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The Building Knowledge Hubs

Advanced practical training for 21st century construction

Train-to-NZEB

The Building Knowledge Hubs

Contents

Foreword

Figure 1: Dragomir Tzanev, Project Coordinator EnEffect.
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The building sector plays an important role for the execution not only of the 2020 climate and energy package but also for the years ahead, as it still represents about 40% of energy use in the EU with the largest cost effective savings potential. In the view of the debates on the energy and climate goals for 2030 and 2050 and in the light of the Energy Union initiation and the issues with the security of the energy supplies, the EU has adopted an ambitious vision for the energy performance of its buildings as well. This requires a major quality shift throughout the construction sector, which, as already well known, needs to be ready to deliver high energy performing renovations and, in particular, nearly zero energy buildings. This goal necessitates a major effort to increase the number of qualified professionals and building workers, which is directly related to the quality of the educational programs and the inclusion of training on intelligent solutions for energy efficiency and renewable energy in buildings. As long-term impacts, also corresponding to the latest market demands, these changes are expected to contribute to the overall execution of the 2030 and 2050 goals (exemplified by the "Clean Energy for All European" legislative package) in achieving of decarbonized building stock, integration of decentralized energy production based on renewable sources and, as an overarching goal, climate change mitigation: targets which achievement is virtually impossible without the support of innovative tools and instrument for upskilling of the labour force.

Of course, a number of barriers exist, especially in markets driven by low-cost investment decision as in many Eastern European countries. Some of these barriers include the lack of understanding of the nZEB specifics by the professional community, low motivation of the workforce and low educational level of the blue-collar worker;, lack of experience and practice with nearly-zero energy renovations, low level of penetration of RES technologies , and many others. There is a pressing need for upgrading and facilitating the available large-scale qualification and training schemes and also to promote flexible continuing training schemes for architects, engineers, building managers, local authorities and other influencers, emphasizing on the application of ambitious and proven international standards and approaches for execution of quality nZEB projects. The goal to involve all relevant stakeholders and professional target groups requires the establishment of a well-designed networking structure supported by enhanced web-based communication tools. Attracting the end users and the investors in creating a positive market environment relies on the deployment of a targeted information and communication campaign. These activities should be supported by networks of one-stop shop training, information and consultation centres, providing not only integrated building design services and demonstration, but also administrative and financial advice (extremely important in situations, in which

Figure 2: Practice makes perfect.
© EnEffect

building projects rely to a large extent on EU cohesion policy funding). A really complex situation, where a uniform approach might really make a difference.

Figure 3: A Certificate of Attendance is handed to a course participant.
© EnEffect

Here, the Passive House concept and approach comes in handy. As an evidence-led, scientifically robust, international low energy design methodology, it ticks all the boxes. Passive buildings are nearly zero-energy buildings and, over time, make a significant contribution to reducing the EU's dependence on imported fossil fuels and to the achievement of its climate change targets. At the level of individual projects, the air tight thermally sealed insulation envelope ensures high levels of energy efficiency and secures low fuel consumption for both heating and cooling purposes. And it's worth it: a passive building is a more economic one to live and work in. But that's not all: due to the mechanical ventilation systems with heat recovery, the passive buildings provide the perfect health and sanitary living environment. Actually, in our cities, in terms of exposition to harmful emissions, they are one of the safest places to stay in.

And their worth has been proven in practice over the past quarter century. Those construction professionals from design through to delivery who advocate this standard are not simply expressing personal opinions but can point to the system's proven worth over time through careful scientific observation and abundant supporting evidence. Good experience with Passive House buildings was one reason for the European Commission to state the Nearly Zero Energy Building (nZEB) as the goal in the second decade of the 21st century. Heating demand in new passive buildings can be reduced by more than 80% compared to the existing average, and there will be no problem with the additional energy demand of new construction - buildings with such an efficiency can easily be supplied with renewable energy. And this also applies for deep energy retrofits: following the passive house concept, the results can be really stunning and reduce the heating demand by a factor of 10 – and even more. We just have to follow a simple principle: "if you do it, do it right".

With these assumptions, the idea for establishing of a network of well-equipped training centres (Building Knowledge Hubs, BKHs) to provide nZEB and passive house training in Central and Eastern Europe was developed and gained financial support by the Horizon 2020 of the EU in the project Train-to-NZEB (*www.train-to-nzeb.com*). Five new such centres - in Bulgaria, Romania, Czech Republic, Turkey and Ukraine - were established under the guidance of Passive House Institute and and MosArt/Passive House Academy (Ireland), as currently most of them deliver training courses under the internationally recognized certification schemes for Certified Passive House Designer/Consultant and Tradesperson. Additionally, a number of other training programmes are developed in close contact with the national authorities responsible for the vocational training sector, the professional chambers, the industry and other vocational training providers, which diversifies the training offer and channels new trainees to the Passive House training schemes.

Figure 4: Familiarising with new tools.
© EnEffect

The BKHs are equipped with all necessary tools and materials to demonstrate in practice the leading principles of the passive and nZEB concept and approach based on the "energy efficiency first" principle, with all of them having full pressurization testing and infrared imaging equipment, operational mechanical ventilation with heat recovery systems, practice training walls for application of airtightness materials and products, and full-size demonstration models showing the approach to the nZEB concept in different construction types specific for the participating countries. Through the integration of practical training exercises in the generally theoretical training schemes, a large number of industrial partners were attracted to support the development of the training centres and now use the facilities for training not only of construction workers but of sales and marketing personnel, which is another positive feature of the undertaking. Additionally, the training programmes have proven to be a matter of interest (as according to expectations) for building managers and supervisors, who are best positioned to transfer the knowledge at the building sites, especially in countries with depleted human capital and largely underqualified working force in the construction sector.

Figure 5: Airtightness testing lecture.
© EnEffect

Last but not least, being positioned as nZEB knowledge centres, the BKHs have attracted a number of enquiries for direct consultations on actual passive house construction projects and have conducted series of training courses and demonstration sessions for local authorities. Supported by the strong international movement towards energy efficiency and climate change adaptation planning at city level and the national programmes supporting energy efficiency building renovation, the BKHs have proven to be a logical influencer of decision for managing and strategic planning of development of the building stock – hopefully, for the years to come.

Dragomir Tzanev
EnEffect
Project Coordinator Train-to-NZEB

Figure 6: Training for all target groups.
© EnEffect

Introduction:

The Building Knowledge Hubs

1

What Is Train-to-NZEB About

The **“Train-to-NZEB”** project, financed under Grant Agreement No 649810 of Horizon 2020 Programme of the EU, aims to provide world-class training on energy efficiency and RES in buildings, based on new training programmes, business plans and up-to-date training equipment for a set of training and consultation centers around Europe.

Figure 7: Watch – touch – comprehend – express. © EnEffect

Its goal is to improve the knowledge and skills in the construction sector and to provide practical **trainings, demonstrations and comprehensive consulting services** for design and construction of Nearly Zero-Energy Buildings (nZEB) supported by RES, based on the Passive House concept.

The training centers (or Building Knowledge Hubs) form an international network, providing trainings on the curricula developed under the European BUILD UP Skills initiative and by project partners, as well as continuous opportunities for exchange, updating and improving of the existing training programmes. The modern training facilities enable the conduction of practical exercises in addition to the theoretical programmes already available in the focus countries.

Our Goals

The main tasks of the project include design and equipment of 5 fully active Building Knowledge Hubs - in Bulgaria, Romania, Turkey, the Czech Republic and Ukraine; the adaptation of existing and the development of new curricula for training of building professionals; training and certification for a total of 90 trainers, 2,400 construction workers, 480 designers and 720 non-specialists (representatives of public authorities, business managers, NGOs, consumer groups, media, etc.).

All of these, combined with the provision of consulting services based on the "One-stop shop" principle, is expected to increase the interest and capacity for design and construction of nZEBs supported by RES in the focus countries and to stimulate the market demand for such solutions for both new buildings and building renovations.

Figure 8: Hands-on nZEB experience. © EnEffect

What Is The Idea Of The Building Knowledge Hub

It doesn't matter if you are a designer, a construction worker, a public official responsible for the city infrastructure, or you just want to build your new passive house: we offer trainings and advice especially for you. With our up-to date training programmes and materials coming from the world's leaders in sustainable building, you'll learn things for buildings you don't know yet. And with our new training facilities, demonstration tools and numerous partners from the construction industry, you'll see and touch things in buildings you probably haven't seen before.

Figure 9: The right techniques for the job. © EnEffect

Figure 10: Full scale demonstration models. © EnEffect

With this kind of knowledge, right decisions and successful projects would be easily within your reach. And if you need further advice for your own project, we'll be there to help and ask the best.

Figure 11: Hands-on training with latest products. © EnEffect

Training Models Developed In Ireland, United Kingdom And United States

Integral to the development of BKH's for the purpose of training in the Train-to-NZEB project and afterwards is the production of physical construction models. The latter, as the primary basis for practical training, comprise both demonstration and practice / hands-on models. MosArt, which also operates as the Passive House Academy (PHA), was assigned the task of producing drawings as examples of such models. This was achievable based upon their experience of having initiated the world's first Certified Passive House Tradespersons (CPHT) programme, in tandem with the Passive House Institute (PHI), and setting up such courses and supporting training facilities on four continents.

Figure 12: Demo models in CDETB, Finglas, Dublin training centre.
© MosArt

Whilst these examples reflected the particularities of a given construction tradition and culture as well as climate, they nevertheless provided sufficient indication to the project partners of how they, too, might design and produce similar construction models for training in their respective countries. Accordingly, the model examples provide, inter alia, a sense of scale, durability, stability, complexity and an indication of construction content and sequence, not least in respect of the rigours inherent to achieving the Passive House Standard and nZEB levels of building performance regarding energy, comfort and health.

Figure 13: Demo models, Saint Gobain (British Gypsum)
training centre, Erith, London.
© MosArt

Figure 14: Demo model AEA training centre, The Bronx, NYC.
© MosArt

Figure 15: Practical training, CITB, Glasgow. © MosArt

Figure 16: Practice models, Saint Gobain (British Gypsum) training centre, Erith, London. © MosArt

Figure 17: Ceiling mounted MVHR unit with ducts. © MosArt

The most effective means of achieving highly energy efficient buildings cost effectively, such as intended by the EPBD is to start by focusing on the building envelope, ie. the “fabric first” approach. This will result in significantly improved levels of airtightness which, in turn, necessitate the use of mechanical ventilation and heat recovery. With this as a fundamental basis of building systems, Renewable Energy Systems (RES) are added, as called for in the nZEB definition. Thus, in combination with highly efficient energy use in the first place concerning the building fabric, these RES's can make a significant contribution to moderating energy cost and reducing CO_2 emissions.

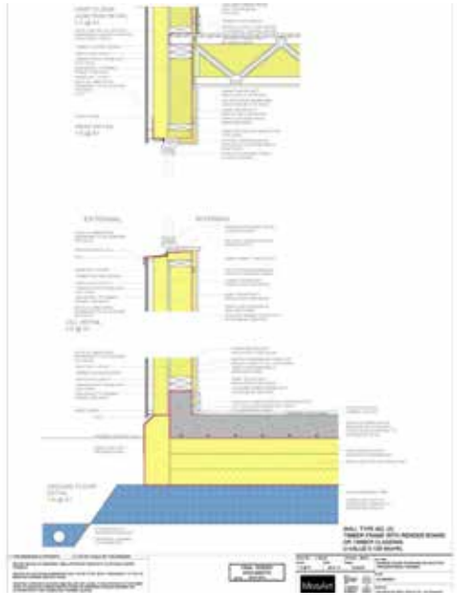


Figure 18: Section drawing for construction as a demo model. © MosArt

Why efficiency first?

The ability for the remaining energy demand to be covered by renewables will be limited if efficiency levels are not prioritized, specifically when greater demand for heating occurs over winter, when less renewable energy is ….

Z-shaped practice models in AEA, The Bronx, NYC.

© MosArt

Figure 19: Rigs supporting solar and PV roof panels. © MosArt

Figure 20: Energy efficient heating systems. © MosArt

Target Groups

Designers

Standing at the heart of the construction value chain, building designers are the key to the energy transformation of the building sector. The new requirements for nearly zero-energy buildings (nZEB) already lead to significant changes in the design practice, as the approach to the energy saving measures is becoming more and more important – also driven by increasing clients' demand. Here, the Building Knowledge Hubs come really handy – they offer short term training programmes for designers, consultants and building managers dedicated to nZEB concept and specifics, developed according to the European best practices and highest standards and delivered by trainers with vast practical experience.

Figure 21: Detail analysis. © EnEffect

An often underestimated issue, the typical classroom pattern of the regular trainings for designers (both architects and engineers) and managers are enhanced by the practical demonstrations made possible through the newly developed facilities, in combination with online training options. Additionally, capacities for organization and conduction of training courses and examinations on the internationally recognized programmes for qualification and certification are developed, as the Certified Passive House Designer/Consultant scheme commands a leading place.

Figure 22: Quality assurance: air tightness testing. © EnEffect

Construction Workers And Specialists

The delivery of quality nZEBs represents a major challenge to the construction industry and requires systematic upskilling of the construction workers around Europe. The Building Knowledge Hubs are the perfect answer to this challenge. The operation of the BKH network with cutting-edge design and facilities, the consultations from partners from some of the most advanced countries in this area, and the high-quality training of trainers, allow the execution of the training courses for construction workers to the best possible standards. The BKHs improve the existing training practice for building professionals through integrating the traditional classroom training environment with the practical, hands-on training experience and interactive distance learning, which in turn leads to better understanding of the actual construction process and improved operational management practices.

