

WP2 Labour market mapping, skills needs assessment and analysis of the state-of-the-art in energy efficiency and sustainable housing

D.2.3 – Compendium of best practices in the VET sector

Project No: **101194014**

Grant Agreement No.	101194014		
Project Acronym	EXCEL4HOUSING4.0		
Project Title	EXCEL4HOUSING4.0		
	Energy Efficiency and Sustainable Housing		
Type of action	ERASMUS Lump Sum Grants		
Call Topic	ERASMUS-EDU-2024-PEX-COVE		
Project Start Date	03.02.2025	Project End Date	03.02.2029
Project Website	www.excel4housing.eu		
Work Package	WP2		
WP Leader / Task Leader	AKMI / CEEC		
Deliverable type Dissemination level	R: Document, report SPU - Public		
Version	V1.0		

Table of contents

1. Executive Summary	5
2. Introduction.....	7
2.1. Purpose and Scope of the Compendium.....	7
2.2. Methodology for Collection	7
2.3. Criteria for Selection.....	7
3. Overview of Selected Best Practices.....	8
3.1. Validation Matrix.....	8
3.2. Statistical Breakdown	13
4. Compendium of Best Practices	14
4.1. Belgium.....	14
4.2. Croatia	18
4.3. Transnational / European Level.....	20
4.4. Germany	22
4.5. Finland	25
4.6. Greece	28
4.7. Italy.....	31
4.8. Poland.....	35
4.9. Portugal	39
4.10. Spain	43
4.11. Sweden	48
4.12. Ukraine	51
5. Cross-Cutting Analysis	55
5.1. Common Trends and Success Patterns	55
5.2. Recurrent Challenges	55
6. Transferability & Adaptation Guidelines for WP4	56
6.1. Modularization and Micro-credentials.....	56
6.2. The "Living Lab" Pedagogy	56
6.3. Train-the-Trainer First	57
6.4. Regional Adaptation	58
6.5. Step-by-Step Adaptation Framework.....	59
6.6. Transferability Readiness Checklist.....	60
7. Conclusions.....	61
8. References & Bibliography	62
9. Annexes.....	63
List of Best Practices.....	63
Annex 1: Build Circular.Brussels (BCB) : Circular Construction Training & Support.....	63
Annex 2: CBCI (Circular Biobased Construction Industry) — Integrated Circular & Biobased	

Construction Innovation.....	70
Annex 3: BE REEL! – Belgium Renovates for Energy Efficient Living	77
Annex 4: CRO Skills RELOAD	84
Annex 5: Incept.....	90
Annex 6: BAUHAUS 4 MED - Testing New European Bauhaus Solutions for Deep Green Transformation of Cities and Regions in Euro-MED area	95
Annex 7: Bau Bildung Digital	103
Annex 8: Circular Bau – Circular economy in construction training.....	109
Annex 9: The qualification initiative for building technology	113
Annex 10: BIMEET BIM-based EU-wide standardized qualification framework for achieving energy efficiency training.....	118
Annex 11: ReCreate	122
Annex 12: BIM-design collaboration	126
Annex 13: Teknikhuset	129
Annex 14: Exoikonomo – Energy Efficiency Upgrading of Buildings	133
Annex 15: CDWaste-ManageVET – Developing skills for sustainable construction and demolition waste management	140
Annex 16: NTUA ZEB Living Lab – GR-Eco Building Living Labs (National Technical University of Athens)	147
Annex 17: ARCA Academy	153
Annex 18: ECO3R and CIRCULAR DESIGN POLITO LAB.....	160
Annex 19: DEAL with DIGITAL WBL – Work-Based Learning digitale	169
Annex 20: Estate with Climate simulation game.....	176
Annex 21: Nationwide Polish program “Eco-workshop – the green heart of the school”	184
Annex 22: Urban Labs.....	190
Annex 23: Circo Hub Portugal.....	197
Annex 24: Katch_e project - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education.....	202
Annex 25: BP25 Eco.nomia portal	208
Annex 26: Construye 2020+ – Energy Efficiency Training and Accreditation	212
Annex 27: LIFE ReNatural NZEB MOOCs – Online Training in Sustainable Construction	217
Annex 28: Specialization Course in BIM (Building Information Modeling)	222
Annex 29: Construye 2030	228
Annex 30: TOP CLeverR	233
Annex 31: Descarboniza calefacción.....	238
Annex 32: Brf Viva – Positive Footprint Housing.....	243
Annex 33: ReTuna Återbruksgalleria – Reuse Shopping Mall	252
Establish Cross-Sector Learning Hubs	259
Annex 34: Stockholm Royal Seaport – Digital Twin for Sustainable Urban Development.....	261
Annex 35: Supporting Energy Modernisation of Enterprises During Wartime	269
Annex 36: Mechanised Application of Decorative Plaster and Airless Painting	275

Annex 37: Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0)	283
---	-----

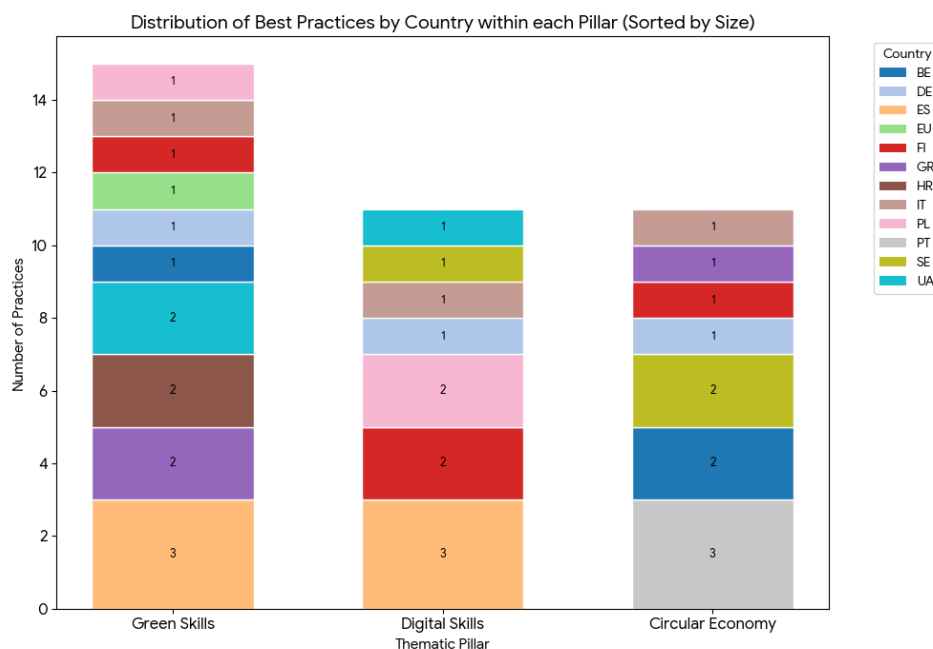
1. Executive Summary

The Compendium of Best Practices (Deliverable 2.3) serves as a strategic resource within the EXCEL4HOUSING4.0 project (Grant Agreement No. 101194014). This document consolidates innovative, evidence-based, and transferable initiatives in the fields of Vocational Education and Training (VET), energy efficiency, and sustainable housing.

