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SYNTHESIS

Transforming vocational education and training for nearly zero-energy building

Linda Clarke¹, Melahat Sahin-Dikmen² and Christopher Winch³**Abstract**

Nearly zero-energy building (NZEB) requires the training of millions of construction workers and significant upgrading of vocational education and training (VET) systems across the European Union. This paper shows how an approach to VET based only on learning outcomes and targeting specific skills is too narrow and lacking in depth to allow for the systematic application of theoretical low-energy construction (LEC) knowledge to practice and develop NZEB expertise in the workplace. Theoretically broader, deeper, more technical and interdisciplinary expertise is needed to build to LEC standards and meet European Performance in Buildings Directive (EPBD) targets. Instead, VET for LEC has been largely confined to short and task-specific continuing vocational education and training (CVET) courses, illustrated in the cases of both Slovenia and Ireland and ranging from a narrow, learning outcomes approach to a broader, standards-based approach linking theoretical considerations to specific applications. Mainstreaming the knowledge, skills and competences required for NZEB into initial vocational education and training (IVET) curricula is rare. Though less successful in Finland, it is achieved in Belgian construction IVET, which takes a standards-based approach, successfully embeds LEC elements, and seeks to overcome occupational boundaries and develop a holistic understanding of the construction process.

Policy and practice relevance

The emphasis on a standards-based, as opposed to a learning outcomes-based, approach to VET for LEC is of relevance to VET practitioners and policy-makers alike, especially given the preoccupation across Europe just with developing specific ‘skills’ through CVET. Broader construction occupational profiles and qualifications are essential for the cross-occupational knowledge and coordination required for successful NZEB, implying a transformation and upgrading of VET systems in many countries. The examples given from Irish CVET and Belgian IVET are valuable in showing what can be done to incorporate LEC elements. In highlighting the strengths and weaknesses of different VET systems in meeting NZEB requirements, the paper is relevant for industry and unions in illustrating the significance of social partnership, the need to overcome the fragmentation of the construction process and the high-quality VET essential to addressing climate change.

Keywords: construction industry; curricula; energy efficiency; labour; qualifications; vocational education and training; zero carbon; Europe

1. Introduction

Creating a workforce capable of reaching the objectives of nearly zero-energy building (NZEB) is a massive undertaking whose dimensions have only been realised by a few countries.¹ Launched with the aim of increasing the number of workers qualified in energy efficiency measures and the installation of renewable energy systems, the European Commission’s (EC) Build Up Skills (BUS) investigation showed that around 3 million workers need to be trained across the European Union (EU), and recommended significant upgrading of vocational education and training (VET)

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structures in several countries. BUS highlighted unsatisfactory interdisciplinary training opportunities, a shortage of cross-occupational knowledge and skills, insufficient coordination between occupations, and lack of understanding of a building as one integrated system (EC 2014). However, most countries have failed to grasp the nature and complexity of what is required, and the measures taken have been inadequate to the task at hand, primarily targeting the existing workforce through continuing vocational education and training (CVET) courses (Clarke *et al.* 2019a). As this paper demonstrates, the response to the educational challenge of NZEB not only falls quantitatively short but also is of variable quality, particularly in providing the theoretically broader and deeper, more technical and interdisciplinary expertise needed to build to the standards anticipated in energy-saving calculations and to meet the targets set in the European Performance in Buildings Directive (EPBD) (Clarke *et al.* 2017).

The paper draws on a recently completed EC project, investigating the VET and low-energy construction (LEC) elements required to create a workforce for NZEB. This project, entitled VET4LEC, was conducted under the auspices of the European Construction Social Dialogue and with the social partners (trade union and employer representatives): the European Federation of Building and Woodworkers (EFBWW) and the European Construction Industry Federation (FIEC) (Clarke *et al.* 2019a). The distinct approaches to developing the qualified workforce needed that emerged from the authors' investigation are exemplified in four countries: Belgium and Finland, both seeking to incorporate LEC requirements into their initial vocational education and training (IVET) construction programmes for those entering construction as trainees; and Ireland and Slovenia, developing specific CVET courses for the existing workforce, assuming prior qualifications and/or some work experience in construction. At one extreme lies the Belgian standards-driven approach to IVET for LEC and, at the other, the Slovenian learning outcomes-based approach to CVET. For each, the characteristics of the VET system and the incorporation of LEC elements into curricula content are examined and compared for their strengths and weaknesses in meeting NZEB requirements.

It is shown how a learning outcomes-based approach to VET for LEC is restricted in its ability to overcome the shortcomings highlighted by BUS, especially the lack of interdisciplinarity and holistic and cross-occupational understanding, being focused on emerging specialisations and targeting the development of specific skills. The approach relies on heavy on-site supervision, in accordance with a Taylorist or human capital perspective, whereby labour is not valued according to the knowledge it incorporates but according to an individual's ability to fulfil the task in hand. Taylorism involves the fragmentation of a process such as building a house or a car into simple task segments, each requiring little skill but controlled by a 'line manager' as, for example, on an industrial production line (Taylor 1911; Becker 1994; Clarke 2006). In this respect, with a learning-outcomes approach, training is geared to meeting individual employers' immediate needs; qualifications are not a prerequisite for entry; and labour is rewarded for its output or product, not for its potential. The outcome is just the ability to perform the task designated in the overall process.

