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Training programme for EQF level 3-5

Training programmes for vocational training centers (EQF 3-4)

Deliverable 6.1

of the FIT-TO-NZEB project, financed under grant agreement No 754059 of the HORIZON 2020 Programme of the EU

Led by:

PHA – Passive House Academy

May 2018

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Table of Contents and Overview

This report presents training programmes for EQF Levels 3 to 4 for the two streams of construction workers involved in the deep retrofitting of buildings:

1. **Building envelope** (including blocklayers, carpenters and plasters)¹
2. **Mechanical systems** (including electricians, plumbers and those working in the HVAC sector)²

Different training programmes are envisaged depending on where the training might take place, as follows:

1. **Delivered at a vocational training centre** - this would be a training centre where models of deep retrofitting are available and where hands-on experience is provided
2. **Delivered at the construction site ('on-site')** – this would be where training is delivered at a construction site of a deep retrofit project, making it more convenient for the construction workers to attend and also helping to solve 'real-problems' which they might be experiencing on any given project.

Lastly, different lengths of courses are envisaged depending on the knowledge and skills level of the construction workers involved, as specified below:

1. **'Full-time training'**, amounting to 40 hours
2. **'Upskilling'**, amounting to either 16
3. **'Validation'**, amounting to 12 hours (the focus of which is directed to validating skills and knowledge of already-experienced construction workers

The above three dimensions ((1) type of construction workers, (2) location where training takes place and (3) length and type of course) are presented below using the following matrix for ease of reference. In the case below, green-highlighting and bold text is used to indicate which type of training is being presented.

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

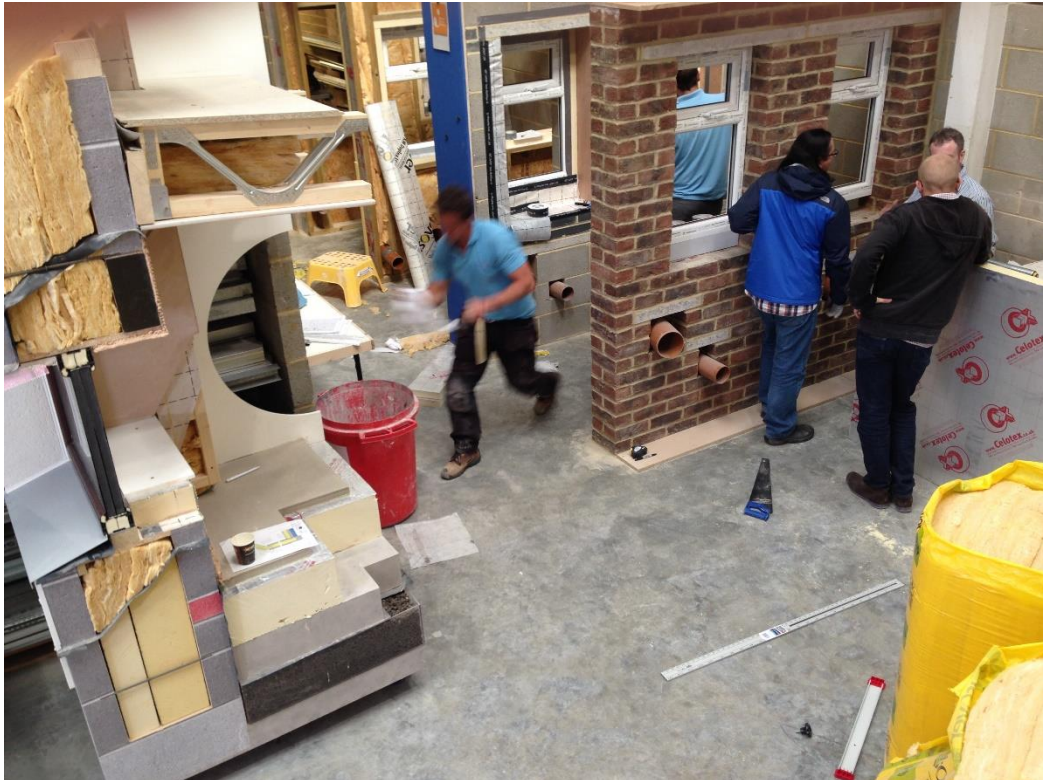
¹ Referring to professional direction "Construction" as described in the Fit-to-NZEB Grant Agreement 754059.

² Referring to professional direction "Electrical engineering and energy sector as described in the Fit-to-NZEB Grant Agreement 754059

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CURRICULUM

Specialty „Deep Energy Renovation of the Building Envelope“



VTC FULL TIME TRAINING and VTC Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of the building envelope
<i>Academic hours</i>	10 hours weekly (theory + practice) Total: 40 hours - 20 hours lectures and 20 hours practical hands-on workshop training
<i>Type of course</i>	Elective
<i>Course field</i>	Construction (foremen, carpenters, block-layers, plasterers, general operatives)
<i>Control and evaluation</i>	Continuous assessment and examination
<i>Term in which the evaluation takes place</i>	After completion of the course
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	Knowledge on: (a) Deep energy retrofit process (b) Principles and practices of deep energy retrofits (c) Overview of key aspects of deep energy retrofit and their implementation during building renovation, including continuous insulation, airtightness, thermal bridges and high-performance windows (d) Principles of moisture movement and risks associated with interior insulation (e) Qualities of different insulation and airtightness product types and their suitability to different application settings
<i>Acquired skills</i>	Cognitive and practical skills on: (a) Overall organization of the building renovation process (b) Implementation of some of the key renovation tasks with regards to affixing of insulation, application of airtightness materials, reducing thermal bridges and installation of high performance windows and doors
<i>Acquired responsibility and autonomy</i>	Responsibility for: (a) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction (b) Adaptation of own behaviour to circumstances in solving problems (c) Taking responsibility to ensure continuity of the insulated and airtight thermal envelope (where assessable)

	(d) Taking responsibility to ensure that all products used in deep energy retrofits are fit for purpose with respect to ensuring insulation and air-sealing of the thermal envelope for the life of the building
<i>Preliminary requirements</i>	The students are expected to have an overall understanding of building systems, construction, processes and materials.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical equipment (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop - Health and safety equipment, including first-aid box - Envelope demonstration models illustrating the classic construction types found in the region of the VTC and including the key junctions of wall to floor, wall to window, wall to intermediate floor and wall to roof - The envelope demonstration models should illustrate both interior and well as exterior insulation strategies and should include typical service penetrations found on high performance retrofits required for ventilation ducts - Multiple samples of the different kinds of insulation, air-sealing and thermal bridge products which can be used for deep energy retrofits - Sample triple-glazed windows available in the region - Blower door equipment used for airtightness testing - Tools and applicators typically used in deep energy retrofits, including smoke-pens used for finding leaks in the building envelope <p>Appreciation of DER mechanical services strategies:</p> <ul style="list-style-type: none"> - Demonstration model for MVHR system, including ducts, registers and simulated wall penetrations - Demonstration model for renewable energy systems including roof mounting fixings, inverter and battery - Demonstration model for exterior air to water heat pump with interior low temperature radiators and / or mini-split wall-mounted cooling evaporator - Demonstration model for insulation of DHW pipes with multiple awkward connections, bends and fittings - Demonstration model for drain waste water heat recovery - Demonstration model of typical deep energy retrofit of the thermal envelope illustrating solutions for insulation, airtightness, thermal bridging and high-performance windows

	- Tools and applicators typically used in deep energy mechanical services retrofits
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Construction related qualification minimum EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice

TRAINING PROGRAMME OVERVIEW

The subject Deep energy renovation of the building envelope is elective in the course field of Construction in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre [insert name of VTC].

The above described deep energy retrofit course is based on the notion that the students already have some knowledge and basic understanding of the building design and construction process and building physics and materials. Some of them may also have solid practical experience in construction as it may be their primary field of work. The design process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of exemplary levels of energy efficiency.

The course is divided in two major parts. The emphasis of the training programme is directed to the first part of the course. It examines the deep energy retrofit (DER) process in relation to the building envelope with particular attention being paid to the design and construction of the distinct building components, underlining the role of comprehensive 'whole-system' design to the DER and examining key renovation principles. Core renovation design principles are being introduced, emphasising what makes a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices with regards to insulation, airtightness, thermal bridging and high-performance window installation. The students get to grasp not only the theoretical knowledge behind the DER practices, but the insight as to why it is advantageous and preferred to the standard energy renovation. Special and particular attention is paid to the step-by-step renovation process where the building owner is not in a position to complete the refurbishment plan in one phase.

The second part of the training programme is dedicated to project management and planning and design instruments, where the basics of economic efficiency and cost-effectiveness of DER, as well as the assurance of high quality building design and construction are presented. An overview of the building services found in DER such as mechanical ventilation with heat recovery (MVHR), heating and / or cooling and renewable energy sources (RES) is also provided.

CURRICULUM CONTENTS³

Version 1: Full-time training (Reference 161-FT-BE). Curriculum for acquiring continuous professional qualification for professions in the "Construction" professional field, including foremen, carpenters, block-layers, plasterers and general operatives according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building envelope			
1.	Basis of building physics, Passive house principles, optimal solar gains	2	2	Y
2	Comfort, health and safety requirements in buildings, incl. indoor air quality	2	2	Y
3.	Insulation of the opaque envelope	2	2	Y
4.	Airtightness, vapour and moisture movement as well as windtightness	2	3	Y
5.	Solving and avoiding thermal bridges	2	2	Y
6.	Installation of highly efficient windows and exposure to high performance building components, products and installation	2	2	Y
7.	"Step-by-step" renovation and the EnerPHit standard	1	1	Y
8.	Site visit – deep energy renovation of an existing building		4	N
	Part II Project management and planning and design instruments			
9.	Overview of building services and how they interface with the thermal envelope: MVHR, heating and / or cooling, RES	2	2	Y
10.	Conservation of historic building fabric, renovation of buildings and monuments of cultural significance	2		Y
11.	Project management and quality assurance	2		Y
12.	Economic efficiency of deep energy retrofitting up to the level of "passive" and "nearly zero energy" buildings	1		Y
	TOTAL	20	20	

³ The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB Project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary training course that can be conducted in WWETB's proposed Vocational Training Centre in Enniscorthy, County Wexford [insert name of VTC].

