



CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS

EPBD implementation in Croatia

Status in December 2016

AUTHORS

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NATIONAL WEBSITES

www.mgipu.hr

1. Introduction

Croatia's first steps towards transposing the EPBD started in 2005; however, the Ministry of Construction and Physical Planning (MCPPI) officially began implementing the EPBD in 2008, and the Ministry of Economy became responsible for transposing certain other areas of the directive. With the new Building Act (OG 153/2013), the MCPPI became the sole ministry in charge of transposing and implementing the EPBD. The Building Act sets the legislative basis for the implementation of all articles of the EPBD.

In 2015, new values for the energy performance of buildings were established as follows:

- maximum annual primary energy consumption per usable floor area of a building (E''_{prim});
- maximum delivered energy per of usable floor area of a building (E''_{del});
- maximum annual energy needs for heating per usable floor area of a building ($Q''_{H,nd}$), for new buildings and for existing buildings undergoing renovation; and
- maximum E''_{prim} for NZEB and the share of RES in the total energy consumption.

Also prescribed within the Building Act are: the need for lighting, efficiency of technical building systems, energy efficiency class of the building automation and control systems. The study on the application of alternative energy supply systems is mandatory for buildings with a useful floor area of $\geq 50 \text{ m}^2$.

Currently, Croatia is running a test phase for implementing an electronic database for the EPCs and for reports of the regular inspection of heating and cooling/AC systems, as well as a national software tool for the calculation of the EPC.

In order to enhance the energy performance of buildings, four national programmes were adopted. Since 2014, a large number of buildings, particularly single- and multi-family buildings, have been renovated

using incentives provided by the Fund for Environmental Protection and Energy Efficiency (EPEEF). An ESCO model was used to renovate public sector buildings.

2. Current Status of Implementation of the EPBD

2.1. Energy performance requirements: NEW BUILDINGS

Energy performance requirements for new buildings are set for residential buildings and for various types of non-residential buildings heated to a temperature of 18 °C or higher. Furthermore, buildings heated to a temperature of 12-18 °C must meet requirements on minimum thermal protection, reduction of thermal bridges, requirements to prevent overheating, etc.

2.1.i. Progress and current status of new buildings

Based on cost-optimal analyses that were carried out in 2013 and 2014, requirements are set on individual types of buildings regarding annual energy needs for heating per usable floor area of a building ($Q''_{H,nd}$). The requirement regarding annual primary energy per usable floor area of a building (E''_{prim}) is included in the Technical Regulation on the rational use of energy and heat retention in buildings (OG 97/2014 and 130/2014) and the remaining requirements for annual delivered energy per usable floor area of a building (E''_{del}) are specified in the new Technical Regulation on the rational use of energy and heat retention in buildings, published in November 2015 (OG 128/15).

Requirements are prescribed for the maximum E''_{prim} , E''_{del} , $Q''_{H,nd}$, annual energy need for cooling per usable floor area of a building ($Q''_{C,nd}$), the maximum permitted thermal transmittance for individual building components of the building envelope (U-value), the reduction of the effects of thermal bridges (for this purpose, a catalogue of good solutions has been developed), the efficiency of technical building systems, the efficiency class of the building automation and control systems, the airtightness of buildings, and the share of RES. Provisions for indoor environmental quality (including air quality, thermal comfort, lighting and acoustics) are also provided.

2.1.ii. Format of national transposition and implementation of existing regulations

The EPBD is transposed within the Building Act (OG 153/2013), which also lays down penalties in order to ensure that all the requirements of the EPBD are fulfilled. The Building Act also sets some secondary regulations, including:

- the Technical regulation on the rational use of energy and heat retention in buildings (OG 128/2015);
- the Ordinance on energy audits of buildings and energy certification (OG 48/2014, [150/2014](#), [133/2015](#), [22/2016](#), [49/2016](#), [87/2016](#));
- the Ordinance on individuals authorised to perform energy certifications of buildings, energy audits of buildings and regular controls of heating systems and cooling or AC systems of buildings (OG 73/2015 and 133/2015);

- the Ordinance on the control of EPCs of buildings and of reports on energy audits of heating systems and cooling or AC systems (OG 73/2015);
- the Methodology for carrying out energy audits on construction activities with the algorithm for calculating the energy performance of buildings (June 2014), which includes the algorithm for calculating the energy performance of buildings based on CEN standards, except in individual cases where CEN standards were not appropriate, in which case other solutions were used (e.g., the application of the roof standard, ventilation and AC). This algorithm is updated occasionally. For the purpose of primary energy calculations, a set of primary energy conversion factors was determined. The calculation used three-year average data from actual annual energy balances of Croatia in 2009-2011. At the moment, some of these factors are under review;
- the Ordinance on energy audits of buildings and energy certification (OG 88/2017), entering into force on 30 September 2017;
- the Methodology for carrying out energy audits of buildings, entering into force on 30 September 2017.