Figure 23: Feel the difference.
© EnEffect

Figure 24: Knowledge is (em)power(ing).
© EnEffect

It is expected that this approach will result in intensive cross-disciplinary exchange, which will not only increase the “energy literacy” of the involved professionals but will improve the existing qualifications with respect to the industry standards. Within a flexible schedule and responding to the user demand, the BKHs offer training courses on the programmes developed on the European BUILD UP Skills, qualifications under the respective national standards, and importantly, training and examination under the Certified Passive House Tradesperson scheme.

Non-Specialists And Building End-Users

No nZEB is possible without quality design and construction works, but the energy transformation in the building sector is actually driven by non-specialists – decision-makers and end users, who steer the political process and take investment decisions in favour of energy efficient buildings. Targeting the increasing demand for quality consumer-oriented information about nZEBs, new short training programmes for non-professional groups are developed. They are tailor-made to cover the needs and expectations of public officials (governmental agencies, experts from regional and local administrations, city planners and architects in municipalities), managers of public buildings, policy makers, SMEs, private investors, school and university teachers, NGOs, media representatives, facility managers, end users… practically everyone interested in making their new building project a success.

Figure 25: Competent Introduction to Passive House/nZEB. © EnEffect

A special emphasis will be put on financing and administration issues in the execution of energy efficiency projects and on energy planning for public authorities and SMEs.
Taking into account the experience gained from the demonstration classroom courses, a concise e-learning course is developed addressing the non-specialist audience. This offers an additional and powerful path to distribute the content as it effectively fights off the existing time and spatial constraints. However, seeing is believing – so come and visit us at our Building Knowledge Hubs.

Figure 26: Nothing is ever more convincing than the tangible example seen with own eyes. © EnEffect

After 25 years of continuous operation on the first Passive House was subject to a thorough health check.
Its heating demand is continually even lower than predicted.
All materials are sound and retain their characteristic values, the air tightness is not compromised and as new. Windows and ventilation system with heat recovery still perform well. The prototype is ready for the next 25+ years.

Figure 27: The first Passive House in Darmstadt-Kranichstein after 25 yerars.
© Peter Cook

Why Passive House

The Train-to-nZEB project was granted in order to help ensure the uptake of nearly Zero Energy Buildings (nZEB).
The Directive 2010-31-EU also known as the Energy Performance of Buildings Directive or EPBD calls for buildings that feature

1. **very high energy efficiency / nearly-zero energy demand**
2. **cost-optimal levels of energy efficiency in life-cycle perspective**
3. **very significant contribution from renewable energy sources (RES) from on-site or nearby**

There is no such thing as an "nZEB-standard", however, as each Member State is responsible for its own building codes and will adhere to its own ideas on improved building standards- using its own rationale and comprehension of EPBD definitions and local traditions. Comparisons between buildings in different Member States will therefore remain challenging if not altogether impossible. In a multinational cooperation project this lack of common ground is a serious shortcoming.

The Passive House

Is truly a building standard in that it is clearly defined, with precise criteria and based on sound scientific evidence.
Moreover, the Passive House Standard represents an existing, supra-national, consistent, tried and tested implementation of the nZEB definitions, which ticks all the boxes:

- √ **very high energy efficiency / nearly-zero energy demand**
- √ **cost-optimal levels of energy efficiency from a life cycle perspective**
- √ **very significant contribution from renewable energy sources (RES) from on-site or nearby**

The latter may be obvious for a premium or plus class Passive House with solar panels, but any classic Passive House with a heat pump uses renewable energy from on-site, too. Moreover, heat pumps can use renewable electricity from the region.

The Passive House Standard offers a proven implementation of the nZEB with over 25 years of experience. It can be applied to any climate. Design tools, training and quality assurance procedures are available to help ensure reliable performance - thus avoiding "performance gaps". The standard is public and available for anyone to use free of charge.
The Passive House Standard is therefore a useful reference for the Train-to-NZEB project and for training the workforce with regard to international working opportunities.

The Passive House Principles

1. Good insulation
2. Thermal bridging minimized
3. Air tightness
4. High performance windows
5. Heat recovery ventilation

Can also be applied to the refurbishment of existing buildings – then called EnerPHit.
Significant improvements in the building stock is the major challenge in the next decades.

www.europhit.eu

Implementation:

The Building Knowledge Hubs

2

Training Programmes

Annual training plans were provided by the partners in Bulgaria, Romania, Czech Republic, Turkey and Ukraine. These plans determined the need for specific training courses through training needs analysis, best practice approaches to the design and implementation of the courses and the monitoring and evaluation process.
Each partner investigated the status quo of the construction market in their country with respect to training needs in energy efficiency, low energy training and nearly zero energy buildings (nZEB). Further to this training needs analysis a clear understanding of the needs and skills gaps within the construction industry were identified and specific training courses have been designed and implemented as new training programmes or modified existing programmes developed to suit the market.
It is important to understand the target groups and these have been identified in each country as the following:

Specialists, Designers, Professionals and Consultants
Construction Workers and Craftspeople
Non-Specialists

Training Courses

It is intended that the existing training programmes available in each country will be adapted to incorporate nZEB construction wherever possible otherwise new curricula for nZEB and RES training will be developed for building professionals and construction workers in class, on-line and on-site. Within the Train-to-nZEB project it is proposed that a total of 2,400 construction workers, 480 designers and 720 non-specialists (representatives of public authorities, business managers, NGOs, consumer groups, media) are to be trained and certified in 5 countries.

Trainers

Not only were the BKHs organisations required to schedule and deliver training programmes for the construction industry, but Train the Trainer courses were also required to ensure the competency of the trainers taking part. Train the Trainer courses were held in each country with the intention to certify at least 90 competent trainers. A list of approved Trainers is available on a repository at *http://www.train-to-nzeb.com/list-of-trainers.html.*

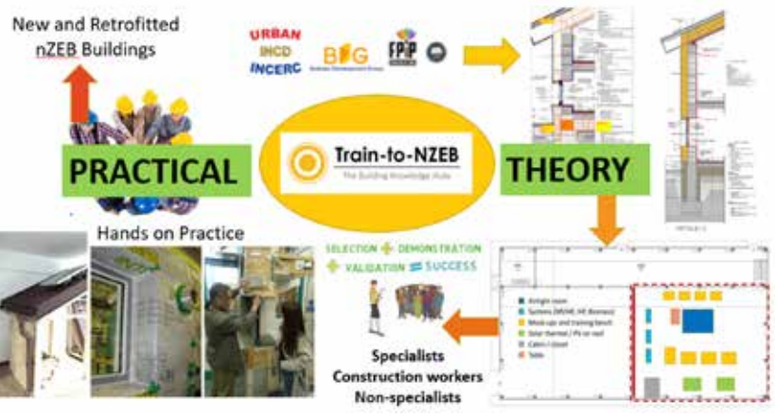


Figure 28: Train the Trainer learning process. © INCD URBAN-INCERC

Train the Trainer Courses

1-2 day courses were held in each country with PHI and PHA presenting the theoretical aspects of the "Passive House Train the Trainer Course" and LIT providing the pedagogical teachings. A visit to the BKH demonstration centre was also provided to discuss and view the training products, demonstration models and materials.

The Train the Trainer course content included the following:

- Summary of Passive House bases and overview of PHPP
- Certification and quality assurance: the certified training schemes by PHI
- Economics/Energy cost comparison between PH and conventional houses
- Insulation, including Lambda and U-values and demo materials
- Thermal (and repeating) thermal bridging
- Increased airtightness and site examples
- Passive House windows and doors, including U-value calculation demo
- Description of mechanical ventilation systems and training, including systems suited to retrofitting
- Train to nZEB – Pedagogical Approaches
- RES in Passive Houses.

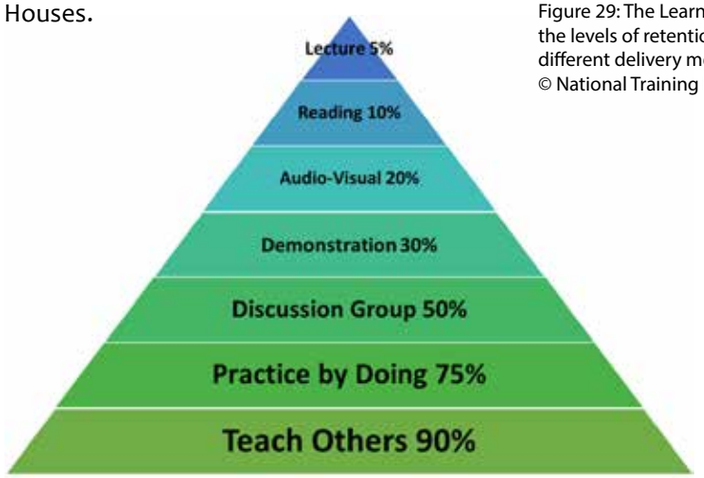


Figure 29: The Learning Pyramid, show the levels of retention of information for different delivery methods.
© National Training Laboratories, Maine

Results of the Feedback Survey - train the trainers course - 20.06.2017
From a total of 108 participants, 55 questionaires were received.

		Strongly Agree	Agree	Neutral	Disagree	Stronlgy disagree
1.	The content was relevant to my learning needs	82	16	2	-	-
2.	The trainer had a good knowledge of the material and general area	98	2	-	-	-
3.	The material was delivered at an appropriate pace	73	26	1	-	-
4.	Class participation was encourared	87	10	3	-	-
5.	Programme materials were useful and relevant	97	3	-	-	-
6.	Training room was suitable for the programme	98	2	-	-	-
7.	I would recommend this training to others	63	37	-	-	-

Figure 30: Feedback questionnaire from Turkish Train the Trainer programme.
© LIT

Monitoring and Evaluation

It is important to ensure that trainers have the knowledge and skillset both technically and pedagogically to deliver nZEB related and technological courses and have the understanding on how to monitor and evaluate such training courses through feedback to develop and update further programmes.

Train-to-nZEB Trainers have been provided with information to complete these tasks.

It is important during the training course to determine how the participants are doing. On the completion of each course or module, it is important to ensure that the participant:

- is able to understand a number of Learning Outcomes, LOs.
- completes a number of skill LOs.
- sequentially work in order with practical training

Checking the progress ...

Understanding – Question the learners during classroom discussions to check their understanding of the material being taught.
Participation – Encourage questions in class
Discussion – Paired/group discussions and asking them for feedback. (but check the time)
Engagement – Walk around during practical work and engage in one-to-one contacts with the learners
Assessment – Assigning and collecting feedback evaluation sheets.

Figure 31: Different groups learn differently. © Passive House Institute

Figure 32 & 33: Certification seals for on-site workers and design experts.
© Passive House Institute

The PHI – Training and Certification Schemes

Passive Houses do not look any different from other buildings. However, on account of their clearly defined energy standard, they exhibit a high level of thermal comfort and extremely low energy consumption. Good planning as well as careful execution of the details is essential in the construction and cost-effective delivery of Passive House buildings and EnerPHit retrofits. This ensures that the high requirements for the building envelope and services can be met.

As a result, designers and specialist planners as well as on-site workers need additional expertise which can be acquired and substantiated with the Certified Passive House Designer/ -Tradesperson training courses respectively.

Moreover, a common language of both professional groups is essential in order to effectively handle the necessary day-to-day communication and any changes of plan without compromising quality.

Certified Passive House Professionals substantiate their knowledge in the field -in the respective level of detail- by passing a third-party assessed examination.

All certificates provided by the PHI are based on published criteria and characteristics or qualifications that have been objectively verified. PHI certificates are acquired on a voluntary basis.

All certified professionals can be searched found in an on-line database.

Knowledge is always bound to individual persons, therefore only physical persons are certified but not businesses or organisations.

Furthermore, knowledge is not static. If not actively used it deteriorates. Passive House technologies advance rapidly and long breaks therefore decrease the applicable knowledge.
For this reason certificates are issued temporary for five years. When expired they need a renewal.

Every BKH is invited to become an accredited Course Provider in those schemes and the BKH's in Bulgaria and Romania as well as the project partner Passive House Academy in Ireland are very active in this field.

Conversely, some organizations who have been accredited as Course Providers long before have signed Memoranda of Understanding with the Train-to-NZEB project in order to benefit from its comprehensive and model-based approach.

Further information, detailed Learning Targets and procedures can be found at:
www.passivehouse-designer.org
www.passivehouse-trades.org

To-date (03/2018)
80+ Course Providers worldwide

have successfully trained
8000+ experts and
3500+ on-site workers

The Building Knowledge Hub in Bulgaria

Airtightness and infrared thermography; mechanical ventilation with heat recovery (MVHR); design and construction skills for delivering quality nearly Zero-Energy Buildings (nZEBs), RES installations in buildings, the Certified Passive House Tradesperson scheme – these are just few of the topics that are covered in the courses in the newly established BKH in Bulgaria. The courses already open for registration are one-click away and easily accessible at *www.busenerpro.com/trainings*, as many of the trainings are still either free of charge or with a very low participation fee.