Version 2: Upskilling training (Reference 161-UP-BE). Curriculum for upskilling training courses in the "Construction" professional field, including foremen, carpenters, block-layers, plasterers and general operatives according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building envelope			
1.	Comfort, health and safety requirements in buildings, incl. indoor air quality; basis of building physics, Passive house principles, optimal solar gains	1		Y
2.	Insulation of the opaque envelope	1	2	Y
3.	Airtightness, vapour and moisture movement, windtightness	1	2	Y
4.	Thermal bridges and high-performance building components	0.5	1	Y
5.	Highly efficient windows: products and installation	0.5	1	Y
6.	"Step-by-step" renovation. The EnerPHit standard.	1	1	Y
	Part II Project management and planning and design instruments			
7.	Introduction to building services: MVHR, heating and / or cooling, RES	1	1	Y
8.	Conservation of historic building fabric, renovation of buildings and monuments of cultural significance	1		Y
9.	Project management, quality assurance, economic efficiency of existing buildings and energy renovation up to the level "passive" and "nearly zero energy" buildings	1		Y
	TOTAL	8	8	

SOURCES

[Insert additional sources relevant to your country]

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

Bulgarian Association for Insulation in Construction (BAIC). **Guide for energy efficient renovation of the building envelopes.** Sofia. 2016

Passive House Institute. **The road to nearly zero energy buildings. The passive house + RES.** Passive house regions with renewable energies (PassREg) project. 2015

Passive House Institute (Germany). **Building a sustainable energy future. A Guide to Success.** Passive House Regions with Renewable Energies (PassREg) Project. 2015

Buildings Performance Institute Europe (BPIE). **Indoor air quality, thermal comfort and daylight. Analysis of residential Building regulations in eight Member States.** March 2015

Passive House Institute / IG Passive House / International Passive House Association. **2nd Passive House Architectural Award. Award Principles and Finalists.** 2013

Buildings Performance Institute Europe (BPIE). **A Guide to Developing Strategies for Building energy renovation. Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks.** February 2013

EnEffect / Bulgarian Construction Chamber / National Agency for Professional Education and Training. **Roadmap for training on Smart Energy Efficient Building Solutions.** BuildUPSkillsProject. 2013

Passive House Institute / IG Passive House / International Passive House Association. **1st Passive House Architectural Award. The Finalists.** 2013

European Institute for Energy Performance of Buildings / Ecofys Germany / EnEffect. **Construction of nearly zero energy buildings (nZEB) in Bulgaria. Towards definition and roadmap.** 2012

Buildings Performance Institute Europe (BPIE) / Ecofys Germany / Danish Building Research Institute. **Principles for nearly zero energy buildings. Paving the way for effective implementation of policy requirements. Final draft.** November 2011

EnEffect, Center for Energy Efficiency. **Ten books on green architecture.** Sofia. 2010

European Commission, General Directorate Energy / EnEffect. **GREEN VITRUVIUS.** Principles and practices of architectural design. Bulgarian edition, Sofia. 2010

Savov, R. And D. Nazarski. **Energy efficiency. Thermal insulation of buildings.** A series of specialized editions of the Bulgarian Association of Insulation in Construction. Technika. 2006

The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer⁴:

[type person's name]

VTC DEAN⁵:

[type person's name]

Signature:

.....

Signature:

.....

⁴ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

⁵ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it

CURRICULUM

Specialty „ Deep Energy Renovation of Building Systems”



VTC FULL TIME TRAINING and VTC Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of building mechanical and electrical systems
<i>Academic hours</i>	10 hours weekly (theory + practice) Total: 40 hours - 20 hours lectures and 20 hours practical hands-on workshop training
<i>Type of course</i>	Elective
<i>Course field</i>	Heating, Ventilation and Air-Conditioning (HVAC) and Renewable Energy Systems (RES)
<i>Control and evaluation</i>	Continuous assessment and examination
<i>Term in which the evaluation takes place</i>	After completion of the course
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	<p>Knowledge on:</p> <ul style="list-style-type: none"> (f) Deep energy retrofit process (g) Principles and practices of deep energy retrofits (h) Key mechanical systems which impact significantly on building energy efficiency (i) Performance characteristics of insulation products that are typically used to insulated ducts, pipes and vessels (j) Availability of specialist insulating pieces which can be used to insulate joints, sharp bends and connections of hot water distribution pipes (k) Performance characteristics of adhesive tapes that are typically used to seal and secure the attachment of insulation to ducts and pipes with a view to ensuring high performance for the life of the building (l) Principles of heating and domestic hot water generation and distribution and potential for drain waste water heat recovery (m) Principles of mechanical ventilation with heat recovery and its contribution towards indoor air quality and comfort (n) Integrated technologies which offer multiple mechanical services to high performance retrofits (so-called 'Compact' units) (o) Principles of solar renewable energy generation (both electric and thermal) and storage
<i>Acquired skills</i>	<p>Cognitive and practical skills on:</p> <ul style="list-style-type: none"> (a) Overall organisation of the building renovation process (b) Implementing tasks relating to installation of high-efficient heating and domestic hot water systems including full and complete insulation of all vessels and pipework which store and / or distribute heated water

	<p>(c) Implementing tasks relating to installation of mechanical ventilation with heat recovery (MVHR), including placement of supply and extract ducts and registers and thorough sealing and insulation cold air ducts and envelope penetrations</p> <p>(d) Implementing tasks relating to installation of solar renewable energy generation and storage systems including ensuring that (a) all fixings and penetrations do not compromise the building in terms of moisture ingress as well as wind-tightness and airtightness and (b) that any pipes transporting hot water are fully insulated</p> <p>(e) Implementing tasks relating to installation of drain waste water heat recovery systems</p>
<i>Acquired responsibility and autonomy</i>	<p>Responsibility for:</p> <p>(e) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction</p> <p>(f) Adaptation of own behaviour to circumstances in solving problems</p> <p>(g) Taking responsibility to ensure that all ducts, pipes and vessels which transport or store heated water or air are fully and completely insulated and without any gaps whatsoever even at awkward junctions, bends or connections</p> <p>(h) Taking responsibility to ensure that all products used in insulating mechanical services are fit for purpose, most especially adhesive tapes used to secure insulation in-place (which typically fail on domestic retrofit projects)</p>
<i>Preliminary requirements</i>	The students are expected to have an overall understanding of building systems, construction, processes and materials.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical equipment (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop - Health and safety equipment, including first-aid box - Demonstration model for MVHR system, including ducts, registers and simulated wall penetrations - Demonstration model for renewable energy systems including roof mounting fixings, inverter and battery

	<ul style="list-style-type: none"> - Demonstration model for exterior air to water heat pump with interior low temperature radiators and / or mini-split wall-mounted cooling evaporator - Demonstration model for insulation of DHW pipes with multiple awkward connections, bends and fittings - Demonstration model for drain waste water heat recovery - Demonstration model of typical deep energy retrofit of the thermal envelope illustrating solutions for insulation, airtightness, thermal bridging and high-performance windows - Tools and applicators typically used in deep energy retrofits <p>Appreciation of DER envelope strategies:</p> <ul style="list-style-type: none"> - Envelope demonstration models illustrating the classic construction types found in Ireland [insert country or region] and including the key junctions of wall to floor, wall to window, wall to intermediate floor and wall to roof - The envelope demonstration models should illustrate both interior and well as exterior insulation strategies and should include typical service penetrations found on high performance retrofits required for ventilation ducts and other services - Multiple samples of the different kinds of insulation, air-sealing and thermal bridge products which can be used for deep energy retrofits - Sample triple-glazed windows available in the region - Blower door equipment used for airtightness testing - Tools and applicators typically used in deep energy envelope retrofits, including smoke-pens used for finding leaks in the building envelope
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Minimum mechanical building services EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice

TRAINING PROGRAMME OVERVIEW

The subject Deep energy renovation of building mechanical and electrical systems is elective in the course field of Electrical Engineering/HVAC in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre in Enniscorthy, County Wexford [insert name of VTC].

The described deep energy retrofit course is based on the notion that the students already have some knowledge and basic understanding of the building systems and building physics. Some of them may also have a solid practical experience

in installation and maintenance of heating, ventilation and AC systems as it may be their primary field of work.

The training process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of exemplary levels of energy efficiency.

The course is divided in two major parts. The emphasis of the subject is on the first part of the course. It examines the deep energy retrofit (DER) potential for building systems with particular attention being paid to the design and implementation of appropriate systems and services for heating and / or cooling, domestic hot water, mechanical ventilation and renewable energy generation and storage. Basic renovation design principles and practices are introduced, with an emphasis on what renders a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices. The students get to grasp not only the theoretical knowledge behind the DER practices, but an invaluable insight on why it is advantageous and preferred to the standard energy renovation. Particular attention is paid to indoor air quality and comfort and the use of highly efficient thermal energy generation and distribution systems as well as mechanical ventilation with heat recovery (MVHR) and renewable energy sources (RES) as well as lighting.

The second part of the training programme is dedicated to project management and planning and design instruments, where the basics of economic efficiency and cost-effectiveness of DER, as well as the assurance of high quality building services design and construction are presented. An overview of key building envelope retrofit principles such as insulation, airtightness, thermal bridges and high-performance windows is also covered.

CURRICULUM CONTENTS⁶

Version 1: Full-time training (Reference 161-FT-MS). Curriculum for acquiring continuous professional qualification for tradespersons in the “Electrical Engineering/HVAC” professional field according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

Nº	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building systems			
1.	Comfort, health and safety requirements in buildings, indoor air quality, airtightness, vapour/moisture movement, windtightness <ul style="list-style-type: none"> indoor air quality (contaminants and performance levels), thermal comfort, daylight and lighting, noise, influence of nearby landscape, safety requirements in buildings and the compliance ensured during the renovation process: Fire Safety and legal responsibilities in Buildings, Environmental regulations. 	2		Y
2.	Mechanical Ventilation with Heat Recovery (MVHR) <ul style="list-style-type: none"> Indoor air quality parameters (CO₂ and RH) Recommended air flow rates for supply and extract Core components of MVHR units Ducting design and layout options Balancing flow rates Quality assurance issues 	2	3	Y
3.	Heating and / or cooling systems <ul style="list-style-type: none"> Sizing systems appropriate for high performance retrofits Heating and / or cooling generation systems and efficiencies Heating and / or cooling distribution options Insulation of circulation pipework 	2	3	Y

⁶ The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary training course that can be conducted in WWETB’s proposed Vocational Training Centre in Enniscorthy, County Wexford [insert name of VTC].

