DEVELOPMENT OF NEW VOCATIONAL TRAINING MODULES ON SUSTAINABLE BUILDINGS MAINTENANCE AND REFURBISHMENT

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Abstract

This article presents the methodology and main results obtained in Spain within the FORMAR project, a European-funded project under the Leonardo Da Vinci scheme (Lifelong Learning Programme), whose main goal is to jointly develop training resources and modules to improve the skills on sustainability issues of buildings maintenance and refurbishment workers, in three different European countries: Spain, Portugal (Project Coordinator) and France. The Units of Short-term Training (UST) developed within this project are focused on the VET of carpenters, painters, bricklayers, building technicians and installers of solar panels, and a transversal unit containing basic concepts on sustainable construction and nearly Zero Energy Buildings (n-ZEB) is also developed. In parallel, clients' guides for the aforementioned professionals are also implemented to improve the information provided to clients and owners in order to support the procurement decisions regarding building products and materials. Therefore, the project provides an opportunity to exchange experiences between organizations of these three European countries, as the UST will be developed simultaneously in each of them, exploring opportunities for training, guidance and exchange of experience. Even though the UST will have a common structure and contents, they will be slightly different in each country to adapt them to the different specific training needs and regulations of Spain, Portugal and France.

This paper details, as a case study, the development process of the UST for carpenters and building technicians in Spain, including the analysis of needs and existing training materials, the main contents developed and the evaluation and testing process of the UST, which involves the active participation of several stakeholders of this sector as well as a classroom testing to obtain the students' feedback.

Keywords: Vocational Training; sustainable construction; training resources; building professionals; buildings maintenance and refurbishment.

1 INTRODUCTION

The European Union (EU) aims to become an advanced knowledge-based society, with sustainable economic development, more and better jobs and greater social cohesion. To this end, a common language is required in the qualitative and quantitative reference systems that allow supporting the employability and mobility of trainees and workers, important both for vocational education and training systems and labour market. In particular, EU decision makers consider adult education as essential to improve competitiveness and employability, as well as to active citizenship and individual development all over Europe [1][2]. In this regard, the Vocational Education and Training (VET) sector has to play its part and work hard to ensure the development of national qualifications frameworks based on learning outcomes. In this line, the European Credit System for Vocational Education and Training (ECVET) Recommendation of the European Parliament and the Council highlighted in 2009 the need to design and compare the qualifications in the different European countries. Even though this recommendation (ECVET) is voluntary, since 2012 it is a priority to test and introduce the concepts and principles of ECVET across Europe, to guarantee the creation of the necessary conditions for its gradual application to VET.

Although Sustainable Construction is considered a priority within the European Union [3], and despite the availability of proven techniques, most buildings are not constructed or renovated in a sustainable way. The main reason attributed is the lack of interest from builders and buyers who incorrectly perceive sustainable construction as expensive and doubt about the reliability and performance of new technologies. This behaviour should be changed promptly, because Directive 2012/27/EU establishes that from 31st December 2020 all new buildings constructed should be nearly Zero Energy Buildings

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(n-ZEB) and remarks the importance of building refurbishment [4]. This makes indispensable a training renovation in the construction sector, and at all Education levels.

1.1 Background

There are previous studies in the field of Vocational Training, which study, among others, decision making [5] and learning design [6] issues, as well as quality related matters [7][8], but few studies have been found that address specifically the development of VET curricula [9] or more precisely the actual training [10]. From those studies, even though the latter addresses Sustainability in Vocational Training, it is focused on waste management, and specifically in a case study on Mexico [10]. Therefore there is a lack of specific scientific studies published in the field of VET in Sustainable Buildings.

However, there are several previous and ongoing European projects focused on energy and environment as well as on sustainable construction and, in particular, training workers related to these issues. For example, the European Project *"Energy and Environmental training for a Clean Europe"* [11] and more recently *"Build up Skills"* Project, the EU sustainable building workforce initiative running under the Intelligent Energy Europe Programme [12], which is dealing with the training of the building work force to provide skills related to energy efficiency and renewable energies integration in buildings. Likewise, the Concerted Action on Renewable Energies, CA-RES [13], is contributing with the implementation of *Article 14* of the Renewable Energies Directive 2009/28/EC [14] that deals with the certification of installers of 5 renewable energies technologies (solar thermal, solar photovoltaics (PV), biomass boilers and stoves, shallow geothermal and heat pumps).

