SKILLS
INSTRUCT
INSTRUMENTS
CONSTRUCTION

INSTRUCT framework of instruments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 894756.

D3.1 INSTRUCT framework of instruments

Dissemination Level: PU
Lead Partner: Luxembourg Institute of Science and Technology
Due date: 31/06/2021
Actual submission date: 18/11/2021

Published in the framework of:

Evidence-based market and policy instruments implementation across EU to increase the demand for energy skills across construction sector value chain.

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Revision and history chart

Version	Date	Editors	Comment
0.4	2021/11/12	Sylvain Kubicki, Nico Mack, Sébastien Thomas, Annie Guerriero	Initial version
0.4 R2M	2021/11/15	Régis Decorme, Mohaddeseh Maktabifard	Quality-review by R2M
1.0	2021/11/18	Sylvain Kubicki	Submitted version

Disclaimer:

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1 Summary

A framework of instruments shared amongst the project's partners is defined. It consists in crosscutting instruments to be used and deployed across the various project activities and in particular practically applied in the demonstration pilots of WP4. Building on the knowledge gathered in T2.2 and T2.3 those various instruments have been framed according to the requirements defined in T2.4. To achieve this, a global specification of the crosscutting instruments considered for the project activities is proposed in this deliverable D3.1, relying on the engagement of the project's stakeholders (incl. the project partners and interested parties). It is expected to later fine-tune it according to specific needs and requirements that might emerge from further activities, in particular the pilots and their needs of specific instruments (passports/registers, mobile applications, initiatives, financial incentives for renovations). Amongst all, the deployment of a platform spreading knowledge and engaging communities is a pivotal development undertaken by the project team.

2 Introduction

The various analyses and market activities conducted in INSTRUCT WP2 have highlighted the need for novel, adapted instruments, enabling to tackle the key challenges faced by the construction sector in relation with energy efficiency of built assets.

WP3 aims to formulate those instruments which will be then used by the project partners to address the market through real-life demonstration pilot activities which are foreseen in WP4.
Figure 1 summarizes the links and rationale amongst these activities.

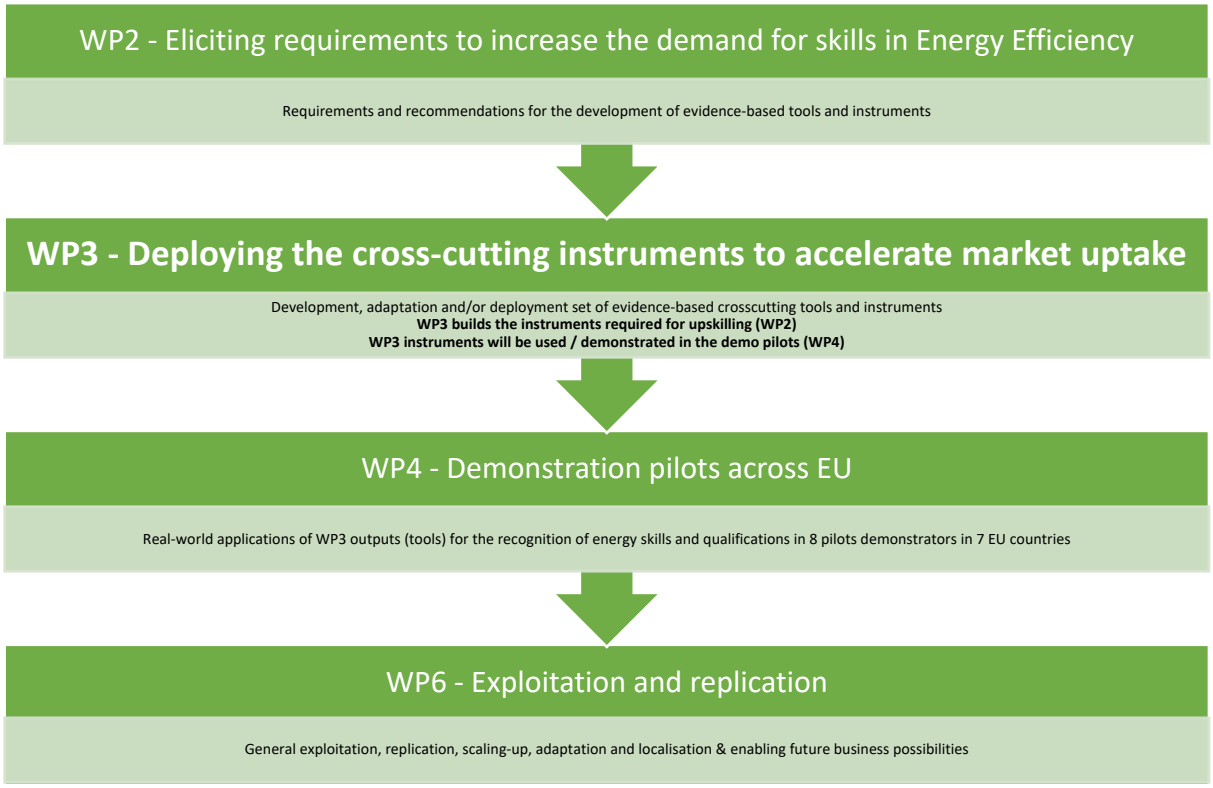

Figure 1: WP3 in the project course

In the following sections, a presentation of BIM4VET/BIMEET instruments is first proposed (section 3), as they serve as a basis for several INSTRUCT applications. Then, section 4 details the various instruments foreseen for INSTRUCT.

3 Background: BIM4VET and BIMEET platforms

The INSTRUCT project has a direct relationship, and inherits several outputs, with previous projects conducted by Cardiff University and LIST:

- BIM4VET funded by the EC ERASMUS+ program developed an *European skills matrix for BIM actors*;
- BIMEET H2020 GA N°753994 focused on *BIM-based EU -wide Standardized Qualification Framework for achieving Energy Efficiency Training.*

Both projects addressed new roles and skills through the lens of training accompanying the market needs. Also, **both projects delivered tools to accompany those changes**, in particular in an era marked by the rapid development of learning resources, the market uptake by training providers which extensively deliver new training modules, the growing requests for skilled professionals in the domain of BIM, and the development of professional certifications at national levels as well as industry-wide (e.g. BuildingSmart Professional Certification).

The remaining sub-sections present the IT tools developed in BIM4VET and BIMEET projects.

3.1 Presentation of the BIM4VET application

The BIM4VET application is dedicated to BIM training courses recommendations for professionals. It relies on the connection of two important results from the BIM4VET project (for more details see bim4vet.eu, as well as [1-6]):

1) The BIM training courses in EU benchmark which provides an inventory of +/- 100 BIM training courses in EU.
2) The BIM competence matrix, which regroups 26 responsibilities, related to four BIM roles: BIM author, Senior BIM author, BIM coordinator, BIM manager.

Then based on the analysis of the content of the training courses the researchers created the link with the BIM responsibilities which are addressed as well as the related level of expertise (i.e. from novice to expert (Dreyfus scale)) as prerequisites and learning outcomes.

The “novice” level is associated to value 1, and this scale goes up to 5 with the “expert” level. Level 0 means that the BIM responsibility is not treated by the training course considered.

The application is composed of three major components (Figure 2):

1) **A SQL database:** The central database of the BIM4VET system includes two types of information coming from two different sources. Firstly, the data related to the BIM training courses are collected based on a specific web questionnaire. Secondly, the data related to the user profile as well as the project requirements are collected through the use of the BIM4VET portal. This portal provides functionality for users to register their information, to conduct their maturity assessment, and additionally to construct projects with user membership and competence requirements.

2) **A Recommender engine:** The web service based recommender takes several trainings for each user and ranks them in order to sort them on the tangible table (Figure 3). A fuzzy expert system to reproduce common-sense recommendation is used. Fuzzy logic [7] is often used to reproduce uncertain knowledge and apply it to imprecise inputs: their use was thus indicated. The inputs consist in the prerequisites and outcomes of the trainings and in the user profile (current level and goal). Regarding these four inputs, it computes a score between 0 and 100: the greater the score, the more recommended the training.

3) **Tulip-CPS**: The Bim4Vet database and the recommender engine are both integrated via the Tulip-CPS extension. TULIP is a JAVA software framework for developing tangible applications developed at LIST (LU) (see section **Error! Reference source not found.** for more details).

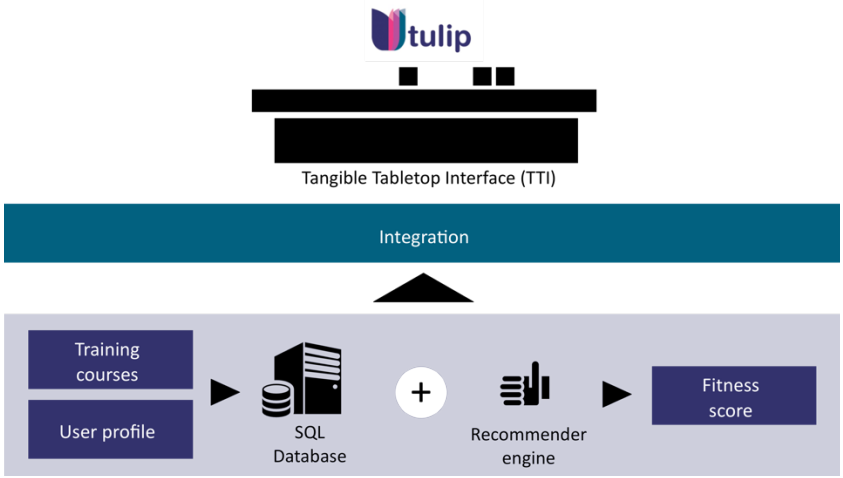

Figure 2. BIM4VET architecture

The application relies on interactions on a tangible table, enabling collaborative use as depicted in Figure 3.

Figure 3. Application BIM4VET relying on a tangible table.

The system allows the users to collectively analyze their needs and obtain a recommendation of the most adapted BIM training recommendations according to the users' preferences (see Figure 4):

1) The token "dashboard" shows the project's BIM requirements (red points are related to the BIM responsibilities required for a project) (See [1] in Figure 4).

2) Each user has a token “Profile” allowing to 1) configure the level of expertise expected for each responsibility and user and 2) configure the filter criteria for training courses recommendation (i.e. cost, duration, localization) (See [2,3] in Figure 4).
3) The token “Training courses” allows the user to visualise the recommended BIM training courses. Each training course is represented by a color sets and a color code is associated to each actor. The thickness of the arc of circle is linked to the fitness score of the recommender engine: the more the thickness is large the more the training course is recommended for the concerned person. A touch interaction allows to access to the details of the course (See [4,5] in Figure 4).
4) Finally, the proximity between a token “user” and a training course item allows the user to subscribe (register) to a session (See [6] in Figure 4).

