the produced electricity in Hungary. By using this system, Hungary should fulfil the previously agreed share of 14,65% renewable energy[10]. The potential applications of the use of renewables will be supported by public funds, and new subsidy programmes will be available.

Focusing only on the NZEB requirements, the structure of the regulation (Decree 7/2006.) is the following:

1. Elements: maximum U values for walls, windows etc. (Table 3).
2. Building envelope: maximum limits for the specific heat loss coefficient (W/m^3K), depending on the surface to volume ratio. This coefficient takes into account the transmission losses as well as the passive solar gains (through which indirectly the effect of thermal mass); thus data depending only on the building itself (Figure 3).
3. Thresholds for the specific yearly primary energy consumption (Figures 2-4).
4. Minimum of '*renewable share*', which is set at 25%. Where the share of renewable energy cannot be reasonably (technically, economically or environmentally) met, legislation allows the builder to replace it by meeting an increased cost-effectiveness requirement.
5. Additional requirements.

There are requirements on balancing, control, pumps, airtightness of ventilation ducts, but these requirements are relatively low. Directive 2009/125/EC on EcoDesign requirements for energy-related products (ErP directive)[11] has a more significant impact on technical building systems.

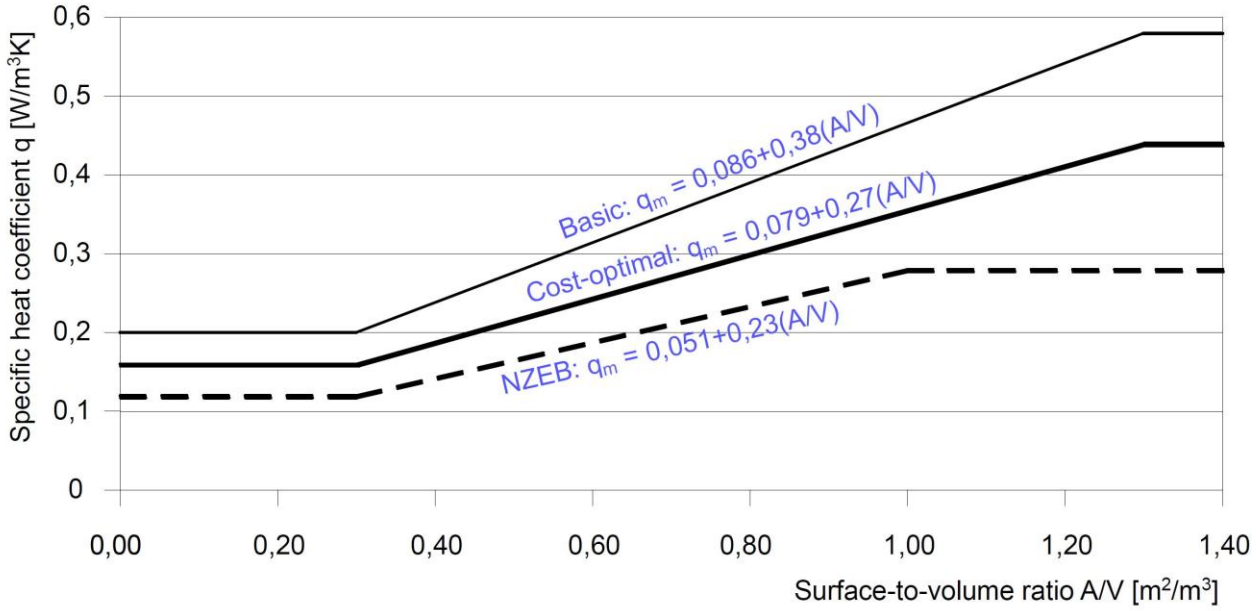

Figure 1. The specific heat loss coefficient [W/m³K] after 2006.

The basic requirement level was in force until the end of 2017. The cost-optimal requirements were introduced in 2015 and used firstly for buildings receiving public funding. The NZEB requirement for the specific heat loss coefficient is identical to the cost-optimal requirement except for lightweight structure buildings.