4.	Summer comfort / passive cooling strategies <ul style="list-style-type: none"> • solar loads, • air exchange / ventilation, • indoor heat sources, • impact of external colours, of thermal insulation and of thermal masses, • shading in summer; • passive cooling technologies to avoid overheating / to reduce the cooling demand during summer. 	1	1	Y
5.	Highly efficient DHW generation, storage and distribution (including drain waste water heat recovery) with special emphasis on full and complete insulation of pipes <ul style="list-style-type: none"> • DHW generation systems • DHW circulation strategies • Heat losses from circulation pipes • Insulation of DHW circulation pipes including sourcing specialist fittings for awkward pipe connections • Drain waste water heat recovery systems, efficiencies and installation principles 	2	3	Y
6.	Energy efficient lighting systems and controls <ul style="list-style-type: none"> • Energy labelling for lighting • Light (lux) levels required for different tasks • Overview of energy efficient lighting systems for internal and external use • Control systems for energy efficient lighting, including occupancy sensors • Emerging lighting technology innovation 	1	1	Y
7.	RES in building retrofit, long and short-term energy storage	2	3	Y
8.	Site visit – deep energy renovation of existing building		4	N
	Part II Project management and planning and design instruments			
9.	Basics of building physics, Passive House principles, optimal solar gains, insulation, thermal bridges, airtightness and wind-	2	2	Y

	<p>tightness, high performance building components, highly efficient windows: products and installation</p> <ul style="list-style-type: none"> • Heat and Heating Energy (Heat Flux/Thermal Conduction) • Thermal environments • The 5 Passivhaus Pillars <ul style="list-style-type: none"> ○ Thermal envelope ○ Windows ○ Airtightness ○ Thermal Bridges ○ Mechanical Ventilation System • insulating materials and their properties (thermal conductivity, water vapor diffusion resistance factor, reaction to fire, etc.) • properties of elements comprising building envelope (U-values, water vapor resistance, fire behaviour on different kind of building envelopes) • thermal bridges • prevention and minimisation of thermal bridges • role of windows regarding energy efficiency and comfort (view towards the outside, thermal protection, solar gains, ventilation during day and during night) • airtight window installation • cross-crafting • Solar radiation and window orientation • Windows installation • special aspects in curtain wall facades • Concept sketches • Shading elements • Green roofs 			
10.	<p>Conservation of historic building fabric, renovation of buildings & monuments of cultural significance, "Step-by-step" renovation & overview of EnerPHit</p> <ul style="list-style-type: none"> • potential for energy savings assessment • renovation standards; certification of the energy performance • details, products and materials 	2		Y

	<ul style="list-style-type: none"> Solutions for ventilation in retrofits of historical buildings Thermal comfort in summer Built examples Step-by-step refurbishment examples 			
11.	Project Management, Quality Assurance <ul style="list-style-type: none"> Introduction – basic principles; Necessary legislation; Executing and Monitoring in project management and energy management; Basic Energy Efficiency principle; Quality assurance of technical equipment of buildings; Coordination of professions on site. 	2		Y
12.	Economic efficiency of deep energy retrofitting up to the level of "passive" and "nearly zero energy" buildings <ul style="list-style-type: none"> EED and EPBD II – What is it nZEB? Prices of construction materials, bill of quantities Energy savings and operational costs - Energy efficiency measures – technological Payback period 	2		Y
	TOTAL	20	20	

Version 2: Upskilling training (Reference 161-UP-MS). Curriculum for upskilling training courses in the “Electrical Engineering/HVAC” professional field (market-based)

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building systems			
1.	Comfort, health and safety requirements in buildings, indoor air quality, airtightness, vapour and moisture movement, wind-tightness <ul style="list-style-type: none"> indoor air quality (contaminants and performance levels), thermal comfort, daylight and lighting, noise, influence of nearby landscape, safety requirements in buildings and the compliance ensured during the renovation process: Fire Safety and legal responsibilities in Buildings, Environmental regulations. 	1		Y
2.	Mechanical Ventilation with Heat Recovery (MVHR) <ul style="list-style-type: none"> Recommended air flow rates for supply and extract Core components of MVHR units Ducting design and layout options Balancing supply and extract flow rates Quality assurance issues 		2	
3.	Heating and / or cooling systems and DHW <ul style="list-style-type: none"> Review of heating and / or cooling generation systems and efficiencies Heating and / or cooling distribution options DHW generation systems and circulation strategies Insulation of heating / cooling / DHW circulation pipes including sourcing specialist fittings for awkward pipe connections Drain waste water heat recovery systems 		3	
4.	Summer comfort / passive cooling strategies and lightning <ul style="list-style-type: none"> solar loads, air exchange / ventilation, 	1		Y

	<ul style="list-style-type: none"> indoor heat sources, impact of external colours, of thermal insulation and of thermal masses, shading in summer; passive cooling technologies to avoid overheating / to reduce the cooling demand during summer. 			
5.	RES in building retrofit, long and short-term energy storage	1	3	
	Part II Project management and planning and design instruments			
6.	<p>Basics of building physics, Passive House principles, optimal solar gains, insulation, thermal bridges, airtightness and wind-tightness, high performance building components, highly efficient windows: products and installation</p> <ul style="list-style-type: none"> Heat and Heating Energy (Heat Flux/Thermal Conduction) Thermal environments The 5 Passivhaus Pillars <ul style="list-style-type: none"> Thermal envelope Windows Airtightness Thermal Bridges Mechanical Ventilation System insulating materials and their properties (thermal conductivity, water vapor diffusion resistance factor, reaction to fire, etc.) properties of elements comprising building envelope (U-values, water vapor resistance, fire behaviour on different kind of building envelopes) thermal bridges prevention and minimisation of thermal bridges role of windows regarding energy efficiency and comfort (view towards the outside, thermal protection, solar gains, ventilation during day and during night) airtight window installation Cross-crafting Climate data and climate zones Reduction factor for solar gains Windows comfort criterion Windows U-value calculation Glazing 	2		Y

	<ul style="list-style-type: none"> • Descriptions of the glazing • g-Values (in accordance with EN410) • Shading • Additional shading elements • A line of deciduous trees • Optimum roof overhangs • Reveal shading on one side • Courtyards 			
7.	<p>Conservation of historic building fabric, renovation of buildings and monuments of cultural significance, "Step-by-step" renovation and overview of the EnerPHit standard</p> <ul style="list-style-type: none"> • potential for energy savings assessment • renovation standards; certification of the energy performance • details, products and materials • The house-in-a-house principle • Built examples • Step-by-step refurbishment examples 	1		Y
8.	<p>Project management, quality assurance, economic efficiency of energy renovation up to the level "passive" and "nearly zero energy" buildings</p> <ul style="list-style-type: none"> • Prices of construction materials, bill of quantities • Energy savings and operational costs - Energy efficiency measures – technological • Payback period 	2		Y
	TOTAL	8	8	

SOURCES

[Insert additional sources relevant to your country]

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

Bulgarian Association for Insulation in Construction (BAIC). **Guide for energy efficient renovation of the building envelopes.** Sofia. 2016

Passive House Institute. **The road to nearly zero energy buildings. The passive house + RES.** Passive house regions with renewable energies (PassREg) project. 2015

Passive House Institute (Germany). **Building a sustainable energy future. A Guide to Success.** Passive House Regions with Renewable Energies (PassREg) Project. 2015

Buildings Performance Institute Europe (BPIE). **Indoor air quality, thermal comfort and daylight. Analysis of residential Building regulations in eight Member States.** March 2015

Passive House Institute / IG Passive House / International Passive House Association. **2nd Passive House Architectural Award. Award Principles and Finalists.** 2013

Buildings Performance Institute Europe (BPIE). **A Guide to Developing Strategies for Building energy renovation. Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks.** February 2013

EnEffect / Bulgarian Construction Chamber / National Agency for Professional Education and Training. **Roadmap for training on Smart Energy Efficient Building Solutions.** BuildUPSkillsProject. 2013

Passive House Institute / IG Passive House / International Passive House Association. **1st Passive House Architectural Award. The Finalists.** 2013

European Institute for Energy Performance of Buildings / Ecofys Germany / EnEffect. **Construction of nearly zero energy buildings (nZEB) in Bulgaria. Towards definition and roadmap.** 2012

Buildings Performance Institute Europe (BPIE) / Ecofys Germany / Danish Building Research Institute. **Principles for nearly zero energy buildings. Paving the way for effective implementation of policy requirements. Final draft.** November 2011

EnEffect, Center for Energy Efficiency. **Ten books on green architecture.** Sofia. 2010

European Commission, General Directorate Energy / EnEffect. **GREEN VITRUVIUS.** Principles and practices of architectural design. Bulgarian edition, Sofia. 2010

Savov, R. And D. Nazarski. **Energy efficiency. Thermal insulation of buildings.** A series of specialized editions of the Bulgarian Association of Insulation in Construction. Technika. 2006

The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer⁷:

[type person's name]

VTC DEAN⁸:

[type person's name]

Signature:

.....

Signature:

.....