2.1.iii. Action plan for progression to NZEB for new buildings

The primary energy requirements for NZEB were established in 2014 as the lowest primary energy values among the analysed systems, providing they do not correspond to high global costs. The least-cost measures have been determined using the cost-optimal analysis, thus setting the optimal level of energy consumption for new and refurbished buildings. In contrast, when determining the requirements for NZEB, the range of options with the lowest primary energy consumption have been chosen to set requirements regardless of the global cost of these options (between the lowest global cost and lowest primary energy requirement).

At least 30% of the annual primary energy must be covered using RES generated on-site (i.e., by the building itself or somewhere in its vicinity); requirements for $Q_{H,nd}$ and U-values for building elements are also applied as for new buildings.

NZEB definitions were set in 2014 for all types of buildings and have recently been updated in the Technical Regulation of 2015. Values for maximum allowed E''_{prim} for some types of buildings (according to the regulations from 2014) have slightly increased due to the variety of reference geometry input when analysing cost-optimality and NZEB. In situations where values for NZEB were higher than the values obtained in the cost-optimal analysis, the values for NZEB were corrected according to the results of the geometry for cost-optimal analysis.

The number of low-energy and passive buildings increases in Croatia on a yearly basis, particularly for single-family houses, multi-residential buildings and recently constructed office buildings.

2.1.iv. Requirements for systems and / or building components for new buildings

Requirements are set:

- for buildings as a whole;
- for the U-values of the building envelope elements;
- for the reduction of the effects of thermal bridges and water vapour condensation inside building elements and on the surface of building elements;
- on the efficiency of technical building systems.

Since 2015, in addition to the previously determined U-values for building envelope elements, U-values are also prescribed for cupolas, light bars and windshields.

The designed and installed heating systems in new buildings must compensate for heat losses in order to maintain indoor thermal comfort. Among other requirements, heating systems must have thermally insulated pipeworks.

For buildings equipped with heating systems with air-to-air heat pumps, the seasonal coefficient of the performance of individual heat pumps (SCOP) should be ≥ 4.0 ; for heating systems with air-to-water, water-to-water and soil-to-water heat pumps, the seasonal performance factor (SPF H3) of individual heat pumps should be ≥ 3.0 . SCOP includes the heat pump, regulation, auxiliary heating unit and other parts of the system, such as pumps and ventilators on the side of the heat storage tank. SPF H3 is the factor which influences the calculated limit that includes the heat pump, regulation, auxiliary heater, and all parts of the system, including pumps and fans on the side of the tank's thermal sources (air, water, soil). Air-to-air systems do not contain the listed parts (they contain freon) and have no impact on the factor.

2.II. ENERGY PERFORMANCE Requirements EXISTING BUILDINGS

Energy performance requirements for existing buildings, heated to a temperature of 18 °C or higher undergoing reconstruction are set depending on building type and the size of the reconstruction. Buildings heated to a temperature of 12-18 °C shall meet requirements on minimum thermal protection, reduction of thermal bridges, requirements to protect overheating, etc.

2.II.i. Progress and current status of existing buildings

Requirements for energy performance are prescribed for existing buildings undergoing major renovations that include more than 75% of a heated building envelope and in the case of a building extension.

In the case where only certain building envelope elements of a heated part of the building covering an area over 25% are renovated, the U-value of the entire building element (for all types of buildings) shall fulfill the prescribed requirements.

In the case where reconstruction covers an area over 75% of the surface of the heated building envelope, requirements are set as U-values for the building elements, $Q''_{H,nd}$, E''_{del} , E''_{prim} (including energy for heating, cooling, ventilation, hot water, and lighting for non-residential buildings).

The application of highly efficient alternative systems should also be considered and taken into account in so far as they are technically, economically and functionally feasible.