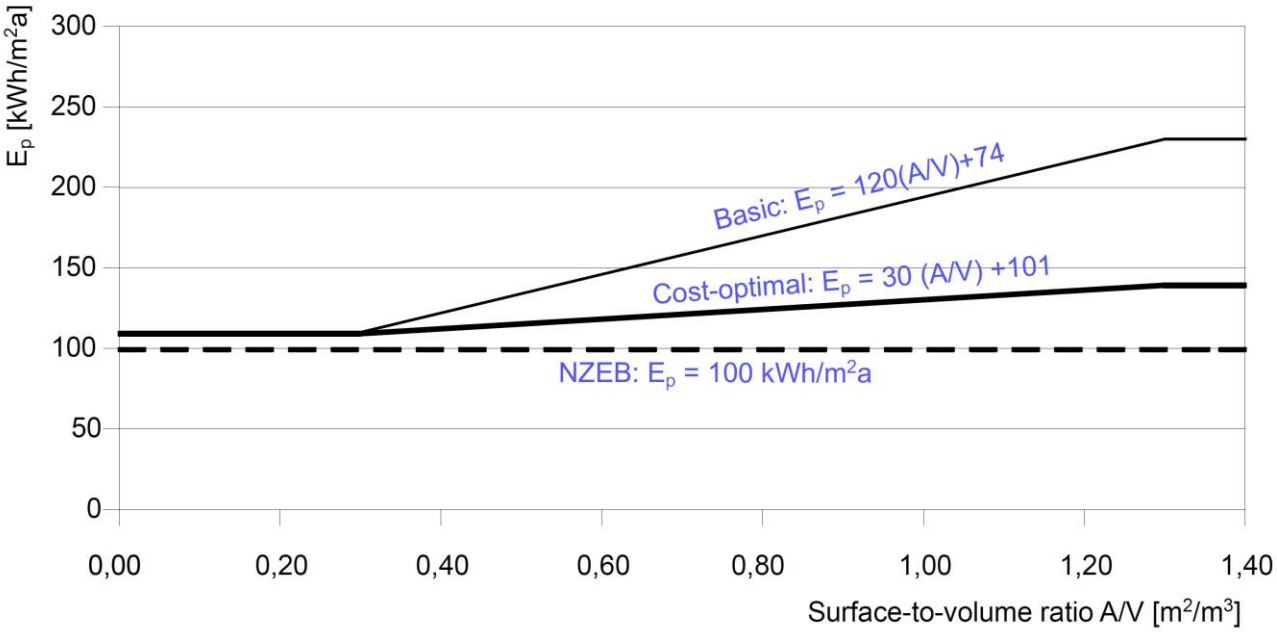

Figure 2. Requirements for the specific yearly primary energy need of residential buildings. (Basic: from 2006, Cost optimal: from 2018 (in some cases 2015), NZEB from 2019.

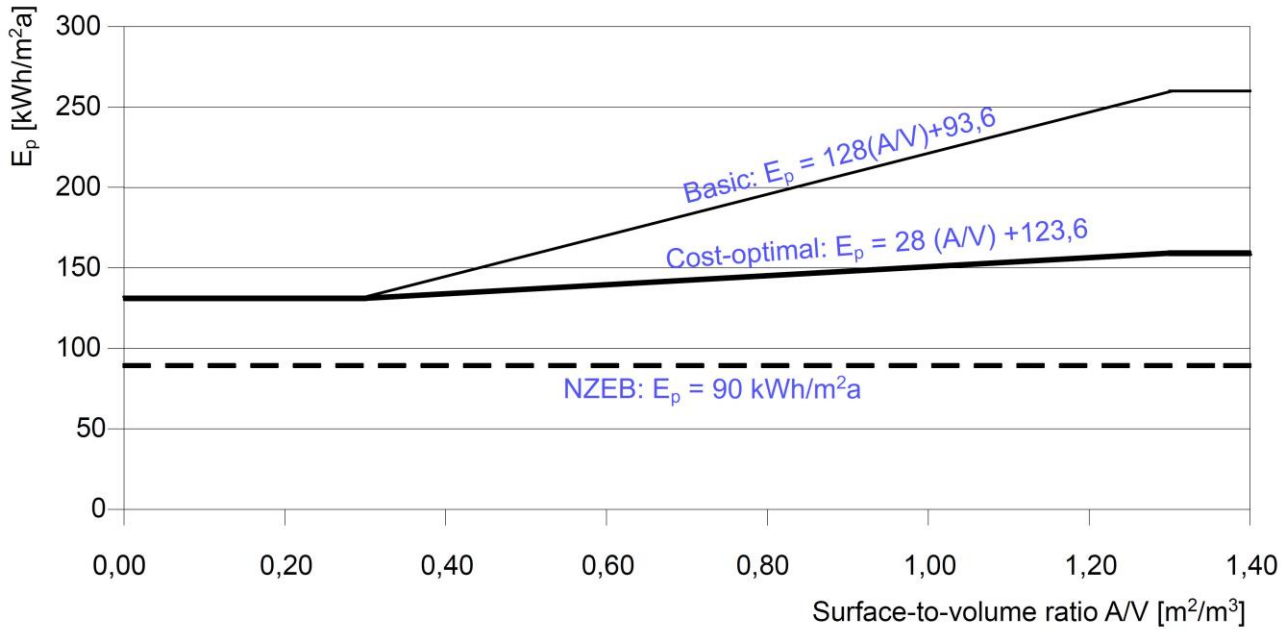

Figure 3. Requirements for the specific yearly primary energy need of office buildings. (Basic: from 2006, Cost optimal: from 2018 (in some cases 2015), NZEB from 2019.