⁷ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

⁸ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it

CURRICULUM

Specialty „Deep Energy Renovation of the Building Envelope”



ON-SITE FULL TIME TRAINING and On-Site Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 161-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of the building envelope
<i>Academic hours</i>	10 hours weekly (theory + practice) Total: 40 hours - 20 hours lectures and 20 hours practical hands-on training at the construction site
<i>Type of course</i>	Elective
<i>Course field</i>	Construction (foremen, carpenters, block-layers, plasterers and general operatives)
<i>Control and evaluation</i>	Continuous assessment and examination
<i>Term in which the evaluation takes place</i>	After completion of the course
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	Knowledge on: <ul style="list-style-type: none"> (p) Deep energy retrofit process (q) Principles and practices of deep energy retrofits (r) Overview of key aspects of deep energy retrofit and their implementation during building renovation, including continuous insulation, airtightness, thermal bridges and high-performance windows (s) Principles of moisture movement and risks associated with interior insulation (t) Qualities of different insulation and airtightness product types and their suitability to different application settings
<i>Acquired skills</i>	Cognitive and practical skills on: <ul style="list-style-type: none"> (c) Overall organization of the building renovation process (d) Implementation of some of the key renovation tasks with regards to affixing of insulation, application of airtightness materials, reducing thermal bridges and installation of high performance windows and doors
<i>Acquired responsibility and autonomy</i>	Responsibility for: <ul style="list-style-type: none"> (i) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction (j) Adaptation of own behaviour to circumstances in solving problems (k) Taking responsibility to ensure continuity of the insulated and airtight thermal envelope (where assessable) (l) Taking responsibility to ensure that all products used in deep energy retrofits are fit for purpose with respect to

	ensuring insulation and air-sealing of the thermal envelope for the life of the building
<i>Preliminary requirements</i>	The students are expected to have an overall understanding of building systems, construction, processes and materials.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical equipment (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop - Health and safety equipment, including first-aid box - On-site DER envelope build-ups including the key junctions of wall to floor, wall to window, wall to intermediate floor and wall to roof - Envelope build-ups should ideally illustrate both interior and well as exterior insulation strategies and should include typical service penetrations found on high performance retrofits required for ventilation ducts - Multiple samples of the different kinds of insulation, air-sealing and thermal bridge products which can be used for deep energy retrofits - Triple-glazed windows and door install scenarios - Blower door equipment used for airtightness testing - Tools and applicators typically used in deep energy retrofits, including smoke-pens used for finding leaks in the building envelope <p>Appreciation of DER mechanical services strategies:</p> <ul style="list-style-type: none"> - MVHR system, including ducts, registers and wall penetrations - Renewable energy systems including roof mounting fixings, inverter and battery (where used on the project) - Exterior air to water heat pump with interior low temperature radiators and / or mini-split wall-mounted cooling evaporator (or equivalent space conditioning equipment used on the project) - DHW pipes connections, bends and fittings to be insulated as part of the on-site training - Drain waste water heat recovery system (if not being applied to the project, ensure a demonstration model is available) - Tools and applicators typically used in deep energy mechanical services retrofits
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Construction related qualification minimum EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation

	<ul style="list-style-type: none"> - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice
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TRAINING PROGRAMME OVERVIEW

This training takes place entirely at a construction site for a deep energy retrofit project. If comfortable training facilities for the theoretical sessions are not available (toilets and coffee facilities, warm, dry, with seating and tables, lighting and a clear surface to project PowerPoint slides onto), then this part of the training should be provided at a convenient nearby location (such as a hotel or other suitable space).

The subject Deep energy renovation of the building envelope is elective in the course field of Construction in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre [insert name of VTC].

The above described deep energy retrofit course is based on the notion that the students already have some knowledge and basic understanding of the building design and construction process and building physics and materials. Some of them may also have a solid practical experience in construction as it may be their primary field of work. The design process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of exemplary levels of energy efficiency.

The course is divided in two major parts. The emphasis of the training programme is directed to the first part of the course. It examines the deep energy retrofit (DER) process in relation to the building envelope with particular attention being paid to the design and construction of the distinct building components, underlining the role of comprehensive 'whole-system' design to the DER and examining key renovation principles. Core renovation design principles are being introduced, emphasising what makes a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices with regards to insulation, airtightness, thermal bridging and high-performance window installation. The students get to grasp not only the theoretical knowledge behind the DER practices, but the insight as to why it is advantageous and preferred to the standard energy renovation. Special and particular attention is paid to the step-by-step renovation process where the building owner is not in a position to complete the refurbishment plan in one phase.

The second part of the training programme is dedicated to project management and planning and design instruments, where the basics of the economic efficiency and cost-effectiveness of DER, as well as the assurance of high quality building design and construction are presented. An overview of the building services found in DER such as mechanical ventilation with heat recovery (MVHR), heating and / or cooling and renewable energy sources (RES) is also provided.

CURRICULUM CONTENTS⁹

Version 1: Full-time training (Reference 162-FT-BE). Curriculum for acquiring continuous professional qualification for professions in the "Construction" professional field, including foremen, carpenters, block-layers, plasterers and general operatives according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building envelope			
1.	Basis of building physics, Passive house principles, optimal solar gains	2	2	Y
2	Comfort, health and safety requirements in buildings, incl. indoor air quality	2	2	Y
3.	Insulation of the opaque envelope	2	3	Y
4.	Airtightness, vapour and moisture movement as well as windtightness	2	4	Y
5.	Solving and avoiding thermal bridges	2	3	Y
6.	Installation of highly efficient windows and exposure to high performance building components, products and installation	2	3	Y
7.	"Step-by-step" renovation and the EnerPHit standard	1	1	Y
	Part II Project management and planning and design instruments			
8.	Overview of building services and how they interface with the thermal envelope: MVHR, heating and / or cooling, RES	2	2	Y
9.	Conservation of historic building fabric, renovation of buildings and monuments of cultural significance	2		Y
10.	Project management and quality assurance	2		Y
11.	Economic efficiency of deep energy retrofitting up to the level of "passive" and "nearly zero energy" buildings	1		Y
	TOTAL	20	20	

⁹ The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB Project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary training course that can be conducted on a DER construction site.

Version 2: Up-skilling training (Reference 162-FT-BE). Curriculum for upskilling training courses in the "Construction" professional field including foremen, carpenters, block-layers, plasterers and general operatives according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building envelope			
1.	Comfort, health and safety requirements in buildings, incl. indoor air quality; basis of building physics, Passive house principles, optimal solar gains	1		Y
2.	Insulation of the opaque envelope	0.5	2	Y
3.	Airtightness, vapour and moisture movement, windtightness	1	2	Y
4.	Thermal bridges and high-performance building components	0.5	1	Y
5.	Highly efficient windows: products and installation	0.5	1	Y
6.	"Step-by-step" renovation. The EnerPHit standard.	1	1	Y
	Part II Project management and planning and design instruments			
7.	Introduction to building services: MVHR, heating and / or cooling, RES	1	1	Y
8.	Conservation of historic building fabric, renovation of buildings and monuments of cultural significance	1		Y
9.	Project management, quality assurance, economic efficiency of existing buildings and energy renovation up to the level "passive" and "nearly zero energy" buildings	1.5		Y
	TOTAL	8	8	

SOURCES

[Insert additional sources relevant to your country]

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

Bulgarian Association for Insulation in Construction (BAIC). **Guide for energy efficient renovation of the building envelopes.** Sofia. 2016

Passive House Institute. **The road to nearly zero energy buildings. The passive house + RES.** Passive house regions with renewable energies (PassREg) project. 2015

Passive House Institute (Germany). **Building a sustainable energy future. A Guide to Success.** Passive House Regions with Renewable Energies (PassREg) Project. 2015

Buildings Performance Institute Europe (BPIE). **Indoor air quality, thermal comfort and daylight. Analysis of residential Building regulations in eight Member States.** March 2015

Passive House Institute / IG Passive House / International Passive House Association. **2nd Passive House Architectural Award. Award Principles and Finalists.** 2013

Buildings Performance Institute Europe (BPIE). **A Guide to Developing Strategies for Building energy renovation. Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks.** February 2013

EnEffect / Bulgarian Construction Chamber / National Agency for Professional Education and Training. **Roadmap for training on Smart Energy Efficient Building Solutions.** BuildUPSkillsProject. 2013

Passive House Institute / IG Passive House / International Passive House Association. **1st Passive House Architectural Award. The Finalists.** 2013

European Institute for Energy Performance of Buildings / Ecofys Germany / EnEffect. **Construction of nearly zero energy buildings (nZEB) in Bulgaria. Towards definition and roadmap.** 2012

Buildings Performance Institute Europe (BPIE) / Ecofys Germany / Danish Building Research Institute. **Principles for nearly zero energy buildings. Paving the way for effective implementation of policy requirements. Final draft.** November 2011

EnEffect, Center for Energy Efficiency. **Ten books on green architecture.** Sofia. 2010

European Commission, General Directorate Energy / EnEffect. **GREEN VITRUVIUS.** Principles and practices of architectural design. Bulgarian edition, Sofia. 2010

Savov, R. And D. Nazarski. **Energy efficiency. Thermal insulation of buildings.** A series of specialized editions of the Bulgarian Association of Insulation in Construction. Technika. 2006

The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer¹⁰:

[type person's name]

VTC DEAN¹¹:

[type person's name]

Signature:

.....

Signature:

.....

¹⁰ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

¹¹ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it



MosArt DER training on-site at EnerPHit social housing project for Dublin City Council. The training session depicted here concerns the upgrading of the exterior envelope using autoclaved aerated concrete blocks (AAC) with exterior mineral-wool insulation and triple-glazed windows.



MosArt DER training on-site at EnerPHit social housing project for Dublin City Council. The training session depicted here concerns the placement of a vapour control and airtightness layer under the roof trusses. The person on the left is the trainee construction worker, and the person on the right is an expert airtightness installer.

CURRICULUM

Specialty „ Deep Energy Renovation of Building Systems“



ON-SITE FULL TIME TRAINING and On-site Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of building mechanical and electrical systems
<i>Academic hours</i>	10 hours weekly (theory + practice) Total: 40 hours - 20 hours lectures and 20 hours practical hands-on training at the construction site
<i>Type of course</i>	Elective
<i>Course field</i>	Heating, Ventilation and Air-Conditioning (HVAC) and Renewable Energy Systems (RES)
<i>Control and evaluation</i>	Continuous assessment and examination
<i>Term in which the evaluation takes place</i>	After completion of the course
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	<p>Knowledge on:</p> <ul style="list-style-type: none"> (u) Deep energy retrofit process (v) Principles and practices of deep energy retrofits (w) Key mechanical systems which impact significantly on building energy efficiency (x) Performance characteristics of insulation products that are typically used to insulated ducts, pipes and vessels (y) Availability of specialist insulating pieces which can be used to insulate joints, sharp bends and connections of hot water distribution pipes (z) Performance characteristics of adhesive tapes that are typically used to seal and secure the attachment of insulation to ducts and pipes with a view to ensuring high performance for the life of the building (aa) Principles of heating and domestic hot water generation and distribution (bb) Principles of mechanical ventilation with heat recovery and its contribution towards indoor air quality and comfort (cc) Awareness of integrated technologies which offer multiple mechanical services to high performance retrofits (so-called 'Compact' units) (dd) Principles of solar renewable energy generation (both electric and thermal) and storage
<i>Acquired skills</i>	<p>Cognitive and practical skills on:</p> <ul style="list-style-type: none"> (f) Overall organisation of the building renovation process (g) Implementing tasks relating to installation of high-efficient heating and domestic hot water systems including full and complete insulation of all vessels and pipework which store and / or distribute heated water