2.II.ii. Plans to improve the existing building stock

Case Study



The office building in Žminj (AGM PROJEKT d.o.o.) is a reinforced concrete building with a total floor area of 802.00 m². The building elements include:

- external walls and walls touching the garage and attics insulated with mineral wool (20 cm);
- flat and sloping roofs above heated spaces and ceilings towards attics insulated with mineral wool (40 cm);
- ceilings above outdoor air and ceilings above garage isolated with mineral wool 25 cm;
- windows with three-layered glazing – tinted glass, double low coating, U-value = 0.9 – 1.1 W/(m² K).

RES in the building: PV power plant 10 kW, total energy production 13,000.00 kWh/year; solar water heating systems for low temperature underfloor heating and domestic hot water; heat pump with a coefficient of performance of 4.13. The air inside the building is exchanged via a forced recuperation ventilation system combined with a heat exchanger.

LED lighting is combined with sensor lighting. Building automation and control systems of the thermal engineering, lighting and shading opening the envelope of the building depending on day lighting throughout the year, with the task to prioritise parts of the technical building systems in order to optimise consumption of operating energy. $Q''_{H,nd} < 15$ kWh/m²year, electrical energy consumption is 882.65 kWh/year.

Figure 1. Office building in Žminj

The national definition of NZEB is the same for both new and renovated buildings. As a result, achieving NZEB standards in existing buildings in many cases can be difficult, specifically when fulfilling the share of RES. The main obstacles for the renovation of the national building stock into NZEB are due to financial constraints, including long periods of return on investment, different priorities for stakeholders, lengthy and complex public tenders for funding, but also the lack of information and motivation for investors, the public and stakeholders.

The National Action Plan to increase the number of NZEB by 2020 (published in 2014) covers all types of buildings, including non-residential buildings that are used by the public, e.g., offices, educational buildings, hospitals and sports facilities.

Croatia plans on increasing the number of NZEB through programmes that stimulate the construction of energy efficient renovations (e.g., the Programme for energy renovations of the public building sector).

According to the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia¹, in order to achieve targets and indicators for the period up to 2050, various measures are envisaged. These include developing renovation techniques (e.g., in relation to the type of material from which a building is built, or specifically for the renovation of historic buildings and buildings of cultural significance), training workers and certifying contracting companies. Around 1% of the building stock is forecasted to undergo holistic renovation to the NZEB standard each year up to 2020. It is then envisaged that 5% of buildings shall be renovated to the NZEB standard or to a high energy-performance level and finally, by 2050, all buildings will be NZEB or have a high energy efficiency, thus reducing greenhouse gases in buildings by 80%.

The costs for achieving the energy renovation objectives (to NZEB standards), including funds for investment and operation, are estimated to be nearly 7 billion € up to 2050.

The required energy saving level in central government buildings (774 buildings with a total floor area of 1,325,000 m²) must be achieved using an alternative approach, in line with Article 5 of the EED. The annual savings (equivalent to renovating 3% of the buildings owned and occupied by the central government) have been calculated to reach 1.36 GWh (4.89 TJ) per year. This consumption corresponds to approximately 17 buildings being renovated annually, and represents 0.0045% of the total final consumption of all buildings in 2012 (ca. 29,777.78 GWh).

The Programme for the energy renovation of the public building sector (central government buildings are included) promotes deep renovation of the buildings, which therefore includes measures for the building envelope as well as for technical building systems. According to the National Energy Efficiency Action Plan III (NEEAP III), on an annual basis up to 2020, it is planned to arrange and implement a comprehensive energy renovation of 33,267 m² of total useful floor area (heated area) of central government buildings (which represents 3% of the total useful floor area).

2.II.iii. Regulation of system performance, distinct from whole building performance

Requirements are set for individual elements of buildings and for technical building systems in case of building renovation. When renovating part of the building envelope, the U-value of this part shall meet the requirements as prescribed for a new building. The prevention of overheating caused by solar radiation and air permeability of the windows, doors and skylights shall comply with the requirements specified for new buildings. When replacing, modernising or upgrading technical building systems, the same requirements apply as for the installation of these technical building systems in new buildings.

2.II.iv. Encouragement of intelligent metering

Promotion and encouragement to include intelligent metering is prescribed by the Building Act. Each building, depending on the type and purpose, must be designed and constructed so that it is possible, without significant costs, to ensure individual metering of energy and water consumption, with the possibility to have remote readings for individual and separate parts of the building.

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

Until now, the role of the government has been crucial in the success of building energy renovation. In 2013, 2014 and 2015, the government adopted four building renovation programmes for single-family houses, multi-family houses, commercial buildings and public sector buildings.