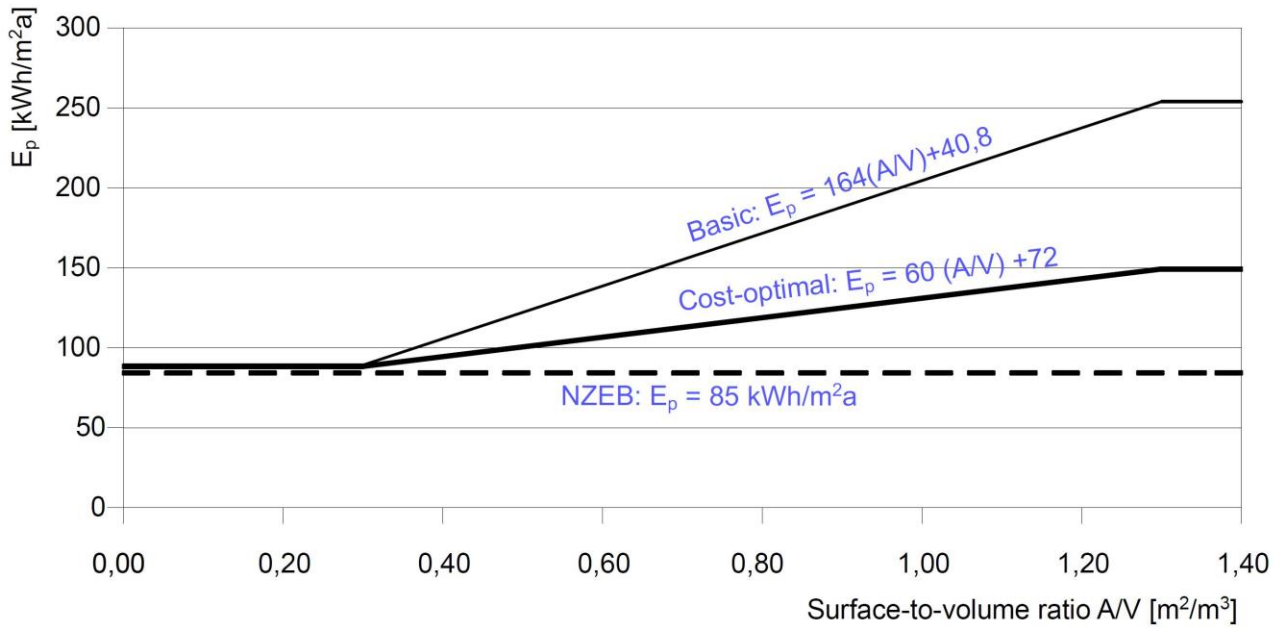

Figure 4. Requirements for the specific yearly primary energy need of educational buildings. (Basic: from 2006, Cost optimal: from 2018 (in some cases 2015), NZEB from 2019.

2.I.iv. Requirements for building components for new buildings

Building element	requirements (cost-optimal and NZEB)
Façade wall	0.24
Flat roof	0.17
Wall bordering heated attic	0.17
Slab below attic	0.17
Arcade	0.17
Slab over unheated space	0.26
Glass	1
Special glazing	1.2
Wood or PVC double layer facade transparent element (>0.5m^2)	1.15
Metal transparent element on facade	1.4
Curtain wall	1.4
Glass roof	1.45
Roof skylight	1.7
Roof transparent element	1.25
Industrial and fire safety door between heated spaces	2
Door on facade or between heated and not heated space	1.45
Gate on facade or between heated and not heated space	1.8
Wall between heated and non-heated space	0.26
Wall between heated buildings	1.5
Wall in contact with the ground, up till 1 m depth (parts below the ground floor are only mandatory for new buildings)	0.3
Slab on ground (only for new buildings)	0.3
Traditional energy collecting walls (e.g., Trombe wall)	1

Table 3. Maximum U values (W/m^{2}K) of building elements, cost-optimal and NZEB levels.

2.I.v. Enforcement systems new buildings

Simplified notification for residential buildings[12]

The 155/2016. (VI. 13.) Government Regulation ensured complete electronic administration of the notification and requested continuous electronic documentation of constructions.

The updated legislation is in force since October 2019 and allows for certain constructions a simplified notification without opening an electronic construction file. The simplified notification must be entered into the electronic documentation system of the building authorities. The notification, which must contain the coordinates of the building site, the short description of the construction and the contact details of the architectural and technical designer, must confirm that the purpose of the construction is for housing.

The construction supervisory authority mandatorily checks every notification on the electronic documentation system and sends a notification only if the documentation is insufficient; it does not check the contents and their correctness. The competent building inspectorate notifies the Chamber of Engineers and the Chamber of Architects, the persons concerned and the mayor of the municipality where the site is located about the construction.

Building permit procedure[13]

The current 312/2012. (XI. 8) Government regulation on the building and construction supervision authority procedures and inspections, as well as the building authority service entered into force on 1 January 2013, together with the comprehensive transformation of the building authority system. The application for a building permit must contain a complete documentation. While assessing an application, the building authority must perform an on-site inspection to verify the correctness of the documentation.

The application can be refused if it does not comply with the legal requirements and /or if the mayor does not see it adequate to the settlement's image. The decision shall be communicated in writing and must be registered in the electronic documentation system of the building authorities.

2.II. Energy performance requirements: EXISTING BUILDINGS

2.II.i. Progress and current status of existing buildings (regulation overall performance)

Since 2006, requirements for major renovations are the same as for new buildings. Other renovations are regulated since 2013 and only requirements for individual elements (both envelope and technical building elements) have to be fulfilled. From 2016, major building extensions are considered as new buildings and all requirements are relevant, but in case of minor extensions only requirements for individual elements are defined. After 2018, cost-optimal requirements shall be obligatory for both renovations and extensions. NZEB requirements are not planned to become mandatory for retrofits.

2.II.ii. Regulation on individual parts, distinct from whole building performance

The regulations include requirements on technical building systems elements (e.g., on balancing, control, pumps, airtightness of ventilation ducts, boilers, performance of the heat recovery system, energy use of fans, passive shading systems). The rulebook does not set any direct system performance requirements; only the upper threshold of the total primary energy consumption of the building is defined.

The requirements of the ErP directive on gas boilers, water tanks, heat pumps, pumps, ventilations systems, etc., have a much more significant impact on the construction sector than element requirements set in the rulebook.

2.II.iii. Initiatives/plans to improve the existing building stock

The renovation target for residential buildings is to reach a 5% renovation rate by the end of the 2021-2030 period. This can reduce the total energy consumption and CO_2 emissions of residential buildings by approximately 30%. Significant results have already been achieved during the last 4 years in the public buildings sector and will continue. The goal is to maintain a stable renovation rate of 3% for public buildings in the period 2021-2030. If this is achieved gradually, the total energy consumption of public buildings as well as CO_2 emissions can be reduced by 12-13%.

2.II.iv. Long Term Renovation Strategies, status

Directive 2018/844 of the European Parliament and of the Council (30 May 2018) amending Directive 2010/31/EU on the energy performance of buildings, and Directive 2012/27/EU on the energy efficiency of buildings, require EU Member States to elaborate their Long-Term Renovation Strategy (hereinafter referred to as the 'LTRS' or 'Strategy'). Its domestic implementation is also set out in the National Energy and Climate Plan adopted by the Government of Hungary on 8 January 2020[14]. The aim of the Strategy is to transform the national stock of privately and publicly owned residential and non-residential buildings to a nearly zero-energy and decarbonised building stock by 2050 through deep renovation. Hungary is currently finalising its Long-Term Renovation Strategy.