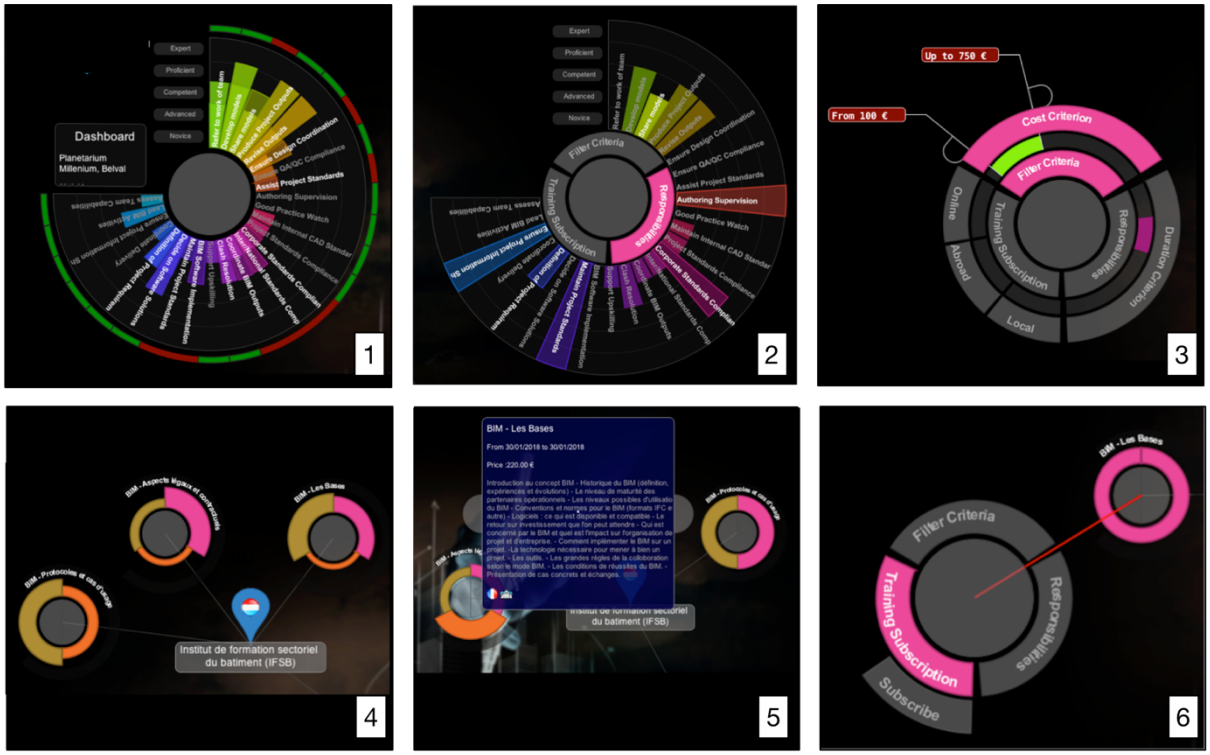

Figure 4. Illustration of the BIM4VET interface and functionalities

(1) project dashboard, (2) responsibilities, (3) filter criteria, (4) trainings, (5) pop-up windows, (6) training subscription.

3.2 Presentation of the energy-bim portal

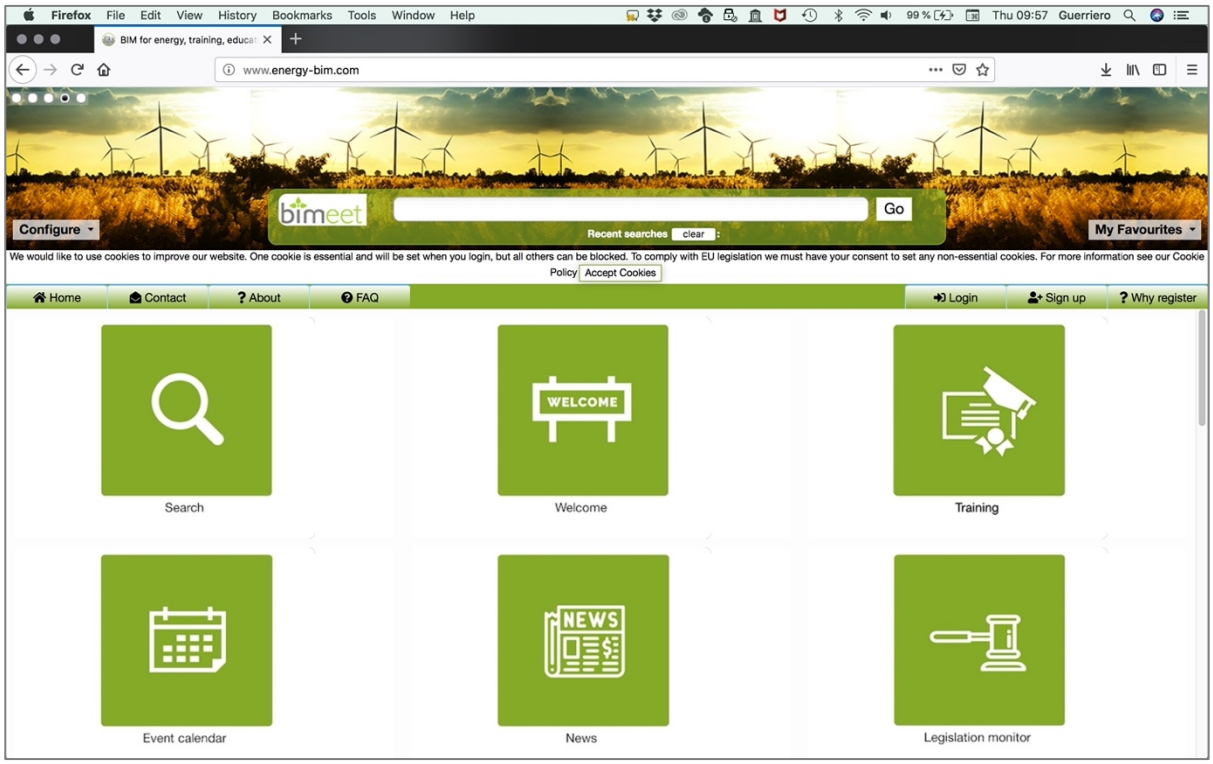

Figure 5. BIMEET portal: www.energy-bim.com

The Energy-BIM platform developed in BIMEET has helped in the process of gathering BIM training requirements for energy efficiency but also aims at solving the key issue of knowledge dissemination in, and stakeholder engagement with, BIM practices and construction. The objective is to identify gaps and requirements as an initial phase but also to support with the project implementation phase in providing construction professionals with the necessary training to offer effective BIM expertise for energy efficient and low carbon solutions, while also enabling them to utilise the latest best practice and regulations.

This is a web-based platform solution that provides integrated access to building information modelling (BIM) resources in the form of interactive, dynamic, and user-oriented services that fully exploit latest advances in computing technologies. The platform is an open, scalable and polymorphic context-based solution with modules enabling serendipitous information and knowledge discovery by utilizing a symbiosis of technologies such as semantic web, social network.

This platform aims to help in the process of defining BIM training requirements for energy efficiency but also to solve the key issue of knowledge dissemination in, and stakeholder engagement with, BIM practices and construction. As part of BIMEET, the objective was to provide construction professionals with the necessary knowledge to offer effective BIM expertise and training for energy efficient and low carbon solutions, while also enabling them to utilise the latest best practice and regulations.

3.2.1 Search service

As part of the platform development during BIMEET project, we have implemented a Search Service that performs semantic searching on the platform BIM knowledge base. The submitted BIM query has

a set of associated ontological concepts for improving the precision and the recall of the returned results. The search service also provides an aggregation of data from a variety of trusted sources related to sustainability via web-crawling. These sources can be proposed by users and validated by a group of experts according to their relevance to BIM for energy efficiency (see Figure 6).

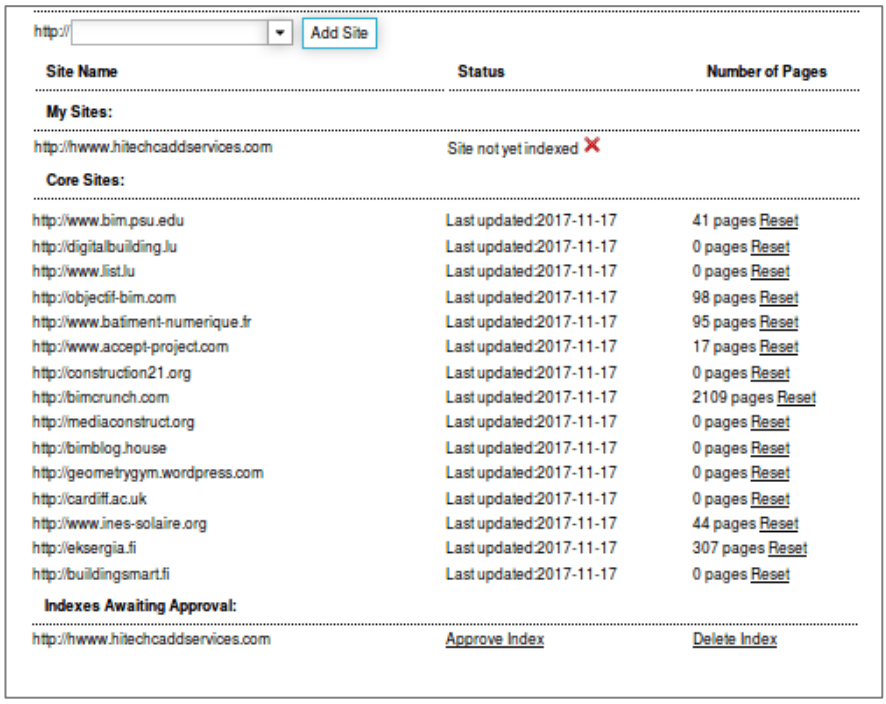

Figure 6. Sources Aggregation

3.2.2 Professional Networking Service

The platform also provides a Professional Networking Service that enables users to collaborate using social networks such as LinkedIn and Twitter by aggregating associated data. This service also allows users to search for partners and colleagues and identify the corresponding networking profiles based on a set of BIM interests and disciplines. An illustration of the associated interface of the professional networking service is provided in Figure 7.

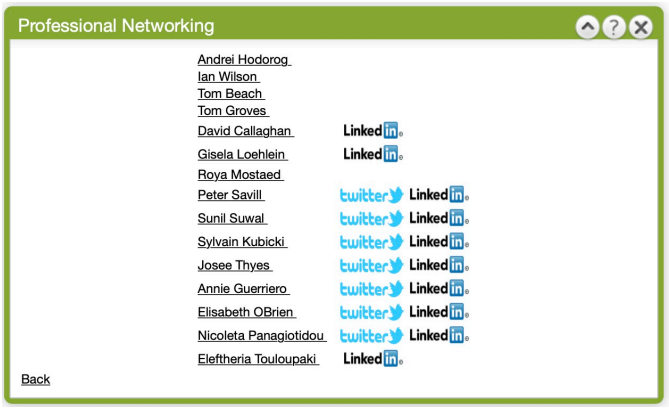

Figure 7. Professional networking service

3.2.3 Other services

An **Events Calendar Service** is used as a reminder of the important BIM events from the engineering community. Users can subscribe and synchronise these events relating to sustainability with their personal calendar.

A **BIM Training Service** has been implemented as part of the BIMEETproject, enabling users to identify courses and lectures related to BIM for energy efficiency in construction from various institutions such as universities, research organisations, governments agencies etc.

Within the EnergyBIM platform the query and expand methods are exposed to provide the key use of the ontology, which is to drive the search engine. Firstly, the terms within the ontology are used to provide keyword suggestions when entering search terms (using the query method). Secondly, the relationships between terms are used to help users expand/restrict their queries based on suggestions from the ontology (Figure 8).

Figure 8. The revised platform interface

For testing and validation of the searching system, we have relied on the group of experts and partners involved in the requirement assessment phase, plus an increasingly expanding constituency as the platform is extended to further users. We are monitoring user activity by employing Woopra Analytics.

The innovative dimension of the BIMEET platform lies in its open, scalable and polymorphic context-based widgets that reconfigure and update themselves to respond to changing user context and (BIM related) queries while enabling serendipitous BIM information and knowledge discovery. Each service has a corresponding widget that can be updated and administered remotely by users.