Furthermore, it should be considered that heating and lighting of buildings accounts for the largest single share of energy use (42%, of which 70% is for heating) and produces 35% of all greenhouse gas emissions [3], therefore the training in these matters should be a priority in the actual Education system, in order to meet the goals stated in the Directive 2010/31/EU on the energy performance of buildings, of improving the buildings' energy efficiency, while reducing CO_2 emissions [15].

Even though these are all important initiatives and goals towards sustainable construction, they are very focused on energy efficiency and renewable energies. Therefore, the issue of sustainability in building construction still needs to be addressed, not only regarding the construction itself and the training and terminology knowledge of the working force, but also concerning all the aspects related to the life cycle of the building, from the planning stages, through construction and retrofitting stages to its end-of-life.

Bearing in mind all the above, it has been identified a need to provide specific vocational training on sustainable construction methods and techniques, sustainable procurement, labelling and standards not only for the planners and all the working force dealing with building construction, maintenance and refurbishment, but also for all building managers and in general all the people involved in the buildings refurbishment (including building owners and users).

Although the National Catalogues of Qualifications are constantly updated to cover several emerging issues, such as the area of sustainable construction and n-ZEBs, nowadays, the training references that are part of these Catalogues do not integrate Units of Short-term Training (UST) concerning sustainability issues. Besides, although the construction industry has adopted several new technical improvements enabling companies to build more sustainable buildings and more energy saving buildings, the training offer is still limited and the European cooperation in this field is relatively weak. In this context, FORMAR project aims to produce resources and modules targeted to sustainable construction, to contribute to integrate this trend in the Vocational Education and Training (VET) itineraries by developing new and specific UST.

1.2 Aims and Objectives

The main goal of FORMAR project is to develop training resources and modules to improve the skills on sustainability issues of workers of buildings maintenance and refurbishment. Five Units of Short-term Training are being developed and integrated in the vocational training of carpenters, painters, bricklayers, building technicians, and installers of solar panels. Besides, a transversal unit has been developed concerning basic concepts on sustainable construction and n-ZEBs. A second goal is to improve the information provided to clients and owners, through the development of a guide, to support the procurement decisions related to building products and materials. The guide will allow an

adequate choice of not only more sustainable products, solutions or services, but also qualified workers with additional skills on sustainable construction.

Thus, this project has the following innovative elements:

- Enable trainees to consider new recommendations related to the sustainable construction;
- Connect the area of sustainability and the construction sector with pedagogical concerns related to the need of appropriate qualified professionals;
- Provide an opportunity for the development of training itineraries more consistent through a transnational cooperation, allowing the adaptation of existing skills to the demands of the present job market, increasing the employability and the labour mobility;
- Allow a joint reflection on the state of the art, analysis, comparison and improvement of the existing educational practices and how to integrate the sustainability issues;
- Provide the project partners with an innovative common European approach, adjustable to their national contexts;
- Consider the methodological principles of the ECVET in the development of the UST, allowing its subsequent integration in the ECVET. This Credit System is expected to be adopted in Europe, which will facilitate the transparency of qualifications and their recognition in all European countries.

2 METHODOLOGY

The FORMAR project includes a group of parallel work packages that aim to develop 25-hours UST on sustainability issues oriented to workers of buildings maintenance and refurbishment: carpenters, painters, bricklayers, building technicians, installers of solar panels, and one UST with transversal contents. These Units of Short-term Training (UST) are learning units capable of being integrated in the training offer, allowing the acquisition of certified skills through ECVET. The present paper focuses on the main work undertaken in Spain, which is the development of the UST for carpenters and building technicians.

For each of the aforementioned building professionals, the following activities have been undertaken:

- Analysis of needs and existing training materials;
- Identification of best practices and constraints;
- Development of training modules: unit program and session plans;
- Development of training resources: training contents, practical exercises, and trainer's manuals;
- Development of a client's guide to support its purchasing decisions;
- Translation from English to three languages: Portuguese, Spanish and French.