The programmes for the energy renovation of both single-family and multi-family houses that were implemented by the end of 2016 provided financial incentives for integral renovations as well as for implementing individual measures to improve energy-efficiency.

So far, 9,574 projects for implementing energy efficiency and installing RES in single-family houses have been completed and about 476 million kuna (64.9 million €) has been disbursed from the national Environmental Protection and Energy Efficiency Fund (EPEEF).

Over 2,300 projects or requests from building managers have been approved and contracted under the programme for the energy renovation of multi-family houses and a total funding of more than 279 million kuna (37.5 million €) was approved.

Also, 170 requests for the energy renovation of commercial buildings have been received, of which 80 have been approved, and for which 46 million kuna (6.2 million €) has been secured. Of those approved projects, 43 projects have been completed, for which about 20 million kuna (2.7 million €) has been paid.

Regarding the implementation of the Programme for the energy renovation of public sector buildings, 57 public procurement procedures have been published for the provision of energy services and 20 agreements on the energy performance of buildings have been signed. The estimated value (excluding VAT) is about 364 million kuna (48.9 million €).

During 2016, a further 7 contracts for building energy performance were signed for an estimated value (excluding VAT) of 219 million kuna (29.4 million €).

Adaptation of existing programmes for energy renovation to the conditions of co-financing from the EU funds, for which 311 million euros are provided up to 2020, is in progress.

2.II.vi. Information campaigns / complementary policies

Information activities are mainly focused on the promotion of national energy renovation programmes. MCPP and EPEEF have been carrying out workshops with interest groups in many cities throughout Croatia. Information leaflets with all the rules for submitting project proposals for subsidies for energy renovations were prepared and distributed. Additionally, the EPEEF has assisted applicants in filling out and completing the forms for incentives for energy renovations.

In order to achieve the required level of energy efficiency, the Croatian Chamber of Architects, the Croatian Chamber of Civil Engineers, the Croatian Chamber of Mechanical Engineers and the Croatian Association of Building Energy Assessors provide seminars for designers and site engineers who carry out and are responsible for the execution of certain buildings works.

A national platform on energy efficiency has been established with the aim to promote energy efficiency at the national level, informing the general public about the plans, realised measures and their effects (www.enu.hr).



Figure 2. Information leaflet for the energy renovation of multi-family houses, MCPP, 2016.



Figure 3. Information leaflet for the energy renovation of public sector buildings and use of RES, MCPP, 2016.



Figure 4. Information leaflet for the energy renovation of family houses, EPEEF, 2015.

2.III. Energy performance certificate requirements

An EPC shall be issued for buildings or their particular components when it is necessary to use energy to maintain the indoor design temperature in accordance with their purpose. EPCs are issued prior to the issuing of a building use permit, or when selling, renting out or leasing a building. The validity of the EPC shall not exceed ten years from the date of its issue.

An EPC for both residential and non-residential buildings contains 5 pages. The energy class is expressed as the annual energy need for heating per usable floor area of a building $\{Q''_{H,nd,ref} [kWh/(m^2 \cdot year)]\}$ in the reference climate for residential buildings and as $Q_{H,nd,rel} (\%)^2$ for non-residential buildings.

In the new Ordinance on energy audit of buildings and energy certification (OG 88/2017), for both residential and non-residential buildings, the energy class shall be expressed in two ways: as the annual energy need for heating per usable floor area of a building $\{Q''_{H,nd} [kWh/(m^2 \cdot year)]\}$ and as the annual primary energy per usable floor area of a building $\{E_{prim} [kWh/(m^2 \cdot year)]\}$.

Energetski certifikat nestambene zgrade	Zgrada <input type="checkbox"/> nova/veća rekonstrukcija <input type="checkbox"/> prodaja <input type="checkbox"/> izmjena/veća rekonstrukcija <input type="checkbox"/> iznajmljivanje <input type="checkbox"/> iznajmljivanje		
	Vrsta zgrade		
	Naziv zgrade		
	Adresa		
	Mjesto		
	k.č.		k.o.
	Vlasnik / investitor		
	Godina izgradnje		Izvođač
	prema Direktivi 2010/31/EU		
	$Q_{H,nd,rel}$		%
			Izračun
			49
	A+		≤ 15
	A		≤ 25
	B		≤ 50
C		≤ 100	
D		≤ 150	
E		≤ 200	
F		≤ 250	
G		> 250	
Podaci o zgradi			
A_c [m ²] V_c [m ³] V_g [m ³]			
$Q_{H,nd,rel}$ [kWh/(m ² ·a)] $H_{g,nd}$ [W/(m ² ·K)]			
Podaci o osobi koja je izdala energetski certifikat			
Ovlaštena fizička ili pravna osoba			
Imenovana osoba u pravnoj osobi			
Registarski broj ovlaštene osobe			
Oznaka energetskog certifikata			
Datum izdavanja / rok važenja			
Potpis ovlaštene fizičke ili imenovane osobe			
Podaci o osobama koje su sudjelovale u izradi energetskog certifikata			
Dio zgrade	Ovlaštena osoba	Registarski broj	Potpis
Građevinski			
Strojarski			
Elektrotehnički			

