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Analysis of existing training programmes for deep energy renovation (DER) in the partner countries with identification of gaps and deficiencies

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SEVEn, Center for Energy Efficiency

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D2.1 Analysis of existing training programmes for deep energy renovation (DER) in the partner countries with identification of gaps and deficiencies

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Executive Summary

In order to position the deep energy retrofit topic into the context of the construction legislation and practice in the participating countries (Bulgaria, Romania, the Czech Republic, Italy, Greece and Croatia), the report starts with an analysis of the nearly zero-energy building (nZEB) definitions in each of them. Thus, it gives a general overview of the national requirements for the energy performance of buildings and the differences between them, which provides a solid basis to compare the educational programmes in the field of nZEB level renovation. As it is often evidenced throughout Europe, the nZEB definitions are not directly applicable to the renovation process; however, they provide a solid basis to forecast the future development trends in this area, which, undoubtedly, has to be reflected in the training and educational programmes.

In the second part of the report, the trends in education in the field of deep energy retrofit (DER) are analysed, listing the related available educational programmes. In all target countries, a tangible lack of integration of the topic in the professional secondary, high and higher education and vocational training programmes is identified. The objectives and availability of the existing programmes are described and analyzed. The observation shows that the allocation of the identified programmes within the European Qualification Framework (EQF) system is quite broad and unstructured, and it is very difficult to harmonize and compare the results of the analysis at national level - as related to both the professional education and the vocational training system. It could be however stated that in most of the target countries, the certified passive house designer/tradesperson courses are mentioned as a well-structured uniform (and sometimes the only one existing) programme that can be used as a basis for the development of detailed programmes in different EQF levels.

In addition to this analysis, the report gives an overview of the target groups of the existing training courses related to DER, including the required entry qualification, expected outcomes, and benefits for the participants of the programmes. The practices for examining and certifying the knowledge, skills and competences acquired by the participants and the requirements to the trainers leading the courses are also mentioned. Furthermore, the structure, duration and training methods of the identified programmes are analysed.

The main result of the report is the identification of learning outcomes of the available programmes in each target country, identification of the existing gaps and recommendations for further development or modification of the system of education in DER field. As a main conclusion of the analysis, it can be clearly stated that no comprehensive and detailed training programme was identified in the field of DER or nZEB renovation in the target countries. Still, significant efforts have to be spent on development of such educational programmes, which would be the next step and major goal of the Fit-to-NZEB prject.

The development of this report was led by SEVEn and the results were reviewed by PHA and TU Wien.

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1. Introduction

The goal of this report is to provide overall review of available training programmes in the partner countries to facilitate and streamline the development of education in the field of deep energy retrofit (DER) and nearly zero energy building (nZEB) renovation. In order to guarantee high quality of new programmes the report contains:

- specific definitions of nZEB and DER, target groups and specialism of existing programmes,
- analysis of the content of the programmes,
- identification of gaps in the programmes and
- recommendations to fill in the gaps

Identifying the sources of programmes, their strengths and shortcomings is essential.

The obligation to only build nearly Zero Energy Buildings from 2021 on puts high demands on expertise during the design, construction and subsequent use of buildings, both newly built and reconstructed. In the target countries implementation of reconstructions deserve much more attention than new construction. Meeting the objectives of the European Union by 2020 requires a high number of qualified construction experts in the field of DER, of which there is currently a lack.

Deficiencies in the training programmes at all levels in terms of both general focus and attention to details related to deep energy renovation is often identified as one of the main reasons for potential lock-in attitude of professionals and, hence, consumers towards renovations. In this report, the relevant plans and programmes within the whole educational and training systems in the participating countries were reviewed with the goal of identifying the content related to deep energy renovations, the gaps and the extent to which the existing materials are adequate for the ambitions set in the national renovation strategies, the existing national requirements and the implementation of the nZEB national standards in the cases where they are related to renovations.

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2. National nZEB definitions, DER definition

Directive 2010/31/EU (EPBD II) sets out the definition for a building with nearly zero energy consumption (nZEB) at the European level. On the basis of this definition, the EU Member States have created a definition for nZEB at the national level, which takes into account the given country's economic and climatic conditions. This chapter contains definition of nZEB in each target country to give an overview of requirements to energy performance of buildings and differences between them. This should give a basis to compare educational programmes in the field of nZEB level renovation.

2.1 nZEB definitions

Czech Republic

The nZEB definition is included in the regulation No. 78/2013 Coll. that specifies requirements of the Energy Management Act No. 406/2000 Coll. The definition compares the evaluated building with a reference building[1] of the same type, size, geometrics, orientation etc. but with pre-defined construction and technological specifications. Then all a) average U-value of envelope, b) delivered energy (without taking into account on site renewables) and c) non-renewable primary energy are considered.[2]

Table 1: Baseline of the average heat transfer coefficient

Parameter	Unit	Reference value		
		Completed building and reconstruction	Newly built building	nZEB
The reduction factor of the required baseline of the average heat transfer coefficient	-	1,0	0,8	0,7

Source: regulation No. 78/2013 Coll.

[1] reference building is a computationally defined building of the same type, of the same geometric shape and size, including glazed surfaces and parts, the same orientation towards the world sides, shading in the surrounding area and natural obstacles, the same internal arrangement and the same typical use, and the same climate considerations as the building under evaluation, but with the reference values of the building's features, structures and technical building systems (Regulation No. 78/2013 Coll.)

[2] *ZEBRA 2020, Data Tool : http://www.zebra-monitoring.enerdata.eu/nzeb-activities/panel-distribution.html#nzeb-definitions-by-country.html*

Table 2: Reduction of the value of non-renewable primary energy that was defined for the reference building

Parameter	**Unit**	**Type of building or zone**	**Reference value**		
			Completed building/ recon-struction after 1.1. 2015	**Newly built building after 1.1. 2015**	**nZEB**
Reduction in non-renewable primary energy	%	Family house	3	10	25
		Apartment building	3	10	20
		Other buildings	3	8	10

Source: regulation No. 78/2013 Coll.

Requirements to introduce nZEBs into practice for different types of building are as follows.

Public buildings:

- energy related floor area[3] more than 350 sq. m. - 1 January2017,
- energy related floor area less than 350 sq. m. - 1 January 2018.

Other buildings:

- energy related floor area more than 1,500 sq. m. - 1 January2018,
- energy related floor area more than 350 sq. m. - 1 January2019,
- energy related floor area less than 350 sq. m. - 1 January 2020.

Italy

According to the Law 90/2013 a "nearly zero energy building" is a building characterized by a very high energy performance in which the very low energy demand is significantly covered by renewable sources, produced within the building system boundaries.

The nZEB has to be performed according to energy requirements in force for 2019/2020 that are defined in the decree D.M. 26 of June 2015, which came into effect in October 2015. Specifically, the nZEBs, new or existing, have to meet simultaneously:

a) the criteria of a lower energy demand than the reference building, determined with the valid values for the 1st of January 2019 for public buildings and the 1st of January 2021 for all the other buildings.

[3] Energy related floor area is understood as the outer floor area of all the spaces with the treated interior environment in the building, defined by the outer surfaces of the structures of the building envelope (Energy Management Act No. 406/2000 Coll.)

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b) The obligations of integration of renewable energy sources in accordance with the minimum principals set out in Annex 3, paragraph 1, letter c) of Legislative Decree 3 of March 2011, n. 28. *(Source: ZEBRA 2020, Data Tool : http://www.zebra-monitoring.enerdata.eu/nzeb-activities/panel-distribution.html#nzeb-definitions-by-country.html*)

The Italian DM 26/06/2015 "Applicazione delle metodologie di calcolo delle prestazioni energetiche e definizione delle prescrizioni e dei requisiti minimi degli edifici" introduces in Italy a new energy label scheme according to the minimum requirements and specifies the definition of the Italian version of the nZEB, a communitarian indication given by the 2010/31/UE Directive for empowering the energy efficiency throughout Europe.

According to the DM 26/06/2015, the minimum energy consumption of the designed building is determined by comparing it with a *reference building* – an ideal version geometrically identical to the original one, placed in the same geographical coordinates and with the same orientation. The building's energetic needs are calculated applying a standard value to the thermal transmittance of the building assemblies according to the climate zone of the project, being considered as comprehensive of structural and geometrical thermal bridges. Standard transmittance values are imposed to glazing surfaces, too.

It is mandatory for the designed building to have at maximum the same final energy demand (expressed in kWh/m^2a) including ventilation EP_v, cooling and dehumidification EP_c, heating EP_h, and domestic hot water generation EP_w.

The real building also needs to have a lower *average global heat transfer coefficient* H'_t than its reference counterpart, and it is required for the efficiency coefficient of the systems installed in the real building to be higher than the minimum efficiency coefficients fixed within the DM 26/06/2015.

Among others, mandatory requirements are for instance:

- The building energetic needs for domestic hot water (DHW) must be covered for at least 50% with renewable energetic resources.
- The sum of the building energetic needs for heating, DHW, cooling and dehumidification must be covered for at least 35% with renewable energetic resources.

In all the cases, it is not possible to generate energy through Joule effect only.

The DM 26/06/2015 also sets a second list of higher standards as minimum requirements for the certification to nZEB class. On January 1st 2021, the *reference building* of any new project will have the same minimum requirements as today nZEB standards, de facto implementing these performances as compulsory.

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Table 3: Thermal transmittance of structures of reference building.

Walls dissipating energy to the external ambient, to unheated zones or to ground	
Climatic zone	**U (W/m^2K)**
	2019/2021 (2)
A e B	0,43 / 0,4
C	0,34 / 0,36
D	0,29 / 0,32
E	0,26 / 0,28
F	0,24 / 0,26
Horizontal assemblies of horizontal or pitched roof, dissipating energy to the external ambient or to unheated zones	
Climatic zone	**U (W/m2K)**
	2019/2021 (2)
A e B	0,35 / 0,32
C	0,33 / 0,32
D	0,26
E	0,22 / 0,24
F	0,2 / 0,22
Horizontal floors, dissipating energy to the external ambient, to unheated zones or to the ground	
Climatic zone	**U (W/m2K)**
	2019/2021 (2)
A e B	0,44 / 0,42
C	0,38
D	0,29 / 0,32
E	0,26 / 0,29
F	0,24 / 0,28
Technical components, both transparent and opaque and shuttercase, including windows, dissipating to the external ambient or to unheated zones	
Climatic zone	**U (W/m2K)**
	2019/2021 (2)
A e B	3
C	2,2 / 2
D	1,8
E	1,4
F	1,1 / 1

In addition to the aforementioned minimum standards, the *reference building* for an nZEB has to respect lower transmittance values for its thermal envelope (see table above) . It also has to cover with energy from renewable sources at least 50% of the building energetic needs for DHW, and at

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least 50% of the cumulative building energy demand for heating, DHW, cooling and dehumidification.

The decree also lists the *primary energy conversion factors* to be used in accordance to the appropriate energy carriers in order to calculate the relative amount of both, renewable and non-renewable, energy contributions.

However, two Italian Regional Councils (Lombardia and Emilia Romagna) independently decided to implement the nZEB standards earlier than the temporal limit imposed by the national DM. It is important to notice that the regional decrees do not modify the nZEB *reference building* national standards. For such cases, the only retrofit solution analysed besides the Passivhaus standard is the nZEB energy level.

The Regione Lombardia approved the “Decreto della Giunta Regionale n.6480 del 30 luglio 2015” [DDUO2015] opting for the application of the nZEB standards as minimum requirement for every new and refurbished, both public and private, building starting from January 1st 2016.

Since January 1st 2017, the Regione Emilia-Romagna already applies the nZEB standard to new and refurbished public buildings while for private buildings the application deadline is set to January 1st 2019 [DGR2015].

Bulgaria

According to the national definition in Bulgaria nZEB is a building with a) primary energy consumption (including electrical appliances) of class A and b) at least 55% coverage of the final energy demand (without electrical appliances) by renewable energy sources.

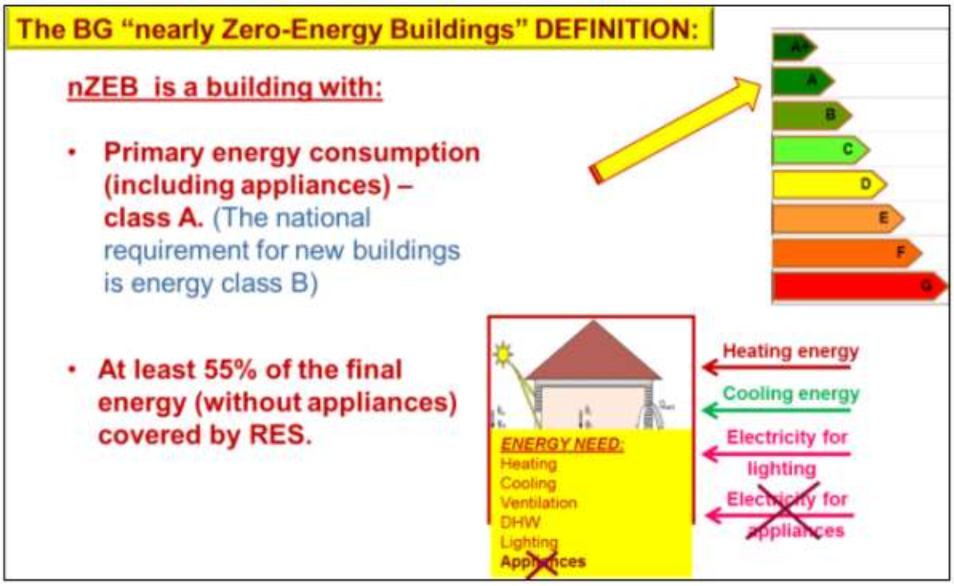

Figure 1: Bulgaria definition of nZEB

(Source: RePublic_ZEB Project, April 2015, http://www.republiczeb.org/filelibrary/WP3/D3-1_EPBD-implementation.pdf)

National definition for nZEB:

nZEB is a building that meets the following conditions:

1. The energy consumption of the building, defined as primary energy, corresponds to class "A" on the scale of classes for the respective type of buildings ;
2. Not less than 55% of the final (delivered) energy for heating, cooling, ventilation, domestic hot water and lighting is energy from renewable sources, located in the building or near the building.

Compliance with the energy efficiency requirements:

Compliance with energy efficiency is met when the annual specific primary energy consumption in kWh/m^2 corresponds to the following energy class:

1. "B" – for new buildings and existing buildings in operation since 1 February 2010;
2. "C" – for existing buildings in operation prior to 1 February 2010;
3. "A" – for nZEB;
4. "A+" – for buildings above the national requirements for nZEB.

Energy classes:[4]

Buildings are evaluated in terms of their energy efficiency according to the value of their integrated energy performance, which represents the calculated consumption of primary energy (for heating, cooling, ventilation, domestic hot water, lighting and electric appliances) per square metre of conditioned area. The conditions for the level of temperature comfort in the building must comply with the normative requirements at standard outdoor climate conditions. The scale of energy classes for residential buildings is presented in Figure 1. The national primary energy factors are listed in the above-cited Ordinance No. 7 for Energy Efficiency of Buildings.

[4] Ordinance No. 7 of 2004 for Energy Efficiency of Buildings
http://www.mrrb.government.bg/static/media/ups/articles/attachments/fc16b6de9bf6a158352de2b65d78e3e4.pdf

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Energy class	EPmin, kWh/m^2	EPmax, kWh/m^3	RESIDENTIAL BUILDINGS
A+	<	48	A+
A	48	95	A
B	96	190	B
C	191	240	C
D	241	290	D
E	291	363	E
F	364	435	F
G	>	435	G

Figure 2. Scale of energy classes for residential buildings

Indoor climate requirements:

Design indoor climate requirements for building are regulated in *Ordinance No. 15 from 2005 for technical rules and norms for design, construction and operation of sites and facilities for the generation, transmission and distribution of heat* for residential buildings the single parameter which is regulated is the indoor temperature in winter. The required value of this parameter depends of the energy class of the building, as follows:

- For A class buildings – 22,0 °C ± 1,0 °C;
- For B class buildings – 22,0 °C ± 2,0 °C;
- For C class buildings – 22,0 °C ± 3,0 °C.

National Energy Efficiency and Indoor Air Quality Requirements

Norms related to energy efficiency in buildings were introduced for the first time in the Bulgarian legislation in 1964 and set mandatory U values for exterior walls, roofs and floors. Until 1999, these values differed depending on the design outside temperature, while for external walls different values also applied depending on the construction of the building - massive, light or very light. The information about the normative U values is summarized in Table 4.

***Table 4**: U-values according to Bulgarian norms, W/m^2K*

Year	Wall			Flat roof	Venti-lated roof	Floor	Windows	Notes:
	massive	light	very light					
1964	1.56	1.43	1.3	1.09	1.2	1.3	-	U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C.
1977	1.56	1.43	1.2	1.09	-	1.2	-	U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C.