At the other extreme to this Taylorist approach is the standards-based approach found, for instance, in Belgium where NZEB-related competencies are incorporated or mainstreamed into the occupational profiles and curricula of each occupation in its social partner-based VET system (Brockmann *et al.* 2008a). Workers mastering the knowledge, know-how and attitudes set out in the occupational profiles and taught via a curriculum are able to act both independently and in teams across broad interfaces, based on problem-solving and some degree of project management, apply expertise acquired appropriately, take responsibility for meeting specified standards and quality with precision, and communicate the reasons for and consequences of their actions (Hanf 2011). In this way, it is possible to meet the five key transversal requirements identified by the VET4LEC project for successful NZEB: communication, coordination, problem-solving, project management and precision (Clarke *et al.* 2019a). This paper shows how, for NZEB quality and standards to be met, such a standards-based approach to VET is paramount, implying a transformation of VET systems in many EU countries.

2. New drivers for incorporating NZEB into VET

Increasing recognition is being given to transforming the construction industry, both to improve productivity and to meet low-carbon emission targets, though this imperative predominantly addresses technical solutions, such as digitalisation, rather than labour process and VET issues (*e.g.* HM Government 2018). Nevertheless, all the evidence points to the industry being more productive, innovative and energy efficient, where VET programmes are social partner based and comprehensive and the construction process less fragmented, with lower levels of self-employment and a lower proportion of the workforce employed in micro-firms, as found in Belgium and Germany (Clarke & Herrmann 2004; Clarke & Wall 1996, 1998a). Apparent labour productivity (in thousands of euros per head) in construction for 2015 in Belgium and Germany, for instance, is estimated at 56 and 61, respectively, compared with Finland and Ireland at 47 and 48, respectively, and Slovenia at only 18 (Eurostat 2015). At the same time, the proportion of self-employed in the construction workforce is: Belgium, 25%; Germany, 11%; Ireland, 37%; and Slovenia, 60% (Clarke *et al.* 2019a). Countries with less fragmented and individualised employment therefore appear to be the most productive. Clear links have, in turn, been shown between increased rates of self-employment in the construction industry and declines in training provision (Clarke & Wall 1998b).

Whilst productivity concerns continue to act as an economic driver for employers, it is no good just speeding up work to increase output if mistakes are made and quality and energy targets are not met. In this respect, most important for improving energy efficiency in construction, in terms of both the construction process and the pre-occupancy thermal performance of the building,² are the legal drivers, stipulating the standards to be met and driven in turn

by the urgency to address climate change. The built environment is responsible for 40% of energy consumption and 36% of energy-related CO₂ emissions in the EU and is, through the Clean Energy for All Europeans strategy for a carbon-neutral environment by 2050, targeted for a major transformation that has far-reaching implications for VET. The EU 2030 development strategy aims by 2030 to reduce emissions by 32.5% and increase the share of renewable energy and energy efficiency by 32% compared with 1990 levels (EC 2019a). Globally, around 28% of energy-related greenhouse gas (GHG) building emissions are attributed to the operational phase (*i.e.* energy needed to heat, cool and power buildings) and 11% to their construction phase (*i.e.* materials and construction process/embodied carbon) (WBC 2019). Thus, improving the energy efficiency of buildings is fundamental to achieving these goals, implying a major transformation of construction driven by EPBD energy saving targets for new buildings and the renovation of existing buildings. Article 9(1) of the EPBD requires member states to take measures to ensure that, by 31 December 2020, all new buildings are NZEB (EU 2010, 2018), though the exact definition for NZEB varies between member states in terms of building typologies (new/retrofit), classifications (private/public), energy balance (demand/generation), physical boundaries (single unit/building unit) and system boundaries for the generation of renewable energy sources (on-/off-site) (EC 2016a). Despite these differences, the energy consumption of buildings for all member states has to be lower than currently prevalent from 1 January 2021.

Whilst the EPBD sets out the general definition of NZEB, member states are tasked with its transposition into national law and with the implementation and development of national energy action plans (NEAPs), detailing financial incentives, energy performance certification, inspection schemes, renovation strategies and other complementary measures. In the four countries addressed here—Belgium, Finland, Ireland and Slovenia—building regulations have been revised to reflect these new requirements, iterated through successive updates over the past two decades. Accordingly, new buildings—public and private, residential and non-residential—have to meet nationally defined energy performance requirements. Energy efficiency assessments are part of planning/building permit applications and energy performance certificates are necessary for properties to be sold or rented. Inspection regimes have been put in place for assessing energy performance, as well as separately for building systems, such as heating and air-conditioning, alongside training and qualification requirements for assessors. Energy efficiency requirements also apply to existing buildings undergoing major renovations, with less stringent expectations for minor maintenance or replacement of parts of buildings (*e.g.* windows, heating systems), as it is understood that retrofitting achievements depend on technical, operational and financial constraints. As such, retrofitting is seen as a long-term objective to be achieved in stages in some buildings and to varying degrees of depth, with financial incentives complementing regulatory requirements (EC 2019b).³

These stringent energy performance requirements for all new buildings and the standards set for the renovation of existing buildings imply fundamental changes in construction materials and methods as well as the type of energy used. It means a systems approach to buildings, in conformity with building information modelling (BIM), as an integrated whole whose parts need to fit together seamlessly. It means continuous insulation, controlled ventilation, heating/cooling and hot water heating, thermal bridge-free and airtight building envelopes and renewable heat and power. The implication for construction companies is that, since buildings will be assessed by their energy performance, the priority is to build to the predetermined standards specified in building regulations.