Figure 5. EPC of a non-residential building – first page.

ENERGETSKI-CERTIFIKAT-ZGRADE				
prema Pravilniku o energetskom pregledu zgrade (energetskom certifikatu) (NN 48/04, 10/07, 10/08, 10/09, 10/10, 10/11, 10/12, 10/13, 10/14, 10/15, 10/16, 10/17, 10/18, 10/19, 10/20, 10/21, 10/22, 10/23, 10/24, 10/25, 10/26, 10/27, 10/28, 10/29, 10/30, 10/31, 10/32, 10/33, 10/34, 10/35, 10/36, 10/37, 10/38, 10/39, 10/40, 10/41, 10/42, 10/43, 10/44, 10/45, 10/46, 10/47, 10/48, 10/49, 10/50, 10/51, 10/52, 10/53, 10/54, 10/55, 10/56, 10/57, 10/58, 10/59, 10/60, 10/61, 10/62, 10/63, 10/64, 10/65, 10/66, 10/67, 10/68, 10/69, 10/70, 10/71, 10/72, 10/73, 10/74, 10/75, 10/76, 10/77, 10/78, 10/79, 10/80, 10/81, 10/82, 10/83, 10/84, 10/85, 10/86, 10/87, 10/88, 10/89, 10/90, 10/91, 10/92, 10/93, 10/94, 10/95, 10/96, 10/97, 10/98, 10/99, 10/100)				
Naziv zgrade				
Mjesto zgrade				
Vrsta zgrade				
Vrsta zgrade prema složenosti tehničkih sustava				
Vlasnik / investitor				
k.č. broj				
k.o. broj				
Plošna korisna površina grijanog dijela zgrade A_c				
Godina izgradnje / rekonstrukcije				
Građevinski (bucni) zvučni zgradje (m ² /s)				
Mjerska i metrološka postaja				
Klimatizacija (m ² /s)				
Klimatizacija				
ENERGETSKI- RAZRED- ZGRADE:				
		Specifična godišnja potrošnja toplinske energije za grijanje $Q_{H,nd}$ [kWh/(m ² ·a)]		
		Specifična godišnja primarna energija $E_{H,nd}$ [kWh/(m ² ·a)]		
		C		
		B		
Specifična godišnja isporučena energija $E_{H,nd}$ [kWh/(m ² ·a)]				
Specifična godišnja emisija CO ₂ [kg/(m ² ·a)]				
Uspoređujući nZEB s najvišom razredom zgrade ($E_{H,nd}$) zadovoljava zahtjeve za nZEB (potrošnja toplinske energije za grijanje) $E_{H,nd}$		nZEB		
ROK-VAŽENJA-CERTIFIKATA /-PODACI-O-OSOBI-KOJA-JE-IZDALA-ENERGETSKI-CERTIFIKAT				
Oznaka energetskog certifikata	Datum izdavanja	Datum važenja		
Nasiv ovlaštena pravna osoba		Registarski broj		
Ime i prezime imenovane osobe u ovlaštenoj pravnoj osobi				
Ime i prezime ovlaštene fizičke osobe /vlastoučni potpis				
PODACI-O-OSOBAMA-KOJE-SU-SUDJELOVALE-U-IZRADI-ENERGETSKOG-CERTIFIKATA				
Dio zgrade	Ime i prezime ovlaštene osobe	Nasiv pravna osoba	Registarski broj	Vlastoučni potpis
Građevinski				
Strojarski				
Elektrotehnički				

Figure 6. EPC of residential and non-residential buildings according to the new ordinance.

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

As of January 2014, sale advertisements published in the media must indicate the building energy class. This obligation is commonly followed.

The law imposes penalties for owners who fail to provide an EPC at the time of selling, renting or leasing a building. Penalties are also imposed if the owner fails to deliver the EPC to the buyer, or if they fail to indicate the energy class in the sale advertisement published in the media.