As part of Work Package 2 (WP2), aimed at mapping labour market needs and analyzing the state-of-the-art, this compendium provides a curated selection of **37 best practices collected** from the project's Centres of Vocational Excellence (CoVEs) across Europe (North, Central, South, Eastern, and South-Central/South-East Europe) and Ukraine.

The selected practices address the critical skills gaps identified in the construction sector, focusing on the project's three core pillars:

- **Energy Efficiency & Net-Zero Buildings:** Methodologies for deep renovation and high-performance building. (15 Practices). The largest share of collected initiatives focuses on energy efficiency, NZEB renovation, and sustainable building techniques, reflecting the sector's urgent drive towards decarbonisation.
- **Digital Transition (Housing 4.0):** Integration of BIM, Digital Twins, and IoT in training and construction. (11 Practices). A significant portion addresses the digitalization of construction, featuring training on BIM, Digital Twins, and smart home technologies.
- **Green Transition (Circular Economy):** Sustainable materials, waste management, and life-cycle assessment (11 Practices). An equal focus is placed on resource efficiency, highlighting innovations in material reuse, waste management, and bio-based construction.



This balanced distribution of best practices, carefully curated from diverse regional and sectoral contexts across Europe, is fundamentally collected to ensure the robustness and relevance of the project's subsequent curriculum development efforts. Specifically, the future curriculum design planned for Work Package 4 (WP4) will be deeply grounded in a holistic, contemporary, and pragmatic understanding of the modern construction sector's evolving needs.

This compendium is designed not merely as a repository of information, but as a practical toolkit for VET providers, policy-makers, and industry stakeholders. The identified practices serve as benchmarks to inspire the design of the new curricula, micro-credentials, and "Train the Trainers" programmes to be developed in Work Package 4. By highlighting successful models of business-education partnerships and innovative pedagogies (e.g., Work-Based Learning, Living Labs), this document lays the foundation for upward convergence in the European construction skills ecosystem.

2. Introduction

2.1. Purpose and Scope of the Compendium

The construction sector is currently facing a dual challenge: the urgent need to decarbonize the European building stock to meet Green Deal targets (e.g., the Renovation Wave) and a severe shortage of skilled workers equipped to implement these changes. The **EXCEL4HOUSING4.0 project** aims to bridge this gap by establishing a transnational network of Centres of Vocational Excellence (CoVEs).

The purpose of Deliverable 2.3 is to identify "what works" in the current landscape. It provides a comparative analysis of successful training initiatives, technical innovations, and governance models that can be replicated or adapted by the project partners.

2.2. Methodology for Collection

To ensure the high quality and relevance of the practices included in this Compendium, the consortium applied a rigorous, multi-step methodology led by CEEC (Task Leader) in collaboration with all national partners.

The validation of best practices followed a Quality Assurance mechanism designed to filter for excellence and scalability. Using a standardized reporting template to ensure data comparability, all submissions underwent a peer-review process. Each practice was evaluated against five key criteria—Relevance, Innovation, Impact, Transferability, and Sustainability—with a mandatory threshold requiring a positive assessment in at least four out of five categories to be included in the final Compendium.

The process was structured as follows:

- **Definition of Scope:** A clear definition of "Best Practice" was established, focusing on initiatives that support the green and digital transition in construction.
- **National Desk Research:** Partners conducted extensive research in their respective regions (Belgium, c, Finland, Germany, Greece, Italy, Poland, Portugal, Spain, Sweden, and Ukraine) to identify initiatives that bridge the gap between education and industry needs.
- **Standardized Documentation:** A common reporting template was used to capture key data points for each practice, including: thematic area, target groups, methods used, quantitative outcomes, and transferability potential.
- **Internal Validation:** The collected practices **underwent a peer-review process** within the consortium to filter out initiatives with low impact or limited transferability.
- **Categorization:** The final selection was categorized by country and thematic area to facilitate cross-cutting analysis.

2.3. Criteria for Selection

Each identified practice was evaluated against five key eligibility criteria to ensure alignment with the EXCEL4HOUSING4.0 objectives:

- **Relevance:** The practice must address green/digital skills in construction or related VET areas, aligning with the "Housing 4.0" concept.

- **Innovation:** It must introduce a novel method, tool, or pedagogical approach (e.g., Micro-credentials, Virtual Reality training) rather than standard traditional teaching.
- **Impact:** The practice must demonstrate measurable positive outcomes (e.g., number of people trained, CO2 reduced, employment rates increased) or strong stakeholder validation.
- **Transferability:** The initiative must have high potential for replication or adaptation in other VET systems or European regions (e.g., modular curriculum, open-source tools).
- **Sustainability:** The practice must demonstrate potential for long-term application or institutionalization beyond its initial funding period.

3. Overview of Selected Best Practices

3.1. *Validation Matrix*

The following matrix presents the **37 selected** best practices that successfully passed the validation criteria. They represent a diverse mix of VET initiatives, industry-led training, and public-private partnerships.

Country-Level Analysis & Observed Trends

The validation process reveals distinct regional strengths and thematic gaps across the participating countries, highlighting how local market needs influence VET priorities:

Southern Europe (Spain, Italy, Greece, Portugal): This region demonstrates a "dual speed" innovation. Spain and Italy stand out as comprehensive leaders, showing strong integration of Digital Skills (BIM) with Energy Efficiency. In contrast, Portugal has emerged as a specialized hub for the Circular Economy, contributing 100% of its accepted practices in this domain (e.g., Circo Hub, Katch_e), signaling a mature focus on resource efficiency that other regions could replicate.

Eastern Europe (Poland, Ukraine, Croatia): The focus here is overwhelmingly on Energy Efficiency and Thermal Modernization. This reflects the urgent need to renovate aging building stock and, specifically in Ukraine's case, to build resilience. While strong in "Green" skills, this region shows a comparative gap in advanced Digital practices (like Digital Twins) within the VET sector compared to their Northern counterparts, identifying a key area for the EXCEL4HOUSING4.0 curriculum to address.