Improving the energy performance of buildings depends, however, on an adequately trained workforce (Clarke *et al.* 2017). It was with this in view that the BUS investigation was initiated by the EU with the aim of increasing the number of workers qualified in energy-efficiency measures and the installation of renewable energy systems. The EU targets for improving the energy efficiency of buildings assume that construction workers already in the sector will be equipped with the necessary expertise to meet the standards for NZEB. The BUS initiative was designed with the aim of stimulating training development, primarily in CVET, in member states. The evaluation of existing CVET for NZEB at the start of the initiative showed that provision is fragmented, with courses run by a range of public and private organisations, presenting a complex and varied picture reflected among the countries included in this research (EC 2014). The present evaluation reveals disparities in the availability of provision for different construction occupations with most CVET catering to those employed in the installation of renewable energy sources and already with some formal qualifications. CVET for NZEB also varies according to the nature of the provider (public or private) and whether it is a one-off or available regularly and therefore standardised for wider access (Clarke *et al.* 2019a).

For the first stage of BUS, Pillar I (2010–12), national status quo analyses were carried out in 30 European countries to establish the number of workers to be trained and the changes needed in existing VET and to develop a road map addressing the 'skills gap' identified. In the second stage, Pillar II (2014–17), short projects in 22 member states took place to begin to address the LEC training needs identified. The findings indicate the scale and kind of expertise needed for NZEB, including: broader and deeper levels of theoretical knowledge and understanding of energy efficiency; interdisciplinary learning to facilitate cross-occupational coordination; a holistic approach to building construction; and transversal abilities such as problem-solving and communication (EC 2014). The significance and implications of inadequate and inappropriate training are evident from the persistence of the energy performance gap, the difference between the energy performance standards intended and those actually achieved (EC 2016b; Zero Carbon Hub 2014). The evidence for the performance gap shows that poor or incorrect installation is a major factor in failing to meet the energy savings stipulated in the legislation (Gleeson 2016; Sunikka-Blank & Galvin 2012). This was, for instance, illustrated in a study for the EU of EPBD compliance in which the gap was in several cases attributed to calculation mistakes (Deliyannis 2017).

3. VET standards versus learning outcomes

Some theoretical understanding of NZEB is necessary if there is to be practical understanding of NZEB in the workplace. The development of an NZEB curriculum involves specifying the knowledge, skills, capacities and other attributes needed by construction workers, which are best set out as standards rather than learning outcomes. This is because a standards-based approach links these attributes to curriculum content, whereas a learning outcomes-based approach offers a description of how the worker should act in the workplace without any reference to curriculum content. Standards describe the attributes a candidate should have at a certain stage and at the end of a formal programme of VET; they do not make sense independently of the content. The Belgian occupational profiles for construction provide an example of standards as they are intended as the building blocks of curricula designed by colleges. The curriculum introduces the attributes needed by workers who can apply knowledge to practice and possess appropriate attitudes. These attributes are required for complex work involving autonomy, teamwork, problem-solving and project management capabilities. By contrast, 'learning outcomes', in the sense understood by the EU in the European Qualifications Framework (EQF),⁴ are, in a vocational context, descriptions of skills and competences needed to undertake tasks (Coles 2007). Indeed, in the strong version of this learning outcomes approach, exemplified in the original National Vocational Qualification (NVQ) in Britain on which the EQF initially drew, they are supposed to be understood independently of content, specifiable without reference to any other learning outcome and unambiguous. In effect, a learning outcomes approach is, it is argued here, suited to the fragmented labour process characteristic of Taylorism; it is unsuited to complex work of the kind required for NZEB (Brockmann *et al.* 2008a).

This distinction between learning outcomes- and standards-based approaches is important as successful NZEB requires a workforce in which individuals understand why they are doing what they are doing and how this fits into the 'bigger picture' of the project on which they are engaged. The know-how required should not be broken down into simple tasks but is, whenever necessary, framed in a way that requires the worker's independence of thought. For example, the know-how requirement to 'keep labels and markings of materials used' in relation to 'quality awareness' for the Belgian occupation of *Couvreur-Étancheur* (roofer-installer) assumes the worker knows how to trace products and justify the work carried out (**Table 1**). Furthermore, the know-how is exercised by working with care, precision, patience, economically, autonomously, with professional conscience and even aesthetically. Workers thus need to recognise the practical importance of the knowledge they have acquired and to use their discretion and judgement, including in 'clarifying when others carry out poor quality work'. This requirement cannot be captured in an enumeration of tasks, such as one finds in a 'learning outcomes' approach, but depends on judgement based on knowledge of the properties of these materials and a disposition to assess quality.

Table 1: Extract from the occupational profile for the Belgian (Walloon) *Couvreur-Étancheur* (roofer-installer).