Figure 34: Air sealing of a pipe penetration. © EnEffect

The opening ceremony of the newly established Building Knowledge Hub (BKH) Bulgaria was held on May 16, 2017 in the University of Architecture, Civil Engineering and Geodesy in Sofia – the host of the Hub. It welcomed more than 80 guests, including representatives of the national government, the construction and educational sectors, and turned into memorable event with the support of several of the most prominent building materials and components suppliers and construction companies.

Figure 35: Opening ceremony at the new BKH in Sofia. © EnEffect

The new BKH facilities incorporate and demonstrate the full range of modern technologies, products and materials necessary for constructing nZEBs.

The new BKH facilities incorporate and demonstrate the full range of modern technologies, products and materials necessary for constructing nZEBs, which are still relatively unknown by the building professionals in Bulgaria. Multiple training programs are offered – from BUILD UP Skills courses, through the internationally recognized Certified Passive House Tradesperson and Designer courses, courses for acquiring professional qualification under the national regulations, and short demonstrational courses for investors and decision-makers. Virtually all topics connected to the nZEB are covered, including insulation and airtightness, window and facade systems, ventilation with heat recovery, contemporary heating and cooling systems, RES, renovation of existing buildings and many more.

The Bulgarian BKH has already hosted more than 20 short training courses and info sessions lead by the most prominent Passive House practitioners in the country, welcoming hundreds of guests, including representatives of the construction industry, producers and distributors of nZEB-compatible products and building components, university and high school students, and local administrations. The attendance of representatives of numerous construction companies and building materials and components suppliers is promising, and with the positive feedback of the training courses and nearly 100% repeat visits, it is expected that these activities will be more and more viable. Furthermore, a number of vocational training centers and education providers also expressed the willingness to collaborate and organize joint training courses, as official agreements are reached with Sofia High School of Electronics “John Atanasov” for training on RES, Sofia High School of Architecture, Construction and Geodesy “Hristo Botev”, and Higher School of Civil Engineering “Lyuben Karavelov” for practical training on nZEB specifics.

Figure 36: Demonstration models are an asset for all target groups.
© EnEffect

However, in the light of the still limited market demand and expectations for short (and free) training sessions, the most promising feature of the BKH is the vast outreach and the positive public image it has built within broad audiences. Without any doubt, the Open Doors Day organized in the framework of the International Passive House Open Days was a definite highlight, gathering more than 80 in the BKH0 interested guests from all professions and ages – from university professors to organized high-school classes, eager to see the latest trends in sustainable construction. Additionally, a number of different events were hosted, from product demonstration, events for the local authorities, EU project meetings to TV interviews and focus groups on energy efficiency topics.

Currently the expectations are for short – and free – trainings

Figure 37: Involving the construction industy. © EnEffect

Figure 38: Mechanical Ventilation w/ Heat Recovery on display and in operating condition for training. © EnEffect

The intensive publicity has already lead to the first enquiries for nZEB project consultations, and the active work with the academia resulted in specialized events and articles analyzing the experience gathered, and in joint initiatives actively involving university students. The work continues through a new project – Fit-to-NZEB (*www.fit-to-nzeb.com*), which will further develop the training offer with quality new programmes on deep energy building retrofit – a topic particularly relevant for Bulgaria. Find out more at *www.busenerpro.com/trainings* and *www.facebook.com/eneffect.*

Figure 39: Training models awaiting use.
© EnEffect

The Building Knowledge Hub in Czech Republic

Expanding knowledge in nearly zero-energy buildings (nZEB) is a growing business area, which is expected to continue in its current trend. nZEB are very important for the Czech Republic in relation to the fulfilment of European Directive 2010/31/EU and the gradual increase in the share of nZEB in the country through newly constructed and reconstructed buildings. The Czech Republic has opted for gradual introduction of nZEB according to the ownership of buildings (owned by the public administration and all remaining) and according to the size of the energy consuming areas.

It is necessary to point out that trends are not constant and change frequently. If the facilities are adaptable and flexible, training and consulting activities should grow continuously. Keeping an enterprise at the top of the market with occurring changes in technologies and products requires regular allocation of time and a part of the budget for the company's future plans.

The situation of the current market with education and training for professions in construction was assessed by a detailed analysis of a sample comprising 196 educational and training

courses and seminars provided by 13 different course providers, i.e. in particular by educational and training centres and agencies operating in construction. The following details were collected through the research of individual courses: company name, course duration in days, number of training hours, course price excl. VAT, target group or course title, course capacity and number of tutors. Most of the collected data was readily available for all of the courses, with the exception of the course capacity, which was not included in subsequent calculations due to insufficient data. In addition, the data obtained for the number of tutors was incomplete but the assumption that at least one tutor participates in each course was applied. Generally, in comparison with other areas of vocational training, there are not many companies dealing with education in the construction industry. Only the Passive House Centre deals solely with the issues relating to nZEB. All other educational centres operating in the construction industry have a wider range of topics.

Figure 40 : The full range of demonstration models at the BKH in Czech Republic. © SEVEN

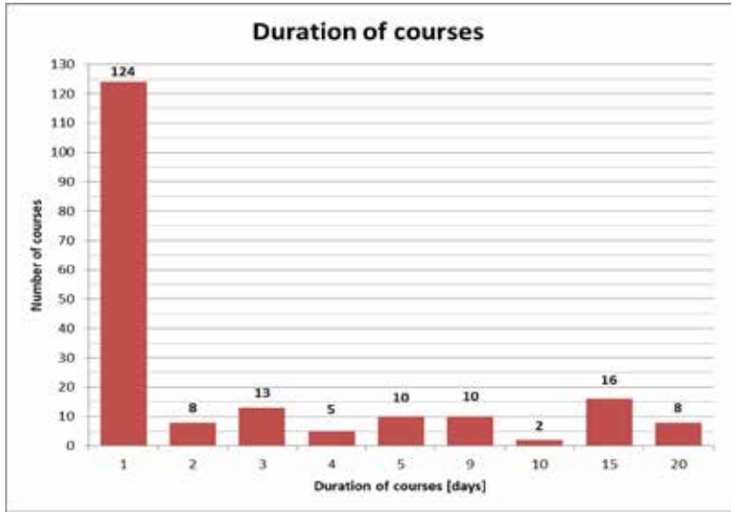


Figure 41: Number and duration of courses offered in the Czech Republic. © SEVEN

The analysis of all 196 courses carried out according to the available data showed that the average duration of a course is almost 4 days, which amounts to the average number of 30 training hours. However, a vast majority of courses (124 of 196) are **one-day courses.** One day of training comprises **7 training hours** on average. The average course price is **EUR 225**, including VAT. The value added tax (VAT) in the Czech Republic for 2016 is 21%. The average course price is **EUR 65** per day, including VAT, and the average course price per hour of training is **EUR 10**, including VAT. The average number of tutors per course is **2 to 3**, which means **2 tutors per one day of course.** While data on the capacity of courses would provide interesting and valuable information, this was not assessed through calculation due to a lack of information.

Shares of individual locations where courses and training are provided were also ascertained.

The highest percentage of courses is provided in the capital city of Prague (48%). Other large towns follow - Brno (26%) and Ostrava (17%). Two companies provide their training nationwide, in particular in regional towns.

Conference *Way to nearly Zero Energy Buildings* in Prague

The conference Way to nearly Zero Energy Buildings on March 2nd, 2017 took place in Prague. The conference was held on the occasion of opening of the national Building Knowledge Hub within Train-to-NZEB project and jointly with exhibition of demonstrating models and technical equipment of BKH has gathered 85 participants. Train-to-NZEB is focused on education of construction workers, designers and non-specialists (representatives of public authorities, business managers, NGOs, consumer groups, media, etc.). The speakers of the conference were experts from the Czech Republic, Germany, Romania and Slovakia including the coordinator of the ingREeS project. The presentations of speakers you can find on the following link: *http://www.svn.cz/en/news-and-media/seminars-and-conferences-source/way-to-nearly-zero-energy-buildings*.

The analysis of 196 courses showed that the average duration of a course is almost 4 days, which amounts to the average number of 30 training hours.

Assessing demo models and explaining their materials, components and build-ups to peers is and important element in the BKH concept.

Figure 42: Full scale model of a massive construction in full use. © SEVEN

Equipment of BKH

- 4 demonstration models of nZEB building construction (2 wooden buildings and 2 masonry construction) made by UCEEB
- Ventilation unit with heat recovery by ATREA
- Measuring instrument for Blower Door test (Minneapolis BlowerDoor MiniFan)
- 2 infrared cameras (FLIR ONE and FLIR E6)
- CO2 concentration meter (Wöler CLD 210)
- 8 information panels with description of equipment
- 2 project roll-ups

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

The competitive advantage of CZ BKH over other training centres is our cooperation with a centre with the longest tradition, that being The Architecture and Building Foundation, and the use of the Czech Construction Academy. Another advantage is having the main office in the centre of the Czech capital with good transport accessibility by public transport and the proximity to the main train station so course participants can commute over longer distances. Being under the auspices of an international project also represents a certain competitive advantage.

Training programmes and activities

For the moment the CZ BKH offers 3 specific training programmes (nZEB – designing of buildings and building technology , Nearly zero energy buildings – implementation and construction, and Nearly zero energy buildings – sustainable development of construction, maintenance and use. By the end of 2017 18 training courses have been delivered, with around 300 trained participants. The three programmes were specifically developed for the three main target groups: specialists, tradespeople, non-specialists. The courses consists of three parts - theoretical lessons, practical exercises and self-study with developed studying materials. The course is closed with a test and, once successfully completed, the participants are awarded a certificate. All courses were accredited by the Czech Chamber of Chartered Engineers and Technicians as a part of lifelong learning education system, proposed by the Chamber to all engineers and technicians authorized in the Czech Republic. The trainings will proceed in 2018.

Figure 43: Full scale model of a massive construction. © SEVEN

Figure 44: Demonstrator for Mechanical Ventilation w/ heat recovery.
© SEVEN

The training facilities are adaptable and will be constantly updated according to the market trends. Training programmes can be modified according to needs of trainees, expressed in the feed-back questionnaire. Two additional shorter and more specified programmes are under development at the moment.
The successful passing of the theoretical and practical parts and the final test will be followed by the award of a certificate to acknowledge that the individual acquired new skills to design or build nZEBs. Trainees holding the certificate will enjoy a better position on the labour market. Investors may demand a contract to be executed by a construction company that employs certified staff, and construction companies with certified personnel may enjoy a competitive advantage in public procurement.

According to the experience gathered during the first months of CZ BKH operation, the expected real attendance of each course is about 10 – 15 participants. The number of participants can be increased, if the course is delivered for free to the participants. In winter, some increase of interest in the courses attendance is expected due to smaller amount of construction works realized in this season.

The strategy to attract participants to the trainings is based on the development of regular training courses for different target groups. Main attraction is the technical equipment of the BKH used in the practical part of the trainings (blower-door testing, thermography, mechanical ventilation unit with heat recovery, sensors, demonstration models of building structures).

It is expected that the demand for the products and services on offer will grow depending on the legislation. The BKH has sufficient capacity with very well equipped premises intended for the project's needs and can react very flexibly to an increased demand for training courses.

The Building Knowledge Hub in Romania

BKH RO is the first nZEB center in the country providing training and consultancy services at the highest standards and using the latest technology in the field, for on-site professionals, high level specialists and decision makers.

BKH RO is a network organization based on the existing Centre for Energy Performance of Buildings within **NIRD URBAN-INCERC** having the set-up support from project partners **Business Development Group (BDG)** and **Fundatia pentru Formare Profesionala si Invatamant Preuniversitar-Viitor (FPIP)** as well as other stakeholders identified and attracted in the course of the project , including the **Pro-nZEB** Cluster.

BKH RO positions itself as an unique place for the interested target groups to find themselves comfortable to communicate and exchange knowledge on nZEB approach, context and framework, stimulating the hub users to reach for first hand professional information and facilitating the dialogue between different market players from influencers and project initiators (research and development, central and local administration etc.) to implementers (designers, suppliers of materials, project developers, contractors) and the final consumer.

Figure 45: First steps into BKH RO in Bucharest. © BDG

In terms of infrastructure, BKH RO is located on the existing facilities of NIRD URBAN-INCERC in Bucharest and FPIP in Brasov.

In Bucharest, NIRD URBAN-INCERC has a dedicated building with training and conference facilities. With regards to the practical trainings, big steps were taken in the past years for the improvement of the existing testing hall (rain proofing, windows insulation, radiant heating etc.), design and realisation of airtight room + MVHR, materials, equipment (with the support of companies such as: Saint Gobain, Aereco, Fabryo, Mark-Holz, Suki, Aluprof, Teraplast, CPpV, Zero Energy Assoc., Knauf Insulation, Atrea, HausEnergy etc.), design and realization of mock-ups, samples and small systems. The much needed infrastructure is still under development.

There are plans to modernize the existing buildings to incorporate a Research lab for development and assessment of nZEB technological solutions, including the existing testing hall.

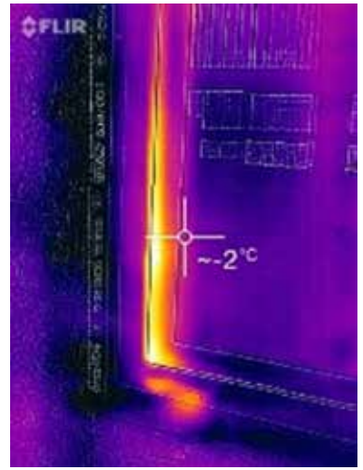


Figure 46:Demonstration Models, Air Tightness testing and thermal imaging at BKH RO in Bucharest. © INCERC

The BKH in Brasov is located in a separate building from the FPIP headquarters. The training unit has been reorganized, mockups have been built and RES equipment have been installed, being functional for pedagogical and consultancy purpose.