3.2.4 Use cases collection

A specific service (form and database tables) has been implemented for the collection of use cases. It has been re-used as part of INSTRUCT WP2 (Figure 9). Figure 10 shows some of those use cases collected.

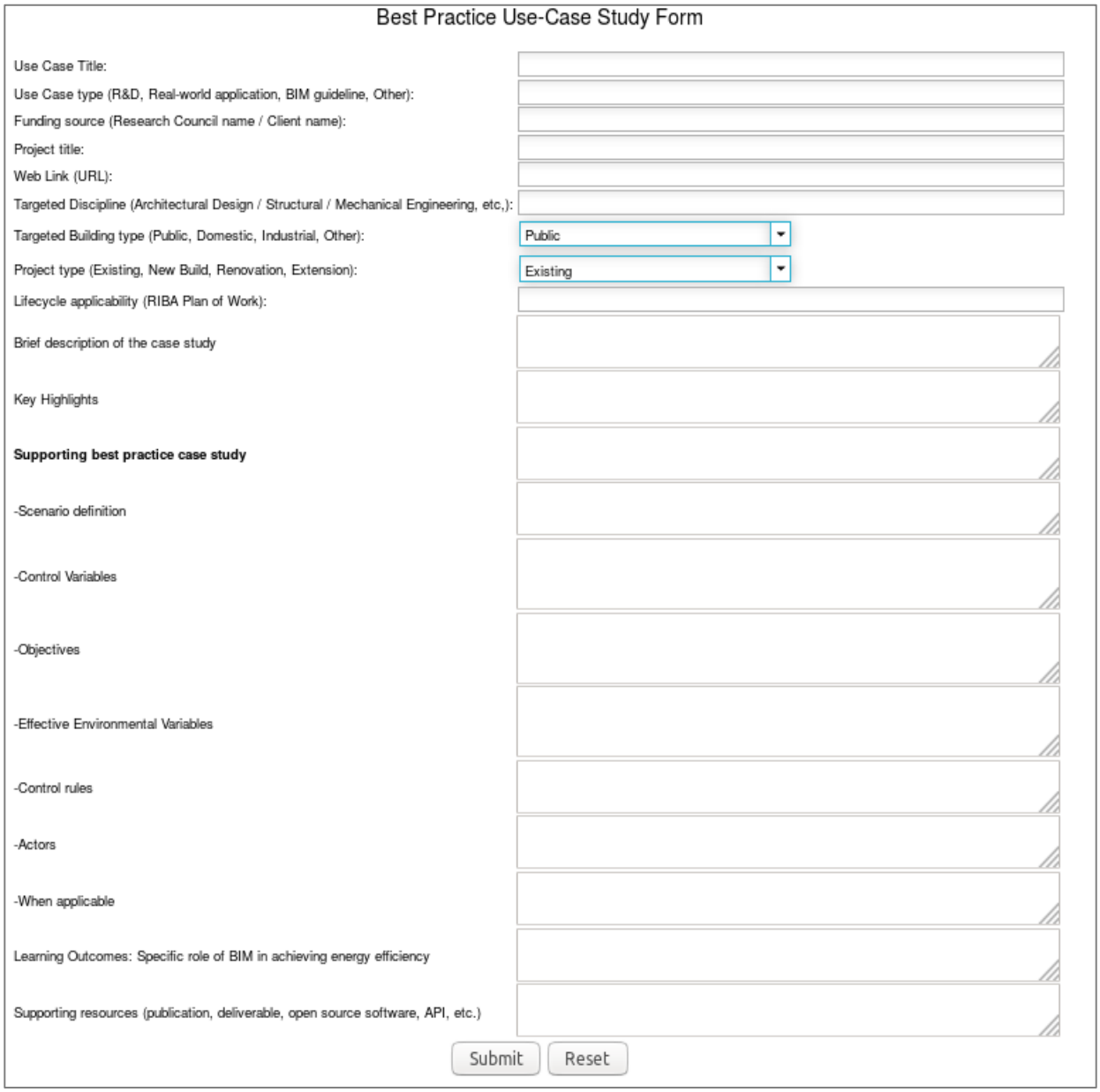

Figure 9. Best practice Use-Case study form

PORTOFOLIO OF EXISTING USE-CASE STUDIES:

1..Reduce the Gap Between Predicted and Actual Energy Consumption in Buildings	Edit	Delete
2..Minimizing operational costs and carbon emissions through matching supply with demand of heat and electricity production.	Edit	Delete
3..Innovative Information and Communication Technologies (ICT) platform able to support the optimization of water networks and to enable change in consumer behavior	Edit	Delete
4..Intelligent management and control of HVAC system	Edit	Delete
5..Rural Regeneration Centre, Hadlow College	Edit	Delete
6..Sustainable Design and Building Information Modelling: Case study Energy Plus House, Hieron's Wood, Derbyshire UK	Edit	Delete
7..Friendly and Affordable Sustainable Urban Districts Retrofitting (FASUDIR) - Heinrich-Lubke housing area, Frankfurt, Germany	Edit	Delete
8..Friendly and Affordable Sustainable Urban Districts Retrofitting (FASUDIR) - Budapest Residential District	Edit	Delete
9..An innovative integrated concept for monitoring and evaluating building energy performance (the gap between predicted and actual building energy performance is addressed by the project).	Edit	Delete
10..BIM-based Parametric Building Energy Performance Multi- Objective Optimization	Edit	Delete
11..Parametric design of a shelter roof in urban context	Edit	Delete
12..Introducing the innovative tool of the Building Sector	Edit	Delete
13..Intelligent Services For Energy-Efficient Design and Life Cycle Simulation	Edit	Delete
14..Collaborative optimisation of building performance during concept design phase	Edit	Delete
15..Robust decision making around building efficiency and occupant comfort	Edit	Delete
16..Delivering highly energy efficient hospital centre	Edit	Delete
17..Design for future climate change - Developing an adaptation strategy	Edit	Delete
18..Parametric modeling for architectural form finding	Edit	Delete
19..Shopping Center using around half the energy of a typical developement	Edit	Delete
20..Use of BIM in design and construction phase to achieve sustainability goals of an office building	Edit	Delete
21..Design of energy-efficient library with high architectural goals	Edit	Delete
22..Use of Optimization tool to compare hundreds of concepts energy efficiency before actual design	Edit	Delete
23..Improving Energy Performance of Office Buildings Based on Light Building Information Model (BIM)	Edit	Delete
24..Retrofit alternatives based on energy simulations	Edit	Delete
25..Energy properties of solar shading devices and their impact on the visual comfort of occupants	Edit	Delete
26..Collaborative Holistic Design Laboratory and Methodology for Energy-Efficient EMBEDDED Building	Edit	Delete
27..Semantic Web for Information Modelling in Energy Efficient Buildings	Edit	Delete
28..Occupant Aware, Intelligent and Adaptive Enterprises	Edit	Delete
29..Building As A Service	Edit	Delete
30..De Lacy Row	Edit	Delete
31..Use of BIM for ESD Analysis of BCA Academic Tower	Edit	Delete
32..CMP_01	Edit	Delete
33..eeEmbedded Pilot Demonstrators	Edit	Delete
34..EFFESUS Glasgow Case Study	Edit	Delete
35..HESMOS Pilot Projects	Edit	Delete
36.. Towards the development of a virtual city model, using a 3D mode of Dundalk city	Edit	Delete
37..Modelling, assessment and Sankey diagrams of integrated electricity-heat-gas networks in multi-vector district energy systems	Edit	Delete
38..Eebers ICT Clusters	Edit	Delete

Figure 10. Portfolio use cases

3.2.5 Training database

A specific form has been developed to collect and document training modules available from BIMEET consortium partners (and later on from a wider community of training providers). The repository includes data about BIM/EE training courses that we have collected or designed all along the BIMEET project.

The data collected are the following:

- Organizer information (i.e., name, address)
- Training information (i.e., title, description, price, language, start /end date, etc.)
- Venue information (i.e., name, address)
- Exam and/or diploma
- Targeted public (i.e., based on roles structuring the matrix defined in D3.1 and D3.2.
- Learning outcome (i.e., prerequisite and expertise after training, based on maturity levels as defined by the Dreyfus scale, ranging from novice (value 1) to expert (value 5) in five levels.)

A form has been implemented to collect those various information. In particular, the following table Figure 11 enables to record the Learning Outcomes (LOs) addressed by a training module (both as pre-requisite and expertise gained).

Architectural design | Building services design | Client & client advisors

		Prerequisite						Expertise level after training course					
		0	1	2	3	4	5	0	1	2	3	4	5
ADLO1	**Explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.**	●	●	●	●	●	●	●	●	●	●	●	●
AD1.1	Recall essential contents, summarize and give examples of BIM terminologies, definitions and standards.	●	○	○	○	○	○	●	○	○	○	○	○
AD1.2	Recall essential contents, summarize and give examples of overall BIM process for a building's life cycle.	●	○	○	○	○	○	●	○	○	○	○	○
AD1.3	Explain and use standard information exchange processes for different design domains in general and especially in detailed technical design.	●	○	○	○	○	○	●	○	○	○	○	○
AD1.4	Explain the essential issues related to information management, data transfer and sharing.	●	○	○	○	○	○	●	○	○	○	○	○
AD1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	●	○	○	○	○	○	●	○	○	○	○	○
AD1.6	Recall, summarize and explain essential contents and relevant parts of national BIM guidelines.	●	○	○	○	○	○	●	○	○	○	○	○
		Prerequisite						Expertise level after training course					
		0	1	2	3	4	5	0	1	2	3	4	5
ADLO2	**Explain the fundamentals of sustainable and energy-efficient buildings and building performance.**	●	●	●	●	●	●	●	●	●	●	●	●
AD2.1	Explain and give examples of aspects and terminologies of energy and building performance.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.2	Describe the financial and environmental aspects and related indicators, benchmarks and certification systems of energy and building performance.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.3	Explain the issues that affect energy performance of buildings and demonstrate competence in domain specific solutions.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.4	Explain relations between life-cycle costs, energy performance and building performance.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.5	List and explain the core concepts of sustainable building rating and certification systems.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.6	Summarize and give examples about the potentials of renewable energy sources applicable to buildings including district-scale solutions.	●	○	○	○	○	○	●	○	○	○	○	○
AD2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	●	○	○	○	○	○	●	○	○	○	○	○

Figure 11. Learning outcomes for a training module.

It is expected to strengthen this functionality as part of INSTRUCT T3.2 (see section 4.1).

4 INSTRUCT Framework of instruments

INSTRUCT project is quite specific, and even if it partially relies on BIM4VET and BIMEET approaches when it comes to the role of BIM in relation with Energy Efficiency, its scope of application is broader. Indeed, the project considerations range from the general lack of information and best practices, preventing the development of a shared, sector-wide vision on energy efficiency, to the lack of skilled workforce associated to inadequate training programs. Moreover, the scope also tackles the regulatory landscape, including the governmental incentives to energy efficiency.

In this context it is foreseen to develop, adapt and/or deploy a set of crosscutting instruments which will support the implementation of market-based activities in the demonstration pilots across EU (WP4). Those activities consist on demonstration and feedback collection from the field actors.