The UST with transversal contents contains modules concerning basic concepts on sustainable construction and n-ZEBs. The other USTs contain modules concerning basic concepts and relevant environmental aspects of the relevant building products for each profession, considering their types and classification, product's life cycle, labelling and standards, best practices and recommendations for their purchasing, installation, use and end-of-life. Besides, all UST consider the possibility of conducting field visits and invitations to external entities for dissemination of sustainable building products.

The main objective is that at the end of the training the trainees should be able to choose more sustainable products, especially through the purchase of products that contribute to improve the energy performance of buildings and the indoor air quality. In addition, the trainees should also be able to use a set of best practices for a more sustainable application, use and end-of-life of these products. In this way, it will be possible to meet the goals of improving the skills of the professionals, and contribute to implement a more sustainable maintenance and refurbishment of buildings.

To achieve this objective, the first version of the UST is evaluated and tested by several stakeholders of the building construction, maintenance and refurbishment sector, and the results obtained are used to improve the training materials. The evaluation of the UST has two steps in each country (Spain, Portugal and France):

- A first evaluation by the associated partners of the project (the National Advisory Group, NAG), which is composed by a group of companies, associations and public entities (High School and VET teachers among others) with previous experience in the construction sector as well as in training.
- A second evaluation by other relevant stakeholders identified in each country, more focused on the pedagogical point of view as well as on the practical application of the knowledge acquired.

Finally, the improved version of the USTs will be tested in classrooms and will be recorded to analyse the results and further improve the training materials.

As mentioned above, this article details, as a case study, the development process and main results of the UST for carpenters and building technicians in Spain.

3 RESULTS

The main results obtained for each of the building professionals are grouped in four documents:

- **Analysis Report:** contains the analysis of needs and existing training materials, as well as the identification of best practices and constraints in each country, related to the UST theme.
- **Training Modules:** consist of the units' program and the sessions' plan. The working version was developed in English, and then it will be translated into the languages of the countries that participate in the project, Portuguese, Spanish and French.
- **Training Resources:** consist of the unit training contents, practical exercises, and trainer's manual. Similarly as before, the working version is developed in English, and then translated into Portuguese, Spanish and French.
- **Guide for Clients:** developed to support purchasing decisions, allowing an adequate choice of products and solutions, as well as an adequate selection of qualified professionals with additional skills on sustainable construction. It will also be translated into the three aforementioned languages.

In the following sub-sections, the main outcomes of each of these documents for each of the UST developed in Spain (Carpenters and Building Technicians) are detailed.

3.1 Analysis Report

The objectives of this document are: i) set-up the needs and existing training materials, and ii) identify the training best practices and constraints, in Spain, related to each of the building professionals considered in the project. The analysis of needs and existing training materials includes a description of the national bodies in charge of training certification and qualification, the different types of certification and qualification, as well as the levels of the training qualification in Spain. Afterwards, some of the Spanish best practices' examples on sustainable construction are identified, and also the main constraints for the implementation of vocational training to carpenters in Spain are identified and discussed. It should be noted that the following sub-sections detail the main results obtained only for UST for carpenters and building technicians.

3.1.1 Analysis of needs and existing training materials

It has been identified that in Spain there is not any specific certification course of sustainable construction for carpenters. There are only available general training schemes such as the *"Assembly and installation of timber constructions"* (MAM422_2) course (Level 2), or the VET Diploma Level 2 (mid-grade initial training): *"Technician in furnishing and Installation"* (RD 880/2011) [16]. Apart from that, there are also some Certificates of Professional Standard Level 2, the *"Assembly and installation of timber constructions"* (MAMB0210) and the *"Installation of timber components"* (MAMS0108).

Regarding building technicians, in Spain there are available two high-grade training modules imparted by the Ministry of Education, Culture and Sport (MECD): *"Expert in project building"* and *"Expert in civil works project"*, and some Certificates of Professional Standard of Level 3 imparted by the Public employment service (SEPE, Ministry of Employment and Social Security): *"Performance building project"* (EOCO0108), *"Control and supervision project and constructions works"* (EOCO0109), *"Performance civil works project"* (EOCO0208) and *"Building energy efficiency"* ENAC0108. However,

only the latter specifically addresses energy efficiency issues although it does not contain sustainable matters.