The BKH in Brasov has technical, material and intellectual support from different stakeholders, with whom collaboration is planned for the long term. The main stakeholders include Bilka roof and rain system, Saint Gobain, Knauf Insulation, Zecaph design engineering.

There are plans for continuous development of this training facility with materials and equipment serving a wide range of training courses.

Figure 47: BKH RO Bucharest.
© INCD URBAN-INCERC

The training facility in Brasov satisfies the training needs for: PV panels installer, building envelope in nZEB (thermal insulation systems), solar thermal systems, including the non-specialists courses and is preparing the infrastructure for the airtightness in nZEB and building systems (HVAC) in nZEB and other training courses.

Figure 48 & 49 :BKH RO Brasov.
© FPIP

Training courses

The „Certified Passive House Tradesperson“ and „Installers of PV Systems“ were the first courses organised within BKH RO, in Bucharest and Brasov. The first program was implemented by NIRD URBAN-INCERC as PHI official training provider, while the second one was organised by FPIP based on the programme developed within the Intelligent Energy Europe PVTRIN project. BDG has an important role in attracting the target group, creating partnerships, promoting and organizing the training courses within the project. The organization of these courses will continue while new programs focused on nZEB knowledge and skills will be developed.

Another success was the „Legal Framework and Concepts for nZEB” training workshop for decision makers, as a result of the intensive efforts made by the Romanian Train-to-NZEB team for promoting the concept and its importance to this target group.

© BDG

Figure 50: Training courses organised within BKH RO.
© INCD URBAN-INCERC & FPIP

A partnership with the Romanian Chamber of Architects in Bucharest was developed for organizing the “Certified Passive House Designer” training course.

Also other partnerships are initiated for delivering the BKH RO offer and keeping the close contact with the market.

The Consultancy & Research Department

The BKH RO also includes a one-stop shop department (OSS) for technical, administrative and financial consultations. This department is developed along with creating the demand and the development of the nZEB market.

The BKH RO is open for cooperation with suppliers of materials and solutions interested in integration and promotion of innovative concepts on the local market. The NIRD URBAN-INCERC research activities will be enhanced with dedicated research themes developed in cooperation with relevant private and public market players with the purpose of promotion and maintenance of the nZEB principles and quality standards in building retrofitting projects on the Romanian market.

Figure 51: Exhibition dedicated to Technology and Innovative Solutions for nZEB organized within BKH RO. © BDG

Partnerships

The development of BKH RO is strongly based on partnerships with institutions and organizations with a focus on the nZEB sector such as: suppliers of building materials and solutions with EE/nZEB expertise/concerns, organizations providing trainings for relevant occupations in the field of EE in buildings, green buildings and nZEB buildings, partners active in EU projects connected with green, passive house, nZEB concepts, local associations of building owners etc.

During the inception period of the Romanian hub development a program of meetings at local, regional and national level was carried out involving a large number of stakeholders from complementary sectors. The meetings were designed as platforms for knowledge sharing not only as regards the market level and major bottlenecks but also to network and explore the willingness to get involved in the BKH RO activities.

The department for Promotion and Market Development within BKH RO is focusing on creating and maintaining a diverse network of local and international partners with the purpose of knowledge sharing in order to facilitate not only promotion of the BKH RO service offer but also the constant self – renewal and adaptation of local practices to a dynamic market, with the final purpose to increase their impact in the society.

CLUSTER pRO nZEB

Partnerships with other organizations and institutions in relation with energy efficiency measures implementation as: public authorities, regional development agencies, architecture universities, banks and financial supporters are taken into account.

Figure 52: BKH RO Roll-up.
© INCD URBAN-INCERC

Dissemination & Promotion

Due to the economic situation in Romania, at the moment the nZEB solutions cannot be considered affordable and the use of renewable energy technologies in buildings is not yet a common practice. There is a need of changing the attitude of the building owners in order to ask for quality instead of lower price and to be more involved in the entire construction or thermal rehabilitation process. It is expected that the nZEBs will be a rarity up to 2020, driven by individual projects of interested private investors or a limited number of municipal projects.

BKH RO is conducting an intensive marketing campaign to support the development of a healthy nZEB market and for changing the attitude at both system and individual level. One should be aware that the design, execution and operation of a building at nZEB level cannot be achieved by applying the "working anyway" principle. Stakeholders should understand that, in order to be able to hope for the actual implementation of the nZEB in Romania, they must firstly change themselves by understanding the physical and economic principles underlying the nZEB concept, by raising the level of competencies, by pursuing adequate and complete approach of the details and by assuming a responsible attitude oriented towards the comfort and health of building' occupants.

One of the main barriers for which the nZEB concept does not seem to be easily applicable yet in Romania consist in the skills gaps experienced by the building sector, the current qualification courses and training schemes being generally not satisfactory and underdeveloped to face the challenge of effective nZEB implementation.

The best way to promote the training courses is through the happy participants in high quality training process. The active marketing and communication campaigns are supporting the growth of the demand for nZEB training courses in Romania. Positive results will be seen in the near future and the demand will rise also with the approaching of the obligatory dates for legal introduction of the nZEB standard.

Figure 53: High Quality courses in BKH RO.
© INCD URBAN-INCERC

The Building Knowledge Hub in Turkey

The Department of Civil Engineering at Ege University (Turkey) has completed establishment of Train-to-NZEB training centre, using the existing facilities but also delivering the necessary demonstration models and training equipment. In its business plan, it sets as its goal to design and develop trainings for most crafts and professions related to nZEBs (building shell, building services and RES installation in buildings) and to support the building sector professionals (engineers, architects, municipality employees and decision makers) on delivering quality nZEB projects.

Figure 54: Demo models in BKH-Turkey.
© EGE

Additionally, the team sets itself the ambitious task to provide continuous technical, administrative consultations for the different stakeholders' groups through case-specific problems on whole building nZEB design, new products and solutions, utilization of the energy saving potential, optimization of the overall energy performance, available financing sources, energy planning for public authorities, etc., according to the national specifics and the capacity. Thus, engineers, architects, municipality employees and decision makers as well as their trainers in Turkey could be brought together through a unique portal, having significant impact on the construction industry in a large and fast-developing country.

Figure 55: Practical trainings in BKH-TR.
© EGE

Local climatic conditions can affect energy performance, indoor environment quality, types of renewable energy sources used in buildings. While cooling is more important for coastal regions, heating demand dominates the building energy needs in inner regions of Turkey. Therefore, meeting the cooling demand for buildings is a particularly important issue in Turkey. The concepts of nZEB in Turkey can be a solution for providing a high level of thermal comfort with minimum energy consumption in summer.

Integrating nZEB design strategies and technologies performing effectively in Mediterranean climate is a necessity. Passive cooling such as natural ventilation and shading can be the most effective design strategy in a region where cooling load is higher than heating load. Air movement is likely to enhance thermal comfort conditions. Building envelope can affect cooling loads

Figure 56: Demo models in BKH -TR. © EGE
Figure 57: Heat recovery system. © EGE

in buildings and determine the amount of solar heat gain.
In hot climates, it is necessary to block sensible and latent heat gains in every possible way to achieve indoor thermal comfort conditions while minimizing energy consumption. Optimizing thermal comfort parameters for a nZEB project is a significant task since adequate indoor thermal conditions in summer should be obtained while guaranteeing the minimum energy consumption in winter. In addition to this, integration of renewable energy resources in nZEB are key factors in achieving a high level of energy efficiency.

Figure 58: Graduates of BKH Certified Professionals in BKH-TR. © EGE

Training courses were provided by BKH-TR for specialists involved in construction sector. Individual training modules for three particular groups, namely, designers, workers, non-specialists were prepared. It was aimed to equip all three groups with both theoretical and practical knowledge, during trainings, academicians and experts from different branches of construction sector which also provided supported in establishment of BKH-TR shared their theoretical and practical experiences:

Figure 59: Practical trainings in BKH BKH-TR. © EGE

- ALARKO-CARRIER
- BLOKSAN
- BRAAS
- DAIKIN
- EBSO
- ENEKO
- FRAENKISCHE
- GULER MUHENDISLIK
- ISIKLAR YAPI
- IZOCAM
- KNAUF
- KUDRET TUĞLA
- MERAM KİREMİT
- REHAU
- SOLIMPEKS
- TUKSAD
- VARDARLI
- WEBER

Figure 60: Demonstration of Blower-Door Test Units. © EGE

Equipments and models in BKH-TR :

- Two full-scale wall-roof construction detail
- Blower-door equipment
- Thermal camera
- Heat Recovery System
- Heat pump
- Photovoltaic Panels with Inverter System
- Different types of window glazings
- Various floor heating systems
- Solar heat water system
- Meteorological Station
- Probes for measuring indoor thermal comfort conditions (U-value tool, Luxmeter, etc.)
- Airtightness model for practical applications
- 6 wall models with various brick types

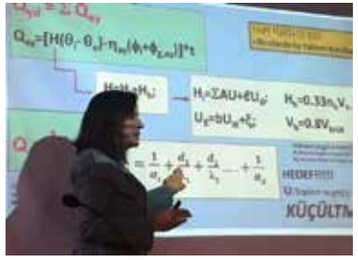


Figure 61: Trainings for designers.
© EGE

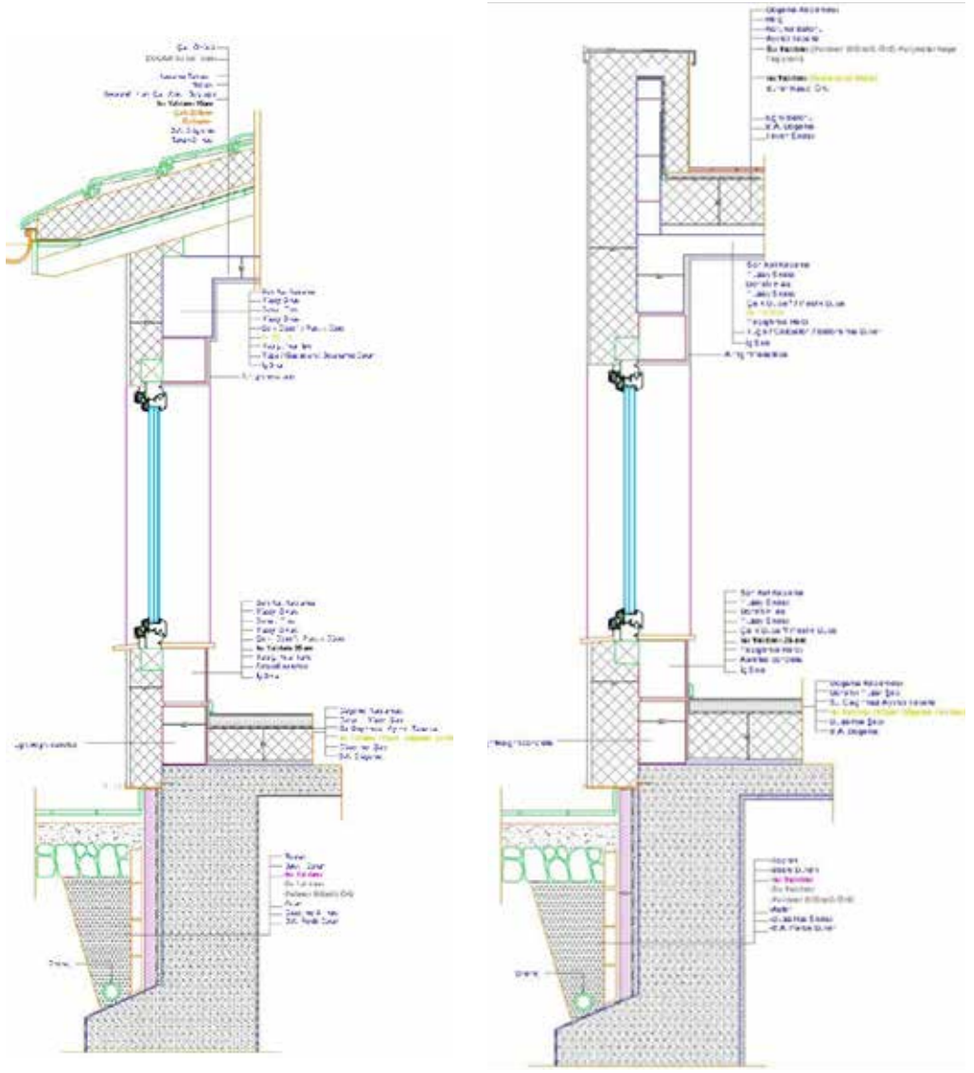


Figure 62 & 63: Demo model drawing.
© EGE

The Building Knowledge Hub in Ukraine

Scientific and Educational Hub for Architectural Designing and Research of Nearly Zero Energy Buildings.

In Ukraine, the Train-to-NZEB Project is implemented by All-Ukrainian Charitable Organization Municipal Development Institute (MDI), with support from the local Project partner Kyiv National University of Construction and Architecture (KNUCA) on the basis of which the Ukrainian BKH was established. The Ukrainian NZEB Centre “Scientific and Educational Hub for Architectural Designing and Research of Nearly Zero-Energy Buildings” is a special scientific division of KNUCA. The Centre is integrated into the University's curriculum.