Figure 12 summarizes the instruments considered in the project. It consists of:

1) The **INSTRUCT platform** (in orange), a web-based system which relies on the above-mentioned energy-bim.com platform,
2) **eLearning modules**, to be adapted or developed for the purpose of the demonstrations;
3) **New legislative frameworks**, and in particular with a focus on public certification policy schemes, sustainable procurement schemes and voluntary agreements;
4) **New partnerships amongst producers, retailers, installers as well as DIY;**
5) Instruments **promoting the added-value of skilled professionals to building and home owners.**

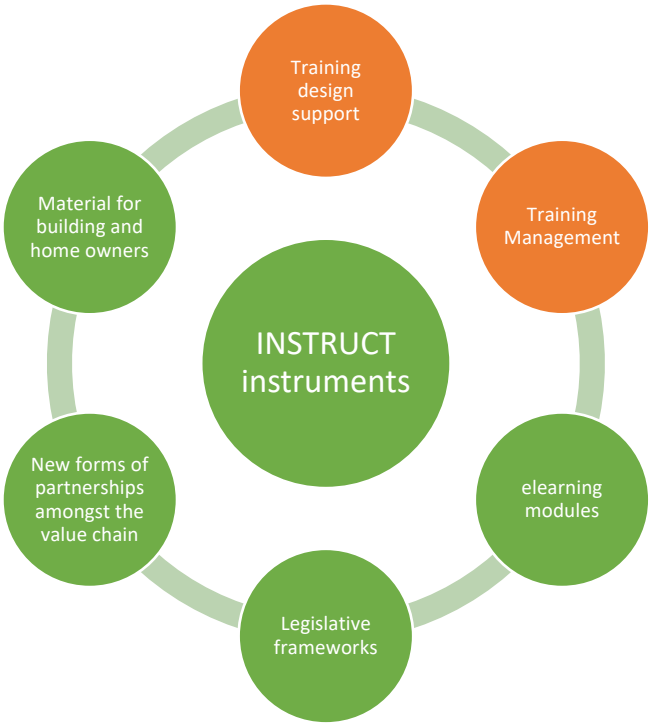

Figure 12. INSTRUCT framework of instruments

4.1 INSTRUCT Platform: tools for facilitating energy skills registers

The INSTRUCT platform already hosts several services enabling the sharing of information amongst the INSTRUCT community. It will be enriched with services targeting the needs of the demonstration pilots to be developed in WP4.

Figure 13 presents the principal use cases which will be studied and further developed as part of the T3.2. These services are further described in the sub-sections below.

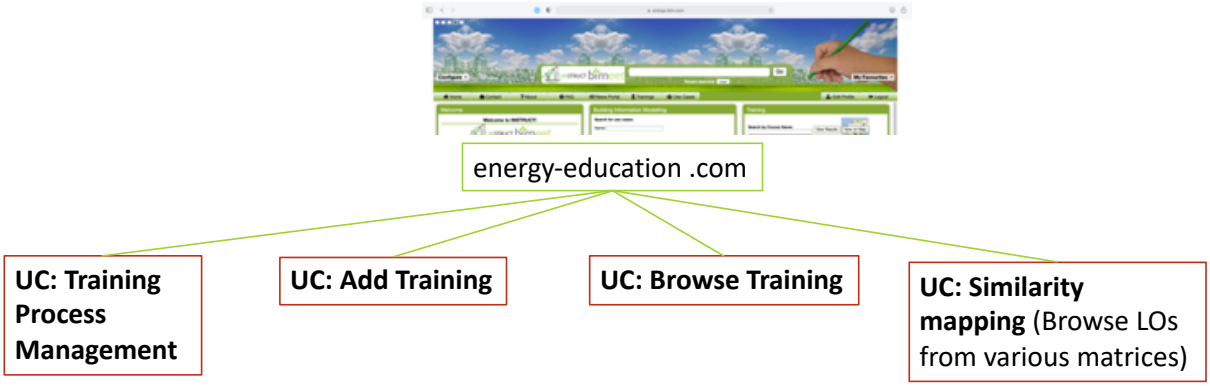

Figure 13: Overview of INSTRUCT platform's use cases

4.1.1 Use case: Training repository (Add & Browse)

The training repository will be reworked, starting from BIMEET version. The aim is to offer a simplified training registration mean, and a training browsing service.

4.1.2 Use case: Similarity mapping

The drive for higher energy efficiency standards and reduced carbon footprint in the construction sector pushes on one hand the actors in the sector to upskill their staff and on the other hand training institutions to identify and deliver the required skills. This symbiotic relationship can of course only work if offer and demand are aligned.

We developed in the context of the BIM4VET and the BIMEET projects a set of tools allowing on one hand actors to find trainings matching the required skills to upskill their staff and on the other hand, helping training institutions in devising new trainings offering skills not yet covered by existing trainings. Both tools relied on a single qualification scheme for representing skills, thus simplifying the task of skill matching.

Activities of the European Union like the Build Up Skills Initiatives however led to a real proliferation of qualification schemes, turning comparison of existing training offer into a daunting task.

The tool we will implement in the context of the INSTRUCT project T3.2 aims at alleviating this problem by **attempting to map learning outcomes from existing qualification schemes based on semantic similarity,** as explained in INSTRUCT's D2.2 deliverable.

The tool will rely on natural language processing techniques to establish similarity scores among individual learning outcomes from existing qualification schemes. Learning outcomes whose similarity score exceeds a given threshold can be considered as being equal, those not reaching a minimum score can be considered as being disparate. Learning outcomes with similarity scores between those two thresholds may need to be validated by a human expert. An example is provided in Figure 14.

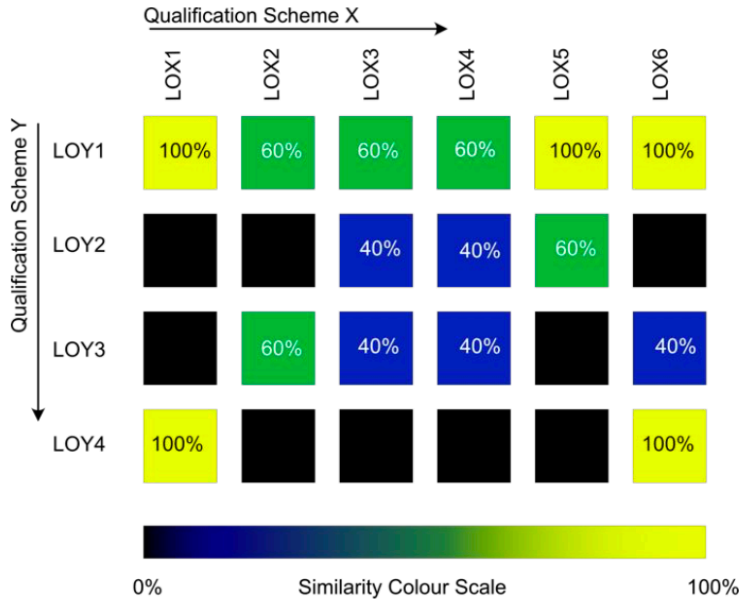

Figure 14: Assessment of similarity map (extract from INSTRUCT D2.2)

By establishing this kind of mapping between qualification schemes we turn a multitude of schemes into a single overarching meta qualification scheme, thus simplifying the comparison of existing training offer.

It is foreseen to consolidate the approach by using the learning outcomes formulated in demo #2. Further application of this tool is envisaged when developing new training module for the pilot #3 in Poland.

4.1.3 Use case: Training Process Management

Relying on INSTRUCT D2.4's chapter 5, this use case will test the implementation of blockchain on several transactions related to the management of training processes, including delivery, certification and verification of energy efficiency training, as a new module on the platform.

4.1.4 Architecture

The overall IT architecture of INSTRUCT platform is presented in Figure 15. It is largely inherited from previous developments realised in BIM4VET and BIMEET projects. Specific improvements and fine-tuning will be reported in D3.2.

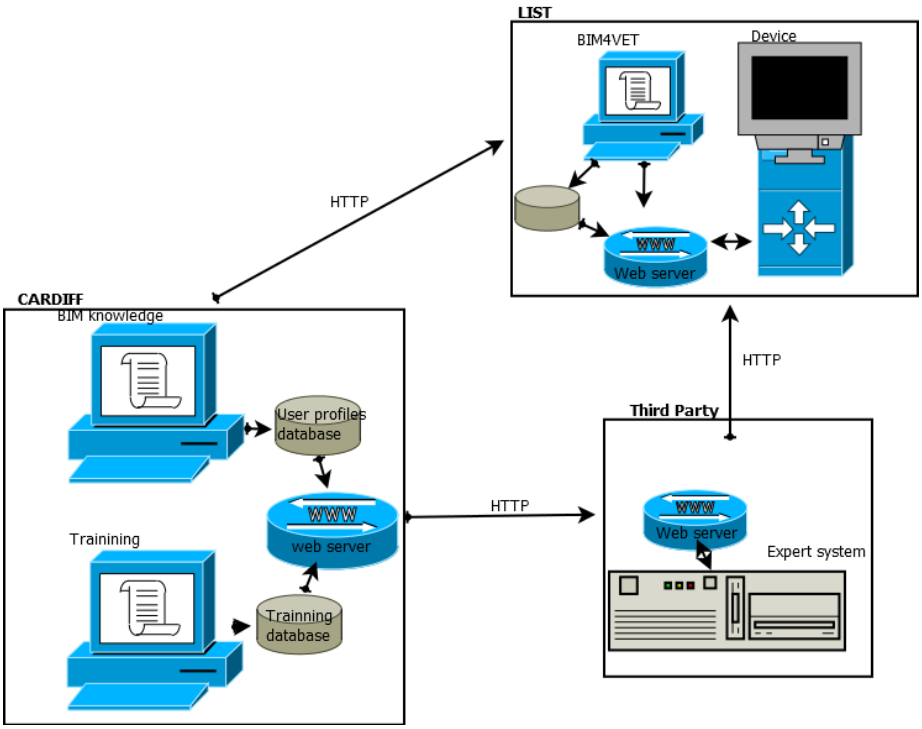

Figure 15. INSTRUCT Platform architecture

The architecture of the system, integrating BIMEET and BIM4VET components, is presented in Figure 15.

- The data capture layer builds on the BIM knowledge harvesting platform www.energy-bim.com, that aggregates BIM data and information to inform training programs and enable access to wider knowledge.
- At the expert system level, we use artificial intelligence techniques for ensuring the required level of reasoning.
- The visualisation layer enables the users to interact with system and explore training attributes, and will be deployed on two distinct User Interfaces: web-browser and tangible table.

From the technical point of view, the BIMEET application will rely on the same components that the BIM4VET and BIMEET applications: 1) ExpressIFTM, a software developed by the CEA LIST since 2010, and 2) TULIP framework, a JAVA software framework for developing tangible applications, progressively developed at LIST since its gestation in 2014.

4.2 Learning and e-learning Instrument

Several of the INSTRUCT demonstration pilots (WP4) will address training, either by referring to training activities, or specifically developing training material.
The enhancement of existing training modules is considered (both for application in university courses and for VET delivery). When applicable, blended learning will be considered.

E-learning is a strong mean to deliver impact through training, allowing to reach large audiences. Moreover, e-learning material can be used in on-site training activities in the form of blended learning.

As part of BIMEET, two e-learning modules have been developed and are candidate for re-use in INSTRUCT (in particular in demonstration pilot 4.2). These training are:

- BIM and Building Energy Efficiency
- BIM for Energy Performance Certificates

They are detailed in BIMEET's D3.4's section 4, and are appended to this deliverable.

The hosting and delivery of such e-learning modules will be studied in INSTRUCT T3.2. The options which are discussed amongst the partners aim for a wide impact towards the professionals.

4.3 New legislative frameworks

Legislative framework has a strong impact on the day to day work of professionals in the building sector. It steers the strategies of companies and reduces uncertainties for the future. EPC (Energy Performance Certification), defined under the EPBD, is the one of the main regulatory instrument that supports the global energy performance of buildings and contributes to lowering their environmental impact. This section details some example of legislative framework instruments or incentives involving training for energy and environmental performance of buildings.

A classification of instruments is proposed according to the people targeted for training, the incentive (usually money related) and the sectors concerned.