2.II.v. Financial instruments and incentives for existing buildings

In Hungary, there are different subsidy programmes for supporting the energy efficient refurbishment of buildings. The *KEHOP* programme[15] focuses mostly on public buildings, with 100% subsidy of costs. The *GINOP/VEKOP*[16] programme supports energy efficiency and renewable energy systems of buildings used by SMEs. *TOP* [17] programme (Operational Programme for Urban Development) supports energy efficiency and renewable energy systems for municipalities. A residential retrofit programme is under preparation providing loans with 0% interest rate and supports higher efficiency boiler installation instead of old units and changing old fridges to high efficiency units with 50% subsidy cost. A bottleneck is that programmes are mainly ad-hoc, often restructured, and funds run out quickly.

2.II.vi. Information campaigns / complementary policies

In 2015, the Ministry for National Development has adopted the *Action Plan to Improve Awareness for Energy Efficiency and Climate Protection* [18]. Certain communication and education actions as well as monitoring mechanisms are put in place to control the implementation of the action plan. The plan envisages several opportunities to submit applications for the implementation of awareness-raising programmes to be co-financed by the EU, which are also able to contribute to numerous programmes to encourage the reduction of energy consumption.

The ÉMI Non-profit Limited Liability Company for Quality Control and Innovation in Building (ÉMI)[19] operating as the background institute of the Ministry of Innovation and Technology in Hungary, in cooperation with the Municipal Government of Szentendre town and the Budapest University of Technology and Economics (BME) won the right to organise the Solar Decathlon Europe 2019 in the designated city of Szentendre, the prestigious international innovative house-building competition of universities.

Hungary was the first in the region to host this international event, which is held between universities and surrounded by high public attention, in the summer of 2019. As the main professional subject matter, the Hungarian organiser emphasised solutions for the renovation of the existing building stock. It posed a number of new challenges to the competitors: the application of local recycled materials, the high-level integration of solar photovoltaic and solar cell systems, the issue and solution of the summer overheating of buildings, bioclimatic planning and nature-based solutions, as well as the use of high-performance composite materials. The event was held at the ÉMI's Science and Technology Industrial Park in Szentendre, including the fourteen days of the competition and the extended exhibition of two months.

The Solar Decathlon Europe is an international competition that challenges collegiate teams to design and build houses powered exclusively by renewable energy sources: the main aim of the competition is to promote architectural solutions related to solar energy, renewable energies and innovative technologies through the houses built by the university teams.

ÉMI is actively taking part in many related international projects. ÉMI acted as the coordinator of the Hungarian Build Up Skills Pillar I. project[20] where a roadmap has been developed to improve training in the construction field. ÉMI also coordinated the Build Up Skills Pillar II. TRAINBUD [21] project which elaborated a crosscraft type (nZEB related) training programme and high-quality training material for HVAC skilled workers to improve their skills in energy efficiency and renewable energy solutions. Additionally, it established a Sustainable Construction Skills Alliance involving more than 70 stakeholders from the field of education and construction. In the recently ended NEWCOM project [22], ÉMI worked on an nZEB training material and training scheme (flat roofing) and conducted a series of pilot training for flat roofers,

ventilation installers and building inspectors. In the actual BIMzeED project [23], ÉMI is responsible for the conduction of pilot training in the field of nZEB and BIM for educators, HEI and VET students, and workers of SMEs in the construction field.

Figure 5. Solar Decathlon Europe 2019, Location: Szentendre, ÉMI Nonprofit Ltd.

2.III. Energy Performance Certificate requirements

Starting from January 2012, all existing residential and non-residential buildings need to be certified when sold. The owner must present a valid EPC to the buyer when the sale contract is agreed upon. For rentals, the EPC is obligatory only since 2015.

In 2016, the energy performance classes were rescaled. The new labels are marked by double letters to differentiate them from the old labelling system. The reference value of the scale is the NZEB requirement on total primary energy performance. Building units meeting the NZEB requirements can get a '*BB*' label or better. EPCs issued before 2016 have been automatically rescaled but, unfortunately, owners are not automatically informed about the change because of technical barriers of the database.

EPCs are valid for 10 years unless the building undergoes a major renovation, in which case a new EPC is required.

The EPCs are issued by independent experts who have passed the necessary exam at the Hungarian Chamber of Engineers or at the Hungarian Chamber of Architects.

2.III.i. Progress and current status on EPCs at sale or rental of buildings

Since January 2013, EPCs are registered in a central database operated by the *Lechner Knowledge Center*. The database is partly public. In the public part, a building´s energy performance class can be searched by using its address. Statistical information from the database is also publicly available, but only a limited number of searching criteria are allowed. Detailed statistical analysis is only for internal use. The licences for the certified experts are issued by the Hungarian Chamber of Engineers and the Chamber of Architects. The Chamber of Engineers runs the control system of the EPCs.

The EPC assigns an energy performance label to residential and non-residential buildings or building units, and it lists cost-effective measures for improving their energy performance. The energy label classifies the

buildings on an efficiency scale ranging from AA++ (high energy efficiency) to HH (poor efficiency). The classification is based on the specific yearly primary energy need. The labels of the new EPC's are presented in Figure 6.