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1980	1.2	0.869	-	0.966	-	0.483	-	Residential, hospitals, kindergartens, hotels, hostels. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for every building type.
1980	1.34	0.968	-	1.087	-	0.604	-	Schools, policlinics. U-values vary in correlation with design winter outside calculating temperature. There for -16˚C. Also Um (max) is determined for every building type.
1987	0.988	0.49	0.434	0.54	-	0.268	-	Residential, hospitals, kindergartens, hotels, hostels. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for every building type.
1987	1.099	0.55	0.48	0.6	-	0.604	-	Schools, policlinics. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for for every building type.
1999	0.55			0.3	-	0.5	2.65	For all buildings. Also Um (max) is determined in relation with A/V ratio.
2005	0.45			0.25	0.3	0.5	2	Insulated inside or in the middle of the wall/floor. Udoors ≤2.2.
2005	0.35			0.25	0.3	0.4	2	Insulated outside. For external door: U≤2.2.
2009	0.35			0.28	0.3	0.28	1.7	For PVC framed windows only. For wood framed windows U≤1,8. For aluminium framed U≤2. For curtain wall U≤1.9-2.2.
2015	0.28			0.25	0.3	0.25	1.4	For PVC framed windows only. For wood framed windows U≤1.6-1.8. For aluminium framed U≤1.7. For curtain wall U≤1.75-1.9.

In 1999, for the first time mandatory U values were introduced for windows and doors. Since 2005 the normative U values are recommended but not mandatory. The current U values are in force since 2015. For the period 1964 – 1999, U values are presented for design outdoor temperature (-16°C) typical for Sofia.

Key document:

Ordinance No 7 for energy efficiency of buildings – the methodology for calculation, attached to this ordinance, is mandatory at the design of the energy efficiency of new buildings and the energy auditing of existing buildings. It has been developed on the base of the standard **BG EN ISO 13790:2008 "Energy performance of buildings. Calculation of the consumed energy for heating and cooling"** and the good European practices for determination of the annual consumption of energy for heating, air-conditioning, cooling and domestic hot water production. The methodology gives quantitative estimation of the influence of: heat losses and gains from heat transfer through the building envelope; heat losses and gains from ventilation due to the replacement of the indoor air by outdoor air; heat gains from sunlight in result of direct radiation through the transparent elements and also by absorption of the radiation by the opaque elements; heat losses by radiation to the sky; heat gains from internal sources – electrical devices, artificial lighting, heat transfer from human bodies; efficiency of the technical systems securing the indoor climate parameters. 24

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different European standards are used in the methodology for performance of the different calculations for buildings and their components.

The ordinance defines the conditions for the buildings compliance with the requirements for energy efficiency, the contents of the project design documentation for energy efficiency and gives definition of nZEB also. The requirements for energy efficiency compliance of buildings are completed when the buildings energy class is B at least if constructed after 2010 and with minimum energy class C if constructed before 2010. nZEBs should be energy class A and 55% of the final energy consumed for heating, cooling, air-conditioning, domestic hot water and lighting should be produced by RES situated in the building or near it.

Calculation tools:

Mandatory requirement is to use of the methodology recorded in Ordinance 7 when calculations during the energy audits are implemented. The use of software is not mandatory. Two software products are used in practice:

“EAB” (Energy Auditing of Buildings) developed in the Sofia Technical University based on the Norwegian software ENSI “Key numbers”. It is given away free of charge to graduates of the training courses for energy auditors that the state has determined to be conducted in four universities in the country only – in the cities of Sofia, Plovdiv, Varna and Gabrovo.

„HC Load” – developed by prof. Stanko Shtrakov – more often used by designers when designing the Energy efficiency of the projects and when new buildings are evaluated. Virtually it is not used in energy audits.

Romania

The Government Ordinance No. 13/2016 (modifying the Law 372/2005 for transposition of EPBD), defines an nZEB as a “building with a very high energy performance, in which energy consumption is nearly zero or very low and is covered in a rate of at least 10% of energy from renewable sources, including renewable energy produced on-site or nearby”. According to the same Ordinance, the level of energy in nZEBs is determined by technical regulations and is updated regularly according to technical progress.

Moreover, the Order 386/2016 of the Ministry of Regional Development and Public administration officially specify the performance levels for nZEB definition. Thus, the maximum admissible level of primary energy from fossil sources and of CO2 emissions resulting from the operation of buildings – by building types and winter climate zones in Romania are specified in Table 5. In order to ensure the total energy consumption of a nearly zero energy building, energy from renewable non-fossil sources should account for at least 10 % of the total calculated primary energy of the building.

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Table 5: Performance levels

Climate zone	Time horizon	OFFICE TYPE BUILDINGS		BUILDINGS INTENDED FOR EDUCATION		BUILDINGS INTENDED FOR THE HEALTH CARE SYSTEM		COLLECTIVE RESIDENTIAL BUILDINGS		INDIVIDUAL RESIDENTIAL BUILDINGS	
		Primary energy [kWh/m²a]	CO_2 emissions [kg/m²a]	Primary energy [kWh/m²a]	CO_2 emissions [kg/m²a]	Primary energy [kWh/m²a]	CO_2 emissions [kg/m²a]	Primary energy [kWh/m²a]	CO_2 emissions [kg/m²a]	Primary energy [kWh/m²a]	CO_2 emissions [kg/m²a]
I	Level of reference (2010)	102	24	135	32	135	48	117	31	271	59
	2015 (31 Dec.)	75	21	115	28	135	37	105	28	131	36
	31 Dec. 2018	50	13	100	25	79	21	100	25	115	31
	31 Dec. 2020	45	12	92	24	76	21	93	25	98	24
II	Level of reference (2010)	113	25	153	39	214	57	132	36	317	70
	2015 (31 Dec.)	93	27	135	37	155	43	112	30	147	42
	31 Dec. 2018	57	15	120	25	97	27	105	28	121	34
	31 Dec. 2020	57	15	115	30	97	26	100	27	111	30
III	Level of reference (2010)	125	29	174	46	241	66	150	41	372	83
	2015 (31 Dec.)	110	28	154	39	171	49	130	36	172	48
	31 Dec. 2018	69	19	136	37	115	32	122	34	155	41
	31 Dec. 2020	69	19	136	37	115	32	111	30	145	40
IV	Level of reference (2010)	147	38	212	58	290	81	182	50	476	109
	2015 (31 Dec.)	107	28	192	56	190	55	152	38	226	57
	31 Dec. 2018	89	24	172	48	149	42	144	40	201	51
	31 Dec. 2020	83	24	170	49	142	41	127	35	189	42
V	Level of reference (2010)	157	43	230	64	314	87	198	55	528	122
	2015 (31 Dec.)	127	29	210	58	214	58	178	48	248	78
	31 Dec. 2018	98	28	192	56	174	49	152	38	229	57
	31 Dec. 2020	89	24	185	53	167	48	135	37	217	54

The performance indicators specified in Table 5 were defined for the key building categories defined in the EPBD transposition law and were fixed taking into accounts the cost-optimal calculation study (published in August 2014), where the baseline of the cost-optimal calculation is represented by the 2010 level of requirements and the nZEB levels are fixed for 31.12.2018 (public buildings) and 31.12.2020 (all buildings), while intermediate levels of performance are set for 31.12.2015 (without being formalized in any further documents).

In terms of minimum energy performance requirements, until April 2017, only prescriptive element-based criteria for thermal insulation (maximum U-values or minimum thermal resistance

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of building component type) were included in National regulation (C107/2005, updated in 2010), together with a global heat transfer coefficient of the heated volume, G-value (W/m³K) depending on the number of the building floors and the external area per volume ratio (A/V). The MDRAPFE Order No. 2641/2017 established (for the first time) minimum requirements in terms of maximum primary energy consumption for heating (only), both for newly built and existing buildings undergoing renovation.

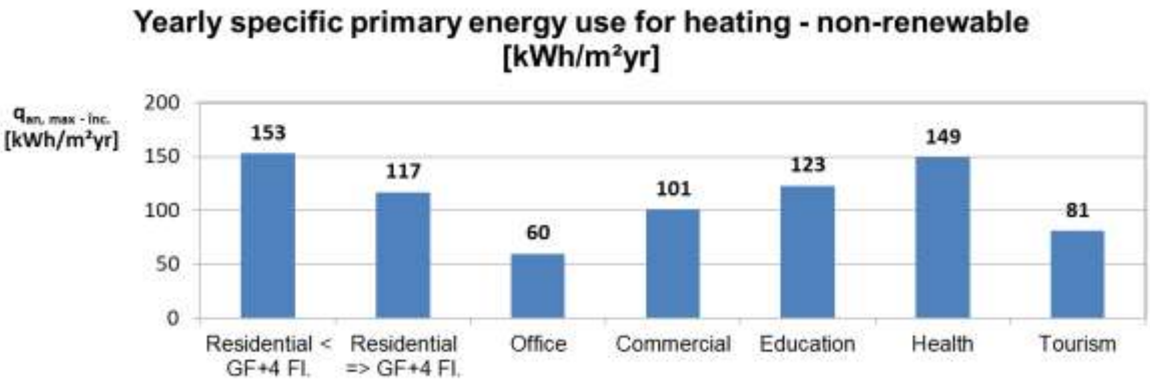

Figure 3. Maximum primary energy for heating – new buildings and major renovations.

The conversion factors used to calculate the primary energy use from final energy (at the consumer level), corresponding to each type of fuel or energy source are provided in Table 6.

Table 6: Primary energy conversion factors

Energy carrier/Sources	Non-renewable	Renewable	Total
Lignite	1.30	0.00	1.30
Coal	1.20	0.00	1.20
Heavy Fuel Oil	1.10	0.00	1.10
Natural gas	1.17	0.00	1.17
Waste	0.05	1.00	1.05
LPG	0.00	0.00	0.00
Biomass – fire wood	0.18	0.90	1.08
Biomass - briquettes, pellets	0.28	0.80	1.08
Electricity from National System	2.62	0.00	2.62
District heating	0.92	0.00	0.92
Thermal energy from solar collectors	0.00	1.00	1.00
Electricity from PV	0.00	2.62	2.62
Thermal energy from outdoors (free cooling)	0.00	1.00	1.00
Thermal energy from outdoors (heat pumps)	0.86	0.67	1.53

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Greece

The nZEB definition has already been introduced to the national legislation, by amendment, in June 2010 and it coincides with the precise EPBD definition. This definition is also included in Law 4122/2013 (recast for the energy efficiency of buildings). The law specifies that after 1 January 2015 every new building of the public sector should be built as nZEB. This obligation is also valid for all new buildings constructed after 1 January 2020.[5] However, the work for the minimum energy performance requirements and nearly zero energy buildings (nZEBs) has not been initiated nor defined yet.

There is no national definition of nearly zero energy buildings (nZEBs). In accordance to the EPBD recast, the national law [N.4122/2013] calls for setting minimum energy performance requirements for achieving cost optimal levels and new buildings meet the minimum energy performance requirements, minimum requirements for technical building systems, and sets the target of nZEB for new buildings by the end of 2020. As of July 2017, the relevant work has not been initiated nor defined.

Since 2010, new Hellenic buildings are to be constructed in accordance to the regulation on the energy performance in the building sector [KENAK] in compliance with EPBD[6]. The minimum specifications for the building's thermal envelope is more stringent compared to the previous regulation (TIR). A comparative presentation of the building envelope specifications of the two regulations is given in the following table. For example, the U-value for external vertical walls in contact with outdoor air was 0.7 W/m2 K with TIR and is reduced with KENAK by 14–43 % for the four national climate zones.

A relevant reference for buildings with minimum energy consumption and exceptional environmental performance is introduced in the new national building code[7]. Accordingly, these buildings should have a maximum total annual primary energy consumption of 10 kWh/m2 for HVAC, domestic hot water and lighting, without any differentiation (e.g. building end-use, climate zone). Apparently, this is a rather unrealistic benchmark.

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[5] RePublic_ZEB Project, April 2015, http://www.republiczeb.org/filelibrary/WP3/D3-1_EPBD-implementation.pdf

[6] Dascalaki et al. 2012

[7] NOK 2012

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Table 7: Minimum allowable U-values (W/m2K) for different building elements at the Hellenic climate zones according to the old TIR and KENAK

Building element	Climate zone (Heating degree days)			
	Zone A (600–1100)	Zone B (1101–1600)	Zone C (1601–2200)	Zone D (2201–2620)
External walls in contact with outdoor air				
TIR	0.70	0.70	0.70	0.70
KENAK	0.60	0.50	0.45	0.40
External horizontal or tilted surface in contact with outdoor air (roofs)				
TIR	0.50	0.50	0.50	0.50
KENAK	0.50	0.45	0.40	0.35
Floors in contact with outdoor air (pylotis)				
TIR				
KENAK	0.50	0.45	0.40	0.35
Floors in contact with ground or indoor non-heated spaces				
TIR	3.00	1.90	0.70	0.70
KENAK	1.20	0.90	0.75	0.70
Walls in contact with ground or indoor non-heated spaces				
TIR	3.00	1.90	0.70	0.70
KENAK	1.50	1.00	0.80	0.70
Transparent openings (windows, balcony-doors etc)				
TIR	5.23	5.23([a])	5.23([a])	5.23([a])
KENAK	3.20	3.00	2.80	2.60
Transparent facades (non operable and partially operable)				
TIR	5.23	5.23[a]	5.23[a]	5.23[a]
KENAK	2.20	2.00	1.80	1.80

[a] TIR recommended for zone B, the use of double glazing (3.26 W/m^2 K) on the facades exposed to prevailing cold winds (depending on location), while for zone C (and D) on all facades. Double glazing was mandated for all transparent elements in locations with an elevation higher than 600 m.

Minimum specifications for the building's electromechanical services are also implemented (e.g. use of outdoor temperature compensation systems, zone thermostatic control, along with heat recovery for central air-handling-units and energy efficient lighting for non-residential buildings, etc). For domestic hot water (DHW) production, in accordance to the national law N.3851/2010 on RES, all new buildings should cover 60% of the load from renewables or substantiate technical difficulties for non-compliance. This requirement has been adapted in KENAK.

A national obligation to implement various energy conservation measures (ECMs) in all energy end-use sectors, including buildings, was introduced in 2010 (N.3855/2010) in order to achieve by 2016 an overall national indicative target of 9% energy conservation. For the building sector, this implied about 1 Mtoe energy savings compared to 2007 data.

Hellenic calculation method to comply with new building regulations for residential buildings

Hellenic Energy Performance Certificates (EPCs) have been issued as of January 2011; the vast majority of them have been issued for buildings or building units rented out or sold and only 0.3 % for new buildings (Dascalaki et al. 2013). The calculations are performed using the official national software TEE-KENAK to issue an official EPC that is returned to the inspector. The general calculation method and overall approach is in accordance to European standards, with the main calculation procedure of the building energy demand according to EN 13790/2008 using the quasisteady state monthly method. The labelling scheme is based on asset rating accounting for heating, cooling, ventilation and DHW (lighting is ac-counted only for non-residential buildings), the minimum energy performance requirements, thermal envelope heat loss constraints, etc.

The ranking label (building class) is based on the calculated primary energy consumption compared to that of a “reference” building. The “reference” building is a carbon copy of the studied (real) building, with the characteristics of its envelope elements and E/M installations automatically adapted to meet the minimum energy efficiency requirements defined in the technical guidelines of KENAK The detailed characteristics of the reference building are revealed in a technical guideline by the Technical Chamber of Greece [TOTEE 20701-1/2010]. By definition, the “reference” building ranks B.

However, it should be noted that some points on the KENAK Regulation need improvement compared to the elements of other European National Energy Regulations (for example ENEV - Energieeinsparverordnung) which are used in other countries. First of all, there is a great difference in the way that the thermal bridges of the windows/doors are calculated. Due to the KENAK 2010 Regulation, there are some tables (TOTEE-KENAK) with usual cases of “openings” that give the factors needed to calculate the thermal bridges. On the other hand, the German regulation gives specific factors for every different type of window (frame, glass) and every different bordering material type, other window or structural component. It is obvious that this method gives more accurate results. The second most important inefficiency of the KENAK Regulation was identified on the airtightness and mechanical ventilation parameters, which are completely absent from the residential building sector. The mechanical ventilation is being taken into account only in the tertiary sector of buildings, which is limiting the applicability of this technology in construction.

An investigation of individual energy conservation measures to reduce space heating (SH) and DHW energy consumption in Hellenic residential buildings, using the TABULA typology has revealed several priorities that have high primary heating energy savings and low pay-back period in case of refurbishment (Droutsa et al., 2014). A total of 18 measures on building’s thermal envelope and E/M systems were investigated. Accordingly, the use of local natural gas boilers for space heating (SH) and DHW and geothermal heat pump for SH, al-ways result in improved energy class. Due to the higher availability of solar radiation in southern Greece the use of geothermal HPs and solar collectors for 100% of DHW (primarily in climate zones A and B, can improve the energy ranking by up to three energy classes. The use of solar collectors for 60% and 100% of DHW is more effective for buildings that are thermally insulated. Reduced infiltration and room thermostatic controls are applicable for buildings with good thermal protection and system efficiencies. Although the use of oil-boilers remains the most popular heating systems, as a result of the increase tax on oil, there is a clear shift to alternative fuel sources throughout the country. The use of natural gas boilers and heat pumps has become more attractive.

Classification of buildings according to TABULA Project

The first Hellenic residential building typology was developed in the framework of the TABULA project [NOA 2011]. The classification was made in accordance to the TABULA scheme using three parameters, namely: the size (single / multi family houses), the age (three age bands: prior to 1980, 1981-2000, 2001-2010) and the climate zone (four climate zones in total (A-D), in accordance to the Hellenic Building Energy Performance Regulation, KENAK). Accordingly, a total of 24 building types were defined, representative of the Hellenic residential building stock. Further details can be found in [NOA 2012]. The typologies were used to develop energy advice material in the form of electronic brochures and an on-line software tool, eKIA (www.energycon.org/ekia.html), which allows home owners for a preliminary assessment of the energy performance of their residence and its potential for improvement. The typology material is accessible in www.energycon.org and ever since it was re-leased, in November 2012, it has been accessed by over 25000 visitors. In the framework of TABULA, the Hellenic typology was also used to set up a basic building stock model and demonstrate the applicability of the typology in scenario analysis. Further enhancement of the building stock model is foreseen in the framework of the EPISCOPE project. In the absence of “typical” buildings and the lack of reliable statistical data in Greece, the TABULA typology is expected to provide the necessary basis for the revision of the minimum requirements and the specification of cost-optimal solutions towards the nZEB goal.