4.3.1 Examples of such legislative instruments in Luxembourg

a. EPC in Luxembourg must be performed by a trained professional. There is a **mandatory training** without exam. A list of trained people is available for residential buildings[1], for non-residential new buildings[2] and for non-residential existing building[3]. Those three lists refer to three different trainings that are given by the same training company[4] leading to a certain uniformity in the training content. There is no mandatory course update to be taken by the professional. The training certificate is linked to the company for residential and non-residential existing building. For new non-residential buildings, the certificate is linked to the professional, it is worth mentioning that those people must be registered with the federation of architects and engineers in Luxembourg[5]. The legislative framework has been fully updated recently and merges all information in one regulation (LEGILUX, 2021). **Feedback and impact:** The instrument is mandatory and lasts for nearly 10 years, so it becomes part of the routine in Luxembourg. As the number of certified people/companies is quite large, this allows a certain competitivity and availability of trained professional for investors and

[1] https://guichet.public.lu/dam-assets/catalogue-pdf/listes-experts-batiments/liste-experts-batiments-habitation/liste-des-experts-pour-batiments-d-habitation.pdf
[2] https://guichet.public.lu/dam-assets/citoyens/fr/logement/construction/performances-energie/demande-passeport-energetique/liste-experts-batiments-fonctionnels-neufs.pdf
[3] https://guichet.public.lu/dam-assets/catalogue-pdf/listes-experts-batiments/liste-experts-batiments-fonctionnels-existants/liste-des-experts-pour-batiments-fonctionnels-existants.pdf
[4] Energie agence https://www.energieagence.lu
[5] OAI, Ordre des Architectes et Ingénieurs-Conseils, https://www.oai.lu/

home owners. A quality control is done, 8% of EPC certificates (122 EPC controlled) were found not acceptable[6]. Here are the probable reasons for this low level of quality:

- lack of training update
- quality of the training
- non accredited people make EPC, finally signed by an accredited professional
- ...

Instrument	Targeted audience	Incentive	Sector	Training duration
EPC-Luxembourg	Eng, archi, energy consultant	Mandatory	Designers	1-5 days

b. "Myenergy certified" is **an instrument (subsidy) to favorize the contracting of highly skilled people in energy efficiency for building construction or refurbishment**. The whole process is managed by a governmental agency[7]. The instrument is based on a quality assurance, the consultants "Myenergy certified" must contractually commit to a quality assurance program which includes: Compliance with the quality criteria on the content of the services, Compliance with the processing time of the services, Quality control of services by an third party, Client evaluation system, Continuous training. The project owner can find the list of certified people (people & companies) to help designing their new building or renovation. To introduce a subsidy request (example Primehouse subsidies[8]) only certified people are allowed. Other quality assurance certifications are available for the subsidy request, "my energy certified" is one of them.

Feedback and impact: the impact and feedback are not precisely evaluated. The primehouse subsidies reached 600 projects per year between 2017 and 2019[9]. This represents 0.4% of residential building stock per year according to Luxembourgish household statistics[10].

Instrument	Targeted audience	Incentive	Sector	Training duration
My energy certified	Eng, archi, energy consultant	Only trained people are eligible for subsidies requests	Designers	Not mentioned

c. An incentive towards companies named « accords volontaires pour l'efficacité énergétique » was running for the period of 2017-2020[11]. This incentive is a certain **tax exemption for companies linked with an obligation of training staff and monitoring of energy consumption**

[6] https://www.lsap.lu/wp-content/uploads/Question-parlementaire-sur-le-contr%C3%B4le-des-certificats-de-performance-%C3%A9nerg%C3%A9tique.pdf
[7] My energy https://www.myenergy.lu
[8] List of available subsidies for housing https://www.myenergy.lu/fr/particuliers/lois-et-reglements/soutien-financier
[9] Press article : https://www.wort.lu/fr/luxembourg/la-prime-house-rencontre-le-succes-5e55109ada2cc1784e356e96
[10] https://statistiques.public.lu/catalogue-publications/logement-en-chiffres/2020/PDF-Logement-9.pdf
[11] https://www.fedil.lu/fr/accord-volontaire-2017-2020 /

(not necessarily building consumption). A list of validated training centres is mentioned, the number of training days is described based on staff number and on energy consumption of the company. A methodologic approach is defined and summarizes the incentive (Conrod, 2019).

Feedback and impact: 48 companies were involved in this scheme as explained in the incentive evaluation[12]. Despite a small number of companies, a large amount of energy has been saved. The mean consumption per year per company is circa 150GWh (mainly electricity and gas), the total amount of energy savings lasting for 3 years is 350 GWh, this leads to around 7% drop. Globally the total energy balance for electricity and gas in Luxembourg in 2019 is circa 14500 GWh[13]

Instrument	Targeted audience	Incentive	Sector	Training duration
accords volontaires pour l'efficacité énergétique	Staff of every private company	Tax exemption for companies	Every private company	Detailed in methodology

4.3.2 Examples of such instruments and certification in other countries

a. "Qualiwatt"[14] is a **public certification scheme for PV installers in Belgium** (Walloon region) between 2014 and 2018. This scheme was focused on installers of small capacities PV field for residential buildings (<10kWpeak). Home owners have to make a contract with a Qualiwatt certified company to ask for subsidies. This scheme is not any more available, there is no more subsidies for such installations. A certification scheme for renewable installations in Belgium is currently in operation[15], but does not have any incentive.

Feedback and impact: Due to a big decrease in PV collector prices and the large amount of subsidies, the Qualiwatt plan was a real success more than 16000 PV installations where subsidized based on market regulator statistics[16]

Instrument	Targeted audience	Incentive	Sector	Training duration
Qualiwatt	Staff of PV installers	Only certified companies were eligible for **subsidies requests**	PV installers	Not mentioned, but an exam was mandatory

b. "CO2 performance ladder"[17] is a **sustainable procurement scheme enabling a better weighting of tenders showing a lower carbon footprint.** The tenderer has to compute their carbon footprint in a normative way and communicate it in the procurement procedure. The CO2 performance ladder is quite far from the building energy / environmental performance but emphasizes the impact of tendering procedures in public works. This scheme has started

[12] https://www.myenergy.lu/uploads/editor/files/bilan_AV_2019.pdf
[13] https://statistiques.public.lu
[14] https://energie.wallonie.be/fr/qualiwatt.html?IDC=9789
[15] https://rescert.be/fr
[16] https://www.cwape.be/sites/default/files/cwape-documents/3384.pdf
[17] https://www.co2-prestatieladder.nl/en/

in the Netherlands in 2009, and will be implemented soon in Belgium. This certification scheme is accredited by a third party and the methodology is published (Maud Vastbinder, 2020).

Feedback and impact: based on the statistics of SKAO (Foundation for Climate Friendly Procurement and Business in the Netherlands), more than 1000 certificates have been awarded[18].

Instrument	Targeted audience	Incentive	Sector	Training duration
CO2 performance ladder		Better chance to win a public tender.	Company responding to public call for tenders	No training involved

c. "PassivHaus certification for Designer and Consultant "[19] is a **private certification scheme** coming from passive house institute well known for being involved in the passive house standard. The certification scheme aims to have **better skilled people designing passive buildings**. This is an international scheme across Europe, the training consists in online training and online/presential exam or in designing a new house (with review of passive house institute).

Feedback and impact: the certified staff is about 6700 people all around the world.

Instrument	Targeted audience	Incentive	Sector	Training duration
PassivHaus certification for Designer and Consultant	Eng, archi energy consultant	Notoriety of Passive House Institute to have more customers.	Building designers	Exam: half a day or Design a house

4.3.3 Proposed classification and definition of the legislative frameworks' instruments

Table 1 summarizes the analysis of legislative frameworks in the light of the examples provided above.

Table 1. INSTRUCT classification of Legislative frameworks

Instrument	**Identified in**	**Target**	**Application**
Public certification policy schemes	EU-wide, example Luxembourg	Eng, archi, energy consultant	Mandatory EPC can be delivered by trained professionals only
	Luxembourg ("Myenergy")	Eng, archi, energy consultant	Only trained people are eligible for subsidies requests
	Belgium	PV installer	Only certified companies were

[18] https://media.skao.nl/content/ska/skadownload/CO2%20Performance%20Ladder%20Essentials%202020.pdf
[19] https://cms.passivehouse.com/en/training/certificates/designer-consultant/

			eligible for **subsidies requests**
Sustainable Procurement schemes	The Netherlands, Belgium (soon)	Companies responding to public call for tenders	Public procurement
Voluntary agreement at national, cross-sectors, level	Luxembourg	Every private company	tax exemption for companies linked with an obligation of training staff and monitoring of energy consumption

The following definitions of legislative instruments involving training for energy and environmental performance of buildings are provided:

- **Public certification support schemes** : Financial incentive for investors and building owners to contract a certified professional or company. The certification process is governed by legal texts covering several aspects such as : eligibility criteria for company or people, accredited training center, duration of the training, evaluation criteria, certificate duration, …

- **Public certification mandatory schemes** : People or companies must be certified to perform certain tasks. The certification process is governed by legal texts covering several aspects such as : eligibility criteria for company or people, accredited training center, duration of the training, evaluation criteria, certificate duration, …

- **Sustainable procurement schemes**: A series of rules are defined in legal texts supporting contractors and suppliers to provide added value through the delivery of sustainable working practices, green materials, energy efficiency and reduced carbon emissions. These rules cover at least an evaluation system in order to compare tenders during the bidding phase.

- **Voluntary agreement** : Agreement between people/companies and authorities to support a better energy/environmental performance of buildings. This agreement can involve tax exemption, …

INSTRUCT T3.3 will further analyze such frameworks in the consortium countries, and strengthen the definitions in relation with the need identified in demonstration 1 and demonstration 4.

4.4 Instrument for stimulating partnerships with producers, retailers and DIY

INSTRUCT project also aims to identify schemes for new partnerships with key actors from the construction supply chain, i.e. producers of material & equipment, retailers and DIY, which would enable energy-related skills to be valorised.

4.4.1 Description of actors and challenges

In this section, the **key actors** of the construction supply chain contributing to the overall impact on performance are identified. For each of them, the **impacts** are classified into four categories: energy,

environmental impact, quality (entailing lifespan), trackability (for efficient re-use and replacement). Eventually, the **main challenges** to be addressed are elaborated.

a. Producers

Roles:

- They maintain the quality of their products through respect of standards and communicate on the product and how to install/maintain them.
- They develop new innovative products

Impact:

Energy	low	The installed product in building is chosen in a catalogue by the installer advised by the retailer.
Environmental	medium	Producers drives innovation through lower environmental impact of products
Quality	high	
Trackability	high	They oversee the data linked with their products

Challenges to address:

Improved communication on the product itself: key energy and performance indicators, labelling (Environmental Product Declaration, C2C, circularity,…). How-to re-use the products and maintain them in good conditions. Training towards retailers and installers on the use of the products, re-use them and maintain them in good conditions. This is could be achieved by the use of digital product catalogues and digital product data templates.

b. Retailers

Roles:

- Be aware of the professional installer needs and provide adequate products (and related documentation) from various providers

Impact:

Energy	medium	Advises the installers on the products to install
Environmental	medium	Advises the installers on the products to install
Quality	medium	Advises the installers on the products to install
Trackability	low	

Challenges to address:

- Be a link for the smooth transfer of information between producer and user.
- Provide advice oriented on energy/environmental/trackability features.
- Have a broad view on systems (combination of materials, components).

c. DIY market

Roles :

- Provides adequate information on the products and combination of products to the private installer in order to guarantee the final performance of the works

Impact:

Energy	strong	Advises a non professional installer
Environmental	strong	Advises a non professional installer
Quality	strong	Advises a non professional installer
Trackability	low	

Challenges to address:

- Be a link between the sharing of information between producer and user.
- Advice oriented on energy/environmental/trackability features
- Advice in a way that is understood by the private installer

d. Installers

Even if not directly involved in the supply chain, the installers (professional or private) have a strong impact on the overall quality of the works. We propose to add them in the actors list.