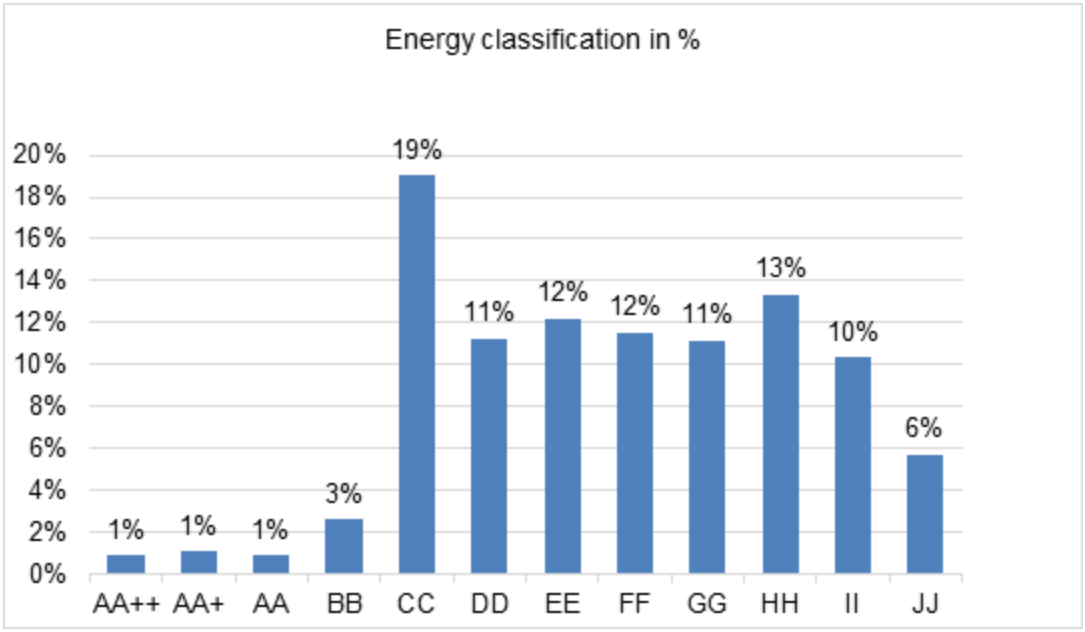

Figure 6. Number of EPCs in function of energy class registered in the electronic system in 2016.

The cost of a certificate for an apartment unit is set by law (40 € + VAT per unit) when the certificate can be prepared based on plans and declarations[24]. The same price applies for single-family houses. This cost has often been criticised by experts as unrealistically low, which has a strong negative impact on the quality of the certificate. For non-residential buildings, there is no legally defined price for an EPC.

2.III.ii. Quality Assurance of EPCs

An EPC electronic registration system has been in operation since 2013. An EPC is only valid after upload into the online system. Roughly, 150,000 EPCs are issued annually.

The online system also serves as a first level of quality control: first, it automatically checks the permit of the energy expert. Following this step, the system checks for unrealistic figures.

The second and third control levels are performed by the Hungarian Chamber of Engineers. Randomly selected, 2.5% of the EPCs are verified by an office check and 0.5% (20% of the 2.5%) are verified on-site. Both controls are carried out by independent experts and all control results are registered in an electronic database. From the beginning of 2017, targeted controls are also possible.

If the quality control detects a miscalculation leading to a difference of more than two energy classes, the expert loses his licence for 3 years. Since 2017, further sanctions can be applied, including fines and penalties.

2.III.iii. Progress and current status of EPCs on public and large buildings visited by the public

In Hungary, the definition of a public building includes every state-owned non-residential building. Initially, only the larger buildings (exceeding 1,000 m^2 floor area) were required to display their EPC, making it visible to the public. Since 2015, the EPC is obligatory for all public buildings and large buildings open to the

public exceeding 250 m^2 floor area, and the EPC must be displayed in a visible place. For the display itself, there is no effective control and sanction system in operation.

The cost of an EPC for public buildings must be determined based on real cost reports and is generally between 100 and 1,500 €, depending on the size and complexity of the building.

2.III.iv. Implementation of mandatory advertising requirement – status

According to the Governmental Decree 176/2008 (VI. 30.), as of 9 January 2013, the energy categories must be displayed in all commercial advertisements for all buildings or building units, (including individual apartments in blocks of flats, single-family houses, and non-residential buildings) when sold or rented, if the EPC is available. In most cases, the EPC is not available in the period of advertising, but only at the moment of sale or rental. As of January 2017, it is neither controlled nor sanctioned if the mandatory advertising requirement is obeyed or not.

2.IV Smart buildings and building systems

2.IV.i. Status and plans on smart buildings

There is no existing legislation about smart buildings in Hungary.

The future plans and educations might be based on the results of the Digital Success Programme 2.0:

The Digital Success Programme 2.0 includes a special emphasis on the topic of Smart City developments. DSP2.0 aims to enable municipalities, citizens, businesses, and communities to make the most of the opportunities offered by Smart City developments. DSP2.0 intends to create harmony between the Smart City settlement development approach and the traditional settlement management on the one hand, and to contribute to the Smart City concept and institutional system being integrated into the Hungarian administrative system, mainly that of the local governments and territorial administrations, as well as into enforcement practices. Smart City development pilot programmes will be launched within the framework of DSP 2.0[25].

The Hi-Smart (Higher Education Package for Nearly Zero Energy and Smart Building Design) project aims to develop educational material for students and professionals in higher education in Hungary, Slovakia and Germany, by supporting the design, construction and operation of smart, energy efficient buildings. The multidisciplinary package covers sustainable building solutions, building services systems, renewable energy sources, and smart technologies for use in buildings.

The objective is to contribute to the professional design of nearly-zero energy and smart buildings, in line with the objectives of the European Directive on the Energy Performance of Buildings. The three-year project, which runs until August 2022 and is supported by the Erasmus + programme, will also focus on bringing students together with industry players, providing a platform for meetings and exchanges of experience.