2.III.ii. Quality Assurance of EPCs

All issued EPCs undergo administrative control during their entry into the database. Detailed quality control is carried out on EPCs that are randomly selected and/or based on complaints.

So far, 324 out of about 150,000 EPCs in total were checked in detail, 50 of which were declared invalid. Detailed control includes checks of the content of the report on the energy audit of the building, the validity and completeness of the input data, the accuracy of the EPC and the calculated and proposed measures to improve the energy performance of the building.

An EPC is declared invalid only if it contains calculation results, input data or proposed measures with significant (more than 30%) deviation and if the result causes a change of one or more energy classes.

Authorised persons shall be sanctioned by means of a fine or by annulment of authorisation in the case of 3 or more invalid EPCs.

Ime i prezime	OIB	E-mail	Status	Username	Role	Registrarski brojevi	
Alen Čurin	44235365931	alen@curinautika.hr	Aktivan	nias.44235365931	MGIPIU_KOR	F-325/2013, P-773/2014	Aktiviraj Deaktiviraj
Alfred Bemt	23605465425	alfred.bemt@hpb.hr	Aktivan	nias.23605465425	MGIPIU_KOR	P-565/2014	Aktiviraj Deaktiviraj
Ante Bašić	13957814236	ante.basic.abinz@gmail.com	Aktivan	nias.13957814236	MGIPIU_KOR	P-410/2013	Aktiviraj Deaktiviraj
Ante Lozica	66165735444	ante@ant-lozica.hr	Aktivan	nias.66165735444	MGIPIU_KOR	P-505/2014	Aktiviraj Deaktiviraj
Arman Budaković	84345603654		Aktivan	nias.84345603654	MGIPIU_KOR	P-117/2011	Aktiviraj Deaktiviraj
ARNOLD HREN	64109743799	arnold.hren@du.t-com.hr	Aktivan	nias.64109743799	MGIPIU_KOR	F-47/2010, P-1039/2016	Aktiviraj Deaktiviraj
BENAK ŽELJKA KOLAR	50855634635	zeljka@trio-projekt.hr	Aktivan	nias.50855634635	MGIPIU_KOR	F-362/2013	Aktiviraj Deaktiviraj
BOGUNOVIĆ SANJA KAIĆ	67992679825	s.kaic.22@gmail.com	Aktivan	nias.67992679825	MGIPIU_KOR	F-103/2011	Aktiviraj Deaktiviraj
Bojan Livaković	20260584527	blivakovic@net.hr	Aktivan	nias.20260584527	MGIPIU_KOR MGIPIU_KONTROLA	P-109/2011, K-6/2015	Aktiviraj Deaktiviraj
BORIS ŠTAMBUK	53917110343	boris.stambuk@ka.t-com.hr	Aktivan	nias.53917110343	MGIPIU_KOR	F-446/2013	Aktiviraj Deaktiviraj

Figure 7. Screenshot of the electronic data base.

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

Public buildings with a total useful floor area of over 250 m² must display the EPC. This includes public buildings used by public authorities for performing their activities and buildings used to house specific population groups (e.g., elderly persons, children, etc.) and non-residential buildings in which a high number of people are present or are provided with a service.

Municipal services officers control whether these EPCs are adequately displayed by visiting the buildings and making a report. In the case of non-compliance with the regulation, they shall ask the owner to display the EPC.

EPCs for public buildings are in the same format as those of non-residential buildings and follow the same procedures (audit followed by issue of EPC).

Fines for public building owners who fail to display the EPC are established by law and amount 15,000 to 30,000 kuna (approximately 2,000 – 4,000 €) for legal entities, and 5,000 to 10,000 kuna (approximately 700 – 1,300 €) for natural persons. The obligation for public display of the EPC is commonly followed and no fines have yet been issued.