Roles:

- Evaluate the needs of products based on the requirements of architects or other consultant or its own experience
- Install the products to guarantee the final performance of the works

Impact:

Energy	medium	The adequate implementation has a significant impact
Environmental	low	
Quality	strong	Implementation has a strong impact on quality and especially on products lifespan
Trackability	low	

Challenges to address:

- Have a sufficient knowledge of the work to do
- Understand the installation guidelines of products and systems
- Be aware of the impact of their work on the performance of building (e.g. air tightness)

4.4.2 Scope of application and definition in INSTRUCT

The creation and transmission of adequate data between the actors are amongst the most challenging aspects of the construction supply chain. The various means for addressing this challenge are on the one hand: video, training, leaflets, … realized by the producers and retailers. This leads to a better choice and installation of the products. On the other hand, a digital product data template would lead to a better trackability and better end of life management.

Definition of partnerships schemes

First of all, the partnership could be considered between the companies themselves, we call it business partnership:

- A business partnership is a legal relationship that is most often formed by a written agreement between two or more individuals or companies. The partners invest their money in the business, and each partner benefits from any profits and sustains part of any losses.

For the purpose of better energy/quality/environmental procurement of materials, equipment and systems, business partnerships can take several forms (non-exhaustive):

- **Procurement partnership**: a company will negotiate with a certain producer/retailer to have better prices, easier way to install,… with or without exclusivity. Some examples:
    - HVAC installers working with only one equipment trademark
    - Retailer dealing with a few producers whom quality is higher.

These forms of partnerships help better communication between the supply chain companies.

- **Subcontracting partnership**: a company will subcontract another one for a part of work of procurement where it is more cost effective of more efficient. Some examples:
    - General contractor subcontracting HVAC installer for a part of the works.
    - Producer subcontracting engineering company for the best selection of its products for a certain project
    - Producer can subcontract its production by another company
      This partnership could lead to loss of information if subcontractors are not well led, or in the case of cascading subcontracting

Secondly, partnership could be done between companies and associations, research centers, universities, public authorities or training centers. There is no general definition, here are some purposes of such partnerships:

- Training of people
- Certification of products
- Development and testing of products

Next steps

As part of T3.4, the team will conduct meeting and workshops with stakeholders on the basis of a map of the value chain related to the key energy efficiency interventions. The purpose of this consultation is to agree on the key challenges mentioned above, and progress towards the identification of possible partnerships which could be implemented and lead to impacts on buildings' energy efficiency.

4.5 Instruments promoting the added-value of skilled professionals to building and home owners

Europe is facing a huge challenge in relation with the acceleration of the renovation rate across Member States. Inadequate and poor housing causes high energy bills, health issues and lowered quality of life for European citizens.

But as the retrofitting technical solutions become more and more efficient, owners are facing significant issues when planning and undertaking their renovation projects.

4.5.1 Description

In too many EU Member States building owners have to face complicated, numerous and often ambiguous administrative and technical procedures. Too often, subsidies are uncertain and prevent solid budgetary forecasts. Overall, this situation is a limit to private investments, and contributes to low renovation rates in EU.

4.5.2 Scope of application

The focus is put on the so-called "Superbonus 110%", the most important incentive - a tax deduction - introduced in Italy in 2020 to deal with the energy efficiency renovation of residential buildings (including social housing).

The Superbonus 110% has known an increasing demand in Italy over the last year, but sometimes it seems quite unclear to the final recipients how it works. In fact, there are specific technical requirements and a strict legal framework to comply with. Moreover, a crosscutting and well coordinated intervention of skilled professionals is also required in this process: i.e. accountants, designers, project checkers, construction workers, installers, banks and lending institutions.

INSTRUCT's partner DTTN plans dissemination activities to increase awareness of building and home owners with regards this incentive scheme. This will be based on specific communication material to be developed, including a set of convincing best practices and other communication means covering 1) legal and fiscal frameworks, 2) technical and performance requirements and 3) an overview of possible energy efficiency interventions carried out in real cases (Figure 16).

Figure 16: Awareness actions foreseen towards building and home owners

In this context, it is foreseen to rely on the target owners that would participate in those events, in order to detect, validate or broaden the scope of potential means to promote the added-value of skilled professionals.

As part of this initiative, a survey will be developed as part of T3.5, with the aim of clarifying those means, and targeting home owners in Italy (in relation with the stakeholders targeted in T4.x) and the UIPI (EU association of building and home owners). The purpose is to deliver the key recommendations for a quick market uptake of energy related skilled workers, including for example the expectations of home owners towards energy professionals.

The next steps to be conducted as part of T3.5 are therefore:

- Investigate the requirements and needs from DTTN target audience in Italy (municipality),

- Define minimum requirements for a survey, considering the constraints associated with getting the attention of this target,
- Compare the needs against other EU/national surveys, if any.

5 Conclusion

In this deliverable, the INSTRUCT instruments are presented. The portfolio of instruments is quite broad and heterogeneous, and aims to support the demonstration activities foreseen in WP4:

1) The INSTRUCT platform, a web-based system which relies on the previous energy-bim.com platform, and will host specifically for INSTRUCT the following services:
   a. Support functions for the design of new trainings, incl. a training database with add and search functions, as well as an innovative mapping module for considering multiple LO matrices.
   b. A training management system, which considers the use of smart contracts for the management of training processes.
2) Elearning modules, to be adapted or developed for the purpose of the demonstrations; In particular the team plans to reuse and deploy further two eLearning modules which have been elaborated in BIMEET: BIM and Building Energy Efficiency and BIM for Energy Performance Certificates
3) New legislative frameworks, and in particular with a focus on public certification policy schemes, sustainable procurement schemes and voluntary agreements;
4) New partnerships amongst producers, retailers, installers as well as DIY; those partnerships will be rigorously analysed and discussed with professionals on the basis of a proposed value chain representation which will guide the process.
5) Instruments promoting the added-value of skilled professionals to building and home owners; this will likely take the form of information sessions which will address 1) legal and fiscal framework, 2) technical and performance requirements and 3) examples of energy interventions

Further developments of those instruments are expected in further T3.2, T3.3, T3.4 and T3.5, and will closely involve the partners involved in the various demonstration pilots of WP4.

6 References

Conrod, F. (2019). *Note explicative et méthodologique Relative à l'implémentation de l'accord volontaire concernant l'amélioration de l'efficacité énergétique dans l'industrie luxembourgeoise pour la période 2017-2020.* Retrieved from My energy agency: https://www.fedil.lu/wp-content/uploads/2019/04/Note_explicative_AV_2019-02-13.pdf

European Construction Sector Observatory. (2020). *Improving the human capital basis.*

LEGILUX. (2021). *Règlement grand-ducal du 9 juin 2021 concernant la performance énergétique des bâtiments.* Retrieved from https://legilux.public.lu/eli/etat/leg/rgd/2021/06/09/a439/jo

Maud Vastbinder, G. T. (2020). *Handbook CO2 performance ladder 3.1.* Utrecht: SKAO Foundation for ClimateFriendly Procurement and Business.

Glossary

Acronym	Full name
AEC	Architecture, Engineering and Construction
CA	Consortium Agreement
CEDEFOP	European Centre for the Development of Vocational Training
EC	European Commission
EASME	The Executive Agency for Small and Medium-sized Enterprises
EQF	European Qualifications Framework
ERD	Entity Relation Diagram
GA	Grant Agreement
PC	Project Coordinator
WP	Work Package
TL	Task Leader
DoA	Description of Action
PSC	Project Steering Committee
SQM	Scientific and Quality Manager
DEC	Dissemination and Exploitation Committee
KOM	Kick-off meeting
ASM	ASM – Market Research and Analysis Centre
VET	Vocational Education and Training
VTT	Technical Research Centre of Finland
LIST	Luxembourg Institute of Science and Technology
RIL	Finnish Association of Civil Engineers
CU	Cardiff University
R2M	Research to Market Solution France
DTTN	Distretto Tecnologico Trentino
ENEFFECT	Center for Energy Efficiency EnEffect
GER	General Exploitable Result
AB	Advisory Board
PM	Person month
M	Month
LO	Learning Outcome
NZEB	Near Zero Energy Building
ECSO	European Construction Sector Observatory

Annex 1 – BIMEET e-learning modules

4. New BIMEET training

Section 4 describes the training modules that have been designed in the later stage of BIMEET action. The consortium decided to build on the lessons learnt in the first steps of the project in order to improve existing training schemes or deliver knowledge based on the research carried out within BIMEET.

Two courses are therefore presented in the following parts.

4.1 BIM and Building Energy Efficiency – blended learning scheme

As it was presented in section 3, The *BIM for building energy efficiency* training was delivered several times and about 85 persons were trained. This is not sufficient to reduce the potential energy saving. That's why we have to increase the number of trained persons. One issue is to transform the in-class training to a blended learning scheme as it is described in Figure 2.

OBJECTIVE OF THE COURSE

Learner gets a coherent overview of BIM and building energy efficiency. (S)he understands the benefits and importance of BIM in enhanced and accurate results of energy efficiency. (S)he also learns what needs to be considered in the information modelling to unleash its potential as the data source for the analysis. An overview of some use cases helps the learner to understand the benefits and challenges of current tools. An in-class practical work consists on understanding some BIM tools and dealing with interoperability issues. Modules of this training can be followed separately.

TARGET GROUP

All stakeholders in the building industry could be interested on this training, especially Architectural design roles and energy design roles. This BIM&EE training may also interest client roles to be aware of the BIM potential for energy efficiency training.

DETAILS OF THE TRAINING

A placement test is required before beginning the training. Here we come to some fundamental questions to assess knowledge typically required of trainees for BIM on the one hand and energy efficiency on the other.

The scores of this placement test permit to customize the in-class training content to best suit the trainees' level.