On the other hand, free training material regarding sustainable construction for carpenters has not been found in Spain, although in some specific association's webpage it is possible to find important information in this regard, such as the Employer Confederation Company of wood [17]. Concerning building technicians, the Official Construction elements' catalogue available online is an interesting tool to elaborate training materials [18]. However, the training centre that imparts the training modules elaborates specific materials, which are not available for free download.

3.1.2 Training best practices

As Spain is promoting the design and construction of sustainable buildings and n-ZEBs, several examples of best practices are provided in the Analysis Report. For instance, there are a few wood-based buildings, such as the building designed by the Architect Ramón Llobera Serentill in Lerida, a 6-floor building made of wood [19] or the "Sociocultural Centre of TEO" in A Coruña [20]. Regarding nearly Zero Energy Buildings, there are also some examples of best practices such as the CIRCE Building in Zaragoza [21] and the LUCIA Building in Valladolid [21].

3.1.3 Training Constraints – SWOT analysis

A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis has been applied to carpenters' and building technicians' professionals, to detect and categorize the existing constraints for the sustainable buildings' maintenance and refurbishment in Spain, as well as to assess the current performance of vocational training and its potential to contribute to the energy efficiency and sustainability in order to achieve the European 2020 objectives.

The SWOT analysis aims to identify the key internal and external factors considered as important to achieve a specific objective. The information and data needed for the analysis have been obtained through an online survey addressed to the main stakeholders. The questionnaire designed included questions that generate meaningful information for each category (strengths, weaknesses, opportunities and threats) to make the analysis useful and find the information required.

SWOT analysis groups key pieces of information in two main categories:

- Internal factors – strengths and weaknesses.
- External factors – opportunities and threats presented by the environment.

The main results found for both building professionals are shown in Table 1:

Table 1. SWOT analysis summary for Carpenters and Building Technicians.

CARPENTERS		**BUILDING TECHNICIANS**	
INTERNAL FACTORS		**INTERNAL FACTORS**	
Strengths	**Weakness**	**Strengths**	**Weakness**
- Positive approach of the Education and Labour Ministries and public and private training organizations.	- Lack of resources and motivation. - Lack of specific trainers. - Private training companies do not consider it profitable.	- There are no limits for the inclusion of sustainable content in the training offer structure. - Positive motivation from the Ministries of Education and Labour and from public and private training organizations	- There are no specific programs which contain sustainable management criteria.
EXTERNAL FACTORS		**EXTERNAL FACTORS**	
Opportunities	**Threats**	**Opportunities**	**Threats**
- Market trends. - Awareness of energy consumption	- Teachers do not know the specific training offer. - No information to homeowners.	- Current market trends and technological development. - Positive society motivation for the existence of this technical profile.	- No information to homeowners.

Regarding carpenters' professionals, Table 1 shows that the main constraints in Spain refer to the training offer due to several reasons: i) there is not enough motivation of professionals, ii) the training companies do not perceive this training as profitable, iii) lack of specific trainers and resources in this matter. Therefore it can be concluded that there is a lot of work to be done in this training field, in particular in providing specific training to teachers to subsequently train current professionals.

On the other hand, market trends are focused on the reduction of environmental impacts and homeowners are increasingly aware of the need of protecting the environment. It has been found that owners seek after an improvement in the health and comfort of their homes, even though there is not enough information about sustainable products, prices or installation requirements needed to contribute to improve the energy performance of buildings.

The main strategies and approaches to overcome these difficulties and obstacles should include an increase in public policies to promote and support sustainable construction. Experts have pointed out that in Spain there is a positive approach of the Education and Labour Ministries regarding this issue.

Concerning building technicians, this analysis concludes that the inclusion of sustainable contents in the Spanish training and educational system is supported by the Ministries of Labour and Education. In this line, it has been found several workshops and specific training sessions for building technicians about new efficient products and sustainable materials which have considerable success among these professionals due to their high motivation for the acquisition of new skills. In this sense, it is important that a national qualification framework develops specific criteria for sustainable management and that a VET system offers new methodologies, case studies and working programs in sustainable development and energy efficient materials.