Northern & Central Europe (Finland, Sweden, Belgium, Germany): These countries exhibit the highest maturity in High-Tech Construction. Practices from Finland and Sweden heavily feature Digital Twins and Industrial Symbiosis (e.g., Stockholm Royal Seaport), while Belgium (Brussels) provides benchmark examples of Circular Construction regulation (Build Circular.Brussels). The strength here lies in the systemic integration of these topics into formal VET systems, rather than just ad-hoc projects.

ID	Title of the Practice	Partner Responsible	Country	Relevance (Green/Digital Skills) YES/NO	Innovation YES/NO	Impact	Transferability	Sustainability	Meets at least 4/5 criteria? (Yes/No)	Final Decision (Include in D2.3? Yes/No)
BE-01	Build Circular.Brussels (BCB)	BGT	Belgium	YES	YES	High	High	YES	YES	YES
BE-02	CBCI (Circular Biobased Construction Industry)	BGT	Belgium	YES	YES	High	High	YES	YES	YES
BE-03	BE REEL! (Belgium Renovates)	BGT	Belgium	YES	YES	High	High	YES	YES	YES
HR-01	CRO RELOAD Skills	UZ	Croatia	YES	YES	High	High	YES	YES	YES
HR-02	INCEPT Project	UZ	Croatia	YES	YES	High	High	YES	YES	YES
EU-01	BAUHAUS MED 4	UZ	Croatia	YES	YES	High	High	YES	YES	YES
DE-01	Bau Digital Bildung	BFW-NRW	Germany	YES	YES	High	High	YES	YES	YES
DE-02	Circular Bau	BFW-NRW	Germany	YES	YES	High	High	YES	YES	YES
DE-03	Qualification Initiative Building Technology for	BFW-NRW	Germany	YES	YES	High	High	YES	YES	YES

ID	Title of the Practice	Partner Responsible	Country	Relevance (Green/Digital Skills) YES/NO	Innovation YES/NO	Impact	Transferability	Sustainability	Meets at least 4/5 criteria? (Yes/No)	Final Decision (Include in D2.3? Yes/No)
FI-01	BIMEET	NOVIA	Finland	YES	YES	High	High	YES	YES	YES
FI-02	ReCreate (Concrete reuse)	NOVIA	Finland	YES	YES	High	High	YES	YES	YES
FI-03	BIM-design collaboration	NOVIA	Finland	YES	YES	High	High	YES	YES	YES
FI-04	Teknikhuset	YA	Finland	YES	YES	High	High	YES	YES	YES
GR-01	Exoikonomo	AKMI	Greece	YES	YES	High	High	YES	YES	YES
GR-02	CDWaste- ManageVET	AKMI	Greece	YES	YES	High	High	YES	YES	YES
GR-03	NTUA ZEB Living Lab	AKMI	Greece	YES	YES	High	High	YES	YES	YES
IT-01	ARCA Academy	FOAT	Italy	YES	YES	High	High	YES	YES	YES
IT-02	ECO3R and Circular Design Polito Lab	FOAT	Italy	YES	YES	High	High	YES	YES	YES
IT-03	DEAL with DIGITAL WBL	FOAT	Italy	YES	YES	High	High	YES	YES	YES
PL-01	Estate Climate (Simulation Game)	MAE	Poland	YES	YES	High	High	YES	YES	YES
PL-02	Eco-workshop –	MAE	Poland	YES	YES	High	High	YES	YES	YES

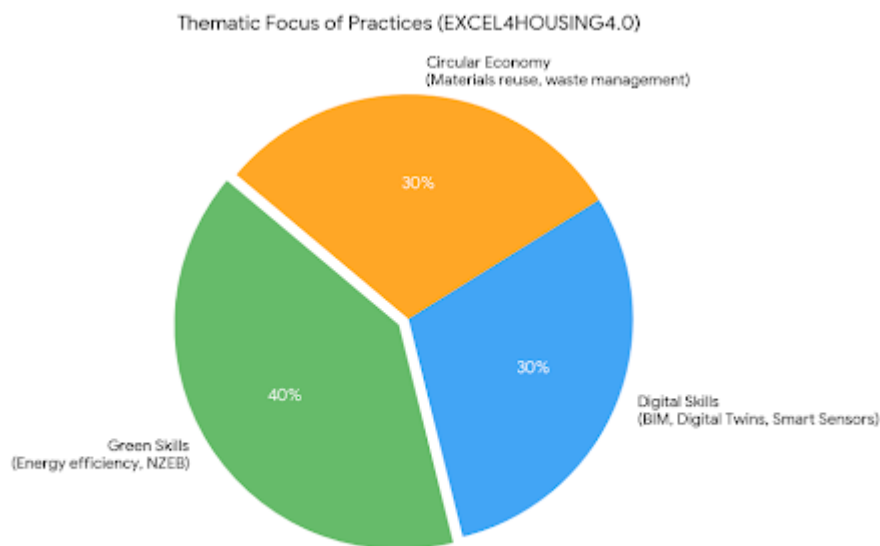
ID	Title of the Practice	Partner Responsible	Country	Relevance (Green/Digital Skills) YES/NO	Innovation YES/NO	Impact	Transferability	Sustainability	Meets at least 4/5 criteria? (Yes/No)	Final Decision (Include in D2.3? Yes/No)
	Green heart of the school									
PL-03	Urban Labs	MAE	Poland	YES	YES	High	High	YES	YES	YES
PT-01	Circo Hub Portugal	LNEG	Portugal	YES	YES	High	High	YES	YES	YES
PT-02	Katch_e Project	LNEG	Portugal	YES	YES	High	High	YES	YES	YES
PT-03	Eco.nomia portal	LNEG	Portugal	YES	YES	High	High	YES	YES	YES
ES-01	Construye 2020+	AGENEX	Spain	YES	YES	High	High	YES	YES	YES
ES-02	LIFE ReNatural NZEB MOOCs	AGENEX	Spain	YES	YES	High	High	YES	YES	YES
ES-03	Specialization Course in BIM	AGENEX	Spain	YES	YES	High	High	YES	YES	YES
ES-04	Construye 2030	LA SALLE	Spain	YES	YES	High	High	YES	YES	YES
ES-05	TOP CLeverR	LA SALLE	Spain	YES	YES	High	High	YES	YES	YES
ES-06	Descarboniza calefacción	LA SALLE	Spain	YES	YES	High	High	YES	YES	YES
SE-01	Brf Viva – Positive Footprint Housing	KTH + FU	Sweden	YES	YES	High	High	YES	YES	YES
SE-02	ReTuna Återbruksgalleria	KTH + FU	Sweden	YES	YES	High	High	YES	YES	YES

