1. Introduction

The implementation of the Energy Performance of Buildings Directive (EPBD) in Croatia started in 2005. Since the recent amendments of the Energy Efficiency Act in May 2012, the implementation of the EPBD has come in its entirety into the responsibility of the Ministry of Construction and Physical Planning.

The EPBD has been transposed into the national legislation. The Physical Planning and Building Act, published in the Official Gazette No. 76/2007, laid the legal basis for the adoption of the implementation regulations regarding the application of the minimum Energy Performance (EP) requirements for new buildings and building components, as well as for existing buildings and building components that are subject to renovation. The Energy Efficiency Act, published in the Official Gazette No 152/2008, laid the legal basis for the adoption of the implementation ordinances regarding the application of other requirements of the Directive: the obligations for issuing Energy Performance Certificates (EPC), and for the inspection of heating and air-conditioning systems, as well as the obligations for establishing an independent control system. All regulations and ordinances are under the responsibility of the Ministry of Construction and Physical Planning.

For the full implementation of the recast EPBD, the EP of a building (which includes a numeric indicator of primary energy) has to be set in order to achieve cost-optimal levels. This is planned to be completed by the end of 2013. An energy certificate of a building includes the determination of its energy class, taking into account its energy performance identified on the basis of a calculated specific annual energy need for heating for the reference climatic data.

The first requirements relating to energy economy and heat retention for buildings were set by a regulation in 1970, which defined the requirements for the building envelope. Requirements were put regarding the specific thermal losses and the maximum permitted thermal transmittance values for building elements. The last improvement of these requirements was in 1987. In 2005, in order to comply with the EPBD, new requirements on buildings were set, which included a maximum permitted annual energy use for heating, as well as new higher restrictions on thermal transmittance values for building elements.

Any improvement of the legislation in the field of construction will allow the reduction of the energy consumption for home heating. Building on principles of implementing energy efficiency measures introduced by the EPBD, brings major changes. In fact, building in compliance with the new rules brings significant reduction in the energy consumption (at least 30%) for space heating in the housing sector, and an average of about 50%, compared to the period before the implementation of the Directive. New savings that are planned for the future are expected to bring an additional reduction of 20% in the final energy consumption for space heating in the housing sector. Real projections will be more accurate after the completion of the cost-optimal analysis.

National Website www.mgipu.hr
The energy standard for Nearly Zero-Energy Buildings (NZEB) includes further reductions of the energy consumption, and establishes the minimum requirements of renewables. It is assumed that the final energy demand for heating in the housing sector until 2021 could be decreased by an additional 40%.

2. Energy performance requirements

The Energy Performance (EP) requirements for new buildings differ with regard to the temperature at which the buildings are heated, their purpose (residential and non-residential) and their size.

2.1 Progress and current status

The regulation imposes limits on the following items:

1. Maximum permitted annual energy use for heating per m² of usable floor area of a building, or per m³ of a heated part of a building.
2. Maximum permitted transmission heat transfer coefficient per m² of a heated part of the building.
3. Prevention of overheating due to solar radiation during summer.
4. Limitation of the air-tightness of the building envelope.
5. Maximum allowed heat transmission coefficients \( U \) of building components of new buildings, small buildings and after renovation works performed on existing buildings (Table 1).
6. Minimisation of the impact of thermal bridges.
7. Maximum permitted water vapor condensation inside a building component.

Specific requirements are set for residential and for non-residential buildings. A residential building planned to be heated at a temperature of 18 °C or higher shall be designed and constructed in such a way that the annual energy need for heating per m² of usable floor area \( Q''_h,nd \) (kWh/m².year), depending on the building shape factor \( f_0 \), does not exceed the following values:

\[
Q''_h,nd = 51.31 \text{ for } f_0 \leq 0.20 \\
Q''_h,nd = (41.03 + 51.41 f_0) \text{ for } 0.20 < f_0 < 1.05 \\
Q''_h,nd = 95.01 \text{ for } f_0 \geq 1.05
\]

When designing a renovation of an existing building, technical requirements relating to energy economy and heat retention shall be required when:

1. An existing building is extended and/or new floors are added, if the floor area of the building heated at a temperature above 12 °C increases by more than 50 m².
2. Building elements forming a part of the envelope of a heated part of the building are renovated, or are partly or completely replaced, so that the works cover at least 25% of the area of each building component, or at least 75% of the envelope of a heated part of the building.
3. Only certain building elements of the envelope of a heated part of the building covering an area over 25% of that building component or element related to each individual geographic orientation are renovated.
4. In case of a conversion of a non-heated building or a part of the surface area of a usable floor area thereof exceeding 50 m² into a space heated at a temperature above 12 °C.
The application for a building permit for a new building and for the improvement of the energy performance of an existing building with a usable floor area over 1,000 m$^2$, in case of a major renovation, shall be accompanied by a study of technical, environmental and economic feasibility of alternative systems for electricity supply, especially decentralised energy supply systems based on Renewable Energy Sources, cogeneration systems, long distance or block heating systems containing heat pumps.

2.2 Format of national transposition and implementation of existing regulations

The EPBD requirements relating to the setting of minimum energy efficiency requirements for new buildings and for existing buildings undergoing renovation have been transposed in the national law through several technical regulations.

The technical regulation on energy economy and heat retention in buildings is a basic technical regulation directly transposing the EPBD requirements, as well as setting a requirement with regard to the maximum annual specific heat consumption for heating.

The use of alternative energy supply systems is promoted through the obligation to develop technical, economical and ecological feasibility studies for alternative energy supply systems. This study must be a part of the main design when submitting the application for obtaining the building permit.

<table>
<thead>
<tr>
<th>No.</th>
<th>Structural part</th>
<th>$U$ [W/m$^2$ K]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\Theta_b$ $\geq$ 18 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\Theta_{\text{c,month}, \min &gt; 3 ^\circ \text{C}}$</td>
</tr>
<tr>
<td>1.</td>
<td>External walls, walls to the garage, attic</td>
<td>0.60</td>
</tr>
<tr>
<td>2.</td>
<td>Windows, balcony doors, roof windows, transparent facade elements</td>
<td>1.80</td>
</tr>
<tr>
<td>3.</td>
<td>Flat and pitched roofs above heated rooms, ceilings to the attic</td>
<td>0.40</td>
</tr>
<tr>
<td>4.</td>
<td>Ceilings above external air, ceilings above garages</td>
<td>0.40</td>
</tr>
<tr>
<td>5.</td>
<td>Walls and ceilings to non-heated rooms and non-heated stairways at a temperature higher than 0°C</td>
<td>0.65</td>
</tr>
<tr>
<td>6.</td>
<td>Walls to the soil, floors on the soil</td>
<td>0.50</td>
</tr>
<tr>
<td>7.</td>
<td>External doors, doors to non-heated stairways, with non-transparent door wings</td>
<td>2.90</td>
</tr>
<tr>
<td>8.</td>
<td>Walls of the roller shutter box</td>
<td>0.80</td>
</tr>
<tr>
<td>9.</td>
<td>Ceilings between apartments, ceilings between heated working premises of various users</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Table 1: Maximum allowed heat transmission coefficients $U$ [W/m$^2$K] of building components of new buildings, small buildings ($A_k < 50 m^2$) and after renovation works performed on existing buildings.

Note: $\Theta_{\text{umean,min}}$ is the mean monthly temperature of the outdoor air in the coldest month at the building location.
or the approved engineer is responsible for conducting an independent building surveillance. Inspectional supervision is also carried out by the building inspection division of the Ministry. After the construction, inspections should be carried out by authorised persons, depending on the requirements prescribed in the main design of the building.

### 2.3 Cost-optimal procedure for setting EP requirements

The EP requirements for buildings are set in such a way as to achieve a higher energy efficiency level, a reduction in the energy demand of buildings, as well as a reduction of the environmental impact. Such requirements prescribed in the technical regulation of 2006 have enabled a reduction by at least 30% of the building’s energy demand for heating, as well as a decrease in CO$_2$ emissions at the same percentage. The setting of requirements for buildings along with the cost-optimal criteria is planned to be developed by the end of 2013 for various designated functions of buildings.