3.2 Training Modules

As explained above, the training modules consist of the units' program and the sessions' plan. The former contains a list with the main objectives of the UST for the corresponding professional and the list of contents: units and sub-units. Following the guidelines given in ECVET, these training units will also be described in terms of knowledge, skills and competences. The structure followed is the same for all professionals, adapting each topic to the corresponding needs. For example, the contents addressed for carpenters and building technicians are shown in Table 2:

Table 2. List of contents of the UST for carpenters and building technicians.

CARPENTERS	BUILDING TECHNICIANS
• Basic principles of Sustainable construction and nZEB. • Main environmental impacts of wood products. • Labeling and Standardization: o European and national standards; o Environmental labeling of wood products; o Building regulation and certification scheme; o Legislative framework related to the trade of carpenters. • Materials: o Low environmental impact materials; o Benefits of using natural materials and other materials for buildings construction;	• Basic principles of Sustainable construction and nZEB. o Passive solutions for the construction and refurbishment of buildings. • Main environmental impacts of life cycle building. • Labeling and Standardization: o European and national standards; o Environmental labelling of paints and varnishes products; o Building regulation and certification scheme; o Legislative framework related to sustainable construction. • Materials: o Low environmental impact materials;

○ The importance of sealant and insulation products. • Wood treatment and construction processes: ○ Construction timber-framed houses; ○ Wood treatment product glazing and coatings. ○ Installation of Ceiling, Siding, Flooring and Decks; ○ Assembly and installation doors and windows; ○ Principal characteristics of bigger wood structures; ○ Technical documentation, control and equipment for wood construction; ○ Characteristic of different type of glazing. • Construction installation process and works management. ○ Comfort and indoor air quality; ○ Acoustic and Thermal comfort; ○ The importance of thermal bridge in the buildings; ○ Air infiltration through windows and doors. • Maintenance, renovations, restorations and refurbishment. • Waste and recycling. • Case studies and recommendations. • Contribution of the carpenter to improve the environmental performance of a building – summary.	○ Ancestral, traditional and innovative materials. • Construction processes: ○ Sustainable construction techniques; ○ Cost evaluation, documentation and quality control of the project; ○ Energy cost; ○ HVAC Installations; ○ Integration of Solar installations (Thermal and FV) in Buildings. • Construction installation process. • Construction works management. • Comfort and indoor air quality: ○ Acoustic and Thermal comfort; ○ Indoor air quality and natural ventilation; ○ Natural lighting. • Maintenance, renovations, restorations and refurbishment. • Waste and recycling: ○ Construction waste and recycling; ○ Deconstruction vs. demolition. • Water reuse. • Case studies and recommendations. • Contribution of the building technician to the improvement of the environmental performance of buildings – summary.

The sessions' plan consists of a table for each training unit that contains: the programmatic content, the specific objectives for each sub-unit, the activities to undertake, the methods and techniques to use, the teaching aids required to teach the unit, the evaluation procedure and the duration of each sub-unit.

3.3 Training Resources

The Training Resources contain the unit training contents, practical exercises, and trainer's manual. The latter provides some guidelines for the prospective trainer as well as the advised qualifications that he/she should own to properly teach the training unit. The unit training contents comprise all the modules listed in the "Training Modules" (see above) and consist of a presentation (or several) for each aforementioned topic, which includes trainer notes in each slide to guide the trainer in the main issues to address. There are also some practical exercises throughout the presentation as well as some debates for the trainees to practice and interact with each other (see examples in Fig. 1).