ID	Title of the Practice	Partner Responsible	Country	Relevance (Green/Digital Skills) YES/NO	Innovation YES/NO	Impact	Transferability	Sustainability	Meets at least 4/5 criteria? (Yes/No)	Final Decision (Include in D2.3? Yes/No)
SE-03	Stockholm Royal Seaport – Digital Twin	KTH + FU	Sweden	YES	YES	High	High	YES	YES	YES
UA-01	Supporting Energy Modernisation (Wartime)	Sumy HVSCD	Ukraine	YES	YES	High	High	YES	YES	YES
UA-02	Mechanised Application of Plaster/Painting	Sumy HVSCD	Ukraine	YES	YES	High	High	YES	YES	YES
UA-03	ENEFEDU 2.0 (Thermomodernisation)	Sumy HVSCD	Ukraine	YES	YES	High	High	YES	YES	YES

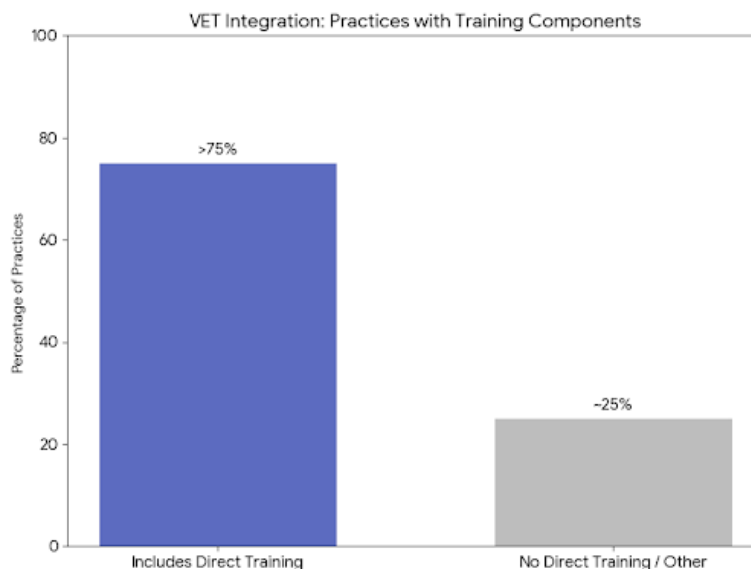
3.2. Statistical Breakdown

The analysis of the collected practices reveals a strong alignment with the EXCEL4HOUSING4.0 priorities:

- Geographical Coverage: The compendium covers all 5 CoVE regions defined in the proposal (North, South, Central, Eastern, and South-Central/East Europe).
- Thematic Focus:
 - ~40% of practices focus primarily on Green Skills (Energy efficiency, NZEB).
 - ~30% focus on Digital Skills (BIM, Digital Twins, Smart Sensors).
 - ~30% focus on Circular Economy (Materials reuse, waste management).



- VET Integration: Over 75% of the practices include a direct training component (curriculum, MOOC, or workshop), confirming their relevance for the upcoming WP4 curriculum design.



4. Compendium of Best Practices

This section presents the detailed analysis of the selected best practices, categorized by country.

4.1. Belgium

BE-01: Build Circular.Brussels (BCB)

Field	Description
Title of the practice	Build Circular.Brussels (BCB) : Circular Construction Training & Support
Country of implementation	Belgium — Brussels-Capital Region .
Organisation(s) involved	Brussels Environment/Leefmilieu Brussel (training offers & technical content); CDR – Centre de Référence Construction (sectoral reference centre running construction trainings); efp/Bruxelles Formation (VET provider delivering modules); ecobuild.brussels (regional sustainable construction cluster & outreach); hub.brussels (enterprise support).
Description	BCB is a regional programme that trains and assists construction professionals to implement circular methods (e.g., reuse inventories, selective dismantling, materials reuse, waste minimisation, digitalisation of renovation). It combines free themed courses & seminars, tailored one-to-one support, and sector tools (guides, checklists) to convert circular ambitions into site-level practice .
Thematic area(s)	Green / Circular / Pedagogical (applied training in construction).
Methods and tools used	>50 free training programmes (e.g., circular site management, wood reuse, digitalisation of renovation); targeted support (>30 support types across 8 themes) ; Guide Bâtiment Durable knowledge base; Reuse inventory method; Circular Built project-monitoring tool; sector platforms like Opalis (reclaimed materials) and reuse.brussels (methods & manuals).
Target group(s)	SMEs and contractors , demolition/renovation firms, architects/engineers , public clients/municipalities, trainers and VET learners engaged via CDR/efp activities.
Outcomes and impact	Documented scale & offer : >50 free courses available to workers; BCB offers >30 tailored support types in 8 areas (e.g., waste & reuse). Broader sector capacity: in earlier push years, 3,542 construction workers trained in Brussels with 73,359 training hours (sector data from Constructiv, illustrating training

	intensity in the region). 41+ circular-economy business support offers are currently available region-wide.
Transferability	Highly transferable to regions with: (i) a sectoral reference centre (or equivalent), (ii) public environment/skills agencies, (iii) an industry cluster for outreach, and (iv) a toolkit (guides, inventories, platforms). The BCB architecture (courses + bespoke support + tooling) can be scaled or modularised.
Relevance to E4H	Offers a ready-made model to integrate circular skills in VET: co-develop training with reference centres, require site-based application (reuse inventories, dismantling), and anchor curricula in regional tools (Guide Bâtiment Durable, Circular Built). Strong match to Energy Efficiency/Sustainable Housing and Circular Economy strands of EXCEL4HOUSING4.0.