The project is coordinated by the Energiaklub (Hungary), and has as project partners the Budapest University of Technology and Economics (Department of Building Engineering and Mechanical Process Engineering), the Technische Universitaet Kaiserslautern (Germany) and the Technical University of Bratislava (Slovenska Technicka Univerzita Bratislave)[26].

2.IV.ii. Regulation of system performance

Regulation under development.

2.IV.iii. Building Automation and Controls (BACs)

Regulation under development.

2.IV.iv. Status and encouragement of intelligent metering

One of the basic conditions for the active participation of consumers in the market is the creation of controllability of consumption where this is not yet possible today. In the electricity and natural gas sectors, the much wider use of smart meters, the proper construction of heating centers for district-heated dwellings, the controllability of systems and the widespread use of cost-sharing, and the active management of distributors will enable consumers to operate. They can get accurate information about the development of their energy consumption, competitive service tariff offers from their service provider, while maintaining and improving the quality of the service. The National Energy and Climate Plan[14] adopted by the Government of Hungary on 8 January 2020 states that the goal is to install 1 million smart meters in the electricity sector. It is planned to stipulate that, if certain conditions are met, traditional meters can only be replaced by smart meters when they expire, the cost of which should not be borne by consumers. In parallel, universal service providers and commercial licensees are planned to be required to offer flexible tariff package offers to their customers with smart meters to encourage better network utilisation. It is also included in the draft Long-Term Renovation Strategy, and it seriously addresses the opportunities, obligations and vision for the deployment of smart meters.

2.IV.v. Progress and current status on heating systems (Inspection / Equivalence)

Hungary has adopted alternative measures for inspection of heating and AC systems. This means that inspection systems will be replaced by other alternative actions, such as information campaigns on the replacement of obsolete or low-efficiency boilers, AC and heating systems. Such campaigns are integrated in the *Action Plan to Improve Awareness for Energy Efficiency and Climate Protection*[18].

The government has initiated several programmes to subsidise the installation of new condensing boilers to replace obsolete low-efficiency boilers and water heaters. The *Environmental and Energy Efficiency Operation Programme*[18] supported heating system modernisation actions and the integration of renewable energy systems for public buildings in recent years. The applicants can select from several renovation packages, including complex renovation and different combinations of 2 or 3 retrofit measures.

2.IV.vi. Progress and current status on AC systems (Inspection / Equivalence)

Split and multi-split AC systems are becoming more widespread in households. According to a law which passed in 2015, systems with cooling capacity higher than 7 kW must be registered in a state authority and should be maintained annually.

The support of AC systems is not a priority of the Hungarian energy policy actions. Instead of subsidising AC systems, the installation of shading devices is preferred. In the '*window exchange*' programme for single-family houses and small residential apartment buildings, the installation of shading devices was a priority[27].

2.IV.vii. Enforcement and impact assessment of inspections Enforcement and penalties

As mentioned above, Hungary has adopted alternative measures for the inspection of heating and AC systems. Therefore, the issue of enforcement and penalties is not relevant.

Three per cent (3%) of the 1.2 million boilers operating in Hungary have capacities below 20 kW, 80% have capacities between 20 and 30 kW, and 17% have capacities above 30 kW. Overall, 1,116 million boilers are affected by the EPBD requirement for on-site inspections. The share of household boilers is 90%, while the share of boilers in commercial and public institutions is 10%.

In 2018, the Ministry for Innovation and Technology sent the report on relevance of equivalent measures to the European Commission. The evaluation of this report is still ongoing.

3. A success story in EPBD implementation

The new building of the *Extreme Light Infrastructure* (*ELI*) project's scientific centre in Szeged, commissioned in 2017, is considered a success story for Hungary.

The *ELI* project is an integral part of the European plan to build the next generation of large research facilities identified and selected by the European Strategy Forum on Research Infrastructures (ESFRI). The extreme light infrastructure is the first infrastructure in the world capable of the investigation of the interactions between light and matter with the highest intensity, in the so-called ultra-relativistic range.

The constructed buildings house laser equipment, secondary sources, target areas, laser preparation and other special laboratories. They also provide sufficient administration space for approximately 250 researchers and support staff. There are also seminar, meeting and conference rooms, electrical, mechanical and optical workshops, and a library. These state-of-the-art facilities require specialised design and cutting-edge implementation of the latest technology for vibration levels, thermal stability, relative humidity, clean room facilities and radiation protection conditions.

Special function and comfort requirements are imposed by the function of the building. The technology requires significant ventilation and cooling. The building engineering system relies in part on renewable energy sources by using the air heat pump, thermal water energy and solar energy to reduce the energy required to operate the building[28].

The comfort features of the interior were designed with dynamic simulation, which is not yet widespread in Hungary.

Figure 7. The new building of the ELI scientific centre in Szeged [29]

4. Conclusions, future plans

The implementation of the 2018 EPBD requirements for new buildings and major renovations will bring important energy savings soon and in the long term, although new and renovated buildings only represent a smaller share (around 4.4 million dwellings and single-family houses in total) of the entire building stock in Hungary. There was a positive trend in new housing construction in the period 2016-2020. A