Block of activities	Key activity	Competences		
		Knowledge (<i>savoir</i>)	Know-how (<i>savoir-faire</i>)	Attitudes (<i>savoir-être</i>)
Quality and wellbeing	Energy performance of the building	<ul style="list-style-type: none"> General principles for the energy performance of a building Consequences of the poor placement of insulation and ventilation 		<ul style="list-style-type: none"> To understand why each intervention in the building affects its interior climate and overall energy performance
	Quality surveillance	<ul style="list-style-type: none"> Traceability of products. Proof of what has been achieved 	<ul style="list-style-type: none"> Keep the labels and markings available for the materials used 	<ul style="list-style-type: none"> Work with care and diligence Sense of precision. Attention to detail and patience necessary to meticulously effect detailed work Economical attitude: Using materials, tools and time economically. Avoiding waste Aesthetic sense. Where it is possible to take into account aesthetic considerations in the course of carrying out work Spirit of self-management and concern for quality. Professional conscience. To make it known if other workers produce shoddy work

Note: All cells under the heading 'Quality and wellbeing' are primarily concerned with environmental impact.

Source: Clarke *et al.* (2019b: 12).

A learning outcomes approach to NZEB appears to neglect the element of understanding required of individuals to play an effective part in the construction process. Understanding, in turn, is linked to knowledge, which gives the 'why' and the 'how' of activities and allows workers independence in solving problems individually and collectively, managing more complex activities, and playing a constructive role in the project as a whole—including working with others in related occupations. This is not possible when all that is required is the 'what' or the tasks that a worker necessarily performs, without having to worry about the ability to deal with unexpected or more complex situations. Such a narrow approach to competence is ill-fitted to the NZEB context because it implies assessment only of individual performance on task and not the capacity to be innovative, solve problems and manage projects or relationships within a team (Brockmann *et al.* 2008b). It runs the danger of measuring yesterday's abilities rather than those of today or tomorrow. Without the understanding given by knowledge content applied rigorously to practice, a workforce is liable to be produced that cannot take part in complex, integrated projects, requiring adherence to high levels of specification, as is the case in NZEB.

The problems with a learning outcomes approach to VET for NZEB can be summarised as follows:

- The hierarchy of knowledge and understanding required to gain NZEB expertise is discounted by treating individual learning outcomes as if they were independent of any others previously acquired.
- Specifying learning outcomes as completely independent of other learning outcomes undermines the more holistic understanding of the construction process that NZEB requires.
- The knowledge element (building physics, climate change, construction process) necessary for effective NZEB is downplayed.

The implication for an NZEB programme for VET is that any specification of standards for achievement needs to be firmly linked to content and process. Skills have an important role to play, but they are not the only element in an effective VET programme. Workers also need transversal competences so that they can engage in project management, including such elements as planning, coordination and evaluation. They need a sound knowledge base to solve problems effectively and an appreciation of the importance of taking responsibility for the quality of their own work and that of the teams in which they work.

4. Methodology

The paper draws on a study of VET for LEC developments in Belgium, Bulgaria, Finland, Germany, Hungary, Ireland, Italy, Poland, Slovenia and Spain, coordinated by the EFBWW and FIEC, with project partners in each country from employer organisations, unions or training providers. The main aim of the VET4LEC project was to determine the expertise required for NZEB and to contribute to developing a trans-European framework for VET for LEC. The focus of VET4LEC was on building envelope occupations including bricklaying, carpentry, roofing, insulation and groundworks, rather than building services occupations such as plumbing, heating and ventilation, and electrical work. Its objectives were: to evaluate different approaches to developing and delivering VET for LEC; to develop guidelines and recommendations on how to address the weaknesses identified; and to provide criteria for curricula development. The study analysed current VET for LEC provision in the contexts of NZEB implementation, construction labour market and workforce characteristics, and national VET systems (Clarke *et al.* 2019a, 2019b). For this paper, Belgium, Finland, Ireland and Slovenia are chosen as 'typical' examples of standards and outcomes-based approaches, respectively, and as each representative of distinct industrial relations models: Centre/Germanic (Belgium); Scandinavian (Finland); Anglo-Saxon (Ireland); and East European (Slovenia).

The findings are based on the analysis of documentary evidence and interview data. For each country, secondary data sources consulted consisted of: national reports produced by the project partners to provide information on VET for LEC developments in their respective country; European Construction Sector Observatory country reports;⁵ BUS country reports;⁶ European Centre for the Development of Vocational Training (CEDEFOP) country reports;⁷ and EU NZEB national progress reports (EC 2019b). These sources were supplemented by the expert knowledge of project partners in response to specific queries, requests for clarification and thorough discussions over a two-year period. The project partners had intimate and extensive knowledge of the construction sector and VET systems in their respective countries, though from different perspectives. Two of the partners were unions (CSCBIE in Belgium and Rakennusliitto in Finland), one from industry (The Chamber of Construction and Building Materials of Slovenia), and one a training organisation (Limerick Institute of Technology in Ireland).⁸ In addition, further insight into VET for LEC strategies and implementation was gained through visits to three of the countries—Belgium, Finland and Ireland—involving in-depth interviews with VET providers, unions and employer representatives and on LEC sites, so providing additional primary data (Table 2). This was not possible for Slovenia, though the rich data provided by the highly expert project partner helped to compensate for the lack of first-hand interviews.

For each country, the incorporation of LEC elements was investigated for both IVET, that is, programmes for entrants to the sector usually upon leaving compulsory education, and CVET programmes for the existing workforce, for example, in order to update knowledge and know-how. The programmes were then evaluated for their suitability to developing the kind of expertise needed for successfully meeting the standards anticipated by EU legislation.

Table 2: Interviews conducted.