During the IEE Project EPISCOPE the building type matrix was extended towards new buildings, reflecting the current legal requirements (KENAK2010). Accordingly, the Hellenic TABULA typology was complemented by eight new building types, two for each climate zone, to represent the current standard of constructions for the period after 2010.

Croatia

In Croatia, there are 9 categories of buildings defined (i.e. apartment blocks, single family houses, office buildings, educational buildings, hospitals, hotels and restaurants, sports facilities, wholesale and retail trade services buildings, other non-residential buildings) and thus there are 9 nZEB definitions [Technical regulation on rational use of energy and heat retention in buildings (OG 128/15)]. One can find all the requirements for nZEB buildings in the Annex B Table 8 of the Technical regulation on rational use of energy and heat retention in buildings (OG 128/15) (http://narodne-novine.nn.hr/clanci/sluzbeni/dodatni/438515.pdf). Definition of nearly energy zero building was first introduced in Technical regulation on rational energy use and thermal protection of buildings (OG 97/2014 and 130/14), in August 2014 for single family houses, and in September 2014 for other building types. The definitions of the nZEBs have been updated in the Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015) and are currently in force as follows in table 3.

Nearly zero energy building is defined by level of primary energy demand[8] and 20% coverage of energy demand of the building by RES produced on site or nearby. Only the non-renewable energy component is being used for calculating the energy performance of buildings. Algorithm for calculating the energy performance of buildings (as in June 2014) can be found in the documents under the following link - http://www.mgipu.hr/default.aspx?id=34395. Primary energy values for newly built buildings and nZEBs are given in the table below.[9]

Table 8: Primary energy requirements for newly built and nZE buildings in Croatia.

requirements for newly built and nZE buildings						
	Newly built		**Newly built nZEB**		**Refurbished existing buildings**	
	Continental climate $\theta_{mm} \leq 3°C$	Littoral climate $\theta_{mm} > 3°C$	Continental climate $\theta_{mm} \leq 3°C$	Littoral climate $\theta_{mm} > 3°C$	Continental climate $\theta_{mm} \leq 3°C$	Littoral climate $\theta_{mm} > 3°C$
	E_{prim} kWh/m^{2}a	E_{prim} kWh/ m^{2}a	E_{prim} kWh/ m^{2}a	E_{prim} kWh/ m^{2}a	E_{prim} kWh/ m^{2}a	E_{prim} kWh/ m^{2}a
single family houses	115	70	45	35	135	80
multiapartment buildings	120	90	80	50	180	130
Office buildings	70	70	35	25	75	75
Educational buildings	65	60	55	55	90	75
hotels and restaurants	130	80	90	70	145	115
Wholesale and retail trade services buildings	450	280	170	150	475	300
Hospitals	300	300	250	250	340	330
sports facilities	400	170	210	150	420	215
other non-residential	150	80	-	-	180	130

(Source: Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015))

Detailed requirements to application of RES are set separately for all new buildings without specification for nZEB – to allow for more options regarding the micro location. Newly built building fulfils the RES criteria if:

- 20% of energy need is covered by RES

[8] For heating, cooling, ventilation and domestic hot water, for non-residential buildings also lighting

[9] Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015)

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- or share of RES in delivered energy for heating and cooling and domestic hot water is at least:
  - 25% from solar radiation or,
  - 30% from gaseous biomass or,
  - 50% from solid biomass or,
  - 70% from geothermal energy or,
  - 50% from heat of the environment or,
  - 50% from high efficiency cogeneration plant or,
  - 50% is covered through district heating complying with previous requirements or,
  - the specific required energy for heating $Q''_{H,nd}$ [kWh/m²a] is at least 20% lower than the maximum allowed value of the Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015)

Building components have to satisfy the requirements presented in the following table.

Tab. 9: The requirements for the heat transfer coefficient in cost optimal level in Croatia.

	U [W/m2K]			
	Continental climate θ_{mm}≤3°C	**Littoral climate θ_{mm}>3°C**	**Continental climate θ_{mm}≤3°C**	**Littoral climate θ_{mm}>3°C**
Building envelope structure	**θint≥18°C**	**θint≥18°C**	**12≤θint≤18°C**	**12≤θint≤18°C**
External wall	0,30	0,45	0,50	0,60
Windows, glazed external envelope	1,60	1,80	2,50	2,80
Glazing	1,10	1,40	1,40	1,40
Roofs	0,25	0,30	0,40	0,50
ceilings above unheated and outside air	0,25	0,30	0,40	0,50
walls and ceilings towards unheated spaces	0,40	0,60	0,90	1,20
floors and walls towards ground	0,40	0,50	0,65	0,80
external doors	2,00	2,40	2,90	2,90
roller shutters boxes	0,60	0,80	0,80	0,80
ceilings and walls between different users	0,60	0,80	1,20	1,20
Domes and sun tunnels	2,50	2,50	2,50	2,50
Windshield	3,0	3,0	3,0	3,0

(Source: Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015))

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Additionally, Technical regulation on rational energy use and thermal protection of buildings (OG 128/2015) requires obligatory airtightness testing (according to HRN EN 13829 method A, before the permit for use is issued) of all nZEBs as well as buildings with specific required energy for heating $Q''_{H,nd}$ lower than 50 kWh/m^{2}a for Continental climate ($\theta_{mm} \leq 3$°C) and 25 kWh/m^{2}a for Littoral climate ($\theta_{mm} > 3$°C). The maximum prescribed n_{50} value is n50=3,0 h^{-1} for buildings without the mechanical ventilation system and n_{50}=1,5 h^{-1} for buildings with mechanical ventilation system.

2.2 DER definition in the project

A 'deep renovation' in accordance with the Energy Efficiency Directive, is a cost-effective renovation which leads to a refurbishment that reduces both the delivered and final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance. Such deep renovations could also be carried out in stages. The European Commission Staff Working Document (SWD (2013) 143 final) indicates that the significant efficiency improvements resulting from deep renovation are typically of more than 60% energy savings. This definition is used in the project implementation.

3. DER educational programmes

3.1 Trends in education in DER field

Czech Republic

In the **Czech Republic** construction projects preparation is mainly provided by small and medium-sized companies, which have a limited ability to follow the massive flow of information and knowledge now available. The ongoing changes bring with them a constant need for retraining. Therefore, the issue of the time is a need for skills, lifelong education, finding one's feet in the innovations and the rapid application of research and development. It is more and more common, that after finishing professional school the work requires from the graduate something slightly different, and sometimes even something entirely divergent from what was emphasized during studies. It is then necessary to retrain, brush up and requalify for all new needs, which constantly arise on the labour market.

General trends in education - increase of the role of authentic learning and information technologies in the learning process - influence also DER training programmes. For example, according to the results of feedback in Train-to-nZEB project, the participants stressed the value of shortening of theoretical part in favour of practical learning. Studying on the examples of practical models, real equipment and practical walls, where participant can implement a practical solution, or visits of construction sites with buildings under construction, is the most valuable. Further important trend is to motivate a student to study actively, making a trainer rather a coach and consultant than presenter and controller. In Train-to-nZEB courses the trainees are advised to bring some technical problem to the training to be able jointly with the trainer to find an optimal solution.

Thematically technical equipment of buildings and its development becomes more and more important, as new technical solutions appear rather quickly in practice.

Italy

The Italian education scenario has a lack of available courses in the field of DER, even though the topic of energy efficiency is crucial at the moment. The Italian university education program includes subjects related to energy efficiency in building but they don't go too much into detail.

Among course providers in Italy there are building component manufacturers and building companies which often provide courses on DER, but their courses are done with the aim of selling their products. The two biggest course providers in Italy are ZEPHIR and CasaClima.

CasaClima offers a wide range of courses covering all topics related to energy efficiency including a course on DER: **"Energy retrofitting of existing buildings"**.

ZEPHIR has been committed in providing courses for professionals and craftsman for more than 5 years. In Particular ZEPHIR provides courses on DER and nZEB and it also developed a more specific course on thermal bridges, a crucial topic for refurbishments.

Bulgaria

Professional high schools, colleges and vocational training centers:

The specific topic of deep energy renovation is currently not covered at all in the national vocational education and training system in Bulgaria and only partially covered in the higher education establishments. There is no training programme dedicated to deep energy building renovation for EQF levels 2-5 and only one for EQF level 7 (which could also be applicable for EQF level 6 with minor adaptations). However, there are some signs of change, as the topic of energy efficiency in buildings is slowly but surely entering the national educational standards and plans, particularly under the influence of EU-financed projects as BUILD UP Skills Bulgaria, BUILD UP Skills EnerPro and Train-to-NZEB.

However, in the current state educational standards for the professions “Builder”, “Builder-Technician” and “Builder-Installer” the topic of energy efficiency and application of RES solutions is not mentioned at all. There are only a few indications about the importance of the building renovation.

Deep energy retrofit in the higher education

There is only one known example for specialized discipline dedicated to the issue: “Energy efficient building renovation”, which is currently run in the Masters’ programme “Energy Efficiency in Construction” in the University of Architecture, Civil Engineering and Geodesy.

There are other disciplines which tackle issues related to energy efficiency, but none of them deals with DER as such.:

Romania

Professional high schools, colleges and vocational training centers:

The specific topic of deep energy renovation is currently not covered at all in the national vocational education and training system in Romania. There is no training programme dedicated to deep energy building renovation for EQF levels 3-5.

However, according to the new current state educational standards for the professions “Builder”, “Installer of ventilation and air-conditioning systems”, “Installer of central heating systems” - at EQF level 3, and “Designer technician in constructions”, “Technician in construction and public works”, “Installer Technician in constructions” - at EQF level 3, the topic of energy efficiency and application of RES solutions is partially addressed in the initial education and training system, without reaching / covering all aspects relevant to the subject. Some curricular documents specific to the initial education and training system, respectively some vocational training standards describing certain vocational qualifications that have been taught through vocational and technical education (Insulator, Masonry-stoner, Electrotechnical Technician) include learning outcomes expressed in terms of knowledge, abilities and attitudes regarding energy efficiency and application of RES solutions. However, learning outcomes do not cover all relevant aspects, requiring them to be completed.

However, there are signs of this situation changing, with new educational plans and programmes which allow the development of the curricular offer in partnership with the economic agents. Thus through the local development curriculum, the programmes can be adapted to the training needs of the labour market. In the training plan for the above professions can be included a new discipline within the local development curriculum, dedicated to energy efficiency (including in renovation) and application of RES solutions.

In the vocational training system are some occupations which has competencies related to DER and nZEBs, see Annex C.

The duration of the of vocational training for qualification programme is 720 hours, with 480 hours of practical work

For those who hold the basic qualification of an electrician, could be organized specialization programs, with a total duration of 144 hours, of which 48 hours of theory and 96 hours of practice, to acquire knowledge and skills related to numbered skills from 10 to 19.

Deep energy retrofit in the higher education

There are several energy educational programs in existing universities in Romania focused on efficiency and energy production from renewable sources, however there is no specialized discipline dedicated to “Energy efficient building renovation”. Programs are mostly Master type (1-2 years) or Post-graduate short courses (up to 100 hours, including individual/distant learning). Not all programs are available in detailed description in order to assess the relevance or sufficiency of learning outcomes for DER requirements.

The most relevant university programs are listed below:

- Master course on “Sustainable Development and Energy Audit” (terminated in 2012) @ University of Architecture and Urban Planning “Ion Mincu” Bucharest,
- Master course on “Techniques of Energy Audit in Buildings” (terminated in 2011) @ Unesco Chair within Polytechnic University of Bucharest,
- Master course on “Energy Efficiency in Building Services” (ongoing) @ Faculty of Building Services Engineering within the Technical University of Civil Engineering Bucharest,
- Post university course on “Energy analysis techniques and practices for the implementation of nZEBs“ @ Technical University of Cluj-Napoca (100 h program organized within the H2020 MEnS project),
- Master course on “Energy Upgrading in the Built Environment” (ongoing) @ University Transilvania of Brasov,
- Master course on “Renewable Energies” (ongoing) @ Technical University of Cluj-Napoca,
- Master course “Quality of Environment and Energy Sources“(ongoing) @ University "Babeş-Bolyai" Cluj-Napoca,
- Master course “Engineering of Systems with Renewable Sources“(ongoing) @ University "Ovidius" Constanta,

- Master course “Efficient Use of Energy and Renewable Sources“(ongoing) @ University "Dunărea de Jos" Galaţi,
- Master course “Renewable Energies“(ongoing) @ University of Oradea,
- Master course “Energy Conversion Systems“ (ongoing) @ University of Piteşti,
- Master course “Engineering and Management of Environment and Renewable Energies“ (ongoing) @ University "Lucian Blaga" Sibiu,
- Master course “Modern Systems and Equipment for Energy Generation and Use“ (ongoing) @ University "Valahia" Târgovişte,
- Master course “Renewable Energies – Solar Energy“ (ongoing) @ University Politehnica Timişoara

A Master on Green Buildings has been announced recently, being organised by the Technical University of Cluj-Napoca (The Civil Engineering Faculty) starting October 2017. No information about the detailed content and learning outcomes are available at this time.

Greece

There is no mentioning of energy efficiency, RES installations in existing buildings or deep energy retrofit anywhere in the state educational standards. There were some pilots courses, financed by “Intelligent Energy “ programs, but there was no follow up on these. The lack of nZEB definition and the fact that the national energy efficiency regulation is very new (2010) and faraway of the nZEB concept together with the collapse of the building sector , due to the crisis, are the main reasons for that.

Croatia

The specific topic of deep energy renovation (DER) is currently not covered at all in the national vocational education and training system in Croatia. There are no training programmes dedicated to deep energy building renovation for EQF levels 2-5 as well as EQF levels 6 and 7.

On the other hand, there are producers sporadically providing trainings for blue-collar workers on their specific materials and products for energy refurbishment, but this approach is not systematic.

Furthermore, CROSKILLS and CROSKILLS II projects (which were performed under the BUS initiative in Croatia) contributed in upskilling several hundred blue-collar workers working in the field of energy efficiency, specifically construction workers working on the building’s thermal envelope. Within CROSKILLS projects **11 training centres** were established with **108 trainers** in total that are able to perform trainings on DER with minor adaptations in their current CROSKILLS training programme.

From July 2017, the Ministry of Construction and Physical Planning enforced the “*Ordinance on education and certification system of construction workers working on the installation of building components which affect the energy efficiency of buildings”* which is envisioned to increase the number of skilled workers working on energy refurbishment and construction of new nZEBs. Similar ordinances exist for the installers of RES Systems where there are also several training centres established which give education on installation of RES systems.

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Additionally, it is expected that the Ministry of science and education will recognize the non-formal and informal learning and enable workers to gain qualifications also through those types of learning.

However, in practice on construction sites, there is still no specific focus on blue-collar workers and VET for high-quality or nZEBs, for installation of RES solutions in buildings or for application of new technologies, components or materials, so additional efforts should be exercised in this direction.

Furthermore, in Croatia, the VET system is quite complicated, the short description of the system is describer hereafter. The Ministry of Science and Education (MZO) is fully responsible for managing the preparation, amendments to and reviewing of the corpus of general education subjects, syllabi and curricula, with the assistance of the Education and Teacher Training Agency.

The vocational part of the syllabus in vocational and trade schools falls under the competence of and is approved by the Ministry of Economy, but it also has to be confirmed by MZO and is subject to opinion of the Sectoral Councils. Sectoral Councils are bodies appointed by the minister which analyse the outcomes of schooling, competences within the qualification framework of the respective curriculum and present to the Ministry for adoption an overview of their proposals. Sectoral Councils operate under the Agency for Vocational Education and Training and Adult Education (ASOO).

Moreover, the Ministry of Economy is responsible for the Croatian Chamber of Trades and Crafts (HOK), which proposes amendments to the existing and drafting of the new curricula in the, so called, trades and crafts programmes under the Uniform Education Model (JMO). However, with the possible overlapping of competence of either Ministry, both Agencies, the exclusion of HOK from programming, implementation and issuance of public documents leads to artificially created ambiguities.

The three-year (VET) educational programmes for professions related to DER are obsolete, since they were not changed since 1996 and 1997 and the teaching material used contains very little topics related to energy efficiency.

Never the less the current educational system (three-year VET) programmes content the learning outcomes for professions which could be related to DER and nZEBs, as listed in the Annex C.

Several gymnasiums in Croatia are providing programmes titled Gymnasium for sustainable development as a good preparation for pupils who intend to go to Universities to study similar programmes there. This programme offers three different modules, Eco-sustainability, Energy sustainability and Sustainable construction. Within these three modules, students are among other subject attend courses on Renewable energy sources, Energy refurbishment of buildings, Passive and low-energy buildings. Never the less it has to be enhanced that this is a new four-year programme developed in the last 5 years, where students which finished it are not able to perform construction works, and are intended to attend University.