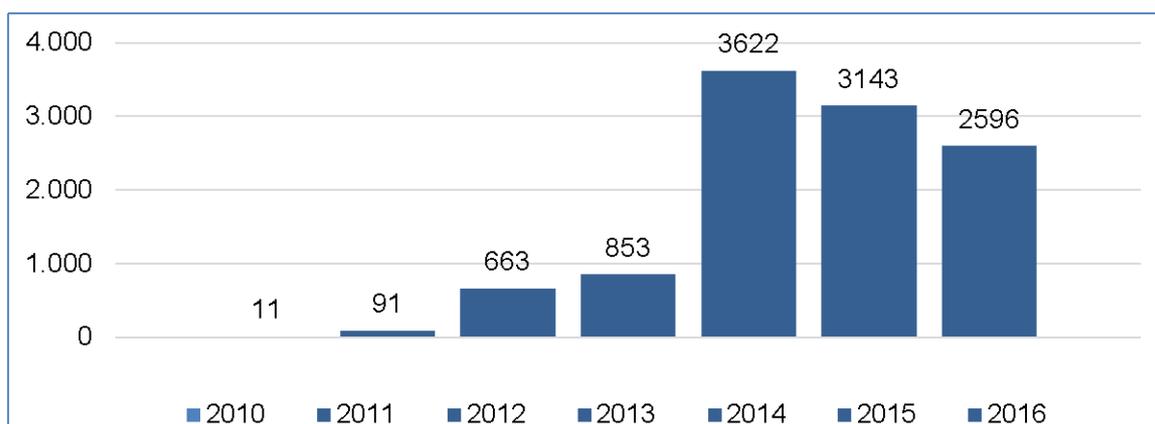


Figure 8. Display of the EPC in public buildings for the period of 2010 – 2016.

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

As of January 2014, there is an obligation to indicate the energy class in the sales advertisements published in the media. Penalties are imposed by law both for owners and for authorised real estate brokers.

Supervision is under the competence of the Ministry of Economy, Market Inspectorate. This obligation is commonly followed and no fines have been issued so far.

2.IV. Inspection requirements - heating systems, air conditioning

2.IV.i. Report on equivalence of model A for Heating Systems

Regular inspection of the heating system in a building must be carried out alongside the energy audit of the building for the purpose of issuing an EPC. When not concurrent with EPC issuance, heating systems with a boiler of an effective rated output of more than 20 kW are regularly inspected every 10 years. Those with a boiler of an effective rated output of more than 100 kW are inspected every 2 years, or 4 years in the case of a gas-fuelled boiler.

2.IV.ii. Progress and current status on heating systems

A regular inspection includes a visual and functional inspection of the heating system and of heated areas, the necessary measurements, an assessment of the size of the system relative to the building's needs and a proposal of measures to improve the energy efficiency of the system and/or to apply alternative solutions.

The registry of inspection reports is prepared and the database of regular inspections is currently in a test phase.

2.IV.iii. Progress and current status on AC systems

The inspection of cooling/AC systems is obligatory and must be carried out alongside the energy audit of the building for the purpose of issuing an EPC. If not established in parallel with the issued EPC, cooling systems with an effective rated output of 12 kW or more shall be regularly inspected, at least once every 10 years.

Regular inspections of cooling/AC systems in buildings include a visual and functional check of the cooling/AC system, cooled and air-conditioned space, the necessary measurements, a proposal of measures for improving the energy efficiency and/or applying alternative solutions as well as drafting a final report.

Regular inspections shall be carried out at least once every ten years. The registry of inspection reports is prepared and the database of regular inspections is currently in a test phase.

2.IV.iv. Enforcement and impact assessment of inspections

Enforcement and penalties

Regular inspections of heating and cooling/AC systems of a building must be performed by authorised personnel. Authorisation is granted by the MCPP for a period of 5 years to a person qualified in the field of mechanical engineering (university study), with 5 years of professional working experience and with a completed appropriate professional training programme.

Enforcement and penalties for the owner of a building are the same as for the EPC. No fine has yet been issued.

Quality control of inspection reports

The quality control of inspection reports is performed by the legal personnel authorised to carry out control checks. Quality control shall be carried out on reports that are randomly selected and based on complaints. The authorised personnel checks the completeness of the report and the proposed measures to improve energy efficiency.

The report on the regular inspection of heating and cooling/AC systems of a building is declared invalid if the control determines that the report contains less than 30% of the required data and there is no justification for this in the report. Authorised personnel who issue invalid reports shall be sanctioned by means of fines and annulment of authorisation in the case of 3 or more reports being invalid.

So far, 35 reports on regular inspections of heating systems in buildings were issued and 2 for cooling/AC systems, all as part of the report on building audits that were performed for the purpose of issuing EPCs.

Up until now no inspection reports have been controlled.

Impact assessment

Since regular inspections of heating and cooling/AC systems started recently and due to the small number of issued reports, no control has yet been performed.