Three e-learning courses are proposed. These ones deal with theoretical contents about:

- Introduction to BIM
- Introduction to energy efficiency of buildings
- How BIM can optimize energy efficiency of buildings

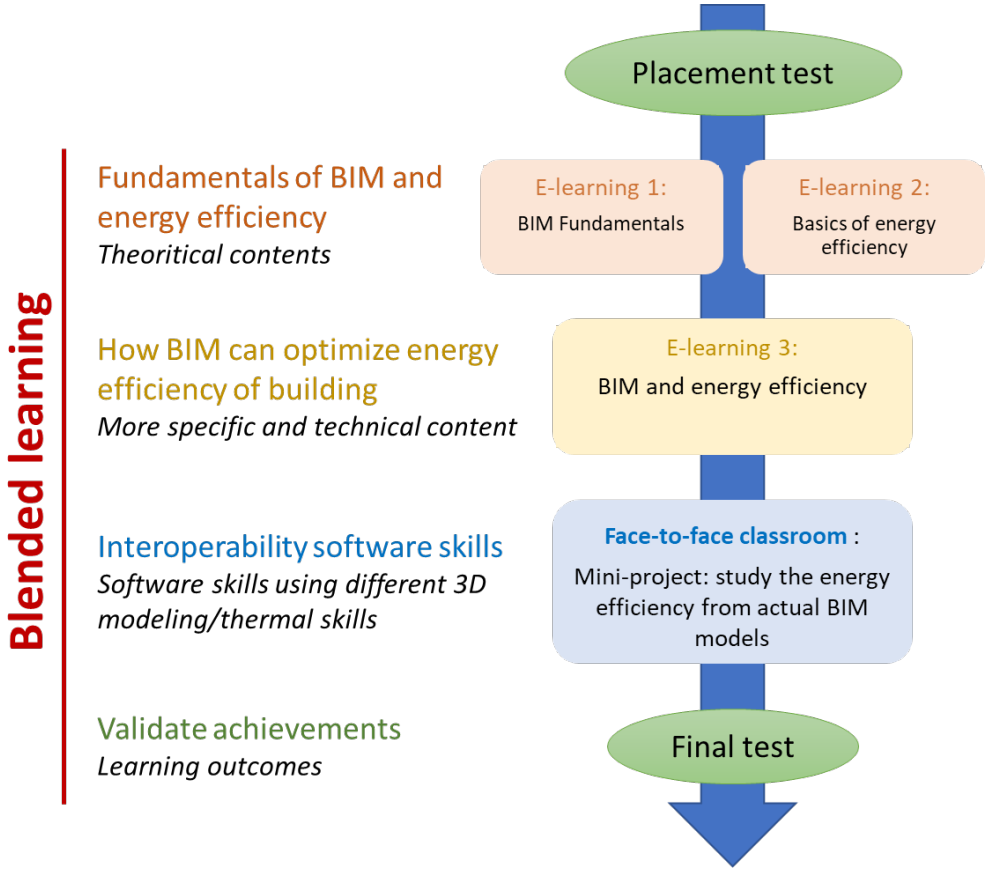

Figure 2: Blended learning scheme for BIM and Building Energy Efficiency training

The following Table 5, Table 6, Table 7 and Table 8 present details of these three e-learning courses and the in-class one.

Table 5: Description of module 1 - introduction to BIM

Module 1: Introduction to BIM		
Learning outcomes	- Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle - Learner is able to explain and use BIM based collaboration methods for project management and processes - Learner is able to explain basic objectives of using BIM during different stages of the building - Learner is able to prove comprehensive knowledge about BIM terminology, definitions and national guidelines for building information modelling	
Content	Chapter 1 What is BIM	Definition of BIM BIM potentials

	Chapter 2 BIM levels	Level of maturity Level of development Dimensions of BIM
	Chapter 3 How BIM works	Closed and Open BIM Interoperability A BIM team
Duration	13 minutes	

Table 6: Description of module 2 - introduction to energy efficiency of buildings

Module 2: Introduction to Energy Efficiency of Buildings		
Learning outcomes	- Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance - Learner is able to prove good knowledge on over all energy efficiency of buildings and excellent knowledge on profession specific demands in achieving energy efficient buildings	
Content	Chapter 1 Introduction	- Energy context - Thermal flows: conduction, convection and radiation
	Chapter 2 Heat losses	- Thermal resistance - How to compute heat losses through opaque surfaces, air infiltration, air renewal, windows and thermal bridges
	Chapter 3 Heat gains	- Solar gains - Internal gains How to compute heating needs
	Chapter 4 How to improve energy efficiency	- How to reduce heating demand - How to improve air tightness and reduce ventilation losses - How to improve the insulation of buildings - How to reduce cooling demand
Duration	20 minutes	

Table 7: Description of module 3 - BIM for Energy Efficiency of Buildings

Module 3: BIM for Energy Efficiency of Buildings		
Learning outcomes	- Learner is able to explain about the procedures and importance of setting targets for energy, sustainability and building performance - Learner is able to implement energy performance, building performance and sustainability targets into design process is able to create and develop sustainable energy efficient buildings using BIM tools - Learner is able to explain the aspects how BIM based projects benefit energy efficient buildings. - Learner is able to prove skills in using BIM-based design software	
Content	Chapter 1 Introduction	- Common BIM - How BIM can optimize energy efficiency through the whole life cycle
	Chapter 2 BIM for energy efficiency of construction	- In programming phase - In design phase - In construction phase - In use and exploitation phase
	Chapter 3 Use cases	- Green O'Valley: buildings by Schneider Electric in Grenoble - Development of a virtual city model, 3D model of Dundalk
Duration	9 minutes	

Following these e-learning contents, about 2 days of in-class training are delivered. The aim is:

- To discuss with the trainee, if there is some questions about what it was followed remotely.
- To use BIM software: perform a thermal simulation on a 3D model (Revit for 3D modelling and Pléiades for energy computation)

The practical work is performed on a simple case study (two rooms individual house for example). Interoperability issues are raised when exporting the 3D model and importing it to the energy computation software.

Details of this in-class training are in the Table 8.

Table 8: Description of module 4: Thermal simulation on a BIM model

Module 4: Practical work – Thermal simulation using a BIM model	
Learning outcomes	- Learner is able to use different relevant software and interfaces between relevant software - Learner is able to understand and correct interoperability errors - Learner is able to prove skills in using BIM-based design software - Learner is able to produce BIM models with accurate and required information content for different uses and phases of a building project - Learner is able to produce different design concepts and make feasibility comparisons with help of simulations to achieve targets set by client - Learner is able to perform different analysis in using assessment, simulation and optimisation tools - Learner is able to explain how to define resources needed for design and defining competence requirements for designers and engineers
Content	- Design 3D model on Revit: simple 2 rooms individual house - Export 3D model to IFC or gbXML model - Import the exported model in a thermal simulation software (Pléiades for example) - Simulate the energy behaviour of the model: compute heating needs and energy consumption
Duration	14 hours

QUALIFICATION FRAMEWORK

The analysis of this BIM&EE training according to the qualification framework proposed in D3.2 is presented in Table 9 and Table 10 for the different stakeholders who followed the training.

Table 9: BIMEET Qualification Framework for Client and Client advisors' roles corresponding to the BIM&EE training

No	Learning outcome	EQF level

Client & Client advisors Client & Project manager (C), BIM manager (BM), BIM coordinator (BC), briefing consultant (Bc)		C	BM	BC	Bc
LO1	**Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.**	**4**	**6**	**6**	**4**
1.1	Recall essential contents, summarize and give examples of BIM terminologies, definitions and standards.	4	6	5	4
1.2	Explain added value of BIM for energy efficient and sustainable projects.	4	6	5	5
1.3	Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.	2	3	3	5
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	3	5	5	2
1.6	Explain the main contents and apply relevant parts of national BIM guidelines.	4	6	5	-
LO2	**Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance.**	**3**	**3**	**3**	**5**
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	4	4	4	3
2.2	Describe the aspects (financial and environmental) and related indicators of energy and building performance.	5	4	4	3
LO4	**Learner is able to explain about the procedures and importance of setting targets for energy, sustainability and building performance.**	**6**	**5**	**3**	**6**
4.2	Include and explain the importance of energy analysis in the decision making starting from the earliest stages of the project and even on the basis of very simple and preliminary BIMs.	6	4	2	6
4.5	Review BIM models and evaluate the functionality of spaces with regard to user needs, designed performance and set performance targets.	4	5	4	5
4.7	Explain the concepts of digital twin and its potential in the optimization of comfort and energy performance of building.	3	3	3	1
4.8	Explain how to define requirements for performance documentation (how and where the targeted, designed and achieved performance is documented to enable the continuous monitoring by the client?).	4	6	4	-
LO7	**Learner is able to use different relevant software and interfaces between relevant software.**	**4**	**5**	**5**	**5**

7.3	Use different tools for BIM-based collaborative working.	3	5	5	3
7.4	Use BIM compatible requirement setting tools.	4	3	3	5
7.5	Prepare and maintain the requirement model.	-	4	4	3
7.6	Create combination model and use model checking tools for design reviews and constructability.	-	3	5	-

Table 10: BIMEET Qualification Framework for Architectural design roles corresponding to the BIM&EE training

No	Learning outcome	EQF level		
Architectural design roles Architectural design and BIM Coordinator (arch), Chief designer (CD), Architect (ARCH), Assistant designer (ASS)		CD	ARCH	ASS
LO1	Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.	6	6	3
LO2	Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance.	4	6	2
LO4	Learner is able to implement energy performance, building performance and sustainability targets into design process.	5	6	1
LO5	Learner is able to produce BIM models with accurate and required information content for different uses and phases of a building project.	3	6	2
LO8	Learner is able to use different relevant software and interfaces between relevant software.	5	5	3

4.2 BIM for Energy Performance Certificate (EPC) – e-learning training

Another new training was designed within BIMEET project: *BIM for Energy Performance Certificate* which is a full e-learning training.

Assessing EPC (Energy Performance Certificate) is mandatory for most buildings in the EU. EPC has the potential to direct construction projects towards sustainable solutions. The traditional way of generating EPC can be time consuming. BIM (Building Information Modeling) is becoming a more popular information source during building projects and building life cycle. BIM is a virtual data-bank of the building and has the potential to excessively enhance the EPC process. An energy efficient building is based of integrated effort and knowledge of a variety of different stakeholders, and course can be beneficial to anyone working in the construction sector.

Each country in the EU has their own approach to EPC and BIM. During the course, learner is able to follow course materials according to their country perspective or introduce themselves the developments of other countries. Course consists of slideshows, videos, extra-materials and final exam.

LEARNING OUTCOMES

The learning outcomes defined for BIM to EPC course training is as follows. Additional learning outcomes matrix developed in the project was further consulted for defining module specific learning objectives that are listed in the next heading.

- Explain added value of BIM for energy efficient and sustainable projects.
- Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.
- Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.
- List and explain the core concepts of sustainable building rating and certification systems.
- Explain and give aspects and terminologies of energy and building performance.
- Point out legislation and regulations related to energy performance, thermal comfort and air quality.

OBJECTIVE OF THE COURSE

Learner gets a coherent overview of current and future uses of EPC in the building sector in the EU. (S)he understands the benefits and importance of BIM in enhanced and accurate results of EPC assessments. (S)he also learns what needs to be considered in the information modelling to unleash its potential as the data source for the analysis. An overview of different use cases helps the learner to understand the benefits and challenges of current tools. Overview of the future developments of BIM and EPC presses the importance of developing modelling and assessment skills for better quality building projects.

At the end of the training, the learner is able to:

- Point out legislation and regulations related to EPC (Energy Performance Certificates).
- List and explain core concepts of EPC (Energy Performance Certificate) in the EU.
- List and explain core concepts assessment.
- List initial data needed for EPC assessment.
- Give examples of specific information modeling requirements and outputs to enhance EPC assessment.
- Give examples how to extract needed initial data from BIM for EPC.
- Summarize the process of EPC calculation.
- Discuss about potentials and uses of different available BIM-compatible EPC-tools.

TARGET GROUP

This online course is contributing to the national approach, it is open to all stakeholders in the building industry with special benefit to Clients & Client advisors, Architectural design roles and Building services design roles. Learners are able to follow course materials according to their country perspective or introduce the developments of other countries.