Additional education at Universities as well as lifelong education (EQF level 6 & 7) in the field of nZEBs and DER of existing buildings up to the nZEB level is needed to provide the necessary technical knowledge to public administration, designers, technical supervisors, and site managers, not excluding other experts. At the moment, such education at the Universities is provided sporadically with only one or two subjects in specific field and is lacking interdisciplinary approach.

University of Zagreb has founded and has a third generation of students entered the “University undergraduate studies on energy efficiency and renewable energy sources” which is focused on systems, production of energy and renewable energy sources.

Additionally, currently there is a university programme titled “Sustainable and green building” in the validation procedure which is focused on sustainability in general, but has some learning outcomes related to energy efficiency, nZEBs, building physics and RES.

3.2 Objectives of programmes

Czech Republic

The main objective of the programmes offered is to upskill construction professionals in the field of energy efficiency and use of RES in buildings, including those by retrofit. Depending on the EQF level and specialization of participants, the specific objectives are as follows:

- to explain to the participants how building professionals can contribute to a sustainable environment by means of design, construction and operation on the building, neighbourhood and city scale;
- to present an appropriate distribution of responsibilities and roles in building projects, ensure integrated design, and optimise synergies between the building and its surroundings and users leading to increase of nZEBs implementation;
- to present proper design of technology and structural details of nZEBs;
- to present correct implementation of construction details for nZEBs; to present proper maintenance and use of nZEBs.

Higher education programmes offered at the universities have the following aims:

126YEMG – Energy management of buildings

The subject of Energy Management of Buildings deals with the concepts of management in general, energy management, energy economy, energy efficiency, building on energy efficiency documents of buildings - energy audit, PENB and building certification. The subject also deals with efficiency of investments, return on investment, multi-criteria evaluation, LCA (long live-cycle assessment), LCC (long-life cycle cost), legislation on energy efficiency, renewable energy and sustainable development of buildings.

124BPH Building physics

Students are introduced to basic principles of heat and moisture transfer in constructions and buildings, to main hygro-thermal requirements and to basic principles of building design from the point of view of thermal protection.

Main topics: Thermal protection of buildings - Heat transfer, Fourier laws. Thermal resistance, thermal transmittance. Mean thermal transmittance. Energy performance of buildings. Diffusion and condensation of water vapor. Minimum internal surface temperature, thermal bridges. Building acoustics - Fundamentals of acoustics, Outdoor and indoor sound propagation, Noise Criteria and limiting quantities, Noise control engineering, Room acoustics, Sound insulation in buildings. Daylight and insolation of buildings - Daylight factor, Sun path diagrams

125EABI - Energy audit of buildings

Introduction to basic methods and tools for energy audit of buildings and their practical application. Lectures are in the theoretical part of the subject. In the practical part students prepare preliminary energy audit of a building based on own survey in 2-4 groups. They further determine the energy demands of buildings. Effective Building Surveys. Energy saving measures in buildings. Comprehensive assessment of an object (industrial or civilian building) based on a survey of a particular object using a questionnaire and a visit to the building. Analysis of data obtained and design of austerity measures. In terms of material and organizational background, the course provides a Center for Diagnosis and Optimization of Energy Systems of Buildings.

D25EAU - Energy audit

Getting acquainted with the issue of energy audit of buildings according to the valid legislation as well as in the broader context of energy use in buildings with the aim of reducing the energy performance of buildings. Students will prepare a semester work in the form of an energy audit report on a model example. The theoretical part will be taught by a series of lectures. The course ends with a test in the form of a discussion on the submitted semester work.

A5M16EUE Economy of Energy Use

Organization and energy management of company, buildings or energy systems. Energy need and consumption, energy balance. Energy characterization of aggregate, secondary energy sources. Energy audit and feasibility study, optimization of energy management of energy systems. Prices and tariffs, economy and financial analysis.

BT054 Energy Assessment of Buildings

Methods of energy assessment of buildings, legislative requirements. Energy assessment for project activity and energy audits. Energy audit methodology. Energy assessment of the operation of heating and ventilation systems, systems for the preparation and distribution of domestic hot water, lighting systems, pumps and fans, cooling systems, technological equipment and other energy appliances. Design of energy-saving measures. Economic calculations of the profitability of the austerity measures. Software applications for energy and economic calculations. Energy management. Traffic management and maintenance systems for building equipment.

The aim is to get an overview of energy assessment methods in the Czech Republic and abroad. Methods of energetic evaluation of TZB systems, ventilation heating and others. The basics of thermos-vision work. Knowledge of energy auditing. Ability to perform energy certification of buildings. Economic evaluation of austerity measures.

229-0902 – Energy Efficiency of Buildings

Deepening knowledge of building thermal engineering, building energy and energy efficiency of buildings energy assessment of buildings, legislative requirements. National Calculation Tool. Software applications for energy and economic calculations. Simulation of the effect of changing the operating mode on the energy consumption of the object. Increasing energy end-user efficiency. Design of energy-saving measures.

Learning outcomes of the subject is increase the professional knowledge and skills in the field of building thermal technology and energy efficiency of buildings. Increased energy end-use efficiency contributes to reducing primary energy consumption, to reduce CO2 and other greenhouse gas emissions and thereby prevent dangerous climate change.

225-0931 – Building Energy and Sustainable Construction

The subject is focused on new buildings and reconstructions of old buildings; special attention is paid to the issue of sustainable construction considering the building energy concept.

Designing and designing buildings with special attention to energy according to current Czech and EU legislation.

Italy

“Thermal Bridge Calculation Course”

The course aims to prepare Passivhaus Designers and nZEB technicians, improving their technical skills for the design of Passivhaus buildings. The course main objective is to let Passivhaus designer to recognize the main typologies of thermal bridges and to calculate them correctly.

“PHPP and designPH course”

The course aims to prepare Passivhaus Designers and nZEB technicians, improving their technical skills for the design of Passivhaus buildings. Furthermore, the integration of PHPP software and designPH, aims to let the technicians speed up the Passivhaus design process.

“Certified Passivhaus Designer course”

The Certified Passivhaus Designer course is focused on all aspects of Passive House design, the global leading building energy efficiency standard. The course is addressed to professionals who want to deep their knowledge on building physics and Passivhaus in general. At the end of the course they have an opportunity to pass an exam (for additional fee) to become a certified Passivhaus designer.

Upon successful completion of this course attendees will have a knowledge of:

- The definition of a Passive House
- Basic Principles of Designing a Passive House
- Ventilation and Heating Principles in a Passive House

- Fundamentals on thermal comfort during the summer
- Electrical energy
- Principles of drawing energy balances (PHPP)
- Basics of economic efficiency calculation
- Invitations to tender and allocation
- Construction site management and quality control
- Information and support for occupants
- Refurbishments using Passive House components

“Certified Passivhaus Tradesperson course”

The aim of the course "Certified Passivhaus Tradesperson course " is to acquire excellent onsite workmanship and attention to detail which is critical in achieving the required Passivhaus/ nZEB standards.

Bulgaria

“Technology of construction”

The aim of the course "Building Technologies" is to acquire the basic knowledge of the construction of the buildings and the engineering facilities in a certain technological sequence, as well as the different types of finishing works. Another goal is to develop practical skills and skills for planning the necessary materials, tools, inventory and tools for the implementation of construction works. They also acquire skills to take measures to identify and correct defects in the execution of the construction works.

“Building Installations”

The aim of the course "Building Installations" is to acquire the basic knowledge of the types of installations in buildings and their purpose, to develop the ability to distinguish the types of building installations and their specific features, to increase the knowledge and professional skills regarding the possibilities of using the new technologies to maximize the use of renewable energy sources (solar, wind, geothermal and biomass) to achieve maximum economic and energy effects and protection of the natural environment.

“Energy efficient building renovation”

The course **Energy efficient building renovation** is based on the understanding that trainees are qualified specialists, some of whom may also have some practical experience in design and / or construction. The basic principles of the Passive House concept are used as the basis for structuring the design process, resulting in different levels of energy efficiency being achieved.

The basic 6 principles of the Passive House concept are perceived as universal and applicable in all outdoor climatic conditions. They derive from the essence of the building as a physical object whose functioning is entirely subordinate to natural physical laws. The course also introduces the cost-effectiveness of the concept as well as the potential for using RES in passive buildings and limiting CO_2 emissions generated by the use of buildings.

This project has received funding from the European Union's
Horizon 2020 research and innovation programme

Romania

The existing programs which are relevant to deep energy renovation (DER) are not specifically dedicated to DER, but contain some relevant information and skills development content for DER. The objectives vary in relation to EQF level, scope of the program (qualification of specialisation / CPD) and training supplier (e.g. training centre, university etc.). They range from 1 day nZEB Design course (totally ineffective for the purpose) to good quality programs, e.g. the post-university course developed under MEnS project at the Technical University of Cluj-Napoca (which could be improved in terms of better definition of learning outcomes and increasing coherence of the whole set of lectures, while DER could be considered separately and more focused) and the courses developed within the Building Knowledge Hub Romania under Train-to-NZEB. Among the existing courses which could respond best to the DER topic are the courses developed by the Passive House Institute (PHI) which were recently implemented or are under adaptation within the Train-to-NZEB project in Romania. Their content is of high quality and relevance to what should be nZEB effectively implemented, and contain relevant DER content, while their learning outcomes are very well defined.

“Certified Passive House Designer” course

The Certified Passive House Designer course is focused on all aspects of Passive House design, the global leading building energy efficiency standard. The content was developed by PHI and the training suppliers who are using it have to be accredited by PHI. In Romania, the course is under translation in Romanian and will be implemented jointly by NIRD URBAN-INCERC and The Romanian Chamber of Architects starting January 2018.
Learning Outcomes are clearly defined and are publicly available. Upon successful completion of this course students will have knowledge of:

- The definition of a Passive House
- Basic Principles of Designing a Passive House
- Ventilation and Heating Principles in a Passive House
- Fundamentals on thermal comfort during the summer
- Electrical energy
- Principles of drawing energy balances (PHPP)
- Basics of economic efficiency calculation
- Invitations to tender and allocation
- Construction site management and quality control
- Information and support for occupants
- Refurbishments using Passive House components

The certification is provided by PHI following the successful accomplishment of an exam organised by NIRD URBAN-INCERC and The Romanian Chamber of Architects as accredited examination hosts.

“Certified Passive House Tradesperson” course

The aim of the course " Certified Passive House Tradesperson course " is to acquire excellent onsite workmanship and attention to detail which is critical in achieving the required Passive House / nZEB standards. The content was developed by PHI and it is implemented in Romania by NIRD URBAN-

This project has received funding from the European Union's
Horizon 2020 research and innovation programme

INCERC (who translated the content in Romanian) since May 2017 as accredited training supplier. Learning Outcomes are clearly defined and are publicly available. The certification is provided by PHI following the successful accomplishment of an exam organised by NIRD URBAN-INCERC as accredited examination host.

Greece

CEPH Course

The basic 6 principles of the Passive House concept are perceived as universal and applicable in all outdoor climatic conditions. They derive from the essence of the building as a physical object whose functioning is entirely subordinate to natural physical laws. The course also introduces the cost-effectiveness of the concept as well as the potential for using RES in passive buildings and limiting CO2 emissions generated by the use of buildings.

Environmental Building Design (University of Patras)

The course is based on the Passive House concept. Basic principles are presented, the PHPP software is presented too. The students do some exercises with the PHPP in existing buildings.

SEEDPASS

SEEDpass educational slides on Passive House design feature the chosen case study examples from Italy, Croatia and Greece. Energy balance calculation assessment of case study buildings, done in PHPP (Passive House Planning Package), is presented as The Five Passive House Principles, whereas more descriptive details on each respective slide can be found in the Case Study Report. Educational slides can be used as the training material for Architects and Engineers. Rights of use on these set of training materials are available for third parties from the consortium members in their respective language and from the Passive House Institute in English language.

Croatia

BUILDING CONSTRUCTION (University of Zagreb, Faculty of Civil Engineering – Undergraduate studies)

Inform students about the elements of construction in buildings and houses. It not only includes the presentation and explanation of each element's properties but also the complete context of their usage as well as the possible functional problems of the building structure.

BUILDING PHYSICS (University of Zagreb, Faculty of Civil Engineering – Graduate studies)

Acquiring theoretical knowledge about energy efficiency, combined heat, moisture and air transfer through construction material and structure elements. Acquiring practical knowledge about testing thermal and acoustic properties of materials in laboratory. Acquiring knowledge about calculating thermal and acoustic properties of structures.

BUILDING STRUCTURES II (Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering, Undergraduate studies)

This project has received funding from the European Union's
Horizon 2020 research and innovation programme

Introduction in scientific dicipline building physics. Subject of investigation and goals of building physics. Basic concepts and physics elements in heat science. Classification of heat transfering : conduction, flowing and radiation. Coefficient of thermal conductivity for construction materials. Classification for heat insulation materials. Thermal insulation of building elements. Calculation of coefficient “k” Condensation of water steam on interior surface of external constructin element. Thermal bridges. Diffusion of water steam through the construction elements. Glasser method for calculating diffusion of water steam. Acustic insulation of construction elements. Air suond and sound of impact. Svimming floors. Roofing – tradicional and engineering construction. Types of roofs according to shape. Rafter and purlin roofs. Empty roofs, types of constructions, details. Hipped roofs – order of solving, span length. Flat roofs – classification, details. Protection of the ground humidity – waterproofing. Protection of ground water. Staircases – reinforced concrete, timber and steel stairs. Shapes, details and graphic demonstration in floor plans and sections. Floors. Classification according to materials, thermal loos and way of construction. Doors and windows. Types according to way of opening and materials. Details.

STRUCTURAL PHYSICS (Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering, Undergraduate studies)

Introduction in scientific discipline building physics. Subject of investigation and goals of building physics. Basic concepts and physics elements of heat science. Classification of heat transfer : conduction, flowing and radiation Coefficient of thermal conductivity for construction materials. Classification for heat insulation materials. Thermal insulation of building elements. Calculation of coefficient “k” with one number for building. Linear coefficient “k”. Coefficient “k” with one number for building. Temperature curve. Heat accumulation. Characteristics of humidity air. Condensation of water steam. Thermal bridges. Diffusion of water steam through the construction elements. Affecting of sun radiation on constructive elements. Sun protection. Types of use of solar energy in buildings. Thermal stabilization of exterior constructive elements in the summer period. Temperature changing and Thermal stress. Acoustics. Physics (objective) characteristics of sound. Noise. Physiologic (subjective) characteristics of sound. Sound waves in closed space. Sound transmitting from room to room. Transmitting of sound of impact from room to room. Repairing and reconstruction of buildings as an improvement of physics building characteristics.

DESIGN OF BUILDINGS (University of Rijeka, Faculty of Civil Engineering – Graduate studies)

Inform students about the methodology of planning and qualify them for reading and elaborating the planning documentation. Elements of historical development. Theoretical basis for evaluating an architectural work. Approach to planning, analysis of a location, programme, orientation, physics of a building. From a regional plan to an executional project. Technical conditions of building, standards, regulations, fire and conservation protection, safety at work. Function, construction, design for residential and public buildings. Staircases and elevators, installations, heating, cooling and ventilation. Modern facades and roof frames. Construction as the basis of formation - public buildings for special purposes, halls, big sheds, stadiums, theatres, airports.

On the University of Zagreb, Faculty of Architecture there are several subjects dealing with energy efficiency, i.e. *Energy efficient and sustainable architecture*, *High-tech architecture*, *Architectural* *structures I-VI*, *Building physics*, *Building installations I & II*, *Building shape and thermotechnical installations*. The objectives of these courses are not available, in order to be able to analyse more in depth their content.

3.3 Sources of programmes identified

For example, in the Czech Republic with varying degrees of success, the majority of the specialized agencies develop a lifelong education programme addressing energy efficiency of buildings. The majority of universities are also dedicated to the programmes of lifelong education, but not focused on DER or nZEB renovations.

Main sources of the training programmes in each target country are listed in the table below.

Table 10: Sources of DER training programmes identified within the analysis.