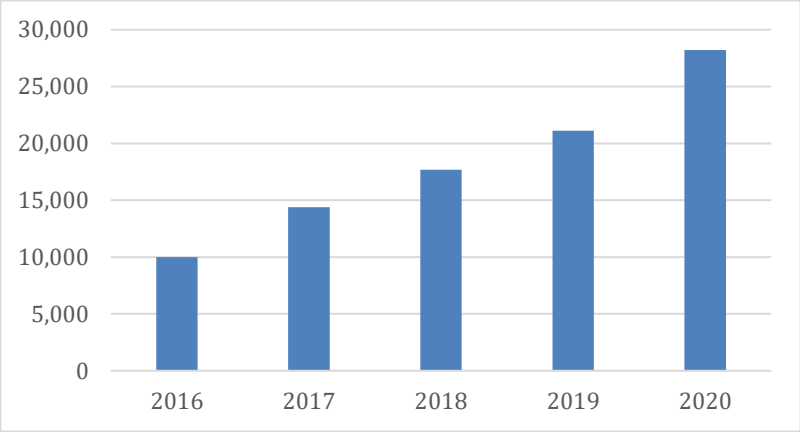

Figure 8: Construction of new dwellings in Hungary (units/year) Source: KSH[30]

A boom was experienced in 2016 due to the governmental support programme *CSOK*[31], which can be used for construction, purchase and expansion of new residential buildings for families with children. In these projects, the cost-optimal requirements have to be applied. *CSOK* gives support to families with one, two and three children for building or buying new houses or flats. Families with at least three children can get about 32,000 € non-refundable financial support and can have a loan of the same value. For one and two children, the loan is not entitled, and the support is significantly lower, too.

The boom in the building sector temporarily stopped with the first waves of the COVID-19 pandemic. In 2019, the performance of the building sector was 53% higher than in 2015. In 2020, 28,208 new flats have been commissioned.

The National Building Energy Strategy[18] envisages a significant reallocation of funds and support for the building sector for the period 2015-2020. Despite the difficulties, the introduction of energy performance requirements on partial renovations since 2013, and the introduction of cost-optimal requirements in 2015 for buildings that obtain public funding, can have a remarkable effect.

The NZEB concept is determining the construction market which in Hungary has been improved rapidly in the last years. The number of new flats in 2020 (~28,000) is still not sufficient to cover the needs. Regulatory changes and affordable technologies are expected to lead to a significant increase in the use of renewable energy sources in the coming years.

The thermal insulation, air tightness and shading characteristics of new buildings are close to reasonably achievable limits.

Perspectives in the fields of smart metering, electric cars, national grid, co-generation are more promising. However, these items are beyond the competence of the designers of individual buildings.

Renovation targets:

The renovation target for residential buildings is to reach a 5% renovation rate by the end of the period 2021-2030. This can reduce the total energy consumption and CO_2 emissions of residential buildings by approximately 30%.
Significant results have been achieved the last 4 years in the public buildings sector, and with the plans in mind, this trend is expected to continue.
The goal is to maintain a deep renovation rate of 3% for governmental buildings in the period 2021-2030. If this is achieved gradually, the total energy consumption and the CO_2 emissions of public buildings can be reduced by 12-13%.

Fire protection characteristics (e.g., façade fire propagation, reaction to fire) of the wide-spread combustible thermal insulation material used on facades and roofs requires more attention in future renovations. To help designers in Hungary to create fire-safe buildings, a set of technical guidelines for fire protection is available.[32]

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Annexes -Key Indicators & Decisions

Key Indicators & Decisions - General Background

no	Key Indicators & Decisions (KI&Ds) – General Background	Description / value / response	Comments
01.01	Definition of public buildings (according to article 9 b)	Buildings having an official function, owned by the state and non-profit.	
01.02	Definition of public buildings used by the public (according to article 13)	Buildings where more than 50% of the total floor area is used by the state or governmental authorities for administrative purposes	Governmental decree 176/2008
01.03	Number of residential buildings	2,722,488 (number of flats: 4,474,531)	Total number Source: Hungarian Central Statistical Office, 2020
01.04	Number of non-residential buildings	287,032	Total number incl. commercial, educational, health care, public administration, social, cultural and other buildings Souce: Hungarian Central Statistical Office, 2005
01.05	If possible, share of public buildings included in the number given in 01.04	22,990	Total number based on consultant's estimation
01.06	If possible, share of commercial buildings included in the number given in 01.04	220,149	Total number Source: Hungarian Central Statistical Office, 2005
01.07	Number of buildings constructed per year (estimate)	approximately 28,000	Highest number in the last decade Source: Hungarian Central Statistical Office, 2020
01.08	If possible, share of residential buildings constructed per year (estimate, included in the number given in 01.07)	63%	Source: Hungarian Central Statistical Office, 2020
01.09	If possible, share of non-residential buildings constructed per year (estimate, included in the number given in 01.07)	37%	Source: Hungarian Central Statistical Office, 2020
01.10	Useful floor area of buildings constructed per year in million square meters (estimate)	6.62	Source: Hungarian Central Statistical Office, 2020

Key Indicators & Decisions – New Buildings

no	Key Indicators & Decisions (KI&Ds) – New Buildings	Description / value / response	Comments
02.01	Are building codes set as overall value, primary energy, environment (CO_2), reference building or other	Primary energy, in some cases reference building	
02.02	Requirements for energy performance of residential buildings in current building code	U values Specific heat loss coefficient: q=1/V(ΣAU + ΣlΨ - (Qsd+Qsid)/72) Total primary energy factor: Ep=EH+EDHW+EV+EC+EL+ETR	Cost-optimal and nZEB after 2020. 3 basic and 3 supplementary requirement levels: -U-values of building envelope elements -Specific heat loss coefficient -Total primary energy factor -Summer overheating -Technical building system elements -Minimum share of RES (only nZEB)
02.03	Requirements for energy performance of non-residential commercial buildings in current building code		For building types other than residential, educational and office a reference building method is applied.
02.04	Requirements for energy performance of non-residential public buildings in current building code		For building types other than residential, educational and office a reference building method is applied.
02.05	Is the performance level of nearly zero energy (NZEB) for new buildings defined in national legislation?	Yes	7/2006. (V. 24.) decree of the Minister without portfolio
02.06	Nearly zero energy (NZEB) level for residential buildings (level for building code)	100 kWh/m^2year primary energy and minimum 25% of renewable to non-renewable ratio	
02.07	Year / date for nearly zero energy (NZEB) as level for residential buildings (as indicated in 02.04)	From 01.01.2021	
02.08	Nearly zero energy (NZEB) level for all non-residential buildings (level for building code)	offices: 90 kWh/m^2year primary energy (110 if air-conditioned building) and 25% renewable share educational: 85 kWh/m^2year primary energy (110 if air-conditioned building) and min. 25% renewable share other: reference building method must be applied and min. 25% renewable share	
02.09	Year / date for nearly zero energy (NZEB) as level for non-residential	From 01.12.2019	Only for buildings used by public authorities