	<p>(h) Implementing tasks relating to installation of mechanical ventilation with heat recovery (MVHR), including placement of supply and extract ducts and registers, thorough sealing and insulation cold air ducts and envelope penetrations</p> <p>(i) Implementing tasks relating to installation of solar renewable energy generation and storage systems including ensuring that (a) all fixings and penetrations do not compromise the building in terms of moisture ingress as well as wind-tightness and airtightness and (b) that any pipes transporting hot water are fully insulated</p>
<i>Acquired responsibility and autonomy</i>	<p>Responsibility for:</p> <p>(m) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction</p> <p>(n) Adaptation of own behaviour to circumstances in solving problems</p> <p>(o) Taking responsibility to ensure that all ducts, pipes and vessels which transport or store heated water or air are fully and completely insulated and without any gaps whatsoever even at awkward junctions, bends or connections</p> <p>(p) Taking responsibility to ensure that all products used in insulating mechanical services are fit for purpose, most especially adhesive tapes used to secure insulation in-place (which typically fail on domestic retrofit projects)</p>
<i>Preliminary requirements</i>	The students are expected to have an overall understanding of building systems, construction, processes and materials.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical equipment (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop - Health and safety equipment, including first-aid box - MVHR system, including ducts, registers and wall penetrations - Renewable energy systems including roof mounting fixings, inverter and battery (where used on the project) - Exterior air to water heat pump with interior low temperature radiators and / or mini-split wall-mounted

	<p>cooling evaporator (or equivalent space conditioning equipment used on the project)</p> <ul style="list-style-type: none"> - DHW pipes connections, bends and fittings to be insulated as part of the on-site training - Drain waste water heat recovery system (if not being applied to the project, ensure a demonstration model is available) - Tools and applicators typically used in deep energy retrofits <p>Appreciation of DER envelope strategies:</p> <ul style="list-style-type: none"> - Retrofitting approach to whole project envelope including the key junctions of wall to floor, wall to window, wall to intermediate floor and wall to roof - The envelope renovation should ideally illustrate both interior and well as exterior insulation strategies and must include typical service penetrations found on high performance retrofits required for ventilation ducts and other services - Multiple samples of the different kinds of insulation, air-sealing and thermal bridge products which can be used for deep energy retrofits - Triple-glazed windows and door install scenarios - Blower door equipment used for airtightness testing - Tools and applicators typically used in deep energy envelope retrofits, including smoke-pens used for finding leaks in the building envelope
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Minimum mechanical building services EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice

TRAINING PROGRAMME OVERVIEW

This training takes place entirely at a construction site for a deep energy retrofit project. If comfortable training facilities for the theoretical sessions are not available (toilets and coffee facilities, warm, dry, with seating and tables, lighting and a clear surface to project PowerPoint slides onto), then this part of the training should be provided at a convenient nearby location (such as a hotel or other suitable space).

The subject Deep energy renovation of building mechanical and electrical systems is elective in the course field of Electrical Engineering/HVAC in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre in Enniscorthy, County Wexford [insert name of VTC].

The described deep energy retrofit course is based on the notion that the students already have some knowledge and basic understanding of the building

systems and building physics. Some of them may also have a solid practical experience in installation and maintenance of heating, ventilation and AC systems as it may be their primary field of work.

The training process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of exemplary levels of energy efficiency.

The course is divided in two major parts. The emphasis of the subject is on the first part of the course. It examines the deep energy retrofit (DER) potential for building systems with particular attention being paid to the design and implementation of appropriate systems and services for heating and / or cooling, domestic hot water, mechanical ventilation and renewable energy generation. Basic renovation design principles and practices are introduced, with an emphasis on what renders a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices. The students get to grasp not only the theoretical knowledge behind the DER practices, but an invaluable insight on why it is advantageous and preferred to the standard energy renovation. Particular attention is paid to indoor air quality and comfort and the use of highly efficient thermal energy generation and distribution systems as well as mechanical ventilation with heat recovery (MVHR) and renewable energy sources (RES) as well as lighting.

The second part of the training programme is dedicated to project management and planning and design instruments, where the basics of economic efficiency and cost-effectiveness of DER, as well as the assurance of high quality building services design and construction are presented. An overview of key building envelope retrofit principles such as insulation, airtightness, thermal bridges and high-performance windows is also covered.

CURRICULUM CONTENTS¹²

Version 1: Full-time on-site training (Reference 162-FT-MS). Curriculum for acquiring continuous professional qualification for tradespersons in the “Electrical Engineering/HVAC” professional field according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

Nº	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building systems			
1.	Comfort, health and safety requirements in buildings, indoor air quality, airtightness, vapour and moisture movement, windtightness <ul style="list-style-type: none"> indoor air quality (contaminants and performance levels), thermal comfort, daylight and lighting, noise, influence of nearby landscape, safety requirements in buildings and the compliance ensured during the renovation process: Fire Safety and legal responsibilities in Buildings, Environmental regulations. 	2		Y
2.	Mechanical Ventilation with Heat Recovery (MVHR) <ul style="list-style-type: none"> Indoor air quality parameters (CO₂ and RH) Recommended air flow rates for supply and extract Core components of MVHR units Ducting design and layout options Balancing flow rates Quality assurance issues 	2	5	Y
3.	Heating and / or cooling systems <ul style="list-style-type: none"> Sizing systems appropriate for high performance retrofits Heating and / or cooling generation systems and efficiencies Heating and / or cooling distribution options Insulation of circulation pipework 	2	3	Y

¹² The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary training course that can be conducted on a DER construction site.

4.	<p>Summer comfort / passive cooling strategies [adjust if in a hot climate]</p> <ul style="list-style-type: none"> • solar loads, • air exchange / ventilation, • indoor heat sources, • impact of external colours, of thermal insulation and of thermal masses, • shading in summer; • passive cooling technologies to avoid overheating / to reduce the cooling demand during summer. 	1	1	Y
5.	<p>Highly efficient DHW generation, storage and distribution (including drain waste water heat recovery) with special emphasis on full and complete insulation of pipes</p> <ul style="list-style-type: none"> • DHW generation systems • DHW circulation strategies • Heat losses from circulation pipes • Insulation of DHW circulation pipes including sourcing specialist fittings for awkward pipe connections • Drain waste water heat recovery systems, efficiencies and installation principles 	2	4	Y
6.	<p>Energy efficient lighting systems and controls</p> <ul style="list-style-type: none"> • Energy labelling for lighting • Light (lux) levels required for different tasks • Overview of energy efficient lighting systems for internal and external use • Control systems for energy efficient lighting, including occupancy sensors • Emerging lighting technology innovation 	1	1	Y
7.	RES in building retrofit, long and short-term energy storage	2	4	Y
	Part II Project management and planning and design instruments			Y
8.	Basics of building physics, Passive House principles, optimal solar gains, insulation, thermal bridges, airtightness and wind-tightness, high performance building	2	2	Y

	<p>components, highly efficient windows: products and installation</p> <ul style="list-style-type: none"> • Heat and Heating Energy (Heat Flux/Thermal Conduction) • Thermal environments • The 5 Passivhaus Pillars <ul style="list-style-type: none"> ○ Thermal envelope ○ Windows ○ Airtightness ○ Thermal Bridges ○ Mechanical Ventilation System • insulating materials and their properties (thermal conductivity, water vapor diffusion resistance factor, reaction to fire, etc.) • properties of elements comprising building envelope (U-values, water vapor resistance, fire behaviour on different kind of building envelopes) • thermal bridges • prevention and minimisation of thermal bridges • role of windows regarding energy efficiency and comfort (view towards the outside, thermal protection, solar gains, ventilation during day and during night) • airtight window installation • Cross-crafting • Climate data and climate zones • Solar radiation and window orientation • Windows installation • Glazing • special aspects in curtain wall facades • Shading • Courtyards • Green roofs 			
9.	<p>Conservation of historic building fabric, renovation of buildings and monuments of cultural significance, "Step-by-step" renovation and overview of the EnerPHit standard</p> <ul style="list-style-type: none"> • potential for energy savings assessment • renovation standards; certification of the energy performance 	2		Y

	<ul style="list-style-type: none"> • details, products and materials • retrofit for non-residential historical buildings with high IHG • Internal Insulation as a solution in historical buildings • Improving thermal protection towards the ground when modernising historical buildings • Solutions for ventilation in retrofits of historical buildings • Thermal comfort in summer 			
10.	Project Management, Quality Assurance <ul style="list-style-type: none"> • Introduction – basic principles; • Necessary legislation; • Executing and Monitoring in project management and energy management; • Basic Energy Efficiency principle; • Quality assurance of technical equipment of buildings; • Coordination of professions on site. 	2		Y
11.	Economic efficiency of deep energy retrofitting up to the level of "passive" and "nearly zero energy" buildings <ul style="list-style-type: none"> • Prices of materials, bill of quantities • Energy efficiency measures – technological • Payback period 	2		Y
	TOTAL	20	20	

Version 2: Upskilling on-site training (Reference 162-UP-MS). Curriculum for upskilling training courses in the “Electrical Engineering/HVAC” professional field according to levels 4 to 5 Irish national framework of qualifications (NFQ) [insert national qualification levels if relevant] (equivalent to levels 3 to 4 European qualifications framework (EQF)).