### 2.4 Action plan for progression to NZEB

The national definition of NZEB shall be developed upon the establishment of the minimum EP requirements for buildings in accordance with the results of the cost-optimal analysis. NZEB shall refer to high energy efficiency buildings, and the share of renewables shall be defined in line with the national energy strategy. The envisaged definition shall enable clear and simple implementation, and shall be adapted to buildings in accordance with their designated function. The action plan for progression to NZEB is expected to be developed by the end of 2013.

### 3. Energy performance certificates

The energy certification of buildings started in 2010, when also the authorisation to issue EPCs was granted to the first natural and legal persons.

For purposes of monitoring the energy consumption in public sector buildings, and in order to promote the implementation of measures for energy efficiency improvement, the Energy Management Information System (EMIS) has been developed. This is a web-based application for the control and analysis of the energy and water consumption. The database includes data on 8,000 buildings (construction and energy data), as well as data on the energy and water consumption, which are entered on a monthly basis. In the current test phase, 40 buildings are connected to the system by means of a remote energy consumption meter.

The obligation of the energy certification of buildings is laid down for new buildings prior to their use, existing buildings being sold, rented or leased, and buildings used for public functions. The display of energy certificates of buildings with public functions, with usable floor area above 1,000 m$^2$, is required since the 31st of December 2012. For buildings with usable floor area above 500 m$^2$, the display obligation starts from the 31st of December 2013. For buildings with usable floor area over 250 m$^2$, it starts from the 31st of December 2015.

The energy certification of buildings started in 2010. Since then, and up to January 2013, more than 5,000 energy certificates have been issued, of which 60% for residential buildings (single-family and multifamily houses) and about 40% for non-residential buildings.

#### 3.1 Progress and current status on sale or rental of buildings

The energy certificates are issued for residential buildings, non-residential buildings and non-residential buildings in which energy is used to achieve certain conditioning environments, but without heating them above 18 °C.

The buildings are classified into eight energy classes, from A+ to G, and energy classes are indicated using reference climate data.
Submission of energy certificates of existing buildings or their separately used units for the information of the buyer, tenant or lessee, is obligatory when these buildings are sold, rented out or leased, prior to stipulating the sale, rent or lease contract. If advertising is done in the media, the advertisements shall contain also the energy class of the building or its separately used unit. Although this obligation will come into force only on the date of the accession of the Republic of Croatia to the European Union, on the 1st of July 2013, certain advertisements for the sale of apartments in new residential buildings already include the energy class of the building.

The energy certificates contain recommendations of economically justified measures specifically tailored to the specific building for the improvement of the energy performance. The recommendations are not mandatory. The maximum prices for the development of energy certificates of buildings are established by a Ministerial Decision, and include the price for conducting an energy audit of an energy certificate.

The conditions and criteria for persons performing energy audits and energy certification of buildings are prescribed by the Ordinance OG 81/12. The authorisation requires education (university studies of engineering in the field of architecture, civil engineering, mechanical engineering or electrical engineering), at least five years of professional working experience, successful completion of the Training Programme (pass an examination), as well as professional liability insurance against any potential damage. The validity of the authorisation is 3 years. After this period, accreditation shall be granted if the authorised person continues to comply with the requirements for granting the accreditation, and duly fulfills their obligation of attending the Professional Improvement Programme once a year.

Until the end of 2012, about 980 engineers attended the Training Programme Module 1 for energy audits of buildings with simple technical systems, and about 440 attended the Training Programme Module 2 for energy audits of buildings with complex technical systems. 530 persons are authorised by the Ministry for performing energy audits and energy certification of buildings.

The training is carried out by ten regionally distributed institutions that have obtained the relevant approval from the Ministry of Construction and Physical Planning. For purposes of education of professionals, manuals on energy certification of buildings have also been published.