BE-02: CBCI (Circular Bio-based Construction Industry)

Field	Description
Title of the practice	CBCI (Circular Biobased Construction Industry) — Integrated Circular & Biobased Construction Innovation
Country of implementation	Belgium (Ghent region, KU Leuven campus) + cross-border (NL, UK) within the Interreg / territorial cooperation umbrella (Circularbuilt)
Organisation(s) involved	KU Leuven (Belgium), WTCB / Embuild Vlaanderen, Kamp C (BE), Avans University (NL), HZ University (NL), project partners from the Netherlands and UK, local municipalities, contractors, prototyping labs, researchers (Circularbuilt)
Description	CBCI investigates efficient and biobased use of raw materials in construction, reducing CO ₂ and material throughput by designing and applying circular / bio-based solutions in real building cases (living labs). The project prototypes components, works with procurement frameworks, conducts co-creation with stakeholders, and monitors life cycle performance. The aim is to move beyond isolated demonstrations to embedded systemic change. (Circularbuilt)
Thematic area(s)	Circular / Green / Sustainable construction / Innovation / Pedagogical (research-to-practice)
Methods and tools used	Living labs (real building projects) as testbeds; prototype development of façade units, plug-in modules, HVAC modules, etc.; tendering and procurement frameworks designed for circular & biobased ambition; co-creation workshops;

	performance monitoring (life cycle assessment, CO ₂ metrics); collaboration with labs and makerspaces (e.g. SPARK Maker Space, WTCB). (Circularbuilt)
Target group(s)	Construction professionals, architects, engineers, material producers; public procurers; VET / technical education programs; municipalities and policy actors; researchers and innovators.
Outcomes and impact	- Deployment of two living lab projects : <i>KU Leuven campus expansion (Belgium)</i> and <i>Emergis health care facility expansion (NL)</i> using circular and biobased components. (Circularbuilt) - Prototypes of façade elements and modular systems developed and tested in real conditions. (Circularbuilt) - Creation of white papers / procurement guidelines for circular & biobased tenders. (Circularbuilt) - Stakeholder engagement: over 20 observer partners, many local actors in Belgium and Netherlands. (Circularbuilt) - Knowledge sharing and dissemination of project lessons across regions.
Transferability	The CBCI architecture (living labs + prototype development + procurement frameworks + stakeholder co-design) is transferable to other regions provided there is institutional capacity to run living labs, collaboration between education/institutions and industry, and willingness from public procurement bodies to adopt innovation in tenders. The components and prototypes can be adapted to local material ecosystems and regulatory environments.
Relevance to E4H	CBCI offers a template for integrating experiential, real-world construction projects into VET or CoVE curricula: learners can engage in prototype design, performance monitoring, circular procurement. It directly complements EXCEL4HOUSING4.0's goals in sustainable and circular housing by showing how materials, bio-based systems, and procurement approaches can be innovated in practice, not just theory.

BE-03: BE REEL! (Belgium Renovates for Energy Efficient Living)

Field	Description
Title of the practice	BE REEL! – Belgium Renovates for Energy Efficient Living
Country of implementation	Belgium (Flanders, Wallonia, and cooperation in Brussels)
Organisation(s) involved	Flemish Energy and Climate Agency (VEKA), Service Public de Wallonie, Brussels partners, local municipalities, construction companies, training providers, housing associations, LIFE Programme (EU).

Description	BE REEL! is a LIFE Integrated Project (2018–2024) designed to accelerate Belgium’s long-term renovation strategy. It combines policy support, demonstration renovation projects, training of “renovation advisors,” innovative financing, and awareness raising to create a sustainable renovation wave. The project links national/regional strategies with municipal pilots and VET-related training for advisors and workers.
Thematic area(s)	Green / Energy Efficiency / Pedagogical
Methods and tools used	- 15-module training curriculum for “renovation advisors” (via LearnWorlds digital platform). - Demonstration projects in 5+ municipalities showcasing integrated renovations (insulation, HVAC, solar PV). - Policy guidelines and local authority support tools. - Innovative financing/business models to support deep renovation.
Target group(s)	Construction workers, renovation advisors, municipalities, local authorities, households (including vulnerable groups), VET trainers.
Outcomes and impact	- Demonstration projects in multiple municipalities. - 15-module curriculum developed and rolled out for renovation advisors. - Integration of renovation strategies into local authority planning. - Awareness campaigns reaching households across Belgium. - Strengthened ecosystem of renovation supply chain actors.
Transferability	Highly transferable: combines policy frameworks, practical demonstrations, and training . Other EU regions can adapt the renovation advisor training and replicate the municipality-based demonstration model. The use of digital platforms (LearnWorlds) enhances scalability.
Relevance to E4H	BE REEL! is highly relevant because it addresses the energy efficiency and sustainable housing strand of EXCEL4HOUSING4.0. It provides a model of how to integrate training (renovation advisors), policy alignment, and demonstration projects into one coherent package. It also offers lessons on engaging municipalities and households, ensuring that VET initiatives connect with real demand.

4.2. Croatia

HR-01: CRO Skills RELOAD

Field	Description
Title of the practice	CRO skills RELOAD
Country of implementation	Croatia
Organisation(s) involved	University of Zagreb - Faculty of Civil Engineering, Green Building Council Croatia, Croatian Chamber of Trades and Crafts, Regional Energy Agency North, Association of Construction Engineering Schools of the Republic of Croatia
Description	The CRO Skills RELOAD project revitalized the National Qualification Platform and updated the National Roadmap to support national energy and climate goals. Developed under the Build Up Skills initiative, it targeted all renovation stakeholders—from decision-makers to future nZEB specialists—to promote the adoption of nZEB standards and sustainable construction. The project emphasized education and lifelong learning, building on previous initiatives to advance new skills development.
Thematic area(s)	Energy efficiency, Innovative VET methodologies and tools
Methods and tools used	blended learning, microcredentials, Work-Based Learning
Target group(s)	students, trainers, professionals, workers
Outcomes and impact	The CRO Skills RELOAD project's National Platform united key stakeholders from construction and education sectors. It developed Guidelines for continuous training across vocational, higher education, and lifelong learning to address skill gaps in energy efficiency. These Guidelines offer a clear plan to meet 2030 construction sector goals and have been officially endorsed for implementation.
Transferability	The CRO Skills RELOAD project's approach is highly transferable across the EU, addressing common challenges like an aging workforce, skills gaps, and decarbonization needs. By combining a multi-stakeholder platform with a National Roadmap and training Guidelines, it includes all renovation actors. This model can be replicated by establishing national platforms, developing tailored three-level training guidelines, and aligning with EU climate goals. Its holistic, scalable design adapts to different countries while preparing a skilled workforce for sustainable, energy-efficient construction.
Relevance to E4H	The CRO Skills RELOAD practice adds value by linking education and training to the construction sector's urgent green and digital transition needs. Through the National Qualification Platform and Roadmap, it ensures coordinated involvement of all stakeholders and official endorsement of guidelines. The practice modernizes VET with flexible, accessible methods aligned with labor market demands. Its scalable, holistic framework is transferable across Europe, helping upskill the workforce and support EU energy and climate goals.