no	Key Indicators & Decisions (KI&Ds) – New Buildings	Description / value / response	Comments
	buildings (as indicated in 02.06)		
02.10	Are nearly zero energy buildings (NZEB) defined using a carbon or environment indicator?	No	
02.11	Is renewable energy a part of the overall or an additional requirement?	Yes where the share of renewable energy cannot be reasonably (technically, economically, or environmentally) met, the actual legislation allows the builder to replace it by meeting an increased cost-effectiveness requirement	
02.12	If renewable energy is an additional requirement to NZEB, please indicate level		
02.13	Specific comfort criteria for new buildings, provide specific parameters for instance for airtightness, minimum ventilation rates	Requirements are similar as in standard EN 15251.	

Key Indicators & Decisions (KI&Ds) – Existing Buildings

no	Key Indicators & Decisions (KI&Ds) – Existing Buildings	Description / value / response	Comment
03.01	Is the level of nearly zero energy (NZEB) for existing buildings set in national legislation?	No	
03.02	Is the level of nearly zero energy (NZEB) for existing buildings similar to the level for new buildings?	No	
03.03	Definition of nearly zero energy (NZEB) for existing residential buildings (if different from new buildings)		
03.04	Definition of nearly zero energy (NZEB) for existing non-residential buildings (if different from new buildings)		
03.05	Overall minimum requirements in case of major-renovation	From 2018, cost-optimal requirements must be fulfilled.	See 2.1 and 2.2. Major renovation: if min. 25% of the building shell area is subject to energy retrofit.
03.06	Minimum requirements for individual building parts in case of renovation	From 2018, cost-optimal requirements must be fulfilled.	See 2.1.
03.07	National targets for renovation in connection to Long Term Renovation Strategy (number or percentage of buildings)		
03.08	National targets for renovation in connection to Long Term Renovation Strategy (expected reductions and relevant years)		111 PJ reduction by 2030 for the whole building stock[18] yearly 3% deep renovation of central govermental buildings[15]

Key Indicators & Decisions (KI&Ds) – Energy Performance Certificates

no	Key Indicators & Decisions (KI&Ds) – Energy Performance Certificates	Description / value / response	Comment
04.01	Number of energy performance certificates per year (for instance average or values for of 3-5 years)	approximately 165,000	Based on year 2019. The number is continuously increasing since 2013 (start of electronic registration).
04.02	Number of EPCs since start of scheme	approximately 1,100,000	Number of EPCs issued before 2013 is unknown.
04.03	Number of EPCs for different building types	95% are residential buildings	
04.04	Number of assessors	2,500	
04.05	Basic education requirements for assessors	BSc engineer	Several types of BSc diplomas (e.g., architects, mechanical engineers, civil engineers, environmental engineers, electric engineers) are accepted, but not all.
04.06	Additional training demands for assessors	No specific training required but an exam is obligatory. The exam is operated by the Chamber of Engineers and the Chamber of Architects. However, there are several courses available on the market on a voluntary basis.	
04.07	Quality assurance system	Quality assurance system is operated by the Chamber of Engineers since 2013. 2.5% of EPCs undergo an office check and 0.5% undergo an onsite survey. If the quality control detects a miscalculation of a difference by more than two energy classes, the expert loses his licence for 3 years. Since 2017, further sanctions can be applied including fines and penalties.	The online submission system also serves as a first level of quality control (e.g., checks for unrealistic figures). The second level is a random office check, the third level is an on-site survey carried out by independent experts. Control results are registered in an electronic database. As of the beginning of 2017, targeted control is also possible.
04.08	National database for EPCs	The national database is operated by Lechner Knowledge Centre. Only the main data of EPCs are stored, but calculation details not[20].	https://entan.e-epites.hu/
04.09	Link to national information on EPCs / Database	https://entan.e-epites.hu/	

Key Indicators & Decisions – Smart Buildings and Building Systems

no	Key Indicators & Decisions (KI&Ds) – Smart Buildings and Building Systems	Description / value / response	Comment
05.01	Is there a national definition of smart buildings?	No	
05.02	Are there current support systems for smart buildings?	No	
05.03	Are there currently specific requirements for technical building systems (for instance in building codes)?	No	
05.04	Are there current requirements for automatics (for instance in building codes)?	No	
05.05	Chosen option A or B for heating systems (inspection or other measures)	B	
05.06	Number of heating inspections; reports per year (if option A)	0	
05.07	Chosen option A or B for cooling systems (inspection or other measures)	B	
05.08	Number of air-conditioning / cooling system inspections; reports per year (if option A)	in residential sector estimated less than 5,000	
05.09	Is there a national database for heating inspections?	No	
05.10	Is there a national database for cooling / air-conditioning inspections?	Yes	
05.11	Are inspection databases combined with EPC databases for registration of EPCs and inspection reports?	No	
05.12	Link to national information on Inspection / Database		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement № 820497.