№	Subject	Academic Hours		Option for online lectures
		Lectures	Hands-on Practical	
	Part I Building systems			
1.	Comfort, health and safety requirements in buildings, indoor air quality, airtightness, vapour and moisture movement, wind-tightness	2		Y
2.	Mechanical Ventilation with Heat Recovery (MVHR) <ul style="list-style-type: none"> Recommended air flow rates for supply and extract Core components of MVHR units Ducting design and layout options Balancing supply and extract flow rates Quality assurance issues 		2	
3.	Heating and / or cooling systems and DHW <ul style="list-style-type: none"> Review of heating and / or cooling generation systems and efficiencies Heating and / or cooling distribution options DHW generation systems and circulation strategies Insulation of heating / cooling / DHW circulation pipes including sourcing specialist fittings for awkward pipe connections Drain waste water heat recovery systems 		3	
4.	Summer comfort / passive cooling strategies and lightning <ul style="list-style-type: none"> solar loads, air exchange / ventilation, indoor heat sources, impact of external colours, of thermal insulation and of thermal masses, shading in summer; passive cooling technologies to avoid overheating / to reduce the cooling demand during summer. 	1		Y

5.	RES in building retrofit, Long and short-term energy storage	1	3	
	Part II Project management and planning and design instruments			
6.	<p>Basics of building physics, Passive House principles, optimal solar gains, insulation, thermal bridges, airtightness and wind-tightness, high performance building components, highly efficient windows: products and installation</p> <ul style="list-style-type: none"> • Heat and Heating Energy (Heat Flux/Thermal Conduction) • Thermal environments • The 5 Passivhaus Pillars <ul style="list-style-type: none"> ○ Thermal envelope ○ Windows ○ Airtightness ○ Thermal Bridges ○ Mechanical Ventilation System • insulating materials and their properties (thermal conductivity, water vapor diffusion resistance factor, reaction to fire, etc.) • properties of elements comprising building envelope (U-values, water vapor resistance, fire behaviour on different kind of building envelopes) • thermal bridges • prevention and minimisation of thermal bridges • role of windows regarding energy efficiency and comfort (view towards the outside, thermal protection, solar gains, ventilation during day and during night) • airtight window installation • cross-crafting • Solar radiation and window orientation <ul style="list-style-type: none"> ○ Reduction factor for solar gains ○ Windows comfort criterion ○ Windows U-value calculation • Windows installation <ul style="list-style-type: none"> ○ Concept sketches • Glazing <ul style="list-style-type: none"> ○ Descriptions of the glazing ○ g-Values (in accordance with EN410) 	2		Y

	<ul style="list-style-type: none"> • special aspects in curtain wall facades • Shading <ul style="list-style-type: none"> ○ Additional shading elements ○ A line of deciduous trees ○ Optimum roof overhangs ○ Reveal shading on one side ○ Courtyards 			
7.	<p>Conservation of historic building fabric, renovation of buildings and monuments of cultural significance, "Step-by-step" renovation and overview of the EnerPHit standard</p> <ul style="list-style-type: none"> • potential for energy savings assessment • renovation standards; certification of the energy performance • details, products and materials 	1		Y
8.	<p>Project management, quality assurance, economic efficiency of energy renovation up to the level "passive" and "nearly zero energy" buildings</p> <ul style="list-style-type: none"> • Prices of materials, bill of quantities • Energy efficiency measures – technological • Payback period 	1		Y
	TOTAL	8	8	

SOURCES

[Insert additional sources relevant to your country]

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

Bulgarian Association for Insulation in Construction (BAIC). **Guide for energy efficient renovation of the building envelopes.** Sofia. 2016

Passive House Institute. **The road to nearly zero energy buildings. The passive house + RES.** Passive house regions with renewable energies (PassREg) project. 2015

Passive House Institute (Germany). **Building a sustainable energy future. A Guide to Success.** Passive House Regions with Renewable Energies (PassREg) Project. 2015

Buildings Performance Institute Europe (BPIE). **Indoor air quality, thermal comfort and daylight. Analysis of residential Building regulations in eight Member States.** March 2015

Passive House Institute / IG Passive House / International Passive House Association. **2nd Passive House Architectural Award. Award Principles and Finalists.** 2013

Buildings Performance Institute Europe (BPIE). **A Guide to Developing Strategies for Building energy renovation. Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks.** February 2013

EnEffect / Bulgarian Construction Chamber / National Agency for Professional Education and Training. **Roadmap for training on Smart Energy Efficient Building Solutions.** BuildUPSkillsProject. 2013

Passive House Institute / IG Passive House / International Passive House Association. **1st Passive House Architectural Award. The Finalists.** 2013

European Institute for Energy Performance of Buildings / Ecofys Germany / EnEffect. **Construction of nearly zero energy buildings (nZEB) in Bulgaria. Towards definition and roadmap.** 2012

Buildings Performance Institute Europe (BPIE) / Ecofys Germany / Danish Building Research Institute. **Principles for nearly zero energy buildings. Paving the way for effective implementation of policy requirements. Final draft.** November 2011

EnEffect, Center for Energy Efficiency. **Ten books on green architecture.** Sofia. 2010

European Commission, General Directorate Energy / EnEffect. **GREEN VITRUVIUS.** Principles and practices of architectural design. Bulgarian edition, Sofia. 2010

Savov, R. And D. Nazarski. **Energy efficiency. Thermal insulation of buildings.** A series of specialized editions of the Bulgarian Association of Insulation in Construction. Technika. 2006

Additional references from CVUT

Topic 16: Project management

OBERLENDER, Garold D. *Project management for engineering and construction*. International;Third;. New York: McGraw-Hill Education, 2015. ISBN 9789814670869;9814670863;

BENNETT, J. M. a Danny HO. *Project management for engineers*. New Jersey: World Scientific, 2014. ISBN 9789814447928;9814447927;.

ECOFYS, , 2015. *Assessment of cost optimal calculations in the context of the EPBD* (ENER/C3/2013-414): Final report [online]. BUIDE13705,

CHEGUT, Andrea, Piet EICHHOLTZ a Rogier HOLTERMANS, 2016. *Energy efficiency and economic value in affordable housing*. Energy Policy. 97(-), 39-49. DOI: <http://dx.doi.org/10.1016/j.enpol.2016.06.043>. ISSN 03014215, <http://www.sciencedirect.com/science/article/pii/S0301421516303482>

Additional references from SEVEN

Topic 9: Cost effectiveness

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency

Link: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0027&qid=1523534197292&from=EN>

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

Link: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN>

Directive 2010/31/EU, 2010. In: *DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings*. EU: Official Journal of the European Union, 2010, number 31.

Schneiderova Heralova, 2014, R. *Life Cycle Cost optimization within decision making on alternative designs of public buildings*. Procedia Engineering. 85, 454-463., <https://doi.org/10.1016/j.proeng.2014.10.572>, <http://www.sciencedirect.com/science/article/pii/S1877705814019389>

KlÄpffer, Birgit Grahl 2014 *Life Cycle Assessment (LCA): A Guide to Best Practice*

ISBN: 978-3-527-32986-1

<https://books.google.cz/books?id=NkRsAwAAQBAJ&pg=PT582&dq=LCC+and+LCA&hl=cs&sa=X&ved=0ahUKEwivu93m07baAhXCZVAKHekDCO4Q6AEIMjAC#v=onepage&q=LCC%20and%20LCA&f=false>

<https://www.investopedia.com/exam-guide/cfa-level-1/corporate-finance/payback-period.asp>

Harry F. Campbell, Richard P.C 2016 *Cost-Benefit Analysis: Financial And Economic Appraisal Using Spreadsheets* Routledge ISBN 978-1-138-84879-5

<https://books.google.cz/books?id=qaNGCgAAQBAJ&printsec=frontcover&dq=Cost-Benefit+Analysis:+Financial+And+Economic+Appraisal+Using+Spreadsheets&hl=cs&sa=X&ved=0ahUKEwiD-ZKLzrbaAhWEKVAKHZhiAQ0Q6AEIJzAA#v=onepage&q=Cost-Benefit%20Analysis%3A%20Financial%20And%20Economic%20Appraisal%20Using%20Spread sheets&f=false>

David Whitman, Ronald E. Terry 2012 *Fundamentals of Engineering Economics and Decision Analysis* Morgan and Claypool ISBN: 9781608458646 (9781608458653)

https://books.google.cz/books?id=IJJu4toYTIsC&printsec=frontcover&dq=Fundamentals+of+Engineering+Economics+and+Decision+Analysis&hl=cs&sa=X&ved=0ahUKEwj30_T9zrbaAhXPI1AKHQjIBIYQ6AEIJzAA#v=onepage&q=Fundamentals%20of%20Engineering%20Economics%20and%20Decision%20Analysis&f=false

CHEGUT, Andrea, Piet EICHHOLTZ a Rogier HOLTERMANS, 2016. *Energy efficiency and economic value in affordable housing*. Energy Policy. 97(-), 39-49. DOI:
<http://dx.doi.org/10.1016/j.enpol.2016.06.043>. ISSN 03014215,
<http://www.sciencedirect.com/science/article/pii/S0301421516303482>

FLEITER, Tobias, Simon HIRZEL a Ernst WORRELL, 2012. *The characteristics of energy-efficiency measures – a neglected dimension*. Energy Policy. 51(-), 502-513. DOI:
<http://dx.doi.org/10.1016/j.enpol.2012.08.054>. ISSN 03014215,
<http://www.sciencedirect.com/science/article/pii/S0301421512007367>

The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer¹³:

[type person's name]

VTC DEAN¹⁴:

[type person's name]

Signature:

.....

Signature:

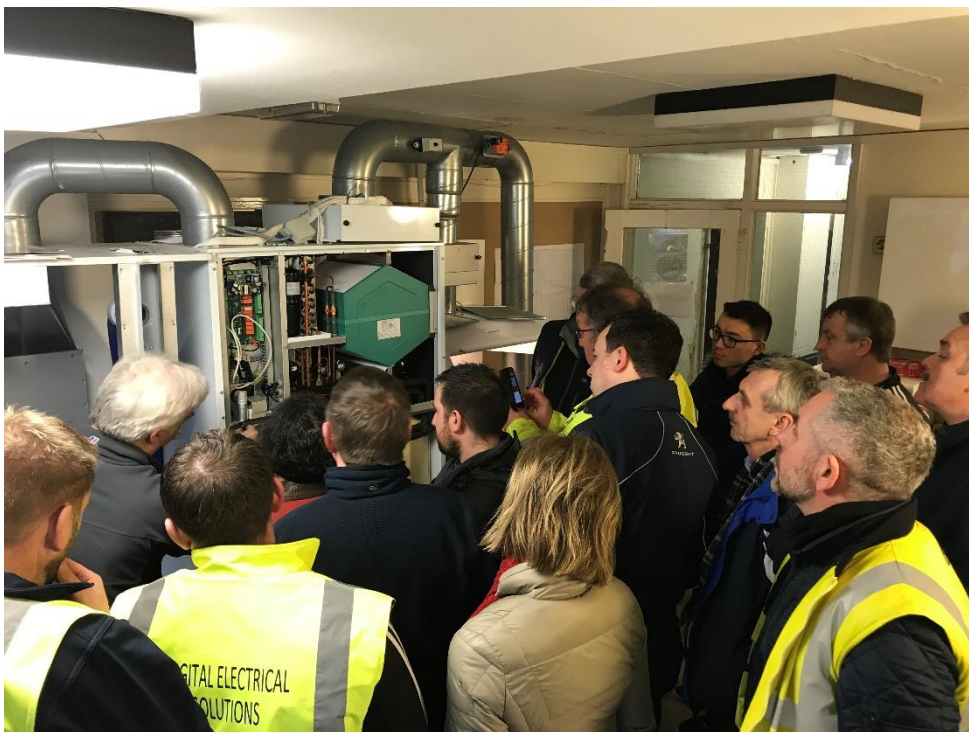
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¹³ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

¹⁴ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it



MosArt DER training on-site at EnerPHit social housing project for Dublin City Council. Provision for delivery of comfortable training conditions is very important. The training session depicted here is from a guest-lecturer Maurice Falvey (Nilan Ireland) speaking about mechanical ventilation with heat recovery.