For purposes of monitoring and ensuring the quality of the developed energy certificates for buildings, a programme has been developed, which is used by authorised persons issuing energy certificates which are also registered in the database maintained by the Ministry of Construction and Physical Planning. The trial operation of this application ended in mid-December 2012, and full implementation is expected from the 1st of July 2013.

For purposes of Quality Assurance (QA), the control of energy certificates of buildings is prescribed in terms of regularity and accuracy, calculation and proposed measures. These controls shall be carried out by persons to whom authorisation will be granted by the Ministry. The selection of energy certificates shall be carried out in one of the proposed ways in the EPBD: at random, from the total number of issued energy certificates.
certificates for buildings of a given energy class, type and designation of the building. During the three-year period of the validity of authorisation, each authorised person shall undergo such a control at least once.

The penalties for authorised persons carrying out energy audits and issuing energy certificates of buildings are prescribed in the Energy Efficiency Act. The penalties are defined to be up to 20,000 € for legal persons, and up to 1,500 € for natural persons in cases prescribed by the Act.

3.2 Progress and current status on public and large buildings visited by the public
Public purpose buildings for which the obligation for energy certification and for public display of EPCs is prescribed, include the following wide range of buildings:

2. Buildings of state administrative and other bodies, bodies of local and regional self-government.
4. Buildings used as courts, prisons, barracks.
5. Buildings of international institutions, chambers, economic associations.
6. Banks, savings banks and other financial institutions.
7. Shops, restaurants, hotels, travel agencies, marinas, other service and tourism activities.
8. Railway, road, air and water traffic buildings, post offices, telecommunication centres, etc..
9. Buildings for pre-school, primary and secondary education, nurseries schools, etc., buildings for higher education, research laboratories, etc..
10. Residential buildings for communities: homes for elderly persons, children, students, employees, as well as homes for temporary or permanent residence.
11. Buildings used by sports associations and organisations, buildings for sports facilities.
12. Buildings for cultural functions: cinemas, theatres, museums, etc..
13. Hospitals and buildings of other institutions with medical, social and rehabilitation functions.

The validity of the energy certificate is 10 years. The first page of the energy certificate, enlarged to A3 format, is publicly displayed, containing the energy class. The page with recommendations of economically justified measures for improving the energy performance of the building, with a simple payback period, is also displayed.

Penalties are prescribed in case of failure to comply with the energy certification obligations with regard to buildings used...
for public functions. These penalties amount to 13,000 € for legal persons who are owners of buildings with public functions if they fail to publicly display the energy certificate of the building. Natural persons who are owners of buildings with public functions may be fined for such offence with a penalty up to 1,300 €.

### 3.3 Information campaigns

Information campaigns regarding the promotion of energy certification of buildings primarily refer to educating stakeholders at targeted conferences. Since 2005, the Energy Efficiency Promotion Project has been implemented in Croatia. Currently, this project is being implemented by the UNDP in Croatia, by the Ministry of Economy, and the Ministry of Construction and Physical Planning, under the financial support of the Environmental Protection and Energy Efficiency Fund and of the Global Environmental Facility (GEF). The primary objective of the project is to promote the application of economically viable, energy efficient technologies, materials and services, both in the public sector and in households, all in order to reduce unnecessary energy consumption and greenhouse gas emissions.

A number of educative workshops were held to inform the public of the obligation of energy management in the buildings used by them, as well as of the mandatory energy certification of buildings and the role of energy certificates of buildings, especially promoting the implementation of energy efficiency measures in buildings.

Since November 2012, these activities have been complemented by the establishment of the Energy Efficiency Green Library (ZeeK), where specialised publications and brochures will be available on increasing energy efficiency through the application of energy efficient measures and RES.

Promotion of activities improving the quality of operation in the field of the energy efficiency of buildings, and increasing the energy efficiency and use of RES are basic tasks of the Croatian Association of Energy Certifiers. The Association was established in late 2009 and it now has 140 members. Within the scope of its activities, the Association has issued a brochure promoting the obligation of carrying out energy audits and energy certification of buildings.