Country	
Belgium	<ul style="list-style-type: none"> · Centre de formation en alternance pme à Bruxelles (EFP) vocational training college · Centres de Référence in the Brussels-Capital Region (CDR) training centre in the Brussels-Capital Region · Belgian Construction Federation · Constructiv, the Belgian paritarian construction organisation
Finland	<ul style="list-style-type: none"> · Central Organisation of Finnish Trade Unions; interview with industrial and climate policy officer · Rakennusliitto, the construction sector union; interview with the international officer · Interviews with the representatives of the Confederation of Finnish Construction Industry and its training body, the Training Centre for the Construction Industries (RATEKO) · Vantaa Vocational College; interviews with several teachers · Visit to a large, low-energy housing scheme in Metsatammi; interview with representatives of the contractor and other personnel onsite
Ireland	<ul style="list-style-type: none"> · Limerick Institute of Technology; interview with the developers of Ireland's Build UP Skills Phase II training programme, Foundation Energy Skills (FES) · Services, Industrial, Professional and Technical Union (SIPTU), the construction sector union · Visit to the Passive House scheme for Wexford County Council; interviews with the contractor

5. Incorporating LEC elements into VET

BUS emphasised the need to re-equip the existing workforce for NZEB capability through CVET, which involves adding and integrating new capabilities to existing ones, usually gained through IVET. In this, some countries have been more successful than others, as an example from Ireland demonstrates. The technical framework provided by the EPBD has, however, tended to promote a narrow view of thermal literacy for building workers, leading only to the development of short and task-specific add-on CVET courses, as in Slovenia, based on a learning-outcomes approach. These courses cater for diverse existing training and qualification levels, but take up remains low given the multitude of small firms and high numbers of self-employed prevalent in the sector.

To meet the new energy efficiency standards it is not a short-term question of just closing a narrow 'skill gap' but providing comprehensive and high-quality VET in NZEB for the long term. This calls for a coordinated strategy, backed up by substantial investment and expertise, addressing both IVET and CVET, for new build and retrofit, and for application in all types of buildings. CVET by itself necessarily represents a short-term solution as it cannot fully address the necessity for NZEB understanding to be embedded in all aspects of the construction process. The future workforce needs to be NZEB-capable from the outset through the IVET system. Within IVET it is possible to integrate all aspects of NZEB into the curriculum so that a good understanding of present and future technologies and changes in the construction process is obtained. Certain countries have come some way towards achieving this, notably Belgium, in its occupational profiles, which, through descriptions of what should be known and done and the attitudes that should be adopted to practical work, provides a good example of an approach that sets out standards to be reached, rather than learning outcomes manifested in the carrying out of relatively simple tasks in the workplace. These profiles, showing which standards need to be reached, are a precursor to a curriculum, which fills out the content of descriptors in such a way that the material, know-how and attitudes to be acquired can be inferred by a curriculum designer with both construction and pedagogic expertise.

In other countries, such as Slovenia, a learning-outcomes approach predominates given the lack of nationally coordinated plans, fragmented VET systems, weak governance structures and government reliance on voluntary action by employers. Here IVET needs to be transformed to facilitate the autonomy, teamwork, problem-solving ability and whole-project understanding so essential to the long-term success of NZEB, ensuring that LEC capability and understanding become the property of the entire construction workforce. But this alone is insufficient as the construction labour process needs to be conducive to accommodating, nurturing and developing these capabilities and to provide a collaborative, non-adversarial environment, one no longer fragmented through a myriad of contractual divisions and factional professional silos. This is then the challenge: to transform the industry and upgrade the construction VET system so that the integrated teamworking, broad occupational capacity and involvement of all workers required to enact a coordinated strategy for zero carbon building are possible.

5.1 IVET: The examples of Belgium and Finland

Such a strategy implies fundamental changes to construction occupational profiles and VET, changes that have already been introduced in some countries, including Belgium, and remain at early stages of implementation in others, such as Finland.

5.2 Belgian (Walloon) IVET for NZEB

Occupational profiles such as those used in the Belgian construction sector set a standard for what good VET for LEC should look like. Belgian IVET is a hybrid of both a dual apprenticeship and a college-based system (Clarke *et al.* 2019a;

CEDEFOP 2012). It operates within a social partnership context in which the state plays a background role confined to the development of the broad outlines of policy within a legal framework. The more day-to-day aspect of Belgian IVET is run through 'paritarian' structures, which involve the close cooperation of employer associations and unions. The social partners (employers and unions) together develop occupational profiles, which consist of the three closely related elements of knowledge (*savoir*), know-how (*savoir-faire*) and attitude (*savoir-être*) (**Table 1**). These comprise the columns of a two-dimensional grid structure, while the rows refer to different content under larger subheadings. These occupational profiles are therefore broad, not confined simply to learning outcomes, but providing a detailed account of what it is to practise an occupation; all recognised qualifications must conform to the respective profile. However, the social partners do not write the curriculum for each occupation; that is a matter for VET providers.