MosArt DER training on-site at EnerPHit social housing project for Dublin City Council. This project is using a 'compact' MVHR system which includes not just ventilation but also domestic hot water and heating (and cooling, if needed).

CURRICULUM

Specialty „Deep Energy Renovation of the Building Envelope“



VALIDATION OF KNOWLEDGE AND SKILLS ACQUIRED AT THE WORKPLACE /
VALIDATION OF INFORMALLY ACQUIRED KNOWLEDGE AND SKILLS

Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
On-Site	Upskilling (16 hours)	Building Envelope (Ref. 1.6.2-UP-BE)	Mechanical Systems (Ref. 1.6.2-UP-MS)
Either at Vocational Training Centre or On-Site	Validation (12 hours)	Building Envelope (Ref. 1.6.3-UP-BE)	Mechanical Systems (Ref. 1.6.3-UP-MS)

Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of the building envelope
<i>Academic hours</i>	12 hours weekly (theory) Total: 12 hours
<i>Type of course</i>	Elective
<i>Course field</i>	Construction
<i>Control and evaluation</i>	Ongoing assessment and examination after each module; Final assessment and evaluation
<i>Term in which the evaluation takes place</i>	After completion of the course Theoretical and practical examination
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	Knowledge on: (ee) Deep energy retrofit process (ff) Principles and practices of deep energy retrofits (gg) Overview of key aspects of deep energy retrofit and their implementation during building renovation, including continuous insulation, airtightness, thermal bridges and high-performance windows (hh) Principles of moisture movement and risks associated with interior insulation (ii) Qualities of different insulation and airtightness product types and their suitability to different application settings
<i>Acquired skills</i>	Cognitive and practical skills on: (e) Overall organization of the building renovation process (f) Implementation of some of the key renovation tasks with regards to affixing of insulation, application of airtightness materials, reducing thermal bridges and installation of high performance windows and doors
<i>Acquired responsibility and autonomy</i>	Responsibility for: (q) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction (r) Adaptation of own behaviour to circumstances in solving problems (s) Taking responsibility to ensure continuity of the insulated and airtight thermal envelope (where assessable) (t) Taking responsibility to ensure that all products used in deep energy retrofits are fit for purpose with respect to ensuring insulation and air-sealing of the thermal envelope for the life of the building

<i>Preliminary requirements</i>	The students are expected to have passed an entry level exam that corresponds to the study programme. Practical and theoretical skills are both examined.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical secure (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop <p>If it is not possible to deliver this training on the construction site and it has to be delivered in a VTC, then the following equipment should be in place:</p> <ul style="list-style-type: none"> - Envelope demonstration models illustrating the classic construction types found in the region of the VTC and including the key junctions of wall to floor, wall to window, wall to intermediate floor and wall to roof - The envelope demonstration models should illustrate both interior and well as exterior insulation strategies and should include typical service penetrations found on high performance retrofits required for ventilation ducts - Multiple samples of the different kinds of insulation, air-sealing and thermal bridge products which can be used for deep energy retrofits - Sample triple-glazed windows available in the region - Blower door equipment used for airtightness testing - Tools and applicators typically used in deep energy retrofits, including smoke-pens used for finding leaks in the building envelope
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Construction related qualification minimum EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice

ANNOTATION

This training takes place entirely at a construction site for a deep energy retrofit project. The objective of this training programme is to validate the knowledge and experience of construction workers who have already been involved in delivering deep retrofit projects in practice. If comfortable training facilities for the theoretical sessions are not available (toilets and coffee facilities, warm, dry, with seating and tables, lighting and a clear surface to project PowerPoint slides onto), then this part of

the training should be provided at a convenient nearby location (such as a hotel or other suitable space).

The subject Deep energy renovation of the building envelope is elective in the course field of Construction in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre [insert name of VTC].

The described deep energy retrofit course is based on the notion that the students already have practical knowledge and a deep understanding of the building design and construction process as well as building physics and materials. They must also have a solid practical experience in construction as it is supposed to be their primary field of work. The design process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of different levels of energy efficiency.

The emphasis of this course is on its theoretical part, since the course is supposed to be giving a theoretical background to the practical skills already possessed by the students. It examines the deep energy retrofit (DER) in connection to the building envelope with particular attention being paid to the design and construction of the distinct building components, underlining the role of the comprehensive design to the DER and examining key renovation principles. Basic renovation design principles are introduced, emphasising what makes a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices. The students get to grasp not only the theoretical knowledge behind the DER practices, but the insight on why it is advantageous and preferred to the standard energy renovation. Special attention is paid to the step-by-step renovation.

CURRICULUM CONTENTS¹⁵

Nº	Subject	Academic Hours		On-site
		Lecture Hours	Seminars	
	Building envelope			
1.	Comfort, health and safety requirements in buildings, including indoor air quality; basic building physics, Passive house principles and optimal solar gains	2	exam	Y
2.	Thermal insulation	2	exam	Y
3.	Airtightness, vapour and moisture movement, windtightness	2	exam	Y
4.	Thermal bridges	2	exam	Y
5.	High performance window installation and other high-performance building components	2	exam	Y
6.	"Step-by-step" renovation process and the EnerPHit standard.	2	exam	Y
	TOTAL	12		

¹⁵ ¹⁵ The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB Project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary validation programme that can be conducted on a DER construction site.

SOURCES

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

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The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer¹⁶:

[type person's name]

VTC DEAN¹⁷:

[type person's name]

Signature:

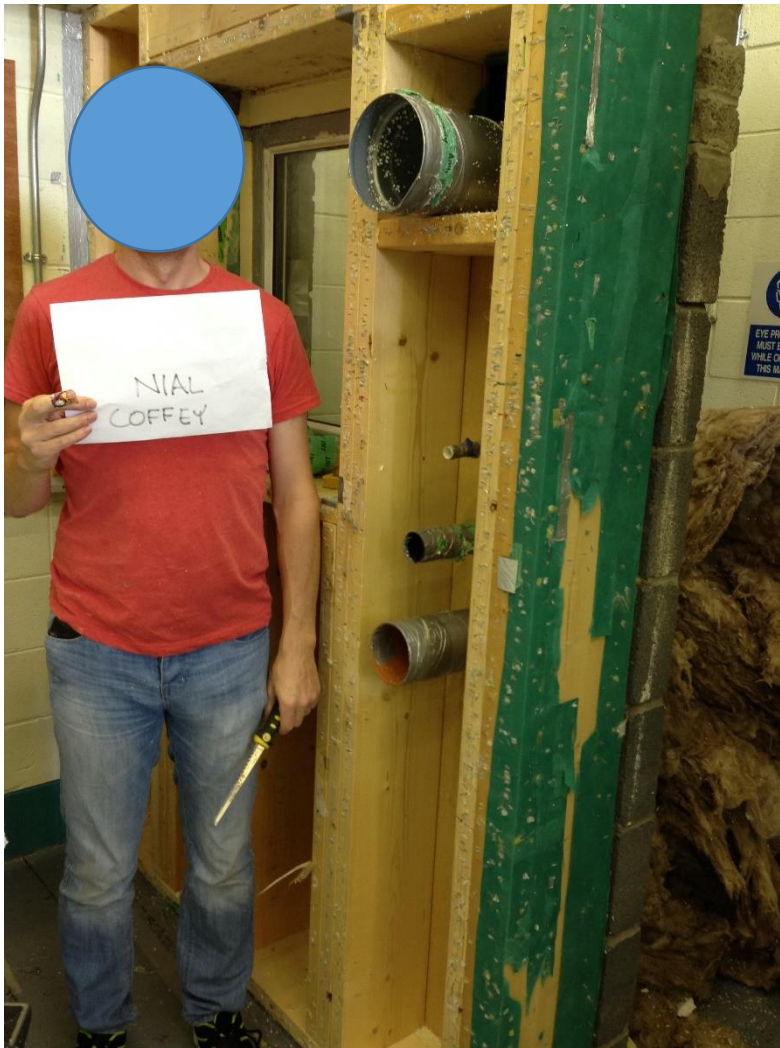
.....

Signature:

.....

¹⁶ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

¹⁷ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it



MosArt examination of practical skills as part of a Certified Passive House Tradesperson Training programme delivered on behalf of City of Dublin Education and Training Board (CDETB). Candidates were photographed (with their identification) in front of the work they had completed as part of the practical training. Photographs such as this were required by the Passive House Institute to confirm that the training did in fact take place and that the candidates completed their own independent skills demonstration.

CURRICULUM

Specialty „Deep Energy Renovation of Building Systems“



VALIDATION OF KNOWLEDGE AND SKILLS ACQUIRED AT THE WORKPLACE /
VALIDATION OF INFORMALLY ACQUIRED KNOWLEDGE AND SKILLS

Up-skilling qualification

Location of Training	Duration	Construction Sector	
Vocational Training Centre	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.1-FT-BE)	Mechanical Systems (Ref. 1.6.1-FT-MS)
Vocational Training Centre	Upskilling (16 hours)	Building Envelope (Ref. 1.6.1-UP-BE)	Mechanical Systems (Ref. 1.6.1-UP-MS)
On-Site	Full Time Training (40 hours)	Building Envelope (Ref. 1.6.2-FT-BE)	Mechanical Systems (Ref. 1.6.2-FT-MS)
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Waterford Wexford Education Training Board (WWETB) [Insert name of VTC]:
30th March 2018 [insert date]