Figure 64: Training facilities. © MDI

The Ukrainian Hub offers professional training courses for target audiences on a regular basis and implements scientific and public education and outreach events for promoting and developing the concepts of nearly zero-energy buildings, disseminating professional knowledge on energy efficiency in architecture and construction, raising awareness of population of energy saving and environment protection, promoting energy efficient technologies and concepts and events aiming at reducing resource consumption in the building sector and in the municipal economy .

The training courses are mainly organized for:

(A) Building industry workers (masters, foremen, technical supervision specialists).
(B) Highly qualified and leading specialists – designers, architects, engineers, building works coordinators, design consultants).
(C) Non-professional decision-makers (public officers, representatives of government organizations and municipalities, mass media, homeowners associations).

There are five divisions in the Ukrainian BKH:

- Training and re-training and scientific work
- Information dissemination
- Marketing, organizational and technical work and planning
- Architectural designing
- Scientific and technical research and computational computer modeling

Such Centre's organization is a basis for the Centre's sustainability in the future.

The Centre occupies four premises, including a demonstration area with samples of equipment and energy efficient materials.

Figure 65: The first training session.
© MDI

The premises are:

1) two lecture rooms (capacity: 25-30 persons), one of which combined with the demonstration area with samples of energy efficient building materials, constructions, and equipment, as well as a special toolkit for energy audit of architectural objects;
2) computer room (capacity: 10-15 seats) for practical tasks on computer modeling and solving special problems. There is also a research and reference library in the computer room;
3) a conference room for fulfillment of practical tasks and holding special-subject debates. The conference room is also used as the exposition area for information stands and temporary constructions exposed during public outreach and education events.

All demonstration models available at the Centre can be divided into three main types:

1) Samples of modern energy efficient construction materials (for walls and roofing; insulation materials; etc.) and products (elements of façade systems, anchors and fixation for insulation materials) and structures (including non-opaque structures, as well as plastic, PVC and metal façade system structures).
2) complex demonstration models showing combined use of energy efficient materials, products, structures, engineering system elements and equipment.
3) Samples of equipment of engineering systems of nearly zero-energy buildings, including systems for utilization of heat energy and alternative energy sources (recovery systems, solar panels, heat pumps) with automated microclimate control systems.

Through the demonstration models main principles regarding design and erection of passive buildings and nearly zero-energy buildings are demonstrated.
The Centre's equipment and demonstration models were provided by manufacturers/vendors of EE materials and equipment, makers of energy efficient technologies and special software applications, and construction firms, design companies and developers of design and cost estimate documentation – Project partners. Project partners participate in the trainings organized at the Centre on a regular basis. They delegate trainers for conducting specialized workshops at the Centre or offer their training- and production facilities for trainings.

Among the attendees of the training courses at the Ukrainian nZEB Centre are students and lecturers of higher educational institutions having training programs for designers and building specialists.

Figure 66: Computer applications form part of the training. © MDI

The Ukrainian BKH organizes tours and workshops for journalists who are interested in energy efficiency and energy saving in the building sector and in the housing and communal services sector.

International conferences:
Ukrainian nZEB Hub provides a platform for exchange of concepts, knowledge and views on energy efficiency in construction and architecture during annual scientific practical conferences.

Students, young scientists and persons with interest in energy efficient technologies are offered an opportunity to attend annual scientific practical conferences. So far, the Centre organized the following conferences:

- Integrated Energy Efficient Technologies in Architecture and Construction ENERGY INTEGRATION
- BUD MASTER CLASS.

The conferences are hosted by KNUCA and are organized with support from the Ministry of Education and Science of Ukraine. The conferences focus on the following subject issues:

- Energy efficient architecture and town planning, modern energy efficient design solutions and materials.
- Mathematical and computer modeling in examination of objects, processes and energy saving systems.
- Development of laws and regulations in the domain of energy efficiency.
- Energy management and resource saving.
- Energy efficient systems and technologies within energy generation, transportation and consumption.
- Computer technologies for design and computation of heat and gas supply systems.
- Technologies of non-conventional and renewable energy sources in energy saving architecture and in the building sector.

Trainings and consultancy

Training programs were developed by MDI in partnership with KNUCA on the basis of training needs assessment for target audiences. The assessment of the training needs covered the following areas:

1) **architectural structures and space and planning solutions for buildings and facilities**
2) **physics of civil engineering**
3) **heating engineering**
4) **engineering systems**
5) **alternative energy sources.**

At the Centre, training programs are developed / adapted to focus on the specific needs of target audiences.

The training program for building industry workers consists of 10 subject blocks and 40 hours of trainings with trainers (16 hours of lectures and 24 hours of practical tasks). The main emphasis in the training materials is laid on the practical aspects of erection of nearly zero-energy buildings. Much attention is also paid to normative requirements to the heat insulating jacket of the building, modern energy efficient materials and design solutions, selection of sources of heating supply, efficiency of ventilation systems in the premises in the buildings.

The training program for highly qualified building industry specialists consists of 10 subject blocks and 40 hours of trainings with trainers (25 hours of lectures and 15 hours of practical tasks).

The main emphasis in the training materials is made on energy efficient design solutions in construction and architecture. Most training materials discuss the methodological aspects of design of energy efficient buildings, design of energy efficient structures for which special software applications are used, use of energy saving ventilation, heating and heating supply systems, and use of alternative energy sources.

The training program for non-specialist decision makers consists of 10 subject blocks and 20 hours of trainings with the trainers (16 hours of lectures and 4 hours of practical tasks). Training materials are mainly aiming at familiarizing the trainees with technical economic and legal aspects of the implementation of energy efficient measures and use of technologies and materials in the building industry, including but not limited to normative requirements to energy efficiency, installation of energy efficient heating, heating supply, water supply, electricity supply, and ventilation systems, certification and energy audit, as well as increasing energy efficiency of the housing stock.

In the framework of the Train-to-NZEB Project in Ukraine, the Ukrainian Hub organizes workshops and consultancy meetings with leading specialists and engineers working for producers/vendors of EE materials and equipment. The Centre also offers consultancy assistance on architectural, design and engineering solutions. The Centre's visitors may visit laboratories and training centers of EE equipment and materials producers/vendors.

Results and future plans

130 specialists in design and erection of nearly zero-energy buildings trained at the Ukrainian NZEB Centre. Training focus will be expanded to energy audit and energy management.

The Centre was established in 2016. Since that time, 130 trainees representing two target audiences were trained at the Centre as:

1) design engineer of nearly zero-energy buildings – 45 trainees
2) specialists in erection of nearly zero-energy buildings – 85 trainees.

MDI plans to expand the existing training programs with the additional distance learning part thus expanding knowledge to be received during the training course. MDI also plans to develop the additional training courses on “Energy Audit” and “Energy Management”. Such subject issues are very well-liked in Ukraine and recently gained more importance with adoption of the Law on Energy Efficiency in Buildings. According to the Law, certification for energy auditors and assessment of the energy efficiency class of residential and public buildings are mandatory.
MDI also plans to produce a scientific technical magazine on energy efficiency and energy saving in the housing and communal services sector. The magazine will be made for scientists and academia of higher educational institutions, scientific research institutes, design engineers and leading specialists of utility companies which generate energy and supply electric energy, water and heating.

Figure 67: Grand Opening of the Ukranian BKH. © MDI

E-learning For Non-Specialists

Taking into account the experience gained from various classroom courses for different target groups and the positive feedback from the on-line train-the-trainers course developed in the scope of the Build-Up Skills enerpro initiative in Bulgaria a concise e-learning course was developed addressing the non-specialist audience.

In order to take into account different perspectives it is subdivided into three categories, for end users, investors and politicians respectively.
It offers an additional and powerful path to distribute the content as it is free and accessible without time and spatial constraints.

Figure 68: E-learning for non-specialists developed in Train-to-nZEB.
© Passive House Institute

It is intended to enable even executives with tight diaries to use occasional spare time on their Passive House/nZEB information. The course was developed in English language to make it useful for an international audience and is available for translation to further languages.

The e-learning course for non-specialists can also be used to advantage as a primer for other target groups, e.g. in preparation of classroom training. This can offer the very beneficial effect of establishing a common language outside of precious classroom time.

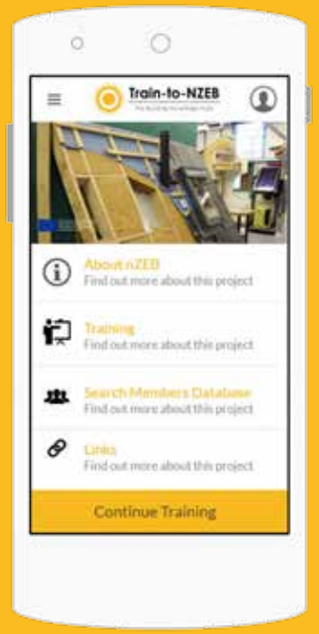
More in-depth training content is also available on the PHI's on-line training platform and Course Providers are invited to use and translate it as necessary.

In the Passive House Fundamentals course participants will spend approximately two days on getting a clear overview of the Passive House standard, certification requirements and the various elements to consider when designing and constructing Passive House buildings. By taking this course they can start to prepare for the Certified Passive House Designer exam or better follow along a classroom training. The course is available in several languages. More topics will be covered in the near future.

Figure 69: Training video with low-threshold content for non-specialists.
© Passive House Institute

Why e-learning?
On-line learning provides easy and interactive access anytime anywhere. It can be used even on mobile devices during short periods of time, e.g. commuting.
For non-specialists with decision making capacity a concise overview of the central issues is presented.
Other target groups will benefit from the accessibility for a general audience and the multitude of references to more in-depth information.
www.elearning.passivehouse.com

Mobile Training App

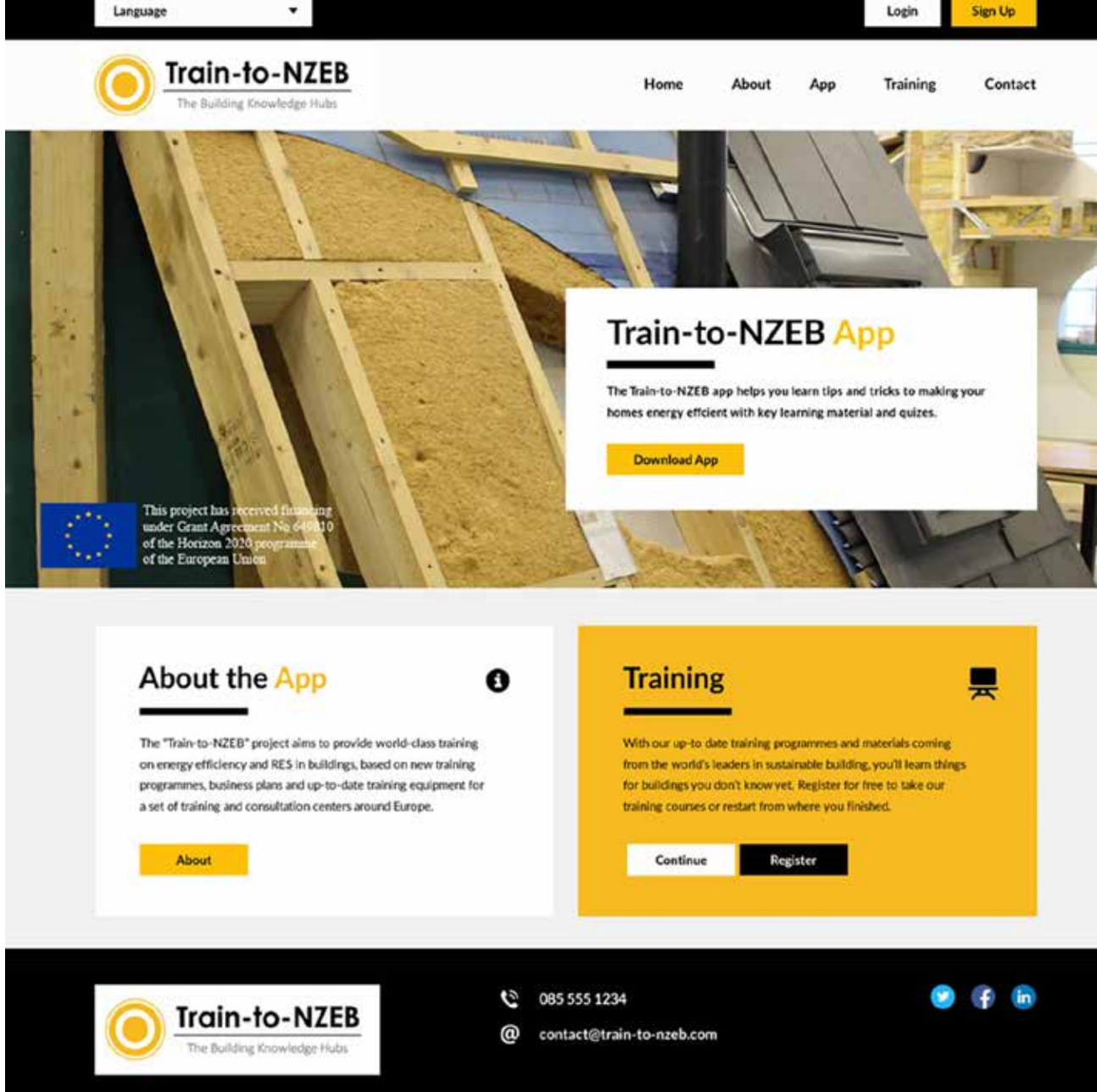


As part of the Train-to-nZEB Project LIT and PHA developed a flexible and adaptable Mobile App for Androids which is linked to the website (android and windows only). A number of training modules are available to complete and important nZEB information can be downloaded for use on site in the construction sector.