This pattern can be seen in the construction sector, where the paritarian organisation Constructiv derives occupational profiles. These profiles are the responsibility of the two principal social partners—unions and employers—but they also rely on training providers, regional authorities with sectoral responsibility for construction and individual experts. Pathways to obtaining a qualification in construction include vocational secondary education, technical secondary education, day release training, special secondary education (for students with special needs) and adult education. A total of 40% of participants follow one of the two secondary education pathways to achieving a qualification (Clarke *et al.* 2019a: 4–10). This paritarian structure has allowed the social partners to revise and update construction occupational profiles to take full account of new NZEB requirements and standards. Belgium also produces sectoral descriptions of occupations that display the relationships between occupations, thus highlighting: potential gaps in activities; areas of common concern for related occupations; and overlapping activities for different occupations. An example of how NZEB requirements are incorporated into occupational profiles is given by the *Couvreur-Étancheur* (roofer-installer) (**Table 1**). The content of **Table 1** gives the standards to be met by a practitioner and the curriculum is constructed with these in mind. The competence of the *Couvreur-Étancheur* is the integrated ability to perform the role expressed in the descriptor for the occupation. This contrasts with the English conception of 'competence', as the ability to perform a task to a threshold level of quality. As explained by Westerhuis (2011: 76) in relation to the Dutch concept of competence, which is very similar to the Belgian one:

Competence is understood as an integrative concept, aiming to cover a wide set of human abilities required to cope with complex tasks. Integrative stands for the facts that 1) competences are multi-dimensional and 2) competent performance is only possible if all dimensions are addressed according to a set of standards.

5.3 Finnish IVET for NZEB

In Finland, the Ministry of Education and Culture provides strategic direction and financial support for IVET, as well as monitoring and supporting providers. Finland uses a predominantly college-based system of IVET in which providers are responsible for developing qualifications, deciding the size of their intake, the language of instruction, location and special needs provision (Clarke *et al.* 2019a: 18–24). Providers have other significant responsibilities, which include organising training, matching provision with market needs and developing curricula based on national qualification requirements, and can be of different kinds: local authorities, municipal training consortia, registered foundations or associations, or even a state company.

The Finnish National Board of Education develops qualifications in conjunction and cooperation with significant stakeholders such as the employers' organisation and unions. There is also a role for local organisations to make curricula relevant to local conditions and provide skills demonstrations. Finland uses a learning outcomes approach in the design of qualifications and there are some competence-based qualifications. Local bodies can be involved in the administration of competence tests. Nearly 20% of the workforce takes part in some form of IVET, and young people enter the IVET system after completing basic education at 16 plus. This route involves at least six months of work-based learning as a student, and the upper secondary VET qualification is at least nominally equivalent to the general academic qualification and provides access to higher education. A smaller number of people undertake apprenticeships, and apprentices tend to be adults rather than young people (CEDEFOP 2019).

Finland has high levels of general educational achievement, but the demand for entry into the construction sector is weak and declining (EC 2012; Clarke *et al.* 2019b). The principal route for IVET is through a three-year college course, two-thirds spent on-site and only the first year in college. Provision for NZEB considerations does not match the thoroughness and detail of the Belgian case and the attrition rate for the programmes is high. Students are well acquainted with the principle of energy efficiency and they learn to build insulated structures. However, the course investigated did not appear to provide students with a theoretical understanding of NZEB or climate change, and there is little scope for interdisciplinary learning between, for instance, construction and building services students. The theoretical element of the programme was described by a construction lecturer as 'very simple'.

5.4 Comparing Belgium and Finland

The standards-based Belgian occupational profiles are detailed, and the knowledge component, so essential to providing understanding of how and why NZEB is carried out and how the efforts of an individual worker contribute to the carrying out of the whole project, is significant. The emphasis on self-management and teamwork in the 'attitude' component of the occupational profile increases the likelihood that work is properly carried out and that cooperation

with workers in related occupations occurs. Occupational overlaps also increase the likelihood of mutual understanding of the practical application of NZEB principles.

Finnish IVET, by contrast, has significant weaknesses, including its learning outcomes approach. The way in which time is distributed between college and the workplace makes it difficult for students to reflect on the implications of practice or to keep theoretical considerations in mind when practising. The lack of NZEB expertise in the workplace will not help here either. The scope given by curricula for the development of understanding of NZEB principles is very limited, which is surprising given the high level of general education characteristic of Finnish students.

5.5 CVET: The examples of Ireland and Slovenia

Unlike the Belgian and Finnish IVET examples, incorporation of LEC requirements is confined for many countries, including Ireland and Slovenia, to CVET. Ireland and Slovenia illustrate distinct approaches to developing and delivering CVET for NZEB, reflecting differences in existing VET systems and the strategy pursued following the BUS investigation. Ireland was one of the 22 countries that developed a short CVET course initiative in the second phase of BUS, whilst Slovenia's bid for funding was unsuccessful. Unlike many other recipients of a BUS Phase II award, Ireland succeeded in developing this course into a nationally recognised and comprehensive introductory qualification that addresses key dimensions of NZEB expertise. This sets the two countries apart because in Slovenia CVET continues to be task specific and divorced from the theoretical knowledge that underpins NZEB standards, with no indication that interdisciplinarity and the coordination competences essential for successful completion are addressed.