<i>Subject</i>	Deep energy renovation of building systems
<i>Academic hours</i>	12 hours weekly (theory) Total: 12 hours
<i>Type of course</i>	Elective
<i>Course field</i>	Heating, Ventilation and Air-Conditioning (HVAC) and Renewable Energy Systems (RES)
<i>Control and evaluation</i>	Ongoing assessment and examination after each module; Final assessment and evaluation
<i>Term in which the evaluation takes place</i>	After completion of the course Theoretical and practical examination
<i>Credits ECTS / Certification</i>	Yes
<i>Acquired knowledge</i>	<p>Knowledge on:</p> <ul style="list-style-type: none"> (jj) Deep energy retrofit process (kk) Principles and practices of deep energy retrofits (ll) Key mechanical systems which impact significantly on building energy efficiency (mm) Performance characteristics of insulation products and tapes that are typically used to insulated ducts, pipes and vessels including availability of specialist insulating pieces which can be used to insulate joints, sharp bends and connections of hot water distribution pipes (nn) Principles of heating and domestic hot water generation and distribution (oo) Principles of mechanical ventilation with heat recovery and its contribution towards indoor air quality and comfort (pp) Awareness of integrated technologies which offer multiple mechanical services to high performance retrofits (so-called 'Compact' units) (qq) Principles of solar renewable energy generation (both electric and thermal) and storage (rr) Existing renewable and non-polluting energy sources (ss) Possibilities of integration of renewable energy technologies in buildings (tt) Existing HVAC technologies with the use of RES (uu) Requirements to drawings for the building equipment with use of renewable sources (vv) Existing systems of short term energy storage (ww) Existing systems of long term energy storage
<i>Acquired skills</i>	<p>Cognitive and practical skills on:</p> <ul style="list-style-type: none"> (j) Overall organisation of the building renovation process

	<p>(k) Implementing tasks relating to installation of high-efficient heating and domestic hot water systems including full and complete insulation of all vessels and pipework which store and / or distribute heated water</p> <p>(l) Implementing tasks relating to installation of mechanical ventilation with heat recovery (MVHR), including placement of supply and extract ducts and registers, thorough sealing and insulation cold air ducts and envelope penetrations</p> <p>(m) Implementing tasks relating to installation of solar renewable energy generation and storage systems including ensuring that (a) all fixings and penetrations do not compromise the building in terms of moisture ingress as well as wind-tightness and airtightness and (b) that any pipes transporting hot water are fully insulated</p>
<i>Acquired responsibility and autonomy</i>	<p>Responsibility for:</p> <p>(u) Interpreting the deep retrofit drawings and schematics and understanding the planning of the main stages of the design and construction</p> <p>(v) Adaptation of own behaviour to circumstances in solving problems</p> <p>(w) Taking responsibility to ensure that all ducts, pipes and vessels which transport or store heated water or air are fully and completely insulated and without any gaps whatsoever even at awkward junctions, bends or connections</p> <p>(x) Taking responsibility to ensure that all products used in insulating mechanical services are fit for purpose, most especially adhesive tapes used to secure insulation in-place (which typically fail on domestic retrofit projects)</p>
<i>Preliminary requirements</i>	The students are expected to have passed an entry level exam that corresponds to the study programme. Practical and theoretical skills are both examined.
<i>Terms for certification of lectures and seminars</i>	An application for accreditation of the training programme will be made by WWETB, most likely to the internationally renowned City and Guilds [insert relevant details for each country].
<i>Exam procedure</i>	Final theoretical and practical examination.
<i>Technical secure (hardware and software)</i>	<ul style="list-style-type: none"> - White board - Multimedia facility - Laptop

	<p>If it is not possible to deliver this training on the construction site and it has to be delivered in a VTC, then the following equipment should be in place:</p> <ul style="list-style-type: none"> - Demonstration model for MVHR system, including ducts, registers and simulated wall penetrations - Demonstration model for renewable energy systems including roof mounting fixings, inverter and battery - Demonstration model for exterior air to water heat pump with interior low temperature radiators and / or mini-split wall-mounted cooling evaporator - Demonstration model for insulation of DHW pipes with multiple awkward connections, bends and fittings - Demonstration model for drain waste water heat recovery - Demonstration model of typical deep energy retrofit of the thermal envelope illustrating solutions for insulation, airtightness, thermal bridging and high-performance windows - Tools and applicators typically used in deep energy retrofits
<i>Trainer qualifications and experience</i>	<ul style="list-style-type: none"> - Minimum mechanical building services EQF Level 4 to 5 - Nationally recognised 'Train the Trainer' accreditation - Certified Passive House Designer or equivalent - Demonstrable project experience with deep energy retrofit practice

ANNOTATION

This training takes place entirely at a construction site for a deep energy retrofit project. The objective of this training programme is to validate the knowledge and experience of HVAC workers who have already been involved in delivering deep retrofit projects in practice. If comfortable training facilities for the theoretical sessions are not available (toilets and coffee facilities, warm, dry, with seating and tables, lighting and a clear surface to project PowerPoint slides onto), then this part of the training should be provided at a convenient nearby location (such as a hotel or other suitable space).

The subject Deep energy renovation of mechanical building systems is elective in the course field of Construction in the Waterford Wexford Education and Training Board (WWETB) Vocational Training Centre [insert name of VTC].

The described deep energy retrofit course is based on the notion that the students already have practical knowledge and a deep understanding of the building design and construction process as well as building physics and materials. They must also have a solid practical experience in HVAC as it is supposed to be their primary field of work. The design process is structured using the basic principles of the Passive House concept applied to the renovation of existing buildings, resulting in the achievement of different levels of energy efficiency.

The emphasis of this course is on its theoretical part, since the course is supposed to be giving a theoretical background to the practical skills already possessed

by the students. It examines the deep energy retrofit (DER) in connection to the mechanical building systems with particular attention being paid to the design and construction of the distinct building components, underlining the role of the comprehensive design to the DER and examining key renovation principles. Basic renovation design principles are introduced, emphasising what makes a retrofit 'a deep energy retrofit' and what are the most common faults in the standard building renovation practices. The students get to grasp not only the theoretical knowledge behind the DER practices, but the insight on why it is advantageous and preferred to the standard energy renovation. Special attention is paid to the step-by-step renovation.

CURRICULUM CONTENTS¹⁸

Nº	Subject	Academic Hours		On-site
		Lecture Hours	Seminars	
	Building Mechanical Systems			
1.	Comfort, health and safety requirements in buildings, including indoor air quality; basic building physics and Passive house principles <ul style="list-style-type: none"> • Heat and Heating Energy (Heat Flux/Thermal Conduction) • Thermal environments • The 5 Passivhaus Pillars <ul style="list-style-type: none"> ○ Thermal envelope ○ Windows ○ Airtightness ○ Thermal Bridges ○ Mechanical Ventilation System • Climate data • Partial shading elements • Automatization in shading 	2	exam	Y
2.	Mechanical Ventilation with Heat Recovery (MVHR) <ul style="list-style-type: none"> • Indoor air quality parameters (CO₂ and RH) • Recommended air flow rates for supply and extract • Core components of MVHR units • Ducting design and layout options • Balancing flow rates • Quality assurance issues 	2	exam	Y
3.	Heating and / or cooling systems <ul style="list-style-type: none"> • Sizing systems appropriate for high performance retrofits • Heating and / or cooling generation systems and efficiencies • Heating and / or cooling distribution options • Insulation of circulation pipework 	2	exam	Y
4.	Highly efficient DHW generation, storage and distribution (including drain waste water heat	2	exam	Y

^{18 18} The programme is compiled mostly from the learning objectives taken from the Fit-to-nZEB Project Deliverable 2.3. Some of the topics or sub-topics are not included, since the programme aims to demonstrate the exemplary validation programme that can be conducted on a DER construction site.

	recovery) with special emphasis on full and complete insulation of pipes <ul style="list-style-type: none"> • DHW generation systems • DHW circulation strategies • Heat losses from circulation pipes • Insulation of DHW circulation pipes including sourcing specialist fittings for awkward pipe connections • Drain waste water heat recovery systems, efficiencies and installation principles 			
5.	Energy efficient lighting systems and controls <ul style="list-style-type: none"> • Energy labelling for lighting • Light (lux) levels required for different tasks • Overview of energy efficient lighting systems for internal and external use • Control systems for energy efficient lighting, including occupancy sensors • Emerging lighting technology innovation 	2	exam	Y
6.	RES in building retrofit, long and short-term energy storage	2	exam	Y
	TOTAL	12		

SOURCES

International Passive House Association / EnEffect. **Active for more comfort: the Passive Building.** Information for contractors, builders and clients. 2016

European Institute for Energy Performance of Buildings / EnEffect. **Acceleration of the buildings stock renovation in Bulgaria. Present and future of the National Energy Efficiency Program for Multifamily Residential Buildings.** 2016

Bulgarian Association for Insulation in Construction (BAIC). **Guide for energy efficient renovation of the building envelopes.** Sofia. 2016

Passive House Institute. **The road to nearly zero energy buildings. The passive house + RES.** Passive house regions with renewable energies (PassREg) project. 2015

Passive House Institute (Germany). **Building a sustainable energy future. A Guide to Success.** Passive House Regions with Renewable Energies (PassREg) Project. 2015

Buildings Performance Institute Europe (BPIE). **Indoor air quality, thermal comfort and daylight. Analysis of residential Building regulations in eight Member States.** March 2015

Passive House Institute / IG Passive House / International Passive House Association. **2nd Passive House Architectural Award. Award Principles and Finalists.** 2013

Buildings Performance Institute Europe (BPIE). **A Guide to Developing Strategies for Building energy renovation. Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks.** February 2013

EnEffect / Bulgarian Construction Chamber / National Agency for Professional Education and Training. **Roadmap for training on Smart Energy Efficient Building Solutions.** BuildUPSkillsProject. 2013

Passive House Institute / IG Passive House / International Passive House Association. **1st Passive House Architectural Award. The Finalists.** 2013

European Institute for Energy Performance of Buildings / Ecofys Germany / EnEffect. **Construction of nearly zero energy buildings (nZEB) in Bulgaria. Towards definition and roadmap.** 2012

Buildings Performance Institute Europe (BPIE) / Ecofys Germany / Danish Building Research Institute. **Principles for nearly zero energy buildings. Paving the way for effective implementation of policy requirements. Final draft.** November 2011

EnEffect, Center for Energy Efficiency. **Ten books on green architecture.** Sofia. 2010

European Commission, General Directorate Energy / EnEffect. **GREEN VITRUVIUS.** Principles and practices of architectural design. Bulgarian edition, Sofia. 2010

Savov, R. And D. Nazarski. **Energy efficiency. Thermal insulation of buildings.** A series of specialized editions of the Bulgarian Association of Insulation in Construction. Technika. 2006

The curriculum has been adopted on [insert date (day, month, year)]

VTC Proposer¹⁹:

[type person's name]

VTC DEAN²⁰:

[type person's name]

Signature:

.....

Signature:

.....

¹⁹ This should be the name of the leading trainer in the VTC, who has read our model, adapted it to the need of the VTC and asks the VTC management to provide the course

²⁰ Dean, or the head of the school/university/VTC governing body who approves the programme by signing and stamping it