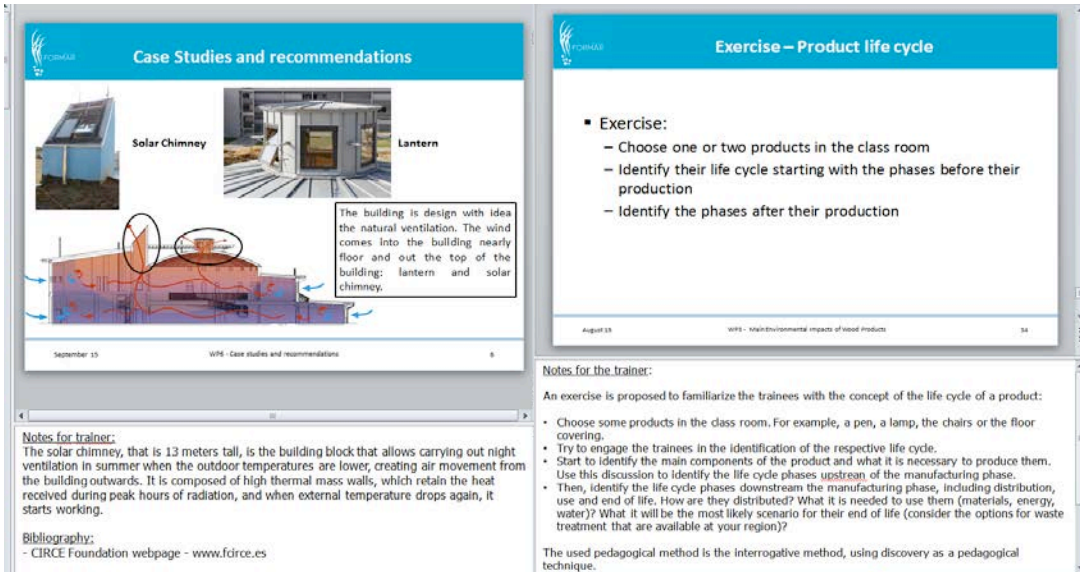

Figure 1. Screenshots of a training unit slide and a practical exercise with instructions.

3.4 Guide for Clients

The Guide for Clients aims to support the purchasing decisions of final users and building professionals, that is, those people that want to buy or rent a house and those that want to make some maintenance or improvement works at home, as well as those people involved in the works development.

In the case of carpenters, the corresponding guide is targeted for the final clients interested in carpentry work and for carpentry professionals. The document is expected to allow an adequate choice of construction products and solutions, as well as an adequate selection of qualified professionals with additional skills on sustainable construction. Thanks to this guide, readers will learn the main principles and goals of sustainable construction regarding carpentry works, the use and characteristics of wood, advantages and disadvantages regarding the selection of appropriate windows, and other interesting data about the sustainable construction.

The guide is divided in several parts; first of all, the objectives and target groups are detailed (Section 1), followed by an explanation of the importance of selecting qualified workers (Section 2) and sustainable materials (Section 3); then, the main economic issues that should be considered regarding sustainable construction and materials are highlighted (Section 4). Afterwards, the comfort concept is explained, together with the importance of thermal bridges and how window frames can contribute to thermal comfort and indoor air quality (Section 5). In the last sections environmental issues and risks (Section 6) and some recommendations for maintenance and troubleshooting issues and risks (Section 7) are addressed.

Similarly, regarding building technicians, the guide has the same objective but in this case it is targeted for the final clients interested in building technician works and for these professionals. The guide is also divided in several parts, following a similar structure than for carpenters, but in this case it provides a more global vision of the construction, outlining more issues. The guide explains the influence of constructive solutions on the building occupant comfort (Section 4). Afterwards, the terms net Zero and nearly Zero Energy Buildings are defined, followed by a brief presentation of the existing certification schemes regarding sustainability, an outline of how to refurbish existing buildings and how to plan and develop new buildings to achieve the nearly Zero Energy Building (n-ZEB) status, and finally some guidelines to optimize the performance of different components are given (Section 5). In the last sections, price (Section 6) and environmental issues and risks (Section 7) are addressed.

Both guides contain several pictures, diagrams and photos to make the concepts as visual as possible as well as understandable for non-technical readers. Some examples are shown in Fig. 2.