5.6 Irish CVET for NZEB

The CVET system in Ireland is, as in most EU countries, varied and fragmented. The State Further Education and Training Authority (SOLAS) is the Further Education and Training (FET) authority responsible for planning, coordinating and funding CVET (Burke *et al.* 2016). FET courses range from one-day courses by private companies to comprehensive three-year programmes. They are generally Levels 5–6 (as defined by Quality and Qualifications Ireland—QQI) and can be awarded by SOLAS or Education and Training Bodies (ETBs) and some education organisations. FET NZEB courses have been available in the installation of renewable energy technologies at National Qualification Framework (NQF) Levels 5 or 6 (equivalent to EQF 4–5), provided by QQI.⁹ City and Guilds, founded in 1878 in England to protect and promote the standard of technical education, is also present in Ireland¹⁰ and it runs courses in energy efficiency and sustainable construction, ranging from two to 14 weeks in duration. Ad-hoc programmes are also provided by the private sector, such as the passive house tradesperson course Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM) training, although these are not certified under QQI.

As part of Ireland's participation in BUS, a new course was developed to target building workers with or without qualifications. Foundation Energy Skills (FES) is a three-day, standalone introductory module that consists of six units:

1. Energy and Buildings
2. How Energy Works
3. Building Fabric 1 (Air and Wind Tightness)
4. Building Fabric 2 (Insulation, Thermal Bridging and Best Practice)
5. Heating and Ventilation
6. Systems Thinking.

It is primarily theoretical, also suitable for self-study, and aims to develop a core understanding of energy efficiency in the context of climate change and of the reasons why NZEB is set to replace traditional construction. This equips workers with an appreciation of the importance of completing buildings precisely and to the standards intended. In this way, the course addresses the knowledge element of NZEB expertise well, which is often missing from task-based courses, for example, in RES installations. The final unit on Systems Thinking addresses coordination and communication.

Following the completion of BUS, FES has been developed for accreditation by City and Guilds to be delivered nationwide under the leadership of ETBs, with further plans to tailor it for specific construction occupations or areas of expertise (*e.g.* NZEB for Bricklayers). The first introductory course was delivered by Wexford and Waterford Education and Training Board in September 2018, and the first trade-specific course in January 2019. There has been a steady increase in attendance on the different courses, totalling 582 until March 2020, including for NZEB fundamentals (457), electrical (18), retrofit (36), plumbing (6), ventilation (60) and carpentry (5). A notable feature of this development process has been collaboration with other agencies and organisations, including employer organisations and trade unions, training bodies, private companies with expertise in energy-efficient construction, and government representatives.

5.7 Slovenian CVET for NZEB

CVET in Slovenia is fragmented with three main pathways available to potential trainees. The first is open to those with existing vocational upper secondary education qualifications and consists of further training provided by professional chambers for facilitating progression to positions as foreperson, manager or master craftsperson. Examinations and

qualifications are approved by the Expert Council for VET and regulated by the Ministry for Economy. Successful completion leads to a Technical Upper Secondary qualification, the highest level of VET. The second main avenue is to complete a work-based NVQ, a nationally coordinated system regulated by the Ministry for Labour and certifying participants' existing skills and competencies, leading to publicly recognised qualifications (CEDEFOP 2017: 2). This NVQ, a derivative of the British NVQ first introduced in 1986 and now largely abandoned, aims to develop narrow competences manifested in tasks and described by learning outcomes, so best adapted to Taylorist or quasi-Taylorist work processes (Jessup 1991). The third avenue is a combination of short and specific in-company training available to employees, often provided by external, private training organisations or manufacturers of new technologies, and other sector-specific, short courses developed by the employment service in response to employer needs. These do not lead to publicly recognised qualifications and are not regulated, although participants may acquire a certificate of completion if valued by specific employers or for specific jobs. Thus, most CVET is competence and learning outcome based, geared to accrediting on-the-job learning or certifying the acquisition of specific skills (Clarke *et al.* 2019b).

The BUS investigation and the authors' VET4LEC research suggests that CVET provision related to NZEB is very limited, does not provide for building envelope workers and is mostly in the installation of renewable energy systems such as solar panel installations by manufacturers of such new technologies. The authors' research collaborators from Slovenia described the courses as very short (consisting of a few hours or a day) and run with the aim of teaching how to install and maintain specific systems. Being technology focused, courses cater to those with existing VET qualifications, such as qualified electricians. Such courses may lead to certification of completion by the manufacturer or private training organisation involved, but the providers are unregulated, training is not standardised and the qualifications are not part of the national qualifications system.

Short and specific courses are unlikely to provide the depth and breadth of education needed for NZEB, such as an understanding of the climate emergency, energy efficiency, building physics, holistic understanding of the building process, coordination or problem-solving.

NZEB-relevant competencies are also yet to be integrated into IVET in Slovenia.

5.8 Comparing Ireland and Slovenia

The recent developments in Ireland are set to put the country on a different path from Slovenia as FES is suitable for providing the existing workforce with an accessible and comprehensive introduction to energy efficiency and can constitute the basis for further, more specific and technical training. Being regulated currently at the regional level, with the aim to roll out nationally, it also enables the establishment of quality standards, monitoring processes and a degree of standardisation often lacking in fragmented approaches to CVET. This approach is also with the increasingly proactive role the Irish government has assumed in the transition to NZEB, as exemplified by the construction of the NZEB training centre for new build in Enniscorthy and for retrofit in Waterford. In contrast, CVET for NZEB in Slovenia continues to be limited to RES installations, narrow in scope and targeting qualified workers. Establishing and monitoring standards in short and ad-hoc courses by private training providers is difficult and fundamentally contrasts with the standardisation and consistently high-quality training needed for NZEB. Equally importantly, whilst the Irish approach recognises the importance of investing in labour, developments in Slovenia imply an instrumental and short-sighted approach to the challenge of transforming buildings.