Country	Source of programme	Link to website with information about the programme
Czech Republic	Train-to nZEB BKH in the Czech Republic	http://www.train-to-nzeb.com/o-projektu.html
	ingREeS training programmes	www.ingrees.eu
	Centre of Passive House (only information about the structure of the course)	http://www.pasivnidomy.cz/akce/rekonstrukce-energeticky-efektivni-renovace-stavajicich-budov-607/765
	PROF / TRAC project	http://proftrac.eu/training-materials.html
Italy	ZEPHIR / Passivhaus Institut	http://www.passivhaus.academy/
Bulgaria	Ministry of Education and Science / Professional High School of Architecture – Pazardzhik	http://www.mon.bg/?go=page&pageId=2&subpageId=40
	University of Architecture, Civil Engineering and Geodesy / EnEffect	http://eec.uacg.bg/
Romania	National Authority for Qualifications / The Romanian Agency for Quality Assurance in Higher Education	http://www.anc.edu.ro/?page_id=610
	Train-to-nZEB in Romania	http://www.train-to-nzeb.com/courses.html
	CPHD and CPHT courses	http://www.train-to-nzeb.com/courses.html
	National Centre for VET under the coordination of Ministry of Education / Technical College of Architecture and Public Works ,,I. N. Socolescu" and Technical College ,,A. Saligny" – Bucharest	http://tvet.ro/ http://www.colegiulionsocolescu.ro/
	University of Architecture and Urban Planning / Polytechnic University of Bucharest / University Valahia of Targoviste / NIRD URBAN-INCERC / Cluster Pro-nZEB	https://www.uauim.ro/ http://www.upb.ro/ https://www.valahia.ro/ http://incd.ro/
Greece	HPHI / Passivhaus Institut	http://www.eipak.org
	Technical University of Patras, Civil Engineering Faculty	http://www.civil.upatras.gr/el/ProptixiakhEkpaideysh/Mathimata/EEtos/entry/0db702ae-a01b-41f1-8b83-f9f233570796/?PageNo=0
Croatia	University of Zagreb, Faculty of Civil	http://www.grad.unizg.hr/predmet/grafiz

	Engineering	
	University of Zagreb, Faculty of Architecture	http://www.arhitekt.unizg.hr/zavodi/arh/default.aspx
	Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering	http://www.gfos.unios.hr/preddiplomski-sveucilisni-studij-gradevinarstvo/gradevinska-fizika-pss-grad
	University of Rijeka, Faculty of Civil Engineering	https://helpdesk.uniri.hr/gradri/kolegiji/222 https://helpdesk.uniri.hr/gradri/kolegiji/112
	Ordinance on education and certification system of construction workers working on the installation of building components which affect the energy efficiency of buildings	https://narodne-novine.nn.hr/clanci/sluzbeni/2017_07_67_1578.html
	Ordinances on Renewable Energy Sources Installer Certification	http://www.mgipu.hr/default.aspx?id=12841
	Republic of Croatia, Ministry of economy, work and entrepreneurship, Zagreb, 2007.	https://narodne-novine.nn.hr/clanci/sluzbeni/2015_11_123_2340.html
	Glasnik Ministarstva prosvjete i športa Republike Hrvatske, Nastavni planovi i okvirni programi za područje elektrotehnike, Zagreb, 1997	http://www.asoo.hr/default.aspx?id=1347

3.4 Programmes availability and quality

Czech Republic

The higher education programmes with the focus on DER and nZEB retrofit have to be developed, no comprehensive programme covering completely the topic is available in the CZ educational system at the moment. The basis for that can be training programmes developed under Train-to-nZEB and ingREeS projects. These programmes are available for project partners, but not for general public.

Italy

No publicly available training materials were identified during the analysis.

Bulgaria

The programmes are publicly available. However, the level of detail is not sufficient and training aids and materials in form of presentations and lectures are not available, except for the **"Energy efficient building renovation"** programme developed by EnEffect and UACEG.

Romania

The occupational standards are publicly available (http://www.anc.edu.ro/?page_id=42), but exist in updated versions for limited number of occupations/qualifications. The National Qualification System needs revision including the improvement of occupations definition and classification and development of updated occupational standards, which is a timely and costly process.

The VET standards were recently updated and are publicly available (http://edu.ro/standarde-de-preg%C4%83tire-profesional%C4%83-pentru-calific%C4%83ri-profesionale-de-nivel-3-si-4-al-cadrului). The inclusion of DER topics and nZEB skills development could be done by means of a local curriculum development together with the construction industry representatives, which fits the objectives and course duration of Fit-to-nZEB.

The programmes organised in various universities are publicly available. However, the level of detail is not sufficient and training aids and materials in form of presentations and lectures are not available.

Greece

CEPH : Trainign materials are not publicly available

SEEDPASS : Material is available as a Webinar and Slides in PDF mode in project’s website

Croatia

The programmes are publicly available for all institutions except University of Zagreb, Faculty of Architecture. However, the level of detail is not sufficient and training aids and materials in form of presentations and lectures are not publicly available, except for the programmes developed by Unizag GF.

The VET programmes (EQF level 2 and 3) are recording decreasing number of students year after year, while the University programmes (EQF level 6 and 7) are managing to keep the same number of students.

The CROSKILLS programmes were reviewed by the experts from the ASOO and the MGiPU which resulted in accepting the programme by the MGiPU within the *Ordinance on education and certification system of construction workers working on the installation of building components which affect the energy efficiency of buildings*. Additionally, training materials (books, manuals and practical examples) were accepted by ASOO and recommended them to be used as a literature in VET schools. There are 11 training centres throughout the Croatia which ensures the programmes availability for all the potential workers interested.

3.5 Developers and providers of the DER programmes

Developers and providers of DER and nZEB renovation training programmes, identified in the target countries, are listed in Table …

Most of the training courses in **the Czech Republic** have been developed by their providers. Analysis aimed at mapping the market for providers of training and educational courses, mainly in the field of construction shows that, compared with other sectors, there are very few educational agencies aimed at energy efficiency in construction sector, none of them specifically focused on renovations. The providers are independent form each other and compete in delivering educational services. The training courses organized by the Passive House Centre (http://www.pasivnidomy.cz/) appear to be the best example as they are clearly aimed at training in the area of nZEBs. Other good examples are the Czech Construction Academy (http://stavebniakademie.cz) and Studio Axis (https://www.studioaxis.cz).

Table 11: Developers and providers of DER training programmes in target countries.

Target country	**Developers of DER training programmes/providers of DER trainings**
Czech Republic	• Passive House Centre • ingREeS project partners • Train-to-nZEB CZ Building Knowledge Hub (in cooperation with Czech Construction Academy)
Italy	• ZEPHIR / Passivhaus Institut
Bulgaria	• Professional high schools of construction and architecture • University of Architecture, Civil Engineering and Geodesy/ EnEffect
Romania	• Technical College of Architecture and Public Works ,,I.N. Socolescu” and Technical College ,,A. Saligny” – Bucharest / Other Professional High schools/Colleges • University Valahia of Targoviste / Technical University of Cluj-Napoca / Cluster Pro-nZEB / The Building Knowledge Hub Romania / The House of Builders Foundation
Greece	• CEPH Course Passivhaus - Institut Dr.Wolfgang Feist (and partners in CEPH and SEEDPASS projects) • Environmental Building Design (University of Patras) - Hellenic Passive House Institute
Croatia	• no specific DER programmes are available • “CROSKILLS programme” developed by consortium of the *Build Up Skills CROatia: Strengthening energy efficiency SKILLS and certification schemes for building workers* (CROSKILLS II project)can be used for DER educational programme, providers are VET schools and public colleges

4. Target groups and specialisms of DER/nZEB programmes

Czech Republic

Situation in the construction industry in the Czech Republic results in shifting the up-skilling challenge in the building sector to the sphere of lifelong learning (adult education), rather than the initial/primary and high education. That’s why main target group of existing DER programmes are construction professionals with quite high qualification – EQF 6-7 and EQF 5. The table below shows a gap in the number of qualified construction professionals in the Czech Republic by 2020 according to the required level of education. It is clear from the assessed size of the gap that DER qualification programs are most needed for EQF 4-5 level, more than for professionals with higher education, and main target group can be shifted to this segment of educational level in the future.

Table 12. Education Needs Balance by Education levels (thousand persons).

Level of Education	2011	Loss over 2011 - 2020	Difference 2011 – Loss 2011/2020	2020 target Need	2020 gap
Basic – EQF 3	14,0	4,5	9,5	8,6	- **0,9**
Secondary with Apprenticeship Certificate – EQF 5	284,4	62,1	223,3	254,0	**31,7**
Secondary with GCSE – EQF 4	126,0	18,0	108,0	116,2	**8,2**
University – EQF 6-7	42,0	5,4	36,6	51,7	**15,1**
Total	466,4	90,0	376,4	430,5	**54,1**

Source: Analysis of the national status quo.

Italy

Main target groups to provide DER education are listed below:

- certified Passivhaus Designers
- technicians in general
- craftsmen
- employees of construction companies
- students of universities and professional colleges

Bulgaria

- **High schools and colleges (EQF 2)**

Students acquiring professional qualification for all specialisms in professions 582030 “Builder” and 582040 “Builder-Installer”, professional direction Construction

- **Higher Education (EQF 7)**

Graduates from architecture and technical universities

Romania

- **High schools and colleges (EQF 3-4)**

Students acquiring professional qualification for all specialisms in professions “Builder”, “Installer of ventilated and conditioning installation”, “Installer of central heating installation” (EQF level3), and “Designer technician in construction”, “Technician in construction and public works”, “Installer Technician in construction” (EQF level 4), - professional direction Construction and architecture

- **On-site workers (EQF 3-5)**

Certified Passive House Tradespersons

Technicians in general

Craftsmen in various occupations

Employees in Building Companies

- **Higher Education (EQF 6-7)**

Graduates from architecture and technical universities, students in final year in engineering/ architecture specialism.

Greece

CEPH, SEEDPASS

- professionals with higher education (EQF 7)
- graduates from architecture and technical universities
- graduates from the programme Environmental Building Design (University of Patras)
- students of the civil engineering faculties (last year)

Croatia

According to the CROSKILLS programme, for qualified construction workers (EQF level 4 – Bricklayer, Plasterer, Carpenter, House painter, Roofer, Drywall installer), semi-qualified construction workers (EQF level 3), non-qualified construction workers (EQF level 1 and 2)

4.1 Entry qualifications

Czech Republic

Graduation from previous level of EQF programme is required for the entrance into a higher-level programme. For commercially offered training courses the required entry qualification is given by the target group of the course, although never checked by the entrance to the course.

Italy

- **"Thermal Bridge Calculation Course":** Participants are required to have a basic knowledge of Building Physics
- **"PHPP and designPH course":** Participants should have an intermediate level of competency in Microsoft Excel

Bulgaria

- **High schools and colleges (EQF 2):** elementary school
- **Higher Education (EQF 7):** Bachelor degree from architecture and technical universities. Preliminary requirements: the students are expected to have successfully completed the following courses: building physics, building materials and building insulation.

Romania

- **High schools and colleges (EQF 2-3):** elementary school/ gymnasium
- **Construction companies (EQF 3-5):** elementary school / gymnasium, professional school or high school (technological line), qualified in various crafts in constructions
- **Higher Education (EQF 6-7):** Bachelor degree from architecture and technical universities. Preliminary requirements: the students are expected to have successfully completed the following courses: building physics, building materials and building insulation.

Greece

CEPH, SEEDPASS

- Higher Education (EQF 7)
- Graduation from architecture and technical universities
- Environmental Building Design (University of Patras)
- Students of the civil engineering faculty (last year)

Croatia

According to the CROSKILLS programme, there are different modules for qualified construction workers (EQF level 4 – Bricklayer, Plasterer, Carpenter, House painter, Roofer, Drywall installer), semi-qualified construction workers (EQF level 3), non-qualified construction workers (EQF level 1 and 2). Construction site experience of at least 6 months, having the knowledge regarding the health and safety. Thus, their qualifications determine the module they are going to have to finish.

4.2 Expected outcomes

Czech Republic

Main expected outcome of the programmes is improvement of qualification of the graduates, confirmed by a certificate or a degree obtained. As official primary and higher education programmes currently do not focus on DER, this niche is covered by professional short-term trainings with final certification. Trainee holding the certificate will enjoy a better position on the labour market. Investors may demand a contract to be executed by a construction company that employs certified staff and construction companies with certified personnel may enjoy a competitive advantage in public procurement.

Italy

Higher Education (EQF 7): Additional professional qualification / specialisation

Construction companies (EQF 3-5): Professional qualification, Additional professional qualification / specialisation/ Technical and practical knowledge

Bulgaria

High schools and colleges (EQF 2): Professional qualification

Higher Education (EQF 7): Master of sciences degree

Romania

High schools and colleges (EQF 3-4): Professional qualification

Construction companies (EQF 3-5): Professional qualification, Additional professional qualification / specialisation

Higher Education (EQF 7): Master of sciences, post-university course

Greece

CEPH : Professional qualification. (EQF 3-5)

Environmental Building Design : post-university

SEEDPASS : General Information , Basics (EQF 3)

Croatia

From CROSKILLS programme, the outcome is certificate issued by the MGiPU (Ministry of construction and physical planning)

4.3 Benefits for programme graduates

Czech Republic

The following table shows the individual target groups and key players who will gain the necessary knowledge and skills by participating in training courses. The courses provide participants with the expertise to properly implement nZEB projects. Participants can get information beyond the courses' framework or assistance in solving specific problems from the consultation activities.

Table 13: Future benefits for the groups of graduates of DER programmes

Target group	EQF level	Benefits for target groups
Workers in the construction industry	3 – 5	Transferring newly gained knowledge into practice, more precise work and applying best practices and information about nZEB.
Highly qualified professionals (architects, designers and engineers)	6 - 7	Developing technical knowledge (standards, procedures, technology) and information about nZEB, knowledge transfer from other regions – innovative educational programmes, practically oriented education, current information obtained through social media, study tours and excursions.
The wider public (media, public administration, business managers)	3 – 7	Understanding the issues and orientation in the legislative context, information about nZEB. The dissemination and development of best practices and information on nZEB - innovative educational programmes, manuals and other educational materials, practically oriented education, current information obtained through social media.

(Source: SEVEn)

Italy

Higher Education (EQF 6-7): Specialization in energy efficiency in both new buildings and existing buildings. Professional opportunities.

Bulgaria

High schools and colleges (EQF 2): Recognition of the acquired qualification and opportunities in the construction sector. Opportunities to develop their qualification to higher levels with recognition of the achieved learning targets.

Higher Education (EQF 7): Specialization in energy efficiency in existing buildings and professional opportunities in programmes and projects for renovation of the existing building stock.

Romania

High schools and colleges (EQF 3-4): Recognition of the acquired qualification and opportunities in the construction sector. Opportunities to develop their qualification to higher levels with recognition of the achieved learning targets.

Higher Education (EQF 7): Specialization in energy efficiency in existing buildings and professional opportunities in programmes and projects for renovation of the existing building stock.

Greece

Opportunities to Specialization in energy efficiency in existing buildings and professional opportunities in programmes and projects for renovation of the existing building stock.

This project has received funding from the European Union's
Horizon 2020 research and innovation programme

Croatia

Recognition of the acquired skills and knowledge and opportunities in the construction sector (EQF 2-7) . Opportunities to develop their qualification to higher levels with recognition of the achieved learning targets (EQF 2-7).

Specialization in energy efficiency in new and existing buildings and professional opportunities in programmes and projects for renovation of the existing building stock (EQF 7).

4.4. Ways of checking trainees knowledge and skills

Czech Republic

The main way to check the acquired knowledge and skills is an examination of the graduates. The examination of performed in most programmes in the form of test, in a written form or electronically.

Italy

Class exercises, final test and examination pre-test

Bulgaria

- **High schools and colleges (EQF 2):** theoretical and practical examination according to approved programmes
- **Higher Education (EQF 7):** course project, theoretical examination (test)

Romania

- **High schools and colleges (EQF 3-4):** theoretical and practical examination according to approved programmes
- **Higher Education (EQF 7):** course project, theoretical examination (test)

Greece

- International PH Examination on CEPH
- Examination on Faculty of Enrgineering

Croatia

According to the CROSKILLS programme, theoretical and practical examination

5. Content of programmes according to EQF level

5.1. Structure

Czech Republic

Because of the gaps in official educational programmes for professional education of EQF 3-7 levels, the programs focused on energy efficient renovations are developed for construction professionals with at least EQF 5 qualification to fill in the gap during training of adults.

Most of programmes are structured into two parts: theoretical and practical. Example of the structure of a two-day course for construction professionals focused on DER is given below.

Course - Retrofit: Energy efficient renovation of existing buildings (EQF 5-7)

1st day:

- Design principles and possibilities of renovation of family houses
- Design principles and possibilities of renovation of apartment houses and panel houses
- Ventilation system by renovation, regulation of heating systems
- Typical problems of renovated buildings
- Project samples

2nd day:

- Design principles of renovation of non-residential buildings
- Historic buildings and their specifics
- Design of ventilation and heating systems including regulation and distribution
- Use of renewable heat sources (solar energy, cogeneration, etc.)
- Workshop - Renovation of an existing building (real example)

Economic assessment of proposed energy saving measures

Italy

Training programmes offered to construction professionals have the following structure.

“Thermal Bridge Calculation Course” (EQF 7):

- Regulation Background
- Thermal bridge definition
- Thermal bridge calculation with isotherm analysis
- Calculation methodology
- Mold and condensation analysis according to UNI EN ISO 13788
- Examples and recap exercises"
- Thermal bridge - Windows

This project has received funding from the European Union's Horizon 2020 research and innovation programme

- Thermal bridge - Ground
- Special solutions
- Exercise

“PHPP and designPH course” (EQF 7):

- Focus on Passivhaus Standard principles & Passivhaus criteria
- Energy balance components heating
- PHPP basics
- Verification Sheet
- Climate Data sheet
- Opaque surfaces
- Thermal bridges calculation
- Ground sheet
- Transparent components
- Ventilation and Domestic Hot water
- Summer in the Passivhaus
- Conclusion and final overview
- New in PHPP9
- Overall efficiency
- The new PH classes
- Examples and exercise
- Building a simple model

“Certified Passivhaus Designer course” (EQF 7):

- Introduction and basic principles on Passivhaus
- Ventilation system
- Heating/Cooling system s
- Thermal bridges + Windows
- PHPP Software (PassivHaus Planning Packet)
- PHPP Laboratory
- Building Envelope + Practice
- Solar Analysis + Project Exercise
- Insights
- Repetitorium + economics + PHPP systems
- CEPH examination exam

“Certified Passivhaus Tradesperson course” (EQF 3-7):

- Introduction and basic principles on Passivhaus
- Worksite (theory and examples)
- Thermal envelope

- Building systems
- Worksite in practice

CPHT examination exam

Bulgaria

High schools and colleges (EQF 2):

Part of more generic training programme. Structured in sections and topics, as described above

“Technology of Construction”

SECTION X. Low energy and "passive" buildings. Renovation of buildings and facilities.