HR-02: INCEPT Project

Field	Description
Title of the practice	INCEPT
Country of implementation	Bulgaria, Croatia, Romania
Organisation(s) involved	New Bulgarian University, University of Architecture and Urbanism 'Ion Mincu' Bucharest, University of Zagreb - Faculty of Architecture
Description	The INCEPT Project developed and implemented a sustainable architecture curriculum within Master of Architecture programs to build students' digital and green skills in energy-efficient, low-carbon design. Aligned with Europe's green transition, key outputs include a compendium, lecture course, online training, and a Climate Neutral Building Design Atelier, all supported by a shared digital platform.
Thematic area(s)	Energy efficiency, Circular economy, Digitalisation, Innovative VET
Methods and tools used	blended learning, digital labs,
Target group(s)	(architecture) students, university lecturers, professionals
Outcomes and impact	The project aligns architecture education with Europe's green transition by integrating low- and zero-carbon design strategies into core curricula, supported by experience-based training. It delivers a future-oriented, climate-focused curriculum and fosters long-term digital collaboration between universities. The validated curriculum has been widely disseminated to maximize national and EU-level impact.
Transferability	The INCEPT Project is highly transferable, offering adaptable curricula and scalable outputs for sustainable built environment education. Through transnational, multi-sector collaboration and strong dissemination, its results can be applied across various countries and systems, especially those facing similar energy efficiency challenges.
Relevance to E4H	The INCEPT Project aligns closely with the goals of E4H, supporting the European Green Deal by addressing skill gaps in energy efficiency, sustainability, and digital innovation. It advances higher education reform through future-proof architecture curricula, promoting green and digital skills. INCEPT's transnational, interdisciplinary approach complements E4H by fostering cross-border collaboration, business-academia links, and scalable training outputs. Both projects contribute to a resilient, climate-neutral, and digitally advanced built environment across Europe.

4.3. Transnational / European Level

EU-01: BAUHAUS 4 MED

Field	Description
Title of the practice	BAUHAUS 4 MED - Testing New European Bauhaus Solutions for Deep Green Transformation of Cities and Regions in Euro-MED area
Country of implementation	Greece, Italy, Bosnia and Herzegovina and Bulgaria as institutional partners - testing city/region partners; Slovenia (Lead partner), Spain, Greece and Croatia as support expert partners; 1 international organization, with the seat in Belgium as international networking partner
Organisation(s) involved	E-institute (Slovenia), Region of Central Macedonia (Greece), SVEM (Marche Region, Italy), Crowdpolicy (Greece), Platoniq Foundation (Spain), Regional Government of Tuscany (Italy), Faculty of Architecture (Croatia), City of Sarajevo (Bosnia and Herzegovina), Burgas Municipality (Bulgaria), IFLA Europe (international organization, with the seat in Belgium)
Description	Building upon the success of the Interreg MED BLUE CROWDFUNDING project, project Euro-MED BAUHAUS tests innovative NEB solutions integrating sustainability, inclusion and aesthetic aspects into decision making process, for improvement of green living areas. Each of the 5 testing regions/cities identifies participative green community challenges, uses crowdsourcing to co-create solution ideas, run civic crowdfunding campaigns to co-finance solutions and use participative budgets to implement pilot solutions. Pilot solutions are focused on circular building materials, regenerated green urban spaces, green products, or green lifestyle. Combining crowdfunding, crowdsourcing and participative democracy principles, with aesthetic green architecture design resulting in citizens tailor-made solutions for better living results in a new "CROWDVOCACY" tool.
Thematic area(s)	Energy efficiency, Circular economy, Digitalisation, Innovative VET methodologies and tools
Methods and tools used	Project-Based Learning (PBL), Gamification, Flipped Classroom, Microlearning, Peer Learning
Target group(s)	In the executive phase, participants representing all Quintuple Helix sectors are actively involved. Engagement is extended to individuals from diverse generations, professional fields, identities, cultural backgrounds, and life experiences (based on NEB inclusivity value).

Outcomes and impact	Testing pilot projects are evaluated and valorised according to predefined criteria from EU BAUHAUS self-assessment tool measuring the impact of solutions on sustainability (climate goals, circularity, zero-pollution and biodiversity), inclusiveness (impact on society, diversity, equality, accessibility and affordability), and aesthetics (quality of experience and style beyond functionality). Based on transnational verification a toolbox has been created, composed of guidance to the transformational process, best example catalogue, lessons learned as well as digital tool for participatory processes. Guidelines have been developed for the continuous training of all participant representing all Quintuple Helix sectors, providing transdisciplinary approach and multi-level engagement, co-creation and co-design of transformative and scalable, locally grounded and context-sensitive public spaces, learning by doing etc.
Transferability	The Euro-MED BAUHAUS transferability plan has been prepared to provide an easier assessment of the feasibility of transferring the project outputs and results to other regions and cities. First, the outputs have been transnationally rechecked to ensure they are in a “mainstreaming format” — reusable and ready to be transferred. Secondly, a list of actions has been prepared to enable further organisations to take up or upscale the outputs. Thirdly, a list of potential territories and partners has been developed for possible transfer.
Relevance to E4H	The added value of the BAUHAUS4MED practice lies in its capacity to systematically connect people living in the same area, united by the public space they share, to create more sustainable, inclusive, and beautiful environments as , the project ensured a coordinated approach that involves all relevant stakeholders, from policymakers to practitioners. These spaces will eventually become their ‘borrowed’ ownership through gamification, flipped classroom methods, microlearning, mutual care, the desire to spend time together, and peer learning — not only in the executive phase but, more importantly, in the usage stage — in order to fulfil all the values of the New European Bauhaus (NEB) initiative and, consequently, the EU Green Deal. Moreover, the practice introduces innovative VET methodologies, which modernize training provision and make it more accessible, flexible, and aligned with contemporary EU policies and initiatives. By re-establishing existing abandoned places — thus preparing the ground and setting guidelines for new projects — the Bauhaus4MED project has ensured a coordinated approach that involves all relevant stakeholders, from policymakers to practitioners. This inclusive model guarantees not only the development of guidelines but also their endorsement and implementation by the responsible authorities. Its transferability across Europe adds further value, as it demonstrates a scalable and holistic framework for addressing common challenges faced by many regions: social and economic disadvantages, inequality, and related crime and security issues. Such areas often lack quality green spaces, which negatively affect human health and well-being and make them more vulnerable to the impacts of climate

	change, while supporting the overall achievement of the EU's energy and climate goals.
--	--