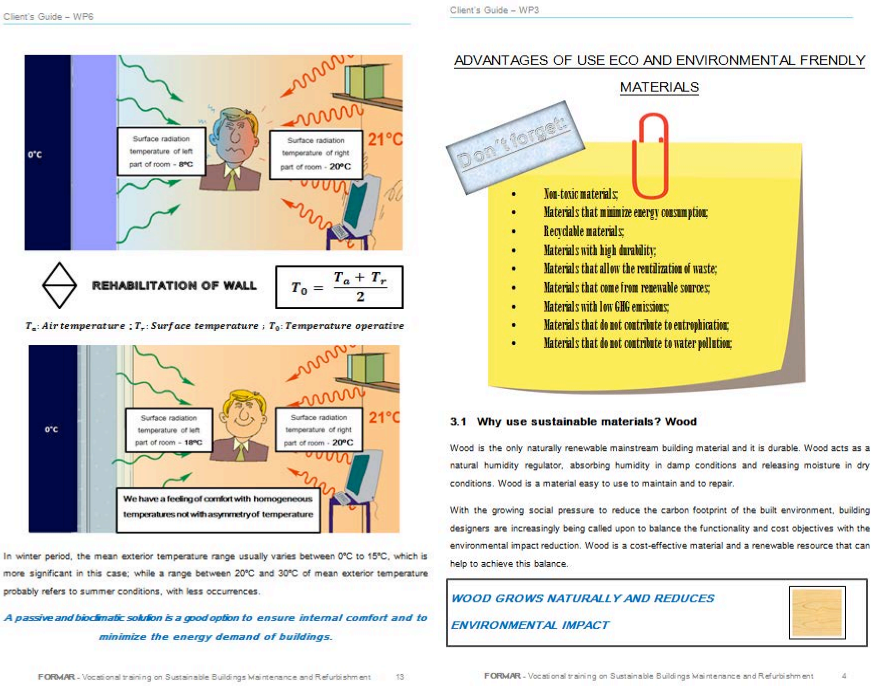

Figure 2. Screenshots of the Guides for Client for Building Technicians (left) and Carpenters (right).

4 CONCLUSIONS

The European Union has identified the Vocational Education and Training (VET) sector as an essential pillar to ensure the education in sustainable issues at all levels through the development of national qualifications frameworks based on learning outcomes. Even though there are already available VET courses in the construction sector, and despite the priority established by the EU towards Sustainable and Energy Efficient Construction, there is not available yet a common European framework for the development of National Catalogues of Qualifications in Sustainable Construction.

In this context, the FORMAR project attempts to fill this gap through the development of resources and modules targeted to sustainable construction, to contribute to integrate this trend in the VET itineraries by developing new and specific Units of Short-term Training (UST). The goal of these units is to improve the skills on sustainability issues of workers of buildings maintenance and refurbishment, covering the different professionals that intervene in a building: carpenters, painters, bricklayers, building technicians, and installers of solar panels. In addition, a guide for clients has been developed to improve the information provided to clients and owners and support the procurement decisions related to building products and materials.

In this paper, the development process and main results of the UST for carpenters and building technicians in Spain are detailed. For these building professionals, four main documents have been developed: i) the Analysis Report, that contains the analysis of needs and existing training materials, as well as the identification of best practices and constraints in each country; ii) the Training Modules, consisting of the units' program and sessions' plan, where the main topics and sub-topics addressed are listed; iii) the Training Resources, composed of the trainer's manual, the unit training contents and some practical exercises, in the form of presentations with trainer notes; and iv) the Guide for Clients, addressed to the final clients, that is, building professionals, building owners and customers in general, developed to support their purchasing decisions, allowing an adequate choice of sustainable products and solutions, as well as an adequate selection of qualified professionals with additional skills on sustainable construction.

As a result of the project, the trainees (building professionals) should be able to identify and purchase products that contribute to improve the buildings' energy performance and the indoor air quality. Furthermore, a set of case studies and best practices are included as part of the training to allow the trainees to achieve a more sustainable application, use and end-of-life of products. Consequently, the skills of professionals will be improved and this will contribute to implement a more sustainable construction sector, helping to meet the 20/20/20 targets established by the European Union.

Another important project outcome is the replicability of the methodology proposed, which can be easily applied to other vocational sectors, improving the quality of the professional certificate contents included in the Vocational Training Catalogue.

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