3. A success story in EPBD implementation

The best example of the promotion of energy efficiency and sustainable construction is when the idea is materialised and visible, and when the results confirm assumptions. Such a best-practice example of multi-family house is the ECO-SANDWICH house. The first house, one of the twelve planned typical multi-family houses with three apartments as a new type of housing within the programme of subsidised housing construction (POS), was completed on 7 September 2016, with an energy class of A+.

The first ECO-SANDWICH house is the first realisation of the prefabricated ventilated facade system ECO-SANDWICH, which is the result of the cooperation between Croatian scientific institutions (Construction and Architecture, University of Zagreb) and Construction industry (Beton Lucko Ltd., Knauf Insulation Ltd., Eurco dd), and was approved to be funded under the EU programme CIP-EIP-Eco-Innovation 2011. As an innovative product, ECO-SANDWICH was also recognised by the EPEEF, which co-financed the project.

The project objectives go beyond energy efficiency alone; the project also encourages the recycling of construction waste, increasing the efficient use of existing resources and increasing the possibility of using construction and demolition waste. The promotion of the use of thermal insulation materials is based on ECOSE³ technology, which does not contain harmful substances such as formaldehyde, phenols, pentane, butane and acrylics, and the production of which requires 70% less energy than in the case of conventional mineral wool using a binder in base oil.

The ECO-SANDWICH wall panels were casted out of concrete containing 50% of recycled aggregates, and thus they contribute to resource efficiency goals, together with the energy efficiency goals. Additionally, the project ECO-SANDWICH promotes the application of prefabricated panels that reduce embedded energy in the product, as well as greenhouse gas emissions and harmful by-products from the production. Environmental Product Declaration (EPD) was produced for the ECO-SANDWICH wall panels in cooperation with Pre consultants from The Netherlands, according to the EN 15804 standard. During the construction of

the residential building in Koprivnica, green public procurement was performed for the design as well as construction phase.



Figure 9. Multi-family house in Koprivnica, Lenišće

4. Conclusions, future plans

The combination of requirements set for new buildings, renovated buildings and NZEB, and subsidies that were assigned to the improvement of the energy efficiency of existing buildings will bring significant energy savings over the coming years. The recommendations in the EPCs serve as good guidelines to help owners decide on implementing some of the possible energy improvements. The number of qualified experts necessary for issuing EPCs and for regular inspections of technical systems is sufficient to cover all the market needs.

The national calculation tool has been developed and is in a test phase; due to complex calculation procedures it will only cover the most commonly encountered combinations of RES and combined heat and power systems, so there is a need for a more comprehensive calculation tool to complement this tool.

The future plans are:

- To strengthen the existing quality assessment scheme and increase the number of EPCs to be controlled, which currently stands at 0.3% of issued EPCs.
- To implement a new scheme for the EPC in which the energy performance indicator for building classification shall be expressed in primary energy (including energy for space heating, cooling, ventilation, domestic hot water and lighting), and the energy class shall be based on the reference energy performance. The ordinance has been published and shall enter into force on 30 September 2017 along with the methodology for carrying out energy audits of buildings.
- To continue information campaign and develop a new campaign to raise awareness on the benefits of building energy renovations and the purpose of energy certification and regular inspection of heating and cooling/AC systems.

- To continue improving the informatics platform that supports the issuing of the EPCs and collecting reports on the regular control of heating and cooling/ AC system.
- To improve and simplify the calculation methodology and software tool for the calculation of the energy performance of buildings.
- To perform a new cost-optimal analysis.
- To implement programmes for the energy renovation of buildings up to 2020, for which 311 million € from EU funds are available and to develop new and improved support schemes for building energy renovation as well as for the construction of buildings to the NZEB standard.

Endnotes

1. http://ec.europa.eu/energy/sites/ener/files/HR-Art4BuildingStrategy_en.pdf
2. The relative value of the annual thermal energy needs for heating for non-residential buildings, $Q_{H,nd,rel}$ [%], is the ratio of the specific annual energy needs for heating in the reference climate, $Q'_{H,nd,ref}$ [kWh/m³.year] and the permitted specific annual energy needs for heating for reference climatic data, $Q'_{H,nd,dop}$ [kWh/m³.year], and is calculated according to the following expression: $Q_{H,nd,rel} = Q'_{H,nd,ref} / Q'_{H,nd,dop} \times 100$ [%].
3. ECOSE technology means production of mineral wool in which natural resins (sugars) are used as the binder which polymerise and bind the fibers of mineral wool at a temperature of approximately 200-250 °C.



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