- General characteristic of low-energy and passive buildings. Criteria and principles of the passive building.
- Renovation of existing buildings with elements for low energy construction

“Building Installations”

SECTION III. Energy standard of a building. Heating, ventilation and air conditioning systems.

- Energy standard of a building: Microclimate in the premises of buildings. Heat comfort. Humidity. Velocity of the air.
- Heating installation: Types of heating systems and circuits. Elements of the heating installation. Types of heat carriers.
- Ventilation installations: Classification. Ventilation installation schemes
- Air conditioning installations: Basic Elements. Operations in air conditioning units: filtration, heating, cooling, flushing and humidification of the air. Air conditioning schemes.

SECTION IV. Renewable energy sources in building installations. Automation of Building Installations (BMS).

- Renewable energy sources.

Solar energy for domestic hot water heating through solar collectors. Photovoltaic systems for electricity generation. Geothermal energy utilized by using heat pumps. Wind energy from wind turbines. Biomass.

- Recuperation system in "passive buildings".

The Passive House Standard. Controlled mechanical ventilation. Elements of the recuperation system. Heat pump.

- Automation of building installations (BMS).

BMS Architecture. Level “Management” - software solutions, with the graphical environment for displaying the state of the managed systems. Level “Automation / control” -programmable controllers and controllers with special application. Level “Field automation”: sensors for data provision and controllers. Sensors for measuring temperature, pressure, humidity, motion and presence, etc.

Higher Education (EQF 7):

The course is divided into three large sections. The first examines the European policy on the renovation of existing buildings and the importance and application of the nearly zero energy building standard in the formulation of national renovation strategies. Particular attention is paid to the particularities of the design and construction of the building envelope and of the building systems in the renovation of existing buildings, as well as the provision of high quality design and construction performance. The second part of the curriculum presents the normative framework, the objectives, the content and the practical implementation of the energy audits of existing buildings. The third section is devoted to the cost-effectiveness of renovating existing buildings and successful practices. Particular attention is paid to the step-by-step renovation, ventilation and its combination with heating systems and the possibilities of heat recovery from the exhaust air using high-efficiency ventilation equipment. Centralized and decentralized solutions are being considered. The basics of the economic efficiency of the renovation of existing buildings are discussed.

Romania

High schools and colleges (EQF 3-4):

Part of more generic training programme. Structured in sections and topics, according to professional qualifications defined.

Higher Education (EQF 7):

Various, according to the curriculum defined for each program in existing universities.

“Certified Passive House Designer” course (EQF 6-7):

- Introduction and basic principles on Passive House
- Ventilation system
- Heating/Cooling systems
- Thermal bridges + Windows
- PHPP Software (Passive House Planning Package)
- PHPP Laboratory
- Building Envelope + Practice
- Solar Analysis + Project Exercise
- Insights
- Retrofitting + economics + PHPP systems
- CPHD/CPHC examination exam

“Certified Passive House Tradesperson” course:

- Introduction and basic principles on Passive House
- Worksite (theory and examples)
- Thermal envelope

- Building systems
- Worksite in practice
- CPHT examination exam

Greece

Environmental Building Design (University of Patras) (EQF 6-7)

- Introduction.
- European EPBD directive and national legislation. The nZE building.
- Regulation of Energy Performance Building and International Standards (ASHRAE, Passive House, etc.) / Introduction to Thermodynamics. Heat, Thermal Balance.
- Energy Planning. Climate Parameters / Thermal comfort - Calculations, Specifications, Standards, Regulations.
- Conventional, Bioclimatic Design and Implementation Methodology.
- Building Fabric. Thermal insulation. Elimination of thermal bridges. Air tightness, implementation of ISO 13829.
- Frames, Glass, Specification (ISO EN 673, ISO EN 410, ISO EN 10077-2) and placement.
- Heating and Cooling. Overheating during the Summer.
- Ventilation and indoor air quality, Mechanical ventilation with energy recovery.
- Energy balance. Software Calculations and Simulation. The use of RES in nZE buildings.
- The cost of construction.
- Energy Retrofits in existing buildings: Regulations and Practices.
- Technical specifications for buildings energy efficiency measurements, Thermography, Air Tightness Test. Building certification. Application examples.

CEPH PROGRAM (EQF 7)

Understanding of the climate-independent Passive House definition and its derivation:

"A Passive House is a building, for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air".

• Understanding of the requirements for hygienic air, fresh air quantity that is necessary per person, extract air demand, minimum air change rate.

• Understanding of the relationship between relative indoor air humidity and effective air exchange.

• Basic principles of the methodology for evaluation of thermal comfort based on ISO 7730.

• Understanding of the certification criteria for Passive House buildings and retrofits using Passive House components (EnerPHit).

• Knowledge of the key parameters (e.g. in the Verification worksheet of the PHPP) heating load, cooling load, annual heating demand, annual cooling and dehumidification demand, n50 value, primary energy (non-renewable and renewable PER), final energy, energy services, frequency of overheating.

• Definition and influence of the reference areas and volumes used in Passive House design and certification.

• Basic understanding of the issue of assessing sustainability of the energy demand of buildings in the context of a changing energy supply system.

SEEDPASS (EQF 3-5)

Basic Principles of Passive House standard are trained within the course.

The 5 Principles of Passive House standard illustrated by Examples from Croatia, Italy and Greece.

- The EPBD
- The PH principles
- Passive House Criteria
- Life cycle cost
- Renewables
- Passive House in the Med
- Climate and Location
- Treated Floor area
- Thermal boundary
- Building Components U-values
- Thermal bridges
- Windows – certified components
- Ventilation zones
- Cooling load
- Overheating
- Night ventilation
- Heating support

Croatia

According to the CROSKILLS programme which was adopted by the MGiPU within the *Ordinance on education and certification system of construction workers working on the installation of building components which affect the energy efficiency of buildings* the workers are intended to go through the general topics like the importance of energy efficiency in buildings, fire protection waste management, quality control, airtightness testing. Afterwards, every of the 6 professions are intended to learn about the traditional, modern and contemporary materials, systems and technologies used in their respective fields. The teaching materials are concentrated to achieve the best possible thermal envelope taking into account the issues of thermal bridges on new and existing buildings, the necessity of internal insulation of existing buildings, etc. The workers are also introduced to the concept of the cross-crafting.

The training materials are developed in a way which enables workers to see what is the correct way of installation of the most commonly used materials and systems in Croatia, what are the common mistakes, and also what are the consequences of poor installation of the respective systems and what are the options available for quality control of their work..

After they go through theoretical part and discuss their positive and/or negative experiences, the workers are obliged to undertake the practical part of the training where they get to work with materials and systems crucial for achieving the airtightness, reduce thermal bridges, etc.

5.2. Duration

Duration of the programmes related to energy efficient renovations of buildings differs a lot between countries and levels of education. It need to be harmonized in newly developed standards according to the level of EQF. Duration of the courses/educational programmes, identified within the analysis is listed below for each target country.

Czech Republic

The analysis of 196 commercially offered courses in the Czech Republic showed that an average duration of such courses is 4 days, respectively 29,5 training hours on average. Most of the courses offered (124 from 196) are one-day courses. One day of training contains on average 6,7 training hours.

Italy

- **“Thermal Bridge Calculation Course” (EQF 7):** 16 hours
- **“PHPP and designPH course” (EQF 7):** 24 hours
- **“Certified Passivhaus Designer course” (EQF 7):** 88 hours
- **“Certified Passivhaus Tradesperson course”:** 32 hours

Bulgaria

- **High schools and colleges (EQF 2):**

“Technology of Construction”: SECTION X. Low energy and "passive" buildings. Renovation of buildings and facilities – 6 academic hours (out of 43)

“Building Installations”: SECTION III. Energy standard of a building. Heating, ventilation and air conditioning systems & SECTION IV. Renewable energy sources in building installations. Automation of Building Installations (BMS): 8 academic hours (out of 14)

- **Higher Education (EQF 7):**

60 academic hours (45 hours lectures and 15 hours exercises)

Romania

- **High schools and colleges (EQF 3-4):**

Education	Grade	Hours allocated by Local Development Curriculum
Professional School	IX grade	150 ore (30 h/week x 5 weeks)
	X grade	270 ore (30 h/ week x 9 weeks)
	XI grade	300 ore (30 h/ week x 10 weeks)
Professional High School	IX grade	90 ore (30 h/ week x 3 weeks)
	X grade	90 ore (30 h/ week x 3 weeks)
	XI grade	66 ore (2 h/ week x 33 weeks)
	XII grade	62 ore (2 ore/saptamanax x 31 saptamani)

- **On-site workers / Construction companies” (EQF 3-4):** 720 hours for a full qualification program
- **“Certified Passive House Designer” course (EQF 6-7):** 88 hours
- **“Certified Passive House Tradesperson” course (EQF 3-5):** 32 hours

Greece

- CEPH : 80 hours
- SEEDPASS : 5 hours
- Environmental Building Design : 39 academic hours (30 hours theory and 19 hours exercises)

Croatia

According to the CROSKILLS programme

- EQF level 4 - 20 hours (8 theory + 12 practice)
- EQF level 3 - 25 hours (12 theory + 13 practice)
- EQF level 1 and 2 - 30 hours (15 theory + 15 practice)

Lifelong learning 8 hours during the validity of the certificate (5 years).

5.3. Resources and equipment required to deliver the programmes

Czech Republic

Main resource for the teaching deliverance is a classroom where participants and trainer will mainly discuss theoretical knowledge in the form of lectures and presentations. Other important part is the training rooms, where the training focused on practical skills and illustrative examples of models takes place. Part of the practical training can also be creation of practical models by course participants.

The training room of Train-to-nZEB BKH is equipped with illustrative teaching models.

Figure 4. Demonstration models.

The following equipment for practical demonstrations is installed in the BKH:

- 4 demonstration models of nZEB building construction
- Ventilation unit with heat recovery
- Measuring instruments for blower door test
- 2 infrared cameras
- CO_2 concentration meter
- 8 information panels with description of BKH equipment

Besides these, project training materials, professional textbooks and publications, power point presentations are given at the disposal of the trainers to deliver training courses, as well as to trainees for efficient self-study.

Italy

"Thermal Bridge Calculation Course" (EQF 7):

The training has to be conducted using the necessary didactic materials and visual aids.

Each participant should have a thermal bridges calculation software installed.

"PHPP and designPH course" (EQF 7):

The training has to be conducted using the necessary didactic materials and visual aids.

A demo version of the PHPP 9 software will be provided to each participant.

"Certified Passivhaus Designer course" (EQF 7):

The training has to be conducted using the necessary didactic materials and visual aids.

A demo version of the PHPP 9 software will be provided to each participant.

This project has received funding from the European Union's Horizon 2020 research and innovation programme

“Certified Passivhaus Tradesperson course”:

The training has to be conducted using the necessary didactic materials and visual aids.

Participant will experience the work site while building a real house (2m X 2m), they will be provided with all the materials needed.

Bulgaria

High schools and colleges (EQF 2):

“Technology of Construction”

“The applied nature of the subject requires the training to be conducted using the necessary didactic materials and visual aids, references and other scientific literature. It is necessary to use multimedia and internet as well as to make visits to suitable construction sites and production facilities.”

“Building Installations”

“The applied nature of the subject requires the training to be conducted using the necessary didactic materials and visual aids, references and other scientific literature. It is necessary to use multimedia and internet.”

Higher Education (EQF 7):

Not specified.

In practice: Didactic materials and visual aids, references and other scientific literature, multimedia and internet. Demonstration equipment available in the Building Knowledge Hub – Bulgaria.

Romania

Practical training facilities within BKH-RO in Bucharest and Brasov, developed under Train-to-nZEB project.

In universities the practical / demonstration facilities are various and were developed in previous research or didactical infrastructure programs.

Greece

Didactic materials and visual aids, references and other scientific literature, multimedia and internet. Demonstration equipment available in the HPHI headquarters , which is a certified Passive House (EnerPHit)

Croatia

The applied nature of the subject requires the training to be conducted using the necessary didactic materials and visual aids. It is necessary to use multimedia and internet as well as demonstration equipment available in the CROSKILLS training centres.

5.4. Training methods of DER programmes

Main training methods in each target country are described below.

Czech Republic

In many programmes (Train-to-nZEB, Center of Passive House) training is divided into theoretical and practical parts. E-learning or other online training format becomes more and more necessary and attractive way to deliver the programme. Workshop or execution of practical tasks is an efficient training method. Demonstration of real practical solutions is a basic method in efficient training programmes. Most important parts of practical solutions and case studies include:

- the execution of building foundation structural elements to feature proper thermal insulation of the lowest heated floor (basement insulation or insulation of the ceiling above the basement, and the like).
- wall construction execution and a suitable windows and doors placement and installation, which is derived from the wall construction design
- roof constructions, which top the envelope of the house and are hardest hit by vagaries of the weather, precipitation, high summer temperatures, passages of chimneys, ventilation shafts, as well as the penetration of solar collectors piping, TV aerials wiring, etc.
- the accuracy of a large number of completely new details, joints with all levels of vertical and horizontal structures , execution of all penetrations through the building envelope (particularly of HVAC) or joining aperture linings.
- Plumbing works, gas and water distribution piping or heating ducts and significantly expanding mechanical ventilation and heat recovery installations. Electrical wiring and lighting distribution.[10]

Italy

"Thermal Bridge Calculation Course" (EQF 7):

classroom training, demonstrations, exercises: attendees will learn by doing. They will be asked to carry out several thermal bridge calculations.

"PHPP and designPH course" (EQF 7):

classroom training, demonstrations, exercises: attendees will carry out an entire PHPP calculation of a real project. They will be provided with all the documentation needed.

"Certified Passivhaus Designer course" (EQF 7):

classroom training, demonstrations, exercises: attendees will carry out an entire PHPP calculation of a real project. They will be provided with all the documentation needed.

[10] BUILD UP Skills Czech Republic. National Roadmap of continuous Professional Education in the Czech construction sector Aimed at Nearly Zero Energy Buildings. November 2013.

This project has received funding from the European Union's Horizon 2020 research and innovation programme

"Certified Passivhaus Tradesperson course":

classroom training, demonstrations, practical exercises: attendees will experience the construction phase, they will build the mock-up of a house.

Bulgaria

High schools and colleges (EQF 2): classroom training, demonstrations, practical exercises (in an additional discipline)

Higher Education (EQF 7): classroom training, demonstrations, study visits, practical exercises (in the Building Knowledge Hub)

Romania

High schools and colleges (EQF 3-4): classroom training, demonstrations, practical exercises (in an additional discipline within the local development curriculum)

Higher Education (EQF 6-7): classroom training, demonstrations, study visits, practical exercises (in the Building Knowledge Hub)

With the exception of the dedicated Passive House Tradespersons and Designers/Consultants, the existing programs include only parts of passive house principles and technologies. Usually a mix between Passive House, Green Building, Active House, "nZEB" (in various understandings), net zero energy buildings etc. is included in the existing training programs. The training is divided into theoretical and practical parts, although the training delivered is generally theoretical-based, with little opportunity for hands-on experience. E-learning or other online training format becomes more and more necessary and attractive way to deliver the programme. Workshop or execution of practical tasks is an efficient training method, but the lack of well-developed facility is usually replaced by isolated visits to various producers of construction materials or technology / systems.

Greece

Main training methods applied are classroom training, demonstrations, practical exercises, webinar, etc.

During the last couple of years all courses were held in HPHI's headquarters, which are in a deep renovated, certified passive house building. Attendees can examine various materials and systems, use them, and find a lot of information on sight. They also can follow the online measuring system of the building. In the office there are some small mock-ups demonstrating external insulation and full functioning ventilation system.

During courses attendees use the Passive House Planning Package (PHPP) for calculating the energy balance of the building. Many exercises are done with PHPP. They also use software for thermal bridge calculation, for ventilation parameters' calculation etc.

During the courses attendees follow a complete blower door test.

Croatia

According to the CROSKILLS programme: classroom and/or field training, demonstrations, practical exercises of real solutions used in nZEB construction such as:

- wall construction execution and a suitable windows and doors placement and installation,
- roof constructions, passages of chimneys, ventilation shafts, as well as the penetration of solar collectors piping, TV aerials wiring, etc.
- all demonstrations included the airtightness of building envelope and thermal bridges minimisation strategies
- new technologies systems, construction methods, details
- methods for testing airtightness and thermal bridges.

5.5. Trainers/lecturers requirements

Czech Republic

Experience and knowledge of the state-of-the art and innovative technologies and techniques in construction industry are considered as the most important criteria in evaluation of the trainer competence. Furthermore an academic title Ph.D. or equivalent is preferable, as well as about 10 years of experience in teaching.

Italy

The vocational training for all the courses above mentioned is carried out by persons with PhD and Master's degree in majors in professional field "Building Physics, Civil Engineering, Architecture". All the teachers have also to be Certified Passivhaus Trainers.

Bulgaria

High schools and colleges (EQF 2): The vocational training for the profession "Construction" is carried out by persons with Master's degree or Bachelor's degree in majors in professional field "Architecture, Civil Engineering and Geodesy" in "Technical Sciences" area of higher education as described by the Classification of Higher Education areas and professional fields, adopted by Decree of the Council of Ministers No 125 of 2002 (SG, 64 of 2002), and corresponding to the subjects (modules) of the compulsory professional training.