DETAILS OF THE TRAINING

The training is composed of 5 lessons and a final exam to validate the learning outcomes as it follows (Figure 3):

- Lesson 1: Review of (2018) Regulations
- Lesson 2: Added value and possibilities of BIM for EPC assessment
- Lesson 3: How to prepare BIM and how to extract data from bim for EPC
- Lesson 4: EPC calculation tools and use cases
- Lesson 5: Future developments of EPC calculations and BIM

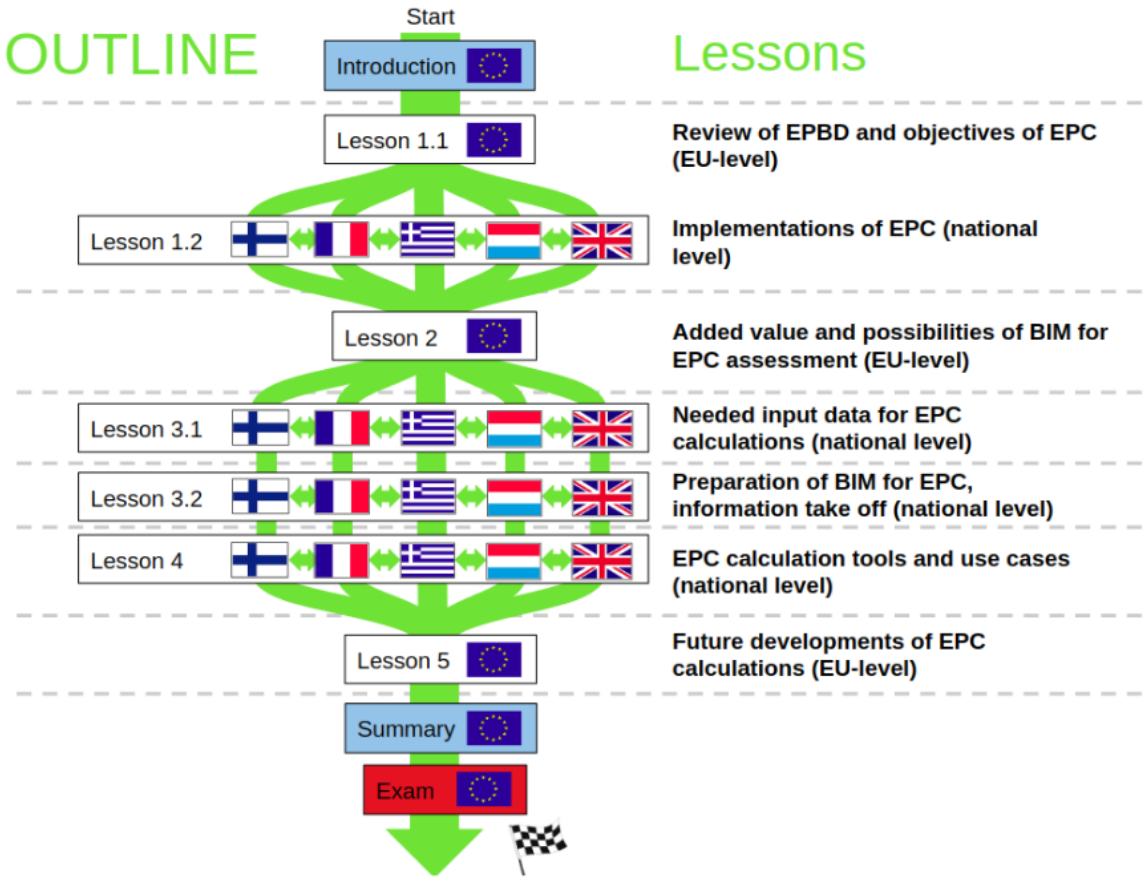

Figure 3: BIM for EPC training scheme

Details of lessons are in Table 11, Table 12, Table 13, Table 14 and Table 15.

Table 11: description of Lesson 1 - Review of EPC in Europe

Lesson 1 – Review of EPC in Europe	
Learning Objectives	- The learner is able to point out legislation and regulations related to EPC

	- The learner is able to list and explain core concepts of EPC in the EU.
Content	- General review of EPBD and objectives of EPC in the EU - National implementations of EPC: Finland, UK and Luxembourg perspectives
Duration	15 minutes

Table 12: Description of lesson 2 - Added value of BIM in EPC assessment

Lesson 2 – Added value of BIM in EPC assessment	
Learning Objectives	- The learner is able to explain added value of BIM for EPC assessment.
Content	- EPC in building energy analysis - EPC calculations - Interoperability - Collaborative approaches - How to enable BIM benefits in EPC assessment?
Duration	10 minutes

Table 13: Description of lesson 3 - How to prepare BIM and how to extract data from BIM to EPC

Lesson 3 – How to prepare BIM and how to extract data from BIM to EPC	
Learning Objectives	- Learner is able to list initial data needed for EPC assessment. - Learner is able to give examples of specific information modelling requirements and outputs to enhance EPC assessment. - Learner is able to give examples how to extract needed initial data from BIM for EPC.
Content	- National implementations of data required for EPC calculations (Finland, UK) - Preparation of BIM to benefit EPC and information take off (Finland)
Duration	20 minutes

Table 14: Description of lesson 4 - EPC tools, processes and software

Lesson 4 – EPC tools, processes and software		
Learning Objectives	- Learner is able to summarize the process of EPC calculation. - Learner is able to explain about potentials and uses of different available BIM-compatible EPC-tools.	
Content	EPC tools, processes and software	- Finland perspective - UK perspective
	Use cases/Animated demos	- EPC assessment in monthly method with – Laskentapalvelut.fi - How to make light 3D-model to enhance EPC assessment – SketchUp - How to import IFC file to dynamic calculation tool – IDA Indoor Climate and Energy
Duration	23 minutes	

Table 15: Description of lesson 5 - Future developments of EPC calculations and BIM

Lesson 5 – Future developments of EPC calculations and BIM	
Learning Objectives	- The learner is able to discuss about the future developments of EPC.
Content	- Next generation of EPC - Integration with BIM models - Benefits of building EPC database - Quality control - Recommendations
Duration	5 minutes

QUALIFICATION FRAMEWORK

Learning outcomes of this BIM for EPC calculations training according to the qualification framework proposed in D3.2 are presented in Table 16, Table 17, Table 18, Table 19, Table 20 and Table 21 for the different stakeholders who followed the training.

Table 16: BIMEET Qualification Framework for Client roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level			
Client & Client advisors Client & Project manager (C), BIM manager (BM), BIM coordinator (BC), briefing consultant (Bc)		C	BM	BC	Bc
1.2	Explain added value of BIM for energy efficient and sustainable projects.	4	6	5	5
1.3	Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.	2	3	3	5
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	3	5	5	2
1.6	Explain the main contents and apply relevant parts of national BIM guidelines.	4	6	5	-
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	4	4	4	3
2.5	List and explain the core concepts of sustainable building rating and certification systems.	3	3	3	5

Table 17: BIMEET Qualification Framework for architectural design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level		
Architectural design roles Architectural design and BIM Coordinator (arch), Chief designer (CD), Architect (ARCH), Assistant designer (ASS)		CD	ARCH	ASS
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	6	6	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	4	4	2

2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	6	6	3

Table 18: BIMEET Qualification Framework for structural design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
Structural design roles Structural design (SD) and BIM Coordinator (structural), Assistant designer (ASS)		SD	ASS
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	6	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	4	1
2,7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	5	2

Table 19: BIMEET Qualification Framework for building services design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
Building services design roles HVAC and energy design (HVAC+E) and BIM Coordinator (HVAC), Assistant designer (ASS)		HVAC+E	ASS
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	5	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	5	2

2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	6	2

Table 20: BIMEET Qualification Framework for construction work roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
Construction work roles Site manager (SM), Construction site workers and installers (CW)		SM	CW
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	4	-
2.5	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	4	-

Table 21: BIMEET Qualification Framework for maintenance work roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level		
Maintenance work roles Maintenance operator (MO), Property manager (PM), Care taker (CT)		MO	PM	CT
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	3	3	1
2.6	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	3	2	2

4.3 How to get to courses

From www.energy-bim.com, and from the e-learning training widget, you have a summary of the training and some other information like the overview of the course, target group, learning objectives, duration, and the access to the contents of courses. These ones are hosted in INES e-learning platform (www.e-learning.ines-solaire.org)(Figure 4).

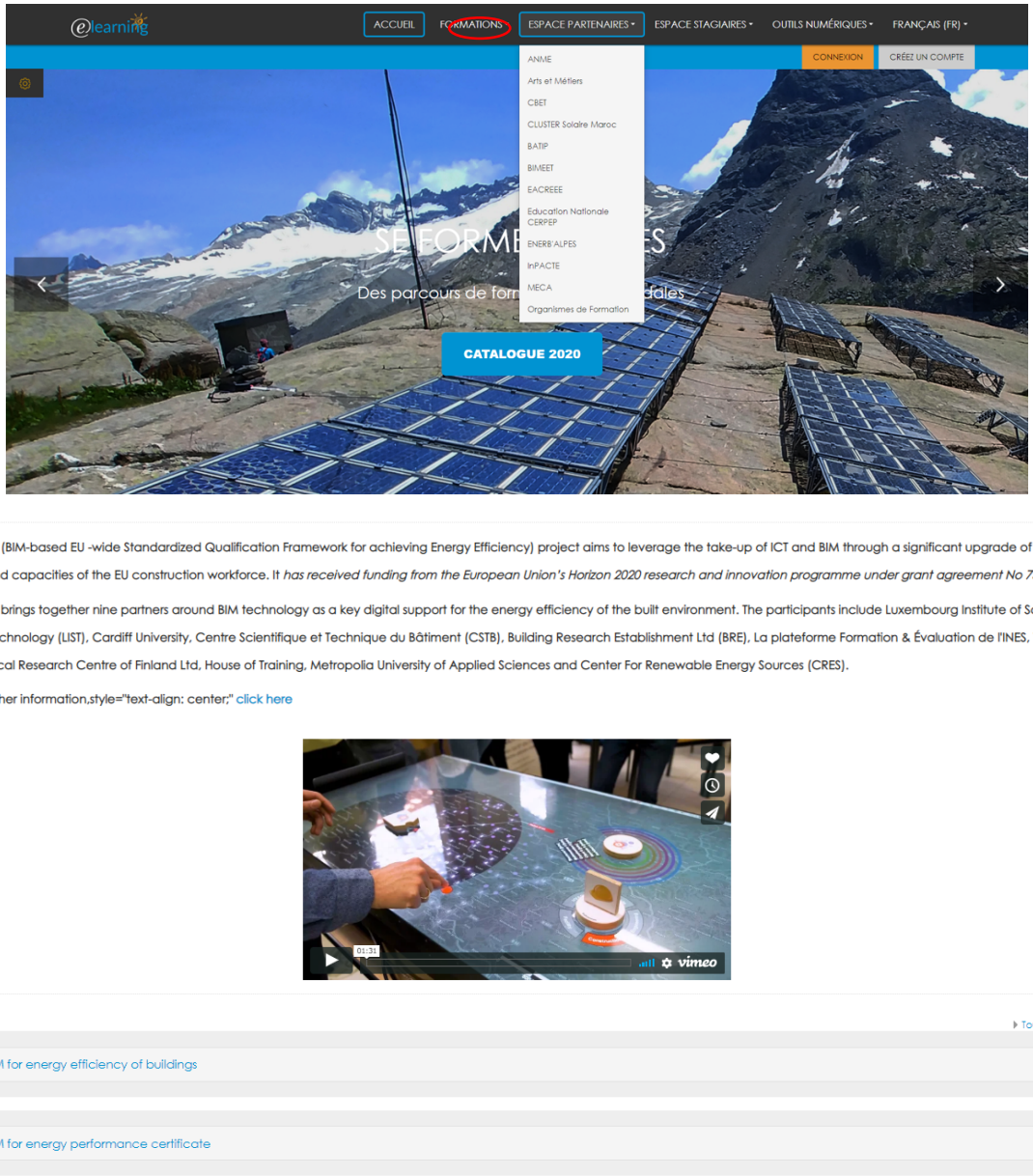

Figure 4: BIMEET trainings on INES platform

In order to make statistics on the numbers of trainings' followers and their profiles, an account registration is mandatory to have access to the courses.

www.instructproject.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 894756.