4.4. Germany

DE-01: Bau Bildung Digital

Field	Description
Title of the practice	Bau Bildung Digital
Country of implementation	Germany
Organisation(s) involved	Bildungszentren des Baugewerbes (z. B. Bau-ABC Rostrup), ZDB, regionale Handwerkskammern
Description	The “Bau Bildung Digital” (Digital Construction Education) project develops digital learning modules for inter-company training in the construction industry. The aim is to supplement traditional classroom-based formats with blended learning and to promote digital skills. The content is practical and based on training regulations.
Thematic area(s)	Digitalisation / Housing 4.0; Innovative VET methodologies and tools
Methods and tools used	Blended learning, digital learning platforms, learning videos, quiz formats
Target group(s)	Trainees in the construction industry, trainers, vocational school teachers
Outcomes and impact	Higher motivation among learners, better preparation for digital work processes, positive feedback from companies and trainers
Transferability	The modules are modular in design and can be easily transferred to other trades or countries. The platform is openly accessible
Relevance to E4H	Practical experience shows how digital tools can be effectively integrated into construction training. It supports the project goals in terms of digitalization and innovative VET methods.

DE-02: Circular Bau

Field	Description
Title of the practice	Circular Bau – Circular economy in construction training
Country of implementation	Germany
Organisation(s) involved	Berlin Chamber of Crafts, Saxony Construction Education, Institute for Ecological Economy Research (IÖW)

Description	The Circular Bau project integrates principles of the circular economy into vocational training in the construction industry. The aim is to raise awareness among trainees about resource-efficient construction, material cycles, and demolition concepts. The learning content was developed in collaboration with companies and environmental organizations.
Thematic area(s)	Energy efficiency & sustainable housing; Circular economy; Innovative VET methodologies and tools
Methods and tools used	Project-based learning, material flow analysis, digital demolition simulations
Target group(s)	Trainees in the construction industry, vocational school teachers, environmental officers
Outcomes and impact	Increased environmental awareness, improved knowledge of sustainable building materials and demolition processes, positive feedback from companies
Transferability	The modules developed are openly accessible and can be easily integrated into other training programs. Particularly suitable for countries with a focus on sustainable construction.
Relevance to E4H	The practical experience supports the project goals by promoting green skills and shows how the circular economy can be effectively integrated into construction training.

DE-03: Qualification Initiative for Building Technology

Field	Description
Title of the practice	The qualification initiative for building technology
Country of implementation	Germany
Organisation(s) involved	Frankfurt-Rhine-Main Chamber of Skilled Crafts, Institute for Energy Efficiency in Building Technology (IEG), regional construction companies
Description	The initiative offers practical training for trainees and skilled workers in the construction industry with a focus on energy-efficient building technology. Content includes thermal insulation, heating optimization, renewable energies, and building automation.
Thematic area(s)	Energy efficiency & sustainable housing; Innovative VET methodologies and tools

Methods and tools used	Workshops, mobile training labs, simulation tools, e-learning
Target group(s)	Trainees in the construction industry, skilled workers, trainers
Outcomes and impact	Increased professional competence in the field of energy efficiency, positive feedback from companies, improved employability
Transferability	The modular training concept can be transferred to other regions and trades. The mobile training laboratories enable flexible implementation.
Relevance to E4H	The initiative supports the project goals by promoting green skills and showing how energy efficiency can be integrated into construction training in a practical way.

4.5. Finland

FI-01: BIMEET (BIM for Energy Efficiency Training)

Field	Description
Title of the practice	<i>BIMEET BIM-based EU-wide standardized qualification framework for achieving energy efficiency training</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	Luxembourg Institute of Science and Technology (LIST), Cardiff University, Centre Scientifique et Technique du Bâtiment (CSTB), Building Research Establishment Ltd (BRE), La plateforme Formation & Évaluation de l'INES, VTT Technical Research Centre of Finland Ltd, House of Training, Metropolia University of Applied Sciences and Center For Renewable Energy Sources (CRES).
Description	Aims to broaden the BIM training agenda to support the European Union building energy efficiency agenda. Assembling evidence-based quantitative / measurable scenarios and use cases that demonstrate the role of BIM in achieving energy efficiency in buildings across the whole value chain
Thematic area(s)	<i>Energy efficiency</i>
Methods and tools used	Screen, benchmark and synthesize projects, map skills
Target group(s)	<i>Professionals, students and trainers</i>
Outcomes and impact	<i>Quantitative and qualitative results</i>
Transferability	Outputs: 1) A skills matrix related to BIM and energy efficiency, 2) Training platform
Relevance to E4H	<i>Strongly related to core topics</i>

FI-02: ReCreate (Reusing Precast Concrete)

Field	Description
Title of the practice	ReCreate
Country of implementation	Finland
Organisation(s) involved	Kungliga Tekniska Högskolan (KTH), Technische Universiteit Eindhoven (TU/e), Brandenburgische Technische Universität Cottbus-Senftenberg (BTU), Liike Oy Arkkitehtistudio, Helsingborgshem AB, IMd Raadgevende Ingenieurs, Ecosoil Ost GmbH, Tampereen kaupunki, Croatia Green Building Council, Ramboll Finland Oy, Umacon Oy, P. Jähne Ingenieurbüro GmbH, Skanska Talonrakennus Oy, Skanska Oy, Consolis VBI, Consolis Parma, Consolis Strängbetong, Lagemaat Sloopwerken bv, TNO, Circular Structural Design, Stadt Hohenmölsen, Lohmann & Robinski Gbr Professional Web Solutions
Description	Develop reusable elements from demolition of concrete buildings, where reuse of elements has not been planned
Thematic area(s)	Green / Circular
Methods and tools used	Case study and methodology development
Target group(s)	Professionals, managers and trainers
Outcomes and impact	Quantitative and qualitative results
Transferability	Handbook for technical, risk assessments and commercial analyses of circular use of concrete elements
Relevance to E4H	One of few reports providing a handbook for how to reuse concrete elements

FI-03: BIM-design collaboration

Field	Description
Title of the practice	<i>BIM-design collaboration</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	<i>Novia UAS, Arcada UAS</i>
Description	<i>Project-based learning with engineering students from several</i>