This App has been developed in 6 languages: English, Bulgarian, Romanian, Czech, Turkish and Ukranian. So choose your language and try out the training modules…

Content:

- A short description of nZEB and the Train-to-nZEB project
- Training modules – short assessments using MCQ.
- nZEB and PH information – downloads available
- Database – Search programmes
- Links – to other training programmes and info on project



Networking

The Building Knowledge Hubs

3

Networking Among Building Knowledge Hubs

Our Network

With the advancement of the negotiations on the new versions of the Energy Performance of Buildings and the Energy Efficiency Directives, the Building Knowledge Hubs are delivering a strong message: The European energy transition will happen only if we put significant effort in qualification of building professionals along the whole construction sector value chain. We need to raise the quality and responsibility within the sector, to bring the understanding of the leading Passive House/nZEB principle to the building sites, and to set the delivery of modern, comfortable and healthy energy efficient buildings that comply with the standards of the future decades as our primary goal.

The BKH network is set precisely around this target: the training centers in Bulgaria, Romania, Turkey, the Czech Republic, and Ukraine offer a wide variety of training courses in a holistic framework which is a guarantee that the users of our training concept will not only raise their knowledge and skills but will also change their mindset and understanding of the integrative concepts that will allow nZEB to move from the realm of desirables and become a reality.

With experience building on, we already have a lot to demonstrate, but probably the most valuable feature to offer is partnerships – partnerships between researchers, investors, designers, construction managers and contractors, as well as central and local authorities' representatives and the local civil actors. Our partnership network is growing and with its support, we are confident of being able to make energy efficiency policies work. And mind you, this is not always an easy task, but if you are in – come and join us at *www.facebook.com/train2nzeb*, *www.twitter.com/Train2nZEB*, at any of our Hubs and partners - or just write an email to the project coordinator at *dtzanev@eneffect.bg.* What is there for you: with signing of a formal agreement, you'll learn what we've done and how we've done, you'll get access to our training programmes, and you'll join a solid network of dedicated professionals who are willing to continue the efforts in the area of vocational education and training in the construction sector. What we need from you: the same dedication and willingness to cooperate. Sounds like a good deal, doesn't it?

And it's a deal for the years to come: Train-to-NZEB partners will continue to cooperate in delivering world class training and education on ambitious energy efficiency standards that are steadily moving in the direction of plus-energy buildings. With the BKH brand constantly evolving and active interactions within supporting networks as the International Passive House Association, we are confident that there is a wealth of partnership and opportunities still unexplored – in Europe and beyond… way beyond. So come and join us in the long journey ahead!

Regional Networking Around The Building Knowledge Hubs

With the support of national networks, regional networks flourish when they are formalised into a university initiative or alumni group with a structured network and a focussed goal.

Informal networks of business partnerships, friendship circles and acquaintances are regularly set up when BKH'S run training events and courses. However, as more courses take place there is a risk that these informal networks will either be lost or become less significant as time progresses.

One way BKHs can turn these informal networks into more permanent networks is by setting up an alumni network for course participants. As courses and events continue, the network of course participants is continuously growing and promotes dissemination of practical experience and knowledge.

Such networks are also a useful source of future course participants as the BKH's develop more advanced courses and training events, especially for qualifications requiring renewal. By maintaining contact, course participants can complete further training to retain their qualifications and strengthen their connection to other sector professionals.

iPHA and the Passive House Institute continually develop the on-line knowledge base Passipedia.org

Passipedia

As a strong network is an effective one, it is imperative to formalise these informal networks with a label – such as the alumni network – in order to retain members. Inclusion in such a formalised network can also spawn motivation, as members feel connected to something greater and know they have somewhere to turn back to in case of questions or ideas.

Another way these networks can be fostered, is by advertising their existence at events for interested persons. By inviting these people to join, their interest can be increased and cemented, furthering the BKH's ability to reach out to new people for training and consultation.

Figure 70: Local study tour on occasion of the International Passive House Open Days. © Passivhaus Kreis Rosenheim-Traunstein

Another opportunity for reaching new members and forming new networks would be through university courses. By using the students' existing class group, a university network could be founded and administered by a course professor. University networks would benefit not only the movement at large by training young talent, but also the youth themselves, who could use it for networking and later employment opportunities. A major consideration here would be the transfer from member of a university network group, to another regional or national network group, as it is integral to retain active members.

Therefore, it would be advisable for professors or other senior members involved with the university network, to be connected to other non-university affiliated networks to direct graduating students towards when they make the shift after their studies. It would also be worth considering linking university groups to a local chapter, to guarantee an easy shift.

Depending on how the network grows and the BKH's observations of its success, an actual member network could be set up. The Rosenheim model, in which members fee's help to pay the salary of a motivated chairperson who is able to lead the network in efforts to provide more member benefits, acquire more members and set up a structure in which the network can influence the further development of nZEB's in the region, has proven to be very successful. The committed work of individuals in a club should be paid, as entirely voluntary commitment cannot be expected. It must be acknowledged however, that the success of a regional network can often depend on the personality, time management and passion of this chairperson. Therefore, it is important to not only rely on a single chairperson, but rather to motivate members to remain active. Similarly, it is imperative that regional networks be able to lean on larger actors for further national or international initiatives and materials. The Rosenheim model functioned particularly well as the Passive House materials required were available in the network‘s native German through the national German network. Similar cases exist in Spain and the USA, where national and international networks provide materials in Spanish and English, making them readily available to smaller regional groups. This information flows in all directions and can be kept up to date by the networks, with the regional network facilitating direct local contact, as personal contacts can be much better used at the regional level, while the national and international networks can act on a larger scale.

National and international network support also provides regional networks with another opportunity to advertise related events to their members, alumni and course participants and promote their participation. Such activities can therefore be organised at little expense but boost networks by providing an opportunity for regional actors to reach local decision makers and construction professionals, thus closing the circle of actors involved in energy-efficient construction. This helps spread effective networking structures and tools, strengthening regional networks and maintaining momentum, which is ultimately necessary to gain the foundation and authority necessary to expand the movement, convince local decision makers and disseminate knowledge.

As these regional networks grow and gain momentum, national networks could begin negotiating ways in which they can be incorporated into the national networks. The Rosenheim model works because it has clearly set goals, committed members and a paid staff member. By focussing on regional networking of all persons and businesses active in the sector, in particular consultants, designers and construction companies, the Rosenheim network can target their public relations work to raise awareness of the Passive House standard in the region, through local reports and lectures on successful local projects. This is especially important as regional medium-sized enterprises are often the first contact addresses and contact points for those interested in building. In so doing, they can also use the network to act at the local policy level and to promote the construction of public Passive House buildings.

Figure 71: Nothing is ever more convincing than a real example.
© Passivhaus Kreis Rosenheim-Traunstein

In order to include upcoming professionals, the network can cooperate with higher education institutions, universities, training companies and training providers in the area, thus ensuring a constant exchange of knowledge and a high level of knowledge. These smaller groups can then be fed into the larger national network. This example has proven to be very successful with over 500 members now part of Spain's national network. They are a successful example of why it is exceedingly important that national networks create and maintain ties to regional networks, so as to promote a unified national approach and prevent a loss of the national overview.

Why cooperation matters:
A movement is only as strong as its feet on the ground. Regional groups can influence local residents and decision-makers. When these networks work together with a larger, national network they can make an impact to their country's views on energy efficient construction. This in turn helps the international effort, because when many smaller regional groups support national groups to support the international network, changes locally become numerous and widespread – making for a greater international outcome.

International Ties

Various players are involved in the field of Passive Houses and nZEB. Positive networking developments can be observed across Europe and worldwide. In many states national platforms have been established in order to share experience, jointly inform the public or organise training.

Sharing practical experience and best practices is of particular importance in order to speed up the innovation process in the otherwise conservative construction industry.
Training, as fostered by the Train-to-NZEB project, is a vital element for almost all national groups.

For the future the challenge is twofold:
Get a foot on the ground regionally where the actual decisions are made. And establish even stronger international ties for intensified dissemination of Building Knowledge Hubs and Passive House/nZEB.

The international Passive House Association iPHA was established to facilitate just that and is actively involved in disseminating the Train-to-NZEB concepts on model based training for various target groups. This very brochure will play its part as do numerous tweets and newsletter articles that update the iPHA membership on the achievements of the project.

Full access to Passipedia, an extensive on-line Passive House/nZEB resource, provides iPHA members with a constantly growing, interactive body of specialised Passive House/nZEB knowledge. Access to the iPHA Forum, which enables members to exchange with hundreds of like-minded professionals worldwide. Regular newsletters keep iPHA members up to date on Passive House/nZEB news and the latest developments in many countries.

With a root in iPHA a Building Knowledge Hub can take advantage of an attractive base for its development, recruit competent trainers and advertise courses.

Figure 72: iPHA team at COP21 in Paris. © Passive House Institute

**The International Passive House Association iPHA provides an umbrella to national Passive House/nZEB initiatives.
iPHA fosters partnership among its membership in various ways.
Sharing of practical experience and project data is explicitly encouraged.
It works to raise awareness on EU and United Nations levels as well as in the construction industry.**

Guide To Setting Up A Building Knowledge Hub

The Building Knowledge Hubs

4

Study The Terms Of Reference Document

Figure 73: Cover of Terms of Reference document. © MosArt

The Train-to-NZEB project is designed to establish a functioning network of training and consultation centres or Building Knowledge Hubs (BKHs), providing practical training, demonstration and consulting services for the implementation of nearly-zero energy buildings (nZEB). Such training and services is to reflect the nZEB definition and meet its manifold criteria, including from “nearly-zero energy demand”, to “cost-optimal levels in life cycle perspective”, to “significant energy supply from on-site or nearby renewable energy systems” (RES). The BKHs will include training for highly-qualified and other building professionals as well as for non-specialists with decision-making authority.

In order to assist the participating countries to set up the required BKH's, MosArt was assigned the task of producing Terms of Reference (ToR) (Fig. 73). The ToR document provides an essential structure, including the physical infrastructure required, as well as an indication of course content and delivery mechanism. It also outlines alternative structures for the support and operation of the BKH's. This information is presented generically at first and then expanded upon and illustrated in the form of five case study examples in which MosArt (through their Passive House Academy) has played a central role regarding their establishment and continuing involvement for training delivery.

Figure 74: Practical training. © MosArt

The BKH's cater for both theory (the why) and practice (the how), the former requiring a classroom and the latter typically a workshop for demonstration and hands-on practice by trainees. The ToR, through generic description and a set of five exemplars case studies, provides guidance material in respect of: classroom and workshop size and layout (Fig.75); life-size demonstration and practice models; an airtight room, including operational airtight testing and mechanical ventilation heat recovery equipment; renewable energy systems; and a selection of supplementary supporting equipment and material. It also provided an indication of how each centre is funded and operates. These exemplars were drawn from across the globe, involving Dublin, New York City, London, Glasgow and Sligo.

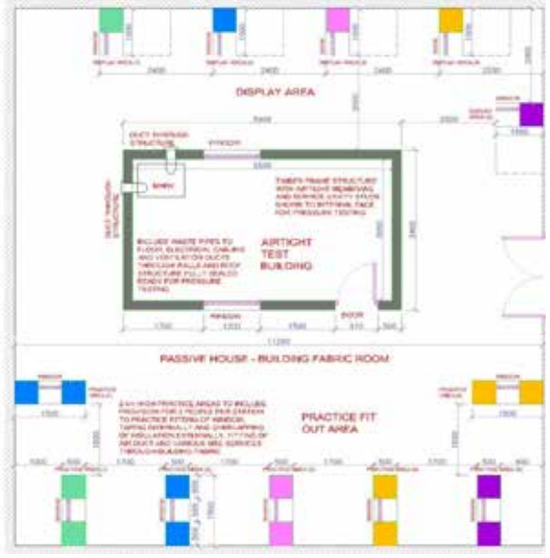


Figure 75: A workshop layout – airtight room as well as demo and practice models. © MosArt

Figure 76: Theoretical training. © MosArt

Organise Training

Key Do's And Don'ts For Theoretical And Practical Training: Passive House Principles

1. Passive House Principles

Highly energy efficient buildings that are cost effective over time are optimally based on the "fabric first" approach. This concerns the thermal envelope and reflects fundamental principles of the Passive House approach, involving:

I. adequate and comprehensive insulation of the major elements, namely, roofs, walls and floor;
II. the unbroken continuity of the insulation at each and every junction from one element to the next, involving the solving of thermal bridges;
III. high thermal performance windows and doors;
IV. a high level of airtightness; and, because of the latter,
V. the use of mechanical ventilation that incorporates heat recovery.

Collectively, these are the five fundamental principles criteria for the realization of the Passive House standard which is also the optimal basis for achieving nZEB.

With these fundamentals established, Renewable Energy Systems (RES) are added, as called for in the nZEB definition and advocated by the Passive House Plus and Passive House Premium approaches.