Higher Education (EQF 7): Habilitated person (PhD or higher) in majors in professional field "Architecture, Civil Engineering and Geodesy" in "Technical Sciences" area of higher education as described by the Classification of Higher Education areas and professional fields, adopted by Decree of the Council of Ministers No 125 of 2002 (SG, 64 of 2002)

Romania

In order to participate as trainer or teacher, a person should prove relevant technical and pedagogical competences. The technical competences could be documented by previous certificates and diplomas, as well as from work expertise and background detailed in a CV. The pedagogical competences could be proven by a document to certify fulfilment of specific pedagogical training requirements for trainers.

Specific pedagogical training requirements for trainers (According to Romanian legislation):

a. Certificate of professional training for the TRAINER profession, issued by a certified training supplier (obtained for the 242401 position/occupation in the Nomenclature of Occupations in Romania in an authorized training program according to the Ordinance no 129/2000 on adult training),
b. Professional competencies or graduation certificate obtained in a UE member state. The recognition and equivalence of certificates will be made by the competent authority (respecting the legal procedures),
c. MASTER diploma in adult education or train the trainer, issued by a higher education institution,
d. DOCTOR diploma in education science, with a doctoral thesis in adult education field,
e. An attestation to prove that he/she is working in a teaching position at vocational, technical or high school level,
f. An attestation to prove that he/she is working in a teaching position in a higher education institution,
g. An attestation to prove that he/she is working in a teaching position in research,

High schools and colleges (EQF 3-4): The vocational training for the professions from the construction, installations and public works field is carried out by persons with Master's degree or Bachelor's degree in professional field area of higher education (e.g. engineering, architecture).

In order to participate as **trainer within the Train-to-nZEB programs** organised in the BKH-RO, a person should comply with one of the above requirements or follow the TTT pedagogical module organized within the project.

In order to participate as **trainer in the PH Tradespersons or Designers/Consultants courses**, a person should have followed a Train-the-trainer Course provided by PHI.

Greece

Vocational training is carried out by persons with Master's degree or Bachelor's degree in majors in professional field "Architecture, Civil Engineering and Geodesy" in "Technical Sciences" area. All Trainers have followed a Train-the-trainer Course provided by PHI

Croatia

According to the CROSKILLS programme:

Theoretical training:

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- Experts with Bachelor's or Master's degree in civil engineering or architecture with at least three-year experience in the specific field of training.
- Finish the training of trainers according to the CROSKILLS programme
- Demonstrate the knowledge and lecturing skills during the training of workers

Practical training:

- Experts with the finished EQF level 4 in the specific field of training and also 6 year experience on the construction site in the specific field of training.
- Experts with Bachelor's degree in civil engineering or architecture with at least 3 year experience on the construction site in the specific field of training
- Finish the training of trainers according to the CROSKILLS programme
- Demonstrate the knowledge and lecturing skills during the training of workers

Training centre should also be able to ensure adequate training facilities for both theoretical and practical training, as well as the administrative person.

5.6. Learning outcomes

Czech Republic

Main learning outcomes in nZEB implementation course include the following skills: trainee should be able to describe principles of nZEB including its material and technical solutions, explain the principles of sustainable development and the importance of energy savings; trainee should be aware of the importance of the quality of nZEB design and implementation, as well as of the impacts on its functionality and durability; he/she should have an overview of the legislative requirements to nZEB and international instruments for assessing quality of buildings; trainee should be able to explain the differences between energy audit, EPB certificate and assessments; to understand the principles of technology used in nZEB and possibilities for using renewable energy sources in nZEB; properly and efficiently to resolve the design of construction details for new buildings and renovations; trainee should be able to describe the life cycle of the building and be aware of the progress of the costs over the cycle.

Highly detailed description of learning outcomes of all available training programmes in the partner countries will be delivered in the Catalogue of learning outcomes.

Italy

"Thermal Bridge Calculation Course" (EQF 7):

Module 1	Introduction to thermal bridges and calculation methodology
Module 2	Examples

"PHPP and designPH course" (EQF 7):

Module 1	PHPP9 software
Module 2	PHPP9 software
Module 3	DesignPH tool

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“Certified Passivhaus Designer course” (EQF 7):

Module 1	Passivhaus principles and building systems
Module 2	Thermal envelope and PHPP
Module 3	Case study project, work site and economics
Module 4	Repetitorium and insights
Module 5	Test

“Certified Passivhaus Tradesperson course”:

Module 1	Passivhaus principles and building work site
Module 2	Thermal envelope
Module 3	Building systems
Module 4	Practical realization of a building model

Bulgaria

High schools and colleges (EQF 2):

“Technology of Construction”

At the end of the training students should have the following knowledge, skills and competences:

Knowledge about:

- basic concepts and principles in the technology of construction production;
- the field of application of the main construction machines;
- materials and tools for implementing the construction works;
- the technological sequence of execution of different types of construction and assembly works.

Skills:

- work with educational, technical and reference literature;
- identify the necessary materials and tools for the implementation of the construction and assembly works;
- observe the technological sequence in the implementation of the construction and assembly works;
- observe the work safety rules of the construction site.

Competencies:

- communication;
- labour discipline;
- responsibility;
- working alone and in a team;
- logical and creative thinking;
- pursuing professional development and career development.

"Building Installations"

At the end of the training students should have the following knowledge, skills and competences:

Knowledge about:

- types of installations and their use in buildings;
- the potential of new technologies to maximize the use of renewable energy sources in building installations;
- the ways to achieve maximum economic and energy efficiency and preservation of the natural environment in the construction and operation of different building installations;

Skills:

- to distinguish the specific features of building installations;
- to make the right choice of electrical appliances and electronic devices;

Competences:

- communication;
- labour discipline;
- responsibility;
- working alone and in a team;
- has logical and creative thinking;
- pursuing professional development and career development.

Higher Education (EQF 7):

Acquired knowledge: general and specific knowledge on:

(a) building renovation process

(b) integrated design process of building renovation

(c) specific details and their implementation during building renovation

(d) policies, norms, regulation and practices in building renovation

Acquired skills: general and specific skills on:

(a) organization of building renovation design process

(b) implementation of specific tasks during renovation such as: thermal bridges insulation, air tightness, fixing of thermal insulation, windows assembling, etc.

Description of the topics (to serve as guidance for the expected outcomes) see Appendix B:

Romania

Main learning outcomes in nZEB implementation course should include at least the following points:

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- Description of principles of nZEB including its material and technical solutions,
- Explanation of the principles of sustainable development and the importance of energy savings;
- awareness of the importance of the quality of nZEB design and implementation, as well as of the impacts on its functionality and durability;
- overview of the legislative requirements to nZEB and international instruments for assessing quality of buildings;
- explanation of the differences between energy audit, EPB certificate and assessments;
- understanding the principles of technology used in nZEB and possibilities for using renewable energy sources in nZEB; properly and efficiently to resolve the design of construction details for new buildings and renovations;
- description of the life cycle of the building and be aware of the progress of the costs over the cycle.

Highly detailed description of learning outcomes of all available training programmes in the partner countries will be delivered in the Catalogue of learning outcomes

Greece

At the end of the training participants should have the following knowledge, skills and competences:

Knowledge about:

- basic concepts and principles in the technology of construction production;
- the field of application of the main construction machines;
- materials and tools for implementing the construction works;
- the technological sequence of execution of different types of construction and assembly works.

Skills:

- work with educational, technical and reference literature;
- identify the necessary materials and tools for the implementation of the construction and assembly works;
- observe the technological sequence in the implementation of the construction and assembly works;
- observe the work safety rules of the construction site.

Competencies:

- communication;
- labour discipline;
- responsibility;
- working alone and in a team;
- logical and creative thinking;

- pursuing professional development and career development.

Croatia

- To be able to explain the importance of energy efficiency in buildings.
- To be able to understand the consequences of poor workmanship.
- To be able to demonstrate the use of correct tools and technologies for installation of different kind of materials and systems for thermal insulation of the building thermal envelope, respectively to the profession in question
- To be able to demonstrate the use of correct tools and technologies for installation of different kind of materials and systems for water vapour and liquid water control through the building thermal envelope, respectively to the profession in question
- To be able to demonstrate the use of correct tools and technologies to ensure the airtightness of the building thermal envelope, respectively to the profession in question
- To be able to demonstrate the use of correct tools and technologies to ensure the minimisation of thermal bridges on the building's thermal envelope, respectively to the profession in question.
- To be aware of the possible technologies for the quality control of the work performed.
- To be aware of the cross-crafting issues
- To be able to identify the basic health and safety issues related to the work on the building thermal envelope, respectively to the profession in question.

6. Gaps identified

6.1 Gaps in programmes content

Czech Republic

In the Czech Republic no comprehensive educational programmes focused on DER or nZEB level renovation were identified during the analysis performed. DER aspect is partially covered by Train-to-nZEB and Passive House Centre programmes. Visits of construction sites with running renovations is the main gap in the available programmes. Further missing point is focus on professions coordination and system of proper checks and inspections during renovation process. Integration of RES systems in building retrofits should be paid more attention in the programmes. The entire content for the EQF 6-7 level has to be developed in a comprehensive and complete form

Italy

Beside the courses described so far, in Italy there are few other courses focused on energy efficiency, those provided by CasaClima. In addition refurbishment is a crucial topic in Italy, but at the moment there are no courses completely dedicated to energy retrofitting. Training materials and training aids must be implemented together with practical exercises and demonstration tools. In this scenario there is also the need to train lot of trainers.

Moreover in Italy the higher education lacks focus on energy efficiency in general, but especially on DER. In order to bridge this gap, Fit-to-nZEB will be a great aid, improving the cooperation between companies, institutes of research and universities.

Bulgaria

In Bulgaria there are no programmes dedicated to DER in the first place, except for one programme for EQF 7. Renovation and its energy aspects are discussed as parts of other, more comprehensive educational and training programmes. In these programmes (2 disciplines for EQF 2, applicable for EQF 3-5), the amount of time allocated to DER is insufficient and there is no clear reference to the learning content. Training aids, materials and reference literature pertaining to DER are not specified. It is unclear what will be the training methods and the demonstration approach to this particular matter. In terms of content, a vast number of issues must be elaborated, including renovation standards, basic analysis and calculation of the energy performance of the building and its components, whole building renovation design, approaches and details for each of the building components, step-by-step renovation, comfort and internal air quality, and many more. Practically no attention is paid to the construction materials suitable for DER, neither in the discussed programmes nor in the dedicated discipline in the training plan. Practical exercises and demonstration tools and equipment should be specified, together with theoretical and practical examination schemes. The training materials are insufficient, as more attention has to be paid on video training materials.

The analysed programme for **the higher education**, although developed to a much higher quality, lack focus on the integration of RES, calculation of GHG emissions, BIM and automation systems, characteristics of the building materials, and building components and technologies suitable for DER. Practical exercises and demonstration tools and equipment should be specified, together with practical examination schemes. The training materials can be developed further, as more attention has to be paid on video training materials and distance learning tools.

Romania

In Romania there are no specific programmes dedicated to DER. Renovation and its energy aspects are discussed as parts of other, more comprehensive educational and training programmes, but there is no clear reference to the learning content. Training aids, materials and reference literature pertaining to DER are not sufficiently specified.

Training materials and training aids must be implemented together with practical exercises and demonstration tools. In this scenario, there is also the need to train sufficient number of trainers.

As a minimum, in terms of content, the courses should cover the following structure (source: Train-to-NZEB):

1. General presentation of the program, goal, and expectations

2. Understanding of complex thermal renovation / Building physics characteristics of old buildings, structural specifics and methods of collection of information; Identification and evaluation of thermal bridges

Knowledge: Potential for energy savings / national renovation standards / EnerPHit standard; Reference levels of thermal protection for all measures; Certification of energy performance for passive house / nZEB buildings, basic requirements and benefits; Economic efficiency of thermal renovation; Why it is not often possible to renovate buildings at passive house / nZEB standards?

Skills: Explain the benefits of renovating to ambitious energy efficiency standards (nZEB / EnerPHit); Explain the difficulties typically encountered in existing buildings when striving for Passive House standard

3. Moisture/ Solutions for existing buildings / Moisture in the masonry, redevelopment possibilities

Knowledge: Advantages of renovating existing buildings using passive house/ nZEB suitable components with reference to the specific problems of old buildings: condensation and dampness, inadequate thermal comfort, poor air quality, high heating costs, environmental pollution;

Skills: Advise on correct measures to eliminate problems and achieve optimal benefits in renovation

4. Heat insulation and plaster / What has to be observed (alternative materials - cellulose, mineral wool plates, hemp dampening plates, straw etc.)

4.1. Thermal insulation and plaster practice

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: Wall, basement ceiling/floor slab, roof, top floor ceiling, thermal bridges

Skills: Be able to read drawings and to install correctly the designed insulation system, eliminating / minimizing the thermal bridges

5. Air- and wind-tightness / Optimum air tightness even in existing buildings

5.1. Air- and wind-tightness practice

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: airtightness and wind-tightness materials and correct application

Skills: Be able to read drawings and install correctly the designed airtightness and wind-tightness layers

6. Indoor insulation / Design of interior insulation with mineral wool plates (Ca-silicate)

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: Interior insulation (risks and disadvantages as well as saving potentials, diffusion-impermeable and diffusion-permeable superstructures)

Skills: Be able to read drawings and install correctly the designed internal installation system, taking into account the risks related to condensation and mould

This project has received funding from the European Union's Horizon 2020 research and innovation programme

7. Windows / PH windows in renovation

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: Windows – types, specifics and correct installation

Skills: Be able to read drawings and install correctly nZEB and PH-suitable windows

8. Building systems / Notes on the retrofitting of ventilation systems, structural requirements in connection with EE systems

Knowledge: Main types of installations in existing buildings; Building installations, incompatibilities with nZEBs; Ensuring of air tightness during the construction of new heating and ventilation systems; Modernisation of the heating system within the context of overall refurbishment; Power and modulation ranges for DHW generation and heating during refurbishment; Suitability of existing heaters after the refurbishment; Retrofitting buildings with exhaust air systems.

Skills: Make airtight passes through exterior walls in existing buildings; Install indoor ventilation units.

9. End / Exchange of experience, results assurance, conclusion – test/exam

Greece

In Greece there are no programmes dedicated to DER in the first place. Renovation and its energy aspects are discussed as parts of other, more comprehensive educational and training programmes. In these programmes the amount of time allocated to DER is insufficient and there is no clear reference to the learning content. Training aids, materials and reference literature pertaining to DER are not specified. It is unclear what will be the training methods and the demonstration approach to this particular matter. In terms of content, a vast number of issues must be elaborated, including renovation standards, basic analysis and calculation of the energy performance of the building and its components, whole building renovation design, approaches and details for each of the building components, step-by-step renovation, comfort and internal air quality, and many more. Practically no attention is paid to the construction materials suitable for DER, neither in the discussed programmes nor in the dedicated discipline in the training plan. Practical exercises and demonstration tools and equipment should be specified, together with theoretical and practical examination schemes. The training materials are insufficient, as more attention has to be paid on video training materials.

Croatia

In Croatia there are no programmes dedicated to DER in the first place, except for the programme developed within the CROSKILLS project which was accepted by the MGiPU with the *Ordinance on education and certification system of construction workers working on the installation of building components which affect the energy efficiency of buildings*. Additionally, this CROSKILLS programme is still not officially recognised by the Ministry of science and education. However, it is expected that the Ministry of science and education will recognize it through the non-formal and informal learning as soon as respective ordinances are prepared and thus enable workers to gain qualifications also through those types of learning.

The CROSKILLS programme is however developed primarily for the blue-collar workers (EQF levels 1-4), while for higher education (EQF levels 6 and 7) there are no specific programmes developed for DER. There are only specific topics regarding both building new and renovation of existing buildings which are being lectured at Croatian Colleges and Universities within the courses dealing with building physics, energy efficiency and/or sustainable buildings.

The amount of time allocated to DER is definitely insufficient and the learning content is lacking the contemporary systems and technologies which are existing on the market. Training aids, materials and reference literature pertaining to DER are scarce, and training providers are often not able to ensure the most contemporary training materials are available for students.

6.2 Gaps in learning outcomes

Czech Republic

Identified gaps for the levels EQF 5- 7 are the following, mainly concerning practical construction skills in renovation. The participants should be able to demonstrate skills in:

- Implementation and installation of HVAC systems of buildings by renovation
- Use of renewable energy sources by DER
- Coordination of professions on construction site during DER
- System of check ups and inspections on construction site during DER

Italy

On completion of the course on DER, the participants should mainly be able to:

- Present the advantages of renovating a building,
- Identify opportunities for energy savings,
- Know the appropriate materials for thermal insulation and airtightness and their specific usages,
- Avoid and eliminate thermal bridges and airtightness problems (especially in refurbishment projects)
- Design of interior insulation, avoiding any related risk
- Identify the risk of moisture and find solutions for existing buildings

Bulgaria

For EQF 2-5, on completion of the course the participants should be able to:

- Present the advantages of renovating a building,
- Interpret the energy audit certificate,
- Identify opportunities for energy savings,
- Know the appropriate materials for thermal insulation and airtightness and their specific usages,

- Avoid and eliminate thermal bridges and airtightness problems,
- Install basic solutions for energy efficiency in existing buildings, related to the thermal envelope,
- Provide conditions for correct exploitation of the building heating and ventilation systems related with insulation and airtightness.

As for **the higher education (EQF 6-7),** learning outcomes should be developed in their entirety.