6. Conclusions

Nearly zero-energy building (NZEB) requires a high standard and quality of vocational education and training (VET), capable of overcoming occupational boundaries and developing a holistic understanding of the construction process. As evidenced here, the knowledge, skill and competences elements necessary to meet European Performance in Buildings Directive (EPBD) targets are wide-ranging and best incorporated or mainstreamed into initial vocational education and training (IVET) programmes. How this can be achieved is illustrated with the Belgian case, which takes a standards-based approach to IVET and successfully embeds low-energy construction (LEC) standards into curricula content and into the VET system. In contrast, the learning outcomes-based approach to IVET in Finland is too narrow and lacking in depth to allow for the systematic application of theoretical LEC knowledge to practice and for the development of NZEB expertise in the workplace.

In terms of continuing vocational education and training (CVET), the Irish Foundation Energy Skills (FES) module comes closest to a standards-based approach, carefully linking theoretical considerations to specific applications and addressing the importance of coordination and communication. It contrasts with the short Slovenian CVET for NZEB courses, which focus on learning outcomes and target specific skills and, as a result, cannot impart the necessary knowledge of LEC or to develop a holistic understanding of the construction process.

The two examples of Belgian IVET and Irish CVET show that a standards-based approach to VET for NZEB is possible, as well as illustrating the problems attached to a learning outcomes-based approach. Transforming VET to meet NZEB standards remains, however, a huge challenge, one which increases in urgency as the deadlines targeted for increasing energy efficiency and reducing carbon emissions creep ever closer and climate change becomes ever more evident. Indeed, lack of attention to quality and standards in VET for NZEB jeopardises the achievement of emission reduction targets and the ability to close the performance gap (Zero Carbon Hub 2014).

However, the continuing preoccupation with a learning outcomes approach across the EU and in the EC (EC 2020; Winch 2020) indicates that much needs to be done to raise awareness of the holistic, standards-based VET and qualifications required for successful NZEB. A narrow approach confined to imparting skills, rather than embracing broader knowledge and competence elements, can only accentuate occupational fragmentation and obstruct the transformation of the construction industry. The development of integrated occupational competences of the kind found in Belgium in the VET4LEC study suggests a pedagogy that combines operational practice, simulation and classroom work, resulting in a complete capacity for action or what is termed in German VET programmes 'vollständige Handlung' (Brockmann *et al.* 2011). The Irish approach, while not as comprehensive as that in Belgium, nevertheless emphasises the importance of knowledge to effective workplace action, thus contrasting with learning-outcomes approaches. Although designed for CVET, Ireland's contribution can be incorporated into IVET programmes that encompass NZEB.

As the imperative of climate change becomes ever more urgent, the temptation is to resort to what appear to be quick, short and simple solutions to equipping the existing and future construction workforce with the necessary skills. The purpose of this paper has been to demonstrate that such a response is short-sighted and unlikely to succeed in achieving the targets set for improving the energy efficiency and reducing the carbon emissions associated with the built environment. To be effective, VET programmes need to move away from learning outcomes-based approaches, focused on imparting narrow skills to carry out specific tasks, and to be founded instead on standards-based approaches and broad occupational profiles that combine knowledge, know-how and attitudes, develop transversal abilities—including communication, coordination, problem-solving, project management and precision—and enable workers to apply theoretical considerations to practice. Whilst CVET courses will, inevitably, be more variable given the different qualifications and experience of the existing workforce, there is no short-cut solution to embedding these competences in the curricula of IVET courses so that the future workforce is well equipped for NZEB, including retrofitting.

Notes

- ¹ This paper is based on an analysis of developments in the EU and uses the terminology of 'nearly zero-energy building' (NZEB) rather than 'zero carbon' because the latter is the definition adopted by the European Performance in Buildings Directive (EPBD).
- ² Three test procedures—air permeability, co-heating and thermal imaging—can be used for the preoccupancy thermal performance of the building envelope (floor, walls/doors, windows and roof), enabling a reasonable assessment of 'as-built' heat loss and the designed heat loss compared with performance without the additional complication of normalising for occupancy (Johnston & Miles-Shenton 2009).
- ³ The latest country updates available are based on the status in December 2016.
- ⁴ The EQF is a learning-outcomes-based 'meta-framework' designed for cross-national comparison of both national qualifications and NQFs from different countries. For more explanation, see Mehaut & Winch (2011: esp. 28–33).
- ⁵ European Construction Sector Observatory Country Reports for all partner countries (https://ec.europa.eu/growth/sectors/construction/observatory_en).
- ⁶ BUS National Status Quo Analysis and Pillar II activities for all partner countries; links to national pages are available at <http://www.buildup.eu/en/skills/>.
- ⁷ CEDEFOP Spotlight reports on all partner countries (<http://www.cedefop.europa.eu/en>).
- ⁸ This paper is based on the authors' interpretation of the data obtained and any inaccuracies are entirely our own and not attributable to the authors' project partners.
- ⁹ An NQF is designed to compare national qualifications, both academic and professional.
- ¹⁰ City and Guilds designs products and services to recognise workplace skills, from qualifications and apprenticeships to accreditation and assessments.

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Competing interests

The authors have no competing interests to declare.

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