### 4. Inspection requirements - heating systems, air-conditioning

#### 4.1 Progress and current status on heating and air-conditioning systems

Regular inspections of heating and Air-Conditioning (AC) systems in buildings are obligatory once every five years. Such inspections shall be carried out by authorised legal or natural persons. The conditions for obtaining the authorisation refer to professional qualification and profession (master of mechanical engineering), work experience (min. 5 years), and completion of the Training Programme prescribed by the Ordinance. Further education following the prescribed education programme is underway. By the end of 2012, the first authorisations were issued to approved inspectors. The inspection is followed by an inspection report which contains...
measures for the improvement of energy efficiency. Quality controls for inspection reports are established and will be carried out by independent authorised legal entities. The selection of the reports to be controlled is prescribed by the Ordinance. A database of heating and AC systems will be established.

The impact of carrying out inspections of heating and AC systems shall be assessed after having collected experience in this field. By the end of 2012, the first two persons to perform regular inspections of these systems were authorised.

Various activities in the scope of system maintenance shall be carried out in accordance with the provisions of the Technical Regulation on heating and cooling systems for buildings, and the Technical Regulation on ventilation systems, partial AC and AC of buildings. Testing during maintenance activities is mandatory for all heating/cooling systems and ventilation systems, partial AC and AC of buildings. Regulatory inspections aimed at the systems maintenance shall be carried out at intervals, in accordance with the requirements of the building design, but not less frequently than once a year. The method of carrying out regular inspections includes at least: visual inspection, repair, replacement and cleaning of the system components, as well as check measurements of the design parameters, of the temperature and of the noise level. The inspection of a system shall always be carried out prior to its first use and prior to its resumed use if the system was out of operation for more than 6 months, unless otherwise specified by a special regulation.

5. Conclusions and future plans

In September 2012, activities began in relation with the definition of reference buildings, for the purpose of cost-optimal calculations in order to set the minimum Energy Performance (EP) requirements. On this task, relevant institutions will be engaged; conclusions are expected by late spring of 2013. In the first stage, four types of buildings will be defined (single-family buildings, apartment block buildings, office buildings and buildings with educational functions). It is envisaged to determine the reference buildings according to their purpose and age of construction (buildings built before 1987 and buildings built in the period from 1987 until today), and according to climatic zones (for two characteristic climates: continental and littoral). In compliance with the defined reference buildings and the carried out cost-optimal analysis, the new minimum requirements on the EP of buildings will be determined. Also, the heat transmission coefficients of building parts which constitute the envelope will be made more stringent, as well as the requirements for technical systems regarding energy efficiency. These new values shall be established within cost-optimality limits. For purposes of defining Nearly Zero-Energy Buildings (NZEBs), the following will be determined: a more stringent criterion of maximum primary energy consumption, more stringent requirements with regard to heat transfer coefficients of parts of buildings, and the share of Renewable Energy Sources (RES) in the total consumption, as well as limit values of annual carbon emissions.

In order to promote the application of alternative systems, and to meet the obligation of establishing the share of RES for new buildings, a programme will be developed for the education of plumbers/fitters of biomass boilers, heat pumps, solar photovoltaic, or solar thermal devices. Authorisation will be granted to plumbers/fitters on the basis of this training programme. The activities for the education of all those involved in planning, designing, building and maintenance of high EP buildings will be continued in a systematic manner. The education will also include public service employees and other authorities in charge of running public buildings.

The continuation of implementation of the Retrofitting Programme for Public Sector Buildings is planned, as well as the Retrofitting Programme for Residential and Commercial Buildings. The implementation of a number of measures for improving the energy efficiency and the construction of new buildings or reconstruction of existing buildings up to achieving a high energy efficiency level will be promoted.

Continuous controls will be carried out in order to achieve a higher quality of the energy audits of buildings, as well as of the energy certificates of buildings issued by authorised persons. Also, the national computer programme to be developed until the end of 2013, through which all authorised persons will calculate the EP of buildings, both in final and primary energy, will contribute to an increase in quality of the whole certification system.
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