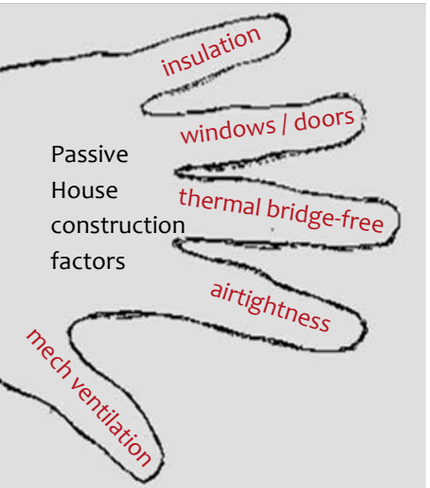


Figure 77: Diagram representing the five construction principles for the Passive House standard:
THE INTELLIGENT HAND / THINKING FINGERS © MosArt

Thus, in combination with highly efficient energy use resulting from the design and construction of the building fabric, these RES's can make a significant contribution to moderate or even negate energy cost.

Realising nZEB and Passive House standard in construction demands a more progressive and rigorous approach than for conventional design and on-site construction. The BKH's are intended to cater for both of these levels of input regarding training. The first step in creating BKH's regarding nZEB implementation consist in creating a facility that caters for training in both theory, the *what* and *why*, and practice, the *how* of hands-on technique. Whereas the former could be delivered in a large classroom with many trainees, the latter will likely be the determinant of trainee group numbers – a single trainer is unlikely to be able to manage more than 14 trainees in a practical workshop situation.

A significant advantage in providing training in BKH's is that there will be abundant opportunity for ensuring sustained interest through interspersing classroom sessions with breaks from the associated mental concentration and static physical position. Such training must be carefully planned and orchestrated as many tradespersons / craftspersons will not be used to sitting at length in a classroom. Conversely, it is important not to simplistically presume that all such trainees want to do is to use their hands – they are intelligent with some level of an enquiring mind. The following are some tips in achieving sustained interest in the classroom.

Figure 78: Even for trainees focussed on building fabric, a brief introduction to the critical role of the MVHR system for human health and comfort is integral to the system and training would be very important. © MosArt

Figure 79: Trainer's humerous demonstration and 'embodiment' of thermal bridging. © MosArt

Repetition of key concepts like a mantra at particular moments as one works through the fundamental criteria can be a useful way of punctuating the flow of delivery, such as the phrase "unbroken continuity of insulation" and "unbroken continuity of the airtight layer". This needs to be again repeated when discussing installation of the MVHR unit and ducts. Trainees thus begin to get the sense of an integrated and coherent construction approach required to ensure high building performance, comfort and air quality.

Image-based language is important also as an "aid memoir". For example, describing a south-facing high performance window, fitted in the right way as a mini-boiler is an effective image for the resulting greater heat gain than heat loss.

Mental categories and Expressive animation: Anything involving calculations and associated units needs careful introduction in order to facilitate mental categorisation. An example of this is the challenge of distinguishing between U-values (W/m^2K) for elemental conductivity, λ-value (W/mK) for material conductivity, ψ-value (W/mK) for thermal linear bridging, and χ-value (W/K) for point thermal bridging. The trainer might describe the first of these as an area-based measurement, hence the squaring of metres; the second as a kind of a linear heat-loss, hence metres with heat movement at right angles to the material, distinguishing it from thermal bridging that uses the same units (W/mK) but involves a linear heat loss along the fabric at junctions between elements or components; and, finally, the intriguing theoretically dimensionless point-thermal bridge involving no metre notation in its units.

Part of the pedagogical approach for delivery can comprise meaningfully expressive body movement by the trainer. Accordingly, hand gestures can express differences, emphasising distinction in heat loss direction, extent (squared metres vs linear metres) and the "mysterious" dimensionless χ -value, including the use of classroom surrounds by spreading ones hands across wall / window surfaces (areas) or finger tracing along junctions (linear) or jabbing the air indicating a point. Such minor drama of body movement across the floor and hand gesticulation, including repetition, potentially makes for an enlivened and interesting presentation expressed in a manner that can be categorized and, so, memorised. A key here is the trainer's embodiment of the different phenomena being portrayed in a manner that can be imagined by each trainee at the moment of delivery. Similarly, forming a gap around one's waist between one's upper garments and lower garments or pulling up one's pants above sock level (including a Charlie Chaplin waddle!) could be used to demonstrate a thermal bridge, asking whether you would do this when it's -5 deg. Celcius?

Class movement and Teamwork: Having the class or trainees rise and move to another location, such as the Workshop, in order to carry out a task, such as measuring or sketching, provides a useful break that involves a change in physical and mental functions. This method could apply to calculations for the likes of compactness ratio by measuring the Airtight Room in surface

Figure 80: Brief demonstration of practical techniques in classroom. © MosArt

areas and volume and hence leaving the classroom for a period and changing the mental focus and similarly for the calculations for airtightness and ventilation requirements.

Furthermore, the latter calculation process can initially comprise a 2 – 3 trainees clustered around a table in the classroom, involving the movement of desks and seats. Again, this creates a useful break from the normal classroom rigours. Likewise with Trainees carrying out sketching exercises along with explanations (as outlined below under Demonstration Models).

Classroom Props and Videos: A box of material and component samples for the purpose of explanation, illustration and handing around the classroom is important pedagogically, including the creation of a change in pace and offering the opportunity for discussion. Similarly, short videos that demonstrate the practical application of theory on site by other tradespersons prove an effective learning medium.

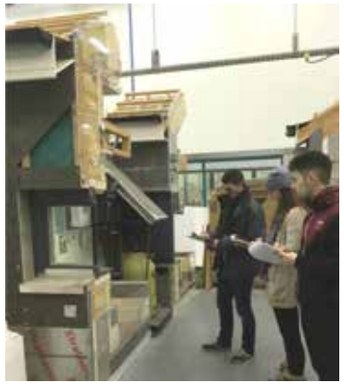


Figure 81: A well timed visit to the Workshop can change the pace and mode of learning and refresh trainees. © MosArt

Figure 82: Sketching exercise using demonstration models. © MosArt

2. Demonstration Models

Demonstration models are an important aid for comprehensive training, bridging the gap between classroom-based theory and hand-on practical work. They typically comprise a single model section through all of the major building elements, that is, floor, wall and roof, including a window and, preferably a door and threshold in section (windows and doors in section may prove difficult to obtain but must be incorporated, notwithstanding). A suspended floor should also be included. Whilst the models may be compressed or shortened in respect of normal building height, they should be at full scale, ie. involving typical dimensions for thicknesses.

Whilst the inclusion in a single model of more than one major building element is preferable as it manifests the continuity of construction, space limitations may require separate parts. Moreover, a single model can easily comprise two wall types, one above and the other below the suspended floor. For example for timber frame, it could be with / without insulation board immediately outside the timber studs, with / without insulated internal service zone and different cladding materials, concrete block / batten and wood cladding. Demonstration models can be compact in size and also be fitted with casters to allow for wheeling and packing to one side.

Figure 83: Sample materials easily transported in a box. © MosArt

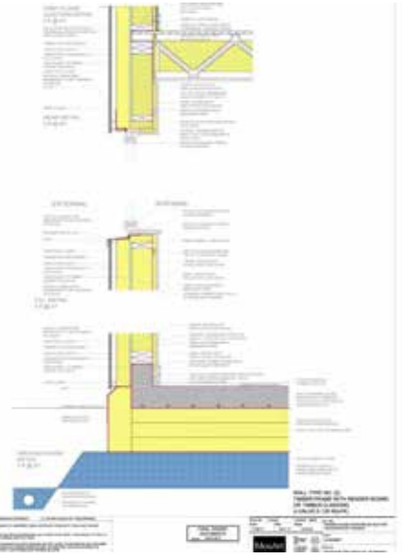


Figure 84: Section drawing for construction as a demo model. © MosArt

These demonstration models should be based on the construction tradition of each country but unequivocally representing the more demanding and rigorous techniques necessary to achieve nZEB and the Passive House standard. Accordingly, the non-negotiable rule for the realisation of these must be unambiguously manifest in the models, namely, unbroken continuity of airtightness and insulation and minimal thermal bridging. The same approach can be used to demonstrate wind tightness. Such characteristics should be easily identifiable as one examines these construction type sections, from one part to the next. The determination of demonstration model types should not solely be based on the construction tradition of each country, but also anticipate emerging construction types - remember, this training is for the advancing of building performance rather than simply the status quo!

These models provide an important basis for describing to trainees the aspects of construction critical to achieve high energy and comfort performance in respect of the concept of unbroken continuity. Having trainees sketch these models and subsequently describing what they have drawn before their colleagues is a particularly effective sequential technique pedagogically, instilling the *what* and the *why* of such construction. These models also facilitate one aspect of practical examination, whereby trainees demonstrate their understanding of the critical principles of such construction.

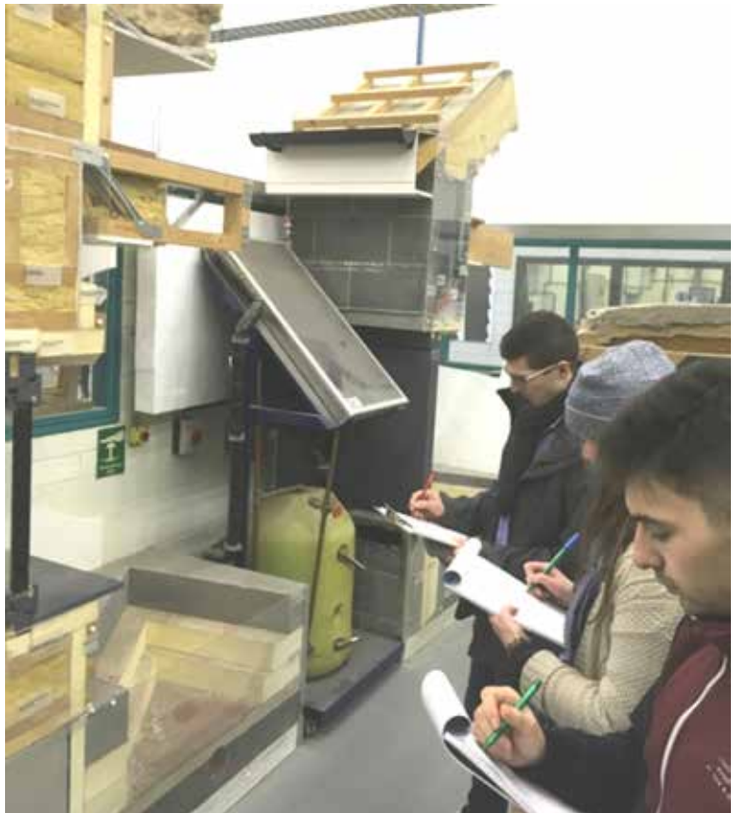


Figure 85: Selection of demonstration models. Involving different construction types. © MosArt

Figure 86: Trainees carrying out sketching exercise using demonstration models. © MosArt

3. Practice Models

Practice models provide a most effective means for conducting hands-on practical training. Pedagogically, the latter focuses on the *how* of such construction. These models are used for the application by trainees of techniques critical to achieving nZEB and Passive House performance. Given that they are subject to continual physical change from the training process, these models need to be stable and robust.

The construction types selected for these models should more or less correspond to the demonstration models. Whilst they might not involve all of the major elements, the more comprehensive the models the better – the height and spread of a model may be determined by the space and money available. Models can comprise, for instance: a simple wall which is fixed at one end to a more permanent structure; a self-supporting L-shaped or Z-shaped plan configuration or a 4-wall room-like space involving different construction types for each leg; and/or a roof components.

Figure 87: Workbench for measuring and cutting of material. © MosArt

Figure 88: Selection of practice models fixed against a wall , including windows and service penetrations. © MosArt

Typically these models comprise as a minimum a portion of a wall, including a small window section, and are penetrated by service pipes of different sizes and a ventilation duct. These components provide the basis for such practical training as the application of airtight tapes and membranes and insulation as well as dealing with the problem of thermal bridging at different junctions. The duct is to be used specifically for training regarding unbroken continuity of airtightness, insulation, including thermal bridging, and vapour-tightness in respect of contiguous construction elements, eg. passing through a wall.

Figure 89: Example of room-like practice model being used for external insulation. © MosArt

It should be understood that this training is intended to focus on techniques that affirm the theoretical understanding of construction standards developed during classroom training as well as developing technical proficiency. The training programme is not intent on producing tradespersons / craftspersons expert in, say, carpentry, block laying or external insulation but, rather, developing the knowledge, skills and attitude in construction workers to ensure that their work meets the performance required for a nZEB and the Passive House standard. In other words, the training complements what construction workers might already be competent at, fine-tuning it to the necessary higher level.

Neither does the training presume to cover all aspects of construction. A case in point is limiting training to achieving airtightness through dry construction using tapes and membranes and glues which allows for repeated stripping and re-application as compared with the use of wet plaster on masonry walls which is messy, time consuming, more difficult to achieve technically and not removable. So, importantly, trainees learn to implement fundamental principles and also increase competence in critical thinking for on-site work.

Figure 90: Instruction of trainees in practical techniques. © MosArt

Figure 91: Detail of airtightness, insulation (thermal bridge avoidance) and vapour-tightness of MVHR duct penetrating wall. © MosArt

Assuming a reasonably broad selection of construction types, trainees should practice on as many as possible, ensuring they deal with both light weight frame and massive / masonry structures. Thus, they should contend with placing insulation both internally and externally. Given that airtight tape is likely to be used over and over again around the likes of windows and service pipes / ducts, it is very important that these elements are protected from the completely permanent adhesion of the tapes by first masking the relevant parts with duct tape which can be easily removed.