Romania

The learning outcomes should be developed in their entirety starting from the Passive House experience and following the results of Train-to-nZEB and developments in Fit-to-nZEB, while practical exercises and work with mock-ups and demonstrators should be a priority. Topics like airtightness or well-defined measures to identify and overcome the risk of mould creation in energy renovation projects are not sufficiently covered. If the first mentioned topic is not relevant from the point of view of the current regulations (although it plays a key role in achieving nZEB standard), the second topic is well placed in the reality of building stock renovation, with many bad examples of appropriateness of current practice for a successful renovation. Besides the need for well qualified trades, there is almost no focus on cross-craft issues and overlap between different trades in relevant renovation training programs. The benefits of using existing standards like EnerPHit to guide deep energy renovations are not highlighted in existing training programs although it would strongly support the understanding of the right measures and approached to include the indoor air quality and comfort along with the risk of mould and condensation in a coherent DER of existing building stock.

Greece

The problem that nZEB is not officially defined yet is the main reason that DER programs are not developed. But even the few ones like CEPH that are provided, don't give to the participants the clear opportunity to implement, what they have learnt in praxis, because of the financial crisis and the collapse of the building sector.

The second reason for this is the lack of main financing in deep energy renovation, because of the bad situation of the banks.

Croatia

The CROSKILLS programme should be amended with the following learning outcomes:

- Present the advantages of renovating a building,
- Interpret the energy audit certificate,

On the other hand, for **the higher education (EQF 6-7)** as well as **VET (EQF level 3 and 4),** learning outcomes for DER should be developed in their entirety since they are obsolete and inadequate for the today's requirements.

7. Conclusions and recommendations

The gaps identified in the official educational programmes related to DER in the target countries are very broad. No programme, that can be applied for a comprehensive professional DER qualification was identified within the analysis. In the secondary and high education (EQF 3-5) system, principles of energy efficient renovation are not included in official training programmes. In higher education (EQF 6-7), there are some fragments of the topic represented by certain subjects that are studied separately from each other. That is why the lack of qualification is filled in most cases by vocational education. Vocational trainings can be divided into two large parts according to the target group, for construction workers (EQF 4-5) and supervising professionals (EQF 6-7), these trainings are however not harmonised and do not provide official DER qualification in their national qualification frameworks. The only common qualification mentioned in all target countries is a certified passive house designer.

The analysis showed the necessity to develop each EQF level programme for DER implementation in each target country.

Czech Republic

Currently the training programmes in primary and higher education do not cover competences and skills required for implementation of DER projects to sufficient extent. As a result short-term courses in this field are offered in the education of adults for construction professionals.

The adult education in the construction sector is however substantively and organizationally very fragmented. Concerning content, the introduction of the National System of Qualifications and the National System of Occupations could provide a methodological unification. These, along with the growing demands of construction companies on the qualifications of their employees, create space for a multiple increase in educational capacity. At present, however, a barrier to the use of this space remains the fact that when recruiting new and using existing workers in the construction industry, small and medium businesses, especially, take into account the workers' experience with practical skills rather than a formal confirmation of qualifications.

Offering training programmes of high quality, focused on the current need in renovation of existing building to nZEB level can help to overcome this barrier.

Especially initial/secondary professional education in construction (EQF 3-5) would need to be streamlined to offer a modern education process and teaching programmes closely linked to the prospective renovation needs. The focus of efforts is to be predominantly on *green skills*, including DER and nZEB renovations.

Italy

Unfortunately, the practice for delivering quality education and training on DER in Italy is very limited. There are only a few examples and signs for early developments in this direction. There is the need of improving training material adapted to each EQF level. The availability of valid training materials on DER will greatly help the improvement of building capacity and it will also enhance the quality of refurbishment in Italy.

Bulgaria

Unfortunately, the practice for delivering quality education and training on DER in Bulgaria is very limited and generally inefficient. There are only a few examples and signs for early developments in this direction, but their scope and impact is far from what is needed to influence the renovation design and construction practice in the country. Overall, the existing training schemes need improvement in virtually all areas, but this is especially relevant to the practical part of the courses. The learning outcomes have to be thoroughly redeveloped and adapted to each EQF level. A repository of training materials and aids, as well as practical exercises, will greatly help the improvement of the quality of the lectures. It is expected that the results from the Fit-to-nZEB project will have a major positive impact on the situation and to support both the programme developers and the course providers for a sustained training offer.

As a minimum, in terms of content, the courses should cover the following structure (source: Train-to-NZEB):

1. Welcome, introduction, goal, and expectations

2. Understanding of complex thermal renovation / Building physics characteristics of old buildings, structural specifics and methods of collection of information; Evaluation of heat bridges

<u>Knowledge:</u>

Potential for energy savings / national renovation standards / EnerPHit standard

Reference levels of thermal protection for all measures;

Certification of energy performance for passive house / nZEB buildings, basic requirements and benefits;

Economic efficiency of thermal renovation

Why it is not often possible to renovate buildings at passive house / nZEB standards?

<u>Skills</u>

Explain the benefits of renovating to ambitious energy efficiency standards (nZEB / EnerPHit)

Explain the difficulties typically encountered in existing buildings when striving for Passive House standard

3. Moisture/ Solutions for existing buildings / Moisture in the masonry, redevelopment possibilities

Knowledge: Advantages of renovating existing buildings using passive house/ nZEB suitable components with reference to the specific problems of old buildings: condensation and dampness, inadequate thermal comfort, poor air quality, high heating costs, environmental pollution;

Skills:

Advise on correct measures to eliminate problems and achieve optimal benefits in renovation

4. Heat insulation and plaster / What has to be observed (alternative materials - cellulose, mineral wool plates, hemp dampening plates, straw etc.)

4.1. Thermal insulation and plaster practice

Knowledge:

Strategies and solutions to handle with specific problems arising in existing buildings:

Wall, basement ceiling/floor slab, roof, top floor ceiling, thermal bridges

Skills:

Be able to read drawings and to install correctly the designed insulation system, eliminating / minimizing the thermal bridges

5. Air and windtightness / Optimum air tightness even in existing buildings

5.1. Air and windtightness practice

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings:

airtightness and windtightness materials and correct application

Skills: Be able to read drawings and install correctly the designed airtightness and windtightness layers

6. Indoor insulation / Design of interior insulation with mineral wool plates (Ca-silicate)

Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: Interior insulation (risks and disadvantages as well as saving potentials, diffusion-impermeable and diffusion-permeable superstructures)

Skills: Be able to read drawings and install correctly the designed internal installation system, taking into account the risks related to condensation and mould

7. Windows / PH windows in renovation

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Knowledge: Strategies and solutions to handle with specific problems arising in existing buildings: Windows – types, specifics and correct installation

Skills: Be able to read drawings and install correctly nZEB and PH-suitable windows

8. Building systems / Notes on the retrofitting of ventilation systems, structural requirements in connection with EE systems

Knowledge:

- Main types of installations in existing buildings;
- Building installations, incompatible with nZEBs;
- Ensuring of air tightness during the construction of new heating and ventilation systems;
- Modernisation of the heating system within the context of overall refurbishment
- Power and modulation ranges for DHW generation and heating during refurbishment
- Suitability of existing heaters after the refurbishment
- Retrofitting buildings with exhaust air systems

Skills:

- Make airtight passes through exterior walls in existing buildings;
- Install indoor ventilation units.

9. End / Exchange of experience, results assurance, conclusion

Romania

Unfortunately, the practice for delivering quality education and training on DER in Romania is still limited and generally inefficient. There are only a few examples and signs for early developments in this direction, but their scope and impact is far from what is needed to influence the renovation design and construction practice in the country. Overall, the existing training schemes need improvement in virtually all areas, but this is especially relevant to the practical part of the courses. The learning outcomes have to be thoroughly redeveloped and adapted to each EQF level. A repository of training materials and aids, as well as practical exercises, will greatly help the improvement of the quality of the lectures. It is expected that the results from the Fit-to-nZEB project will have a major positive impact on the situation and to support both the programme developers and the course providers for a sustained training offer.

Greece

We need, as a country, to define the national nZEB building as soon as possible, because without that any attempt to develop construction will not have a clear goal. The Recommendations are there, the methodology is there, materials and systems are also there.

This doesn't mean that we cannot create new skills and improve the existing ones. Universities and professional high schools should increase their contribution in the education of students towards nZEB. Municipalities and the brighter public sector should ask for continuous lifetime education of all those who participate in the construction sector.

Furthermore we should adapt regulations and testing methods for the improvement of airtightness and as a result of that we should adapt also the international guidelines for the use of mechanical ventilation in residential buildings as well.

We believe that the strongest point in this procedure will be the creation also of Knowledge and Training Hubs in Greece. For one additional reason : to stop the brain drain , which is at its highest levels at the moment.

Croatia

Unfortunately, the practice for delivering quality education and training on DER in Croatia is very limited and generally inefficient for EQF 6-7, while for EQF 3-4 the CROSKILLS programme has proved to be functioning to some extent (it needs to be seen how it will be accepted by the workers in future without the support of the project consortium).

There are only a few examples and signs for early developments in the direction of changing the existing curricula and learning outcomes, but their scope and impact is far from what is needed.

When quality training and workshops are offered for EQF 6-7 it is often attended with a large number of professionals seeking additional knowledge. To influence the renovation design and construction practice in the country, a number of large investors should also be educated.

Overall, the existing training schemes need improvement in virtually all areas (only CROSKILLS programme is deemed to be suitable for minor changes in order to serve for DER), but this is especially relevant to the practical part of the courses.

The learning outcomes have to be thoroughly redeveloped and adapted to each EQF level. A repository of training materials and aids, as well as practical exercises, will greatly help the improvement of the quality of the lectures. It is expected that the results from the Fit-to-nZEB project will have a major positive impact on the situation and to support both the programme developers and the course providers for a sustained training offer.

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Appendices

Appendix A – List of gaps identified

Czech Republic

Knowledge and Skills that Need to Be Expanded in the programmes:

- Proper HVAC system installation by renovation
- Proper installation of systems using RES
- Coordination of professions by renovation
- System of checks ups and inspections by renovation

Italy

- Internal insulation for refurbishment: technologies, materials and risks.
- Moisture/ Solutions for existing buildings / Moisture in the masonry, redevelopment possibilities
- Air and windtightness / Optimum air tightness even in existing buildings
- Proper HVAC system installation by renovation

Bulgaria

General gaps:

- No dedicated programmes for EQF levels 2-5
- No dedicated programmes for continuing training and education (to be used by vocational training centers)
- Need to improve and disseminate the programme for EQF levels 6-7
- Need to improve the training and demonstration facilities
- Need to develop practical exercises and examination schemes
- Need to train a sufficient number of trainers
- Need to develop lectures, presentations and audio-video aid

Content gaps:

The following topics should enter in the structure and content of the courses:

- Understanding of complex thermal renovation / Building physics characteristics of old buildings, structural specifics and methods of collection of information; Evaluation of heat bridges
- Moisture/ Solutions for existing buildings / Moisture in the masonry, redevelopment possibilities
- Heat insulation and plaster / What has to be observed (alternative materials - cellulose, mineral wool plates, hemp dampening plates, straw etc.)

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- Air and windtightness / Optimum air tightness even in existing buildings
- Indoor insulation / Design of interior insulation with mineral wool plates (Ca-silicate)
- Windows / PH windows in renovation
- Building systems / Notes on the retrofitting of ventilation systems, structural requirements in connection with EE systems
- Integration of RE systems in renovation
- BIM and automation
- Environmental aspects of building renovation
- Quality of habitation, health requirements in buildings, indoor air quality
- Legal framework and urban planning basics (main barriers and requirements)

Gaps in learning outcomes

Full sets of learning outcomes have to be elaborated for all EQF levels

Romania

- No dedicated programmes on deep energy renovation of existing buildings for EQF levels 2-7,
- Passive House and other relevant concepts (active house, green building etc.) are not widely known and included in existing training programs for continuing training and education or in universities,
- Need to improve correlation of different occupations and qualifications (National classification, including revision / definition of clear standards),
- Need to improve the existing collection of professional educational standards (VET) and occupational standards (training of adults)
- Need to improve the training and demonstration facilities,
- Need to develop practical exercises and examination schemes,
- Need to train a sufficient number of trainers,
- Need to develop lectures, presentations and audio-video aids,
- Need for actions on raising awareness amongst construction sector (in particular for the construction companies) for the importance of right skills related to Passive House concept / principles and of RES integration in buildings for a healthy implementation of nZEB concept in reality.

Greece

- Internal insulation for refurbishment of historical buildings: technologies, materials and risks
- Air and windtightness / Optimum air tightness even in existing buildings
- Proper HVAC system installation by renovation
- Need to develop practical exercises and examination schemes based on local Mediterranean climate
- Need to develop e-learning and webinars in order to cover the country

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Croatia

- No dedicated programmes for EQF levels 2-5 (Croskills still not recognised as informal or non-formal learning system due to the nonexistence of the Ordinances related to the recognition of informal and non-formal learning)
- No dedicated programmes for continuing training and education (to be used by vocational training centres)
- Need to improve and disseminate the programme for EQF levels 6-7
- Need to improve the training and demonstration facilities
- Need to develop practical exercises and examination schemes
- Need to train a sufficient number of trainers
- Need to develop lectures, presentations and audio-video aid

Full sets of learning outcomes have to be elaborated for all EQF levels related to DER and nZEB.

Appendix B – Learning outcomes according to EQF level in Bulgaria

Description of the topics (to serve as guidance for the expected outcomes):

SECTION 1. STRATEGY FOR RENOVATON OF EXISTING BUILDINGS

Module 1: Characterization of the building stock in the European Union and Bulgaria. European and national regulatory framework for the renovation of existing buildings - strategies and programs

Presentation of the characteristics of the building stock in the European Union. Development perspectives for 2050. Development of the legal framework.

(2 lecture hours)

Module 2: National regulatory framework for the renovation of existing buildings - strategies and programs

Presentation of the national energy efficiency norm, valid for the renovation of existing buildings.

(1 hour lecture and 1 hour exercise)

Module 3: National Program for Renovation of Multifamily Residential Buildings in Bulgaria

Presentation of the National Energy Efficiency Program for Multifamily Residential Buildings in Bulgaria - Principles and Achievements.

(2 lecture hours)

Module 4: Implementation of the National Program for Renovation of Multifamily Residential Buildings in Bulgaria

Presentation of the implementation of the National Energy Efficiency Program for multifamily residential buildings in Bulgaria in different municipalities of the country. Results and Lessons.

(4 lecture hours)

Module 5: Communicating with stakeholders in renovating existing buildings

Communication with the participants in the National Program for Energy Efficiency of Multifamily Residential Buildings in Bulgaria. Goals, tools, results.

(2 lecture hours)

P 1. Visiting a building site - renovation of an existing building

Visiting buildings in the process of energy renovation (rehabilitation). Understanding the organization of the construction processes and of specific technical solutions and their implementation.

(4 hours of practical exercises)

Section II. ENERGY RENOVATION OF EXISTING BUILDINGS

Module 6: Regulatory framework for energy auditing

Presenting the normative framework of energy audits of buildings and industrial enterprises and the requirements for the specialists and the companies that implement them.

(2 lecture hours)

Module 7: Purpose and content of energy audit

The methodological sequence of the actions carried out during the audits.

(2 lecture hours)

Module 8: Energy auditing toolkit

The tools for performing energy audits - software and technical devices and equipment are presented.

(2 lecture hours)

Module 9: Practical exercises

Practical exercises for acquaintance with the process of energy auditing of an existing building.

(2 hours practical exercises)

SEMINAR AND INTERMEDIATE TEST. Application of the basic principles of the passive building when renovating existing buildings

(4 hours classroom seminar-review and mid-term test)

Section III. PROFITABILITY AND SUCCESSFUL PRACTICES IN THE RENOVATION OF EXISTING BUILDINGS

Module 10: Step by step retrofit. The EnerPHit standard. Renovation of buildings - monuments of culture

Too often renovating existing buildings up to the Passive House standard is hampered by lack of sufficient financial resources for comprehensive renovation. This usually leads to undesirable but hard to prevent compromises with regard to the level of renovation. Although analyses clearly show that only deep energy renovation can achieve long-term return on investment, in practice relatively low energy classes (e.g. class C) are often targeted. This module examines the possibilities for step-by-step renovation, where each step is performed in accordance with the requirements of high energy classes. Thus, in the long run, preconditions are created to achieve maximum results (and savings) with limited initial investment.

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(3 lecture hours and 5 hours practical exercises)

Module 11: Heating and ventilation when renovating existing buildings

In existing buildings, heating systems are usually hard to replace. Nevertheless, the importance of ventilation and its combination with heating systems is a leading one and is achieved by regenerating the heat from the exhaust air using high-efficiency ventilation equipment. Centralized and decentralized solutions are presented in this thematic module.

(4 lesson lectures and practical exercises and 4 hours of product presentations)

Module 12: Economic efficiency of energy renovation of existing buildings up to the level of "passive" and "nearly zero energy" buildings

The basics of the cost-effectiveness of the Passive House concept and standard are discussed. The topic is considered in the light of the EC methodology for determining the economic efficiency of buildings in view of the nZEB requirements both in new construction and renovation of existing buildings.

Note: In this curriculum, economic performance is considered within the framework of the Passive House concept. Further details are presented in the course in Economics.

Module 13: Practice examples

Numerous examples from the interantional practice are presented, incl. selected projects from the Second World Passive House Competition (2014). Examples of the "Multi Comfort House" competition of Isover, as well as realizations in Bulgaria are also presented.