Practical training can extend beyond the building fabric to include duct cutting and assembly, following diagrams provided of different configurations. To this end, mock-up MVHR units fitted with four duct spurs can be conveniently positioned between wall models so that at least one duct can connect the unit to a duct in an adjacent wall, ensuring unbroken continuity of airtightness, insulation and vapour-tightness.

These models, whether building elements or MVHR, facilitate practical examination whereby trainees are expected to complete a fit out in a predetermined timeframe. Their aim is to demonstrate their understanding of the necessary techniques.

Figure 92: Demonstration in airtightness taping techniques. © MosArt

4. Airtight Room

Figure 93: Airtight room, light weight construction and including a windtight / humidity resistant external membrane. © MosArt

Figure 94: Demonstration of tape and membrane techniques and airtightness testing with fan in doorway. © MosArt

The Airtight Room serves a number of functions and, thus, plays a central role in practical training. The following are key functions:

Demonstration of techniques in achieving airtightness. Due to convenience of assembly and lightness, typically construction of this room comprises timberframe with a vapour control layer, soft insulation (fiber rolls or cellulose) and service zone. Whilst there is no reason to be limited to these materials, their use in a proper manner and without such finishes as plasterboard provides a valuable opportunity to demonstrate at a scale greater than on the demonstration models relevant techniques. The latter includes, in particular, the use of tapes and membranes as well as considering windtightness and humidity resistance towards the exterior. These materials also allow for some demonstrative experimentation regarding puncturing the airtight envelope followed easily by repair.

Demonstration and practice with the use of airtight testing equipment. The primary purpose of this room is to demonstrate airtight testing. The room, therefore, should be sufficiently large to comfortably accommodate a class of, say, 14 trainees and two trainers. The testing equipment can also be stored to one side of this room.

Demonstration and practice with the use of MVHR equipment. The Airtight Room is ideally suited to the accommodation of the mechanical ventilation heat recovery (MVHR) system along with some associated ducting. Not only can this gear be fully visible, but it can be operative. Of particular importance is the use of this gear for training in respect of balancing the ventilation system, supply and extract. The room can also be used to store the equipment used for this work as well as samples of associated gear, such as for pre- and post-heating, sound attenuation and fire dampers.

Demonstration of measuring techniques. The determination of building performance regarding energy (including airtightness), comfort (draught-free) and health (sufficient air supply) for a given building involves measuring different volumes and surface areas regarding, for example, exterior dimensions for compactness or area/volume ratio (form factor), and various interior dimensions for airtightness (n50 and q50) and air supply. If constructed with these in mind, the Airtight Room can be used as a basis for training in these different categories of calculation.

Figure 95: Airtightness testing with fan in door open. © MosArt

Figure 96: Demonstration in the operation of the MVHR. © MosArt

Figure 97: Product information
© Passive House Institute

Cooperate With Manufacturers

Industry plays an important role in improved market availability and visibility of products for highly energy efficient buildings. Moreover, manufacturers also have a strong influence on the mindset of their audience with advertisement as well as own promotion and training activities. Not least manufacturers often have funds that are vital to make a BKH work economically.

A frequent situation is the inquiry for product samples. Simple samples of materials (e.g. insulation) will always be available with little complication whereas more costly items such as MVHR units, heat pumps or RES eqipment will require negotiation. Beyond that closer cooperation might involve experienced trainers or even immediate funding to support BKH activity.
Such cooperation is more than welcome -even necessary- also in cases where no material assistance is required: Course participants must be trained in handling real world products and materials and need to study the variety of available alternatives.

To manufacturers the benefits of supporting any local BKH or even the whole network are also obvious:
Here is a training centre aimed at highest quality (further) education with a good name and impartial nature that can feature own products among the beforementioned variety of alternatives. Here are eager learners that will in many cases get in touch with the particular kind of product for the first time ever and consequently listen extremely carfully to the explanations and benefits.

Finally, here are centres with sufficient space to exhibit a range of products and introduce them to a whole series of target groups, specialists, experts and even a more general audience of non-specialists, often with decision-making capacity.

In this sense too much competition among manufacturers may destroy or diminish the benefits to the industry at large. It should be acknowledged by all players that innovative technology will only become the norm by way of convincing large numbers of people rather than by persuasion. Common mutual interest should prevail: The increased market volume will later create the business where competition of the different companies makes sense once again.

Prudent development and management of a BKH will strive to avoid any unilateral dependence on a single cooperation partner at any time, however attractive the short-term benefit may appear.

The terms of any cooperation should, therefore, be rated against the self-concept of being an institution that acts with tolerance and in an unbiased manner, independent from special religious, political, economic or other interests.

Avoiding claims that are not scientifically defendable and evidence-based will require some safety clearance to manufacturers. Operating with integrity and transparency, maintaining quality and taking responsibility for work and actions will, ultimately, be vital for the desired long-term sustainability of any BKH.

From the BKH perspective any support is welcome, particularly where course participants hesitate to pay adequate course fees. However, all cooperation must offer mutual benefit.

Figure 98: Sample ventilation system.

Use The Template Business Plan

The BKHs are to be physically established, either through the updating of existing training centres' and consultation facilities or through the provision of equipment for new premises. In parallel, networking activities between the BKHs and within regions are to be initiated, legally substantiated, facilitated through the required infrastructure and sustainably maintained. In short, a sustainable business is to be established in each country and a developed business plan is essential to achieve success.

The Train to nZEB project has established a functioning network of training & consultation centres, known as Building Knowledge Hubs (BKH), providing practical trainings, demonstrations and complex consulting services for the delivery of nearly-zero energy buildings (nZEB).

I. Purpose of the Business Plan

A well developed business plan serves the following four primary purposes:

(a) To serve as an Action Plan – for the next 12 months
(b) To serve as a Roadmap – for the next 3 years
(c) To serve as a Performance Tool – ongoing basis
(d) To serve as a Business Promotions Tool – ongoing basis

Action Plan

A business plan can help by breaking down the many tasks needed when starting a business into many smaller and more manageable tasks, each of which are assigned a due date, person(s) responsible and detailed action plan.

Roadmap

Once the BKH organisation is formed, a business plan can be an invaluable tool to help keep the business on track and moving towards that goal, similar to a roadmap. A business plan keeps everyone focused and serves to help others understand the BKH vision, especially for promoters and financial or funding organisations.

ACTION

ROADMAP

PERFORMANCE

PROMOTION

Performance Tool

The business plan is also an operating tool which, when properly used, will help to manage and guide the business towards success. This sets realistic goals and objectives, and, if maintained, will provide a basis for the performance of the organisation by evaluating and controlling the organisation's performance in the future.

Promotions Tool

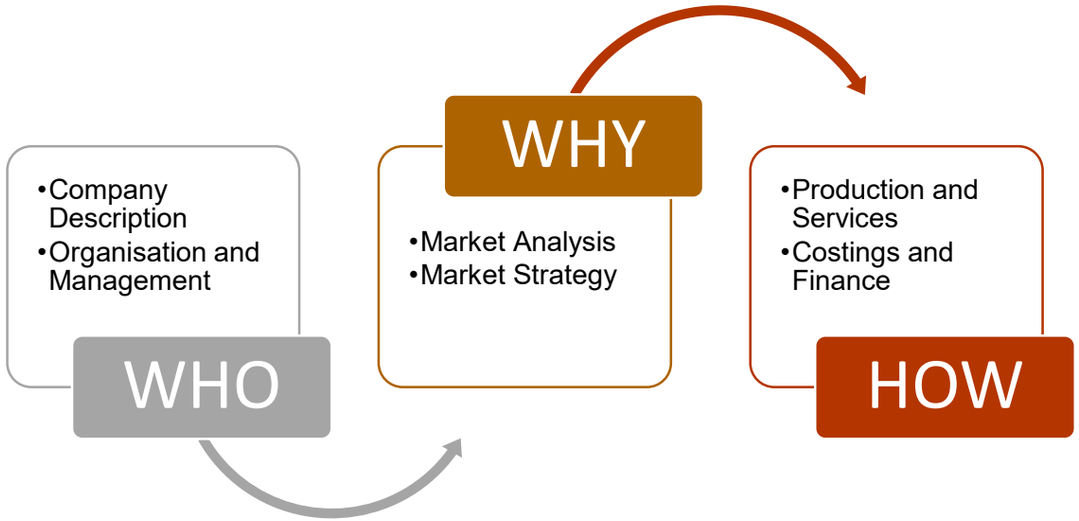
Perhaps most importantly, the business plan serves as a BKH business promotional tool. Most businesses require external financing to fund the business, and a business plan is one of the tools required to persuade investors or lenders to finance the BKH (both financially and for services).

II. Structure of the Business Plan

In order to formulate a business plan so as to access financial funding support and ensure the sustainability of the BKHs, it was necessary for each BKH to provide a clear and concise *Executive Summary*. This may be the first time that investors or stakeholders have met the BKH organisation. Therefore, the summary provides a strong positive impact and contain all the highlights of the business plan.

To assist with the setting out of the business plan, LIT provided a number of comprehensive templates for each organisation. These included a marketing survey and business plan template covering relevant sections to be completed by each BKH organisation relevant to their country:

- Feasibility and Needs Analysis
- Design and setting up of the training and consultation centres (BKH)
- Administrative and Legal Constitution
- Organisation and Management
- Maintenance and Sustainability



WHO

Once the organisation is established, it is important to establish a coherent and effective management strategy within the organisation, demonstrating support from the industry.

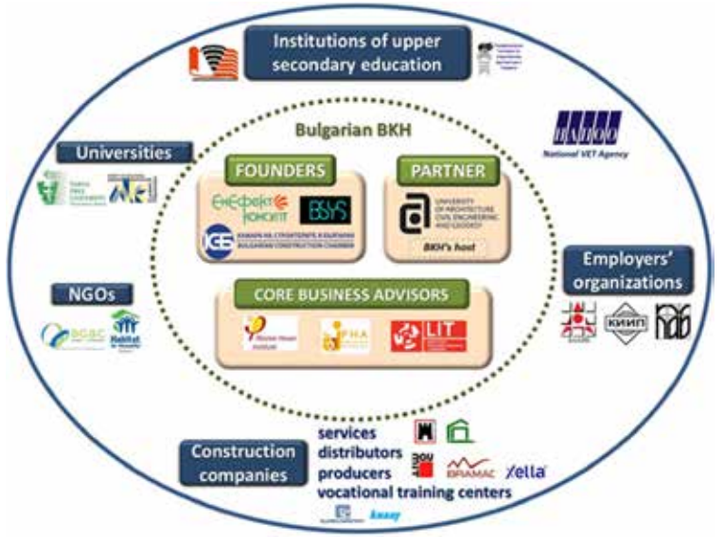


Figure 99: Bulgarian BKH Stakeholders. © EnEffect

Figure 99 shows the extensive number of stakeholders involved in the Bulgarian organization, including partners, board members, promoters and specialist advisors all contributing to the success of the organization.

WHY

It is equally important to review the competition and analyse the current market to establish a marketing strategy. This strategy will be updated every 6 months by the BKH organisations to ensure that all tasks and deadlines are met and the ultimate goal is reached.

HOW

The final section reviewed the legal standing of the business which set out rules and regulations for running and maintaining the BKHs in a financially viable manner. The BKHs are to be a long term initiative and it is important that they are continually assessed to remain viable for at least 3 years after the projects end.

Memorandum of Understandings MOU

To ensure cooperation and continuous support from partners and promoters LIT provided a MOU template which was used and agreed between BKH organisations in various countries to promote nZEB across Europe.

BY COUNTRY:

Each BKH organisation is organised and managed differently within the legal parameters of their own country...

- Bulgaria: Bulgarian Building Knowledge HUB
- Romania: BKH RO
- Czech Republic: BKH CR
- Turkey: Building Knowledge HUB of Turkey
- Ukraine: Ukraine BKH

Further Information

Passipedia
The ever-expanding knowledge database on energy efficient building and Passive House, comprising over two decades of research. Articles relating to step-by-step energy refurbishments and deep retrofits are also found here.
www.passipedia.org

Passive House Database
www.passivehouse-database.org

Component Database
database.passivehouse.com

Passive House Institute
An independent research institute that has played an especially crucial role in the development of the Passive House concepts – the only internationally recognized, performance-based energy standard in construction.
www.passivehouse.com

iPHA – the International Passive House Association
A global network for Passive House knowledge working to promote the Passive House Standard and connect international stakeholders.
www.passivehouse-international.org

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www.lit.ie

Passive House Academy / MosArt (Ireland)
www.passivehouseacademy.com

Passive House Institute (Germany)
www.passiv.de

National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development (Romania)
www.incd.ro

Business Development Group (Romania)
www.bdgroup.ro

Pre-University Education Foundation – Future (Romania)
www.calificat.ro

Bulgarian Construction Chamber
www.ksb.bg

BSYS (Bulgaria)
www.bsys.bg

SEVEn (Czech Republic)
www.svn.cz

Department of Civil Engineering at Ege University (Turkey)
www.ege.edu.tr

Municipal Development Institute (Ukraine)
www.mdi.org.ua

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