	<i>disciplines, designing and producing BIM-based documents for a new building</i>
Thematic area(s)	<i>Digitalisation/Green</i>
Methods and tools used	<i>Project-based learning and a variety of design and project management tools</i>
Target group(s)	<i>HE engineering students</i>
Outcomes and impact	<i>Real-life-like learning situation, where students learn to understand practices in related disciplines and to use and to manage models from different softwares, as well as how to manage projects.</i>
Transferability	<i>Easy to adapt to different settings and local detailed codes can be ignored without greater impact</i>
Relevance to E4H	<i>Supports a central issue in the digitalization development and competence in digital skills and BIM-based management</i>

FI-04: Teknikhuset

Field	Description
Title of the practice	Teknikhuset
Country of implementation	Finland
Organisation(s) involved	YA Vocational College of Ostrobothnia
Description	Construction of a test building by students, as a continuous process of testing and learning, regarding structures, HVAC and energy.
Thematic area(s)	Sustainability
Methods and tools used	Hands-on learning on site
Target group(s)	VET students but also engineering students
Outcomes and impact	The project fosters collaboration across disciplines, enhancing teamwork and innovation in sustainable building. Involving learners in design and implementation improves educational results and industry readiness.
Transferability	The concept can easily be adapted to new settings. Asks for funding or cooperation with companies.
Relevance to E4H	Supports a central goal in green skills, addressing emerging needs and the “jobs of the future” for energy efficient and sustainable housing

4.6. Greece

GR-01: Exoikonomo ("Saving at Home")

Field	Description
Title of the practice	Exoikonomo – Energy Efficiency Upgrading of Buildings
Country of implementation	Greece
Organisation(s) involved	Hellenic Ministry of Environment & Energy (MoEE); Managing Authority for Energy Programmes; Hellenic Development Bank (earlier cycles); regional authorities; energy auditors; licensed contractors.
Description	National grant scheme providing financial incentives and standardized procedures for deep energy renovation of residential buildings.
Thematic area(s)	Energy efficiency/nZEB renovation; digital processes (EPCs, e-platforms, smart controls); circular/low-carbon materials (through specifications).
Methods and tools used	Grant guidelines & technical specifications; digital application portal; energy audits (pre/post); EPC issuance; standard bill-of-quantities; QA/commissioning checks; eligible equipment lists (e.g., heat pumps, insulation, glazing, PV).
Target group(s)	Homeowners/HOAs; SMEs and contractors; energy auditors; engineers/architects/site managers; VET teachers/trainers supporting IVET/CVET.
Outcomes and impact	Hundreds of thousands of applications over successive calls; significant residential energy savings and EPC-class improvements; scale effects on contractor capacity and technician upskilling; diffusion of heat-pump and envelope skills. Over 180,000 households have benefited across cycles since 2011, achieving average primary energy savings of 35–40 %." (source: MoEE summary reports 2024)
Transferability	High—programme design elements (eligibility rules, audit workflow, QA, digital portal, trainer CPD) can be replicated by VET providers and sector bodies to build short modules and micro-credentials.
Relevance to E4H	Direct pipeline for work-based learning, trainer CPD, and micro-credentials in envelope, HVAC/heat pumps, RES, smart controls, QA, and customer advisory skills.

GR-02: CDWaste-ManageVET

Field	Description
Title of the practice	CDWaste-ManageVET – Developing skills for sustainable construction and

	demolition waste management
Country of implementation	Greece (national uptake through PEDMEDE/EKS under Greek pilot phase); transnational partnership (with pilots in Italy, Portugal, Romania, Spain, France)
Organisation(s) involved	Coordinator: Office de l'Environnement de la Corse (FR). Greek partners: PEDMEDE (Panhellenic Association of Engineers Contractors of Public Works, Greece); EKS – European Knowledge Spot (Greece); FORMEDIL (Italy); ISQ (Portugal); UPB – Universitatea Politehnica din București (Romania); FLC – Fundación Laboral de la Construcción (Spain).
Description	An Erasmus+ project addressing skills needs in construction and demolition waste (CDW) management, focusing on developing VET curricula, digital learning materials, and a training platform. The project promotes the circular economy in construction by upskilling workers and trainers in waste reduction, recycling, and resource-efficient site practices.
Thematic area(s)	Circular economy; waste management and recycling; digital learning in construction; sustainable resource management; occupational health and safety; environmental compliance; digital learning resources.
Methods and tools used	Industry-driven analysis; Best-practice handbook; competence matrix & curricula (with WBL); online training platform/VOOC; pilot training; webinars (e.g., Greece with PEDMEDE & EDA); basic assessment/validation guidance.
Target group(s)	Construction SMEs/contractors; site managers/supervisors; demolition crews & waste operators; engineers/technicians; VET providers and trainers; sector bodies/policy stakeholders.
Outcomes and impact	Introduced structured training on CDW prevention and management; produced a freely accessible e-learning platform; enhanced cooperation between VET providers and industry; improved awareness of EU waste directives; supported adoption of circular practices in Greek construction training. Pilot training in Greece was implemented through PEDMEDE and EKS, engaging SMEs and trainers from the construction and demolition sectors. Tangible outputs published (handbook, curricula, VOOC platform); pilot execution; at least 90 VET learners trained, 30 internships/mentorships; ≥18 VET providers expected to integrate modules; dissemination in GR/ES/RO/PT/IT (incl. national webinar in GR).
Transferability	High: modular, multilingual (EN/EL/IT/PT/RO/ES); EQF-aligned learning outcomes; WBL model; open online delivery—directly adaptable to national waste rules and VET systems. Its outputs are referenced in newer Erasmus+ and LIFE projects focusing on circular construction in Greece.

Relevance to E4H	Directly supports the project's green transition focus. Provides a ready-to-use curricula, trainer resources, and a tested model for embedding circular-economy and waste-management competences into construction VET curricula, which can inform short modules and micro-credentials under EXCEL4HOUSING.
-------------------------	---

GR-03: NTUA ZEB Living Lab

Field	Description
Title of the practice	NTUA ZEB Living Lab – GR-Eco Building Living Labs (National Technical University of Athens)
Country of implementation	Greece
Organisation(s) involved	National Technical University of Athens (NTUA) – relevant Schools/Departments (architecture, mechanical/electrical engineering); collaborating ministries/municipalities on pilot activities; industry partners (manufacturers, ESCOs) for equipment and trials.
Description	A full-scale, instrumented building-as-lab for training, demonstration and research on nZEB/positive-energy performance, smart operation and circular solutions. It provides hands-on courses, CPD workshops, trainer upskilling, and access to datasets for case-based learning.
Thematic area(s)	Energy efficiency & nZEB renovation; digitalization & smart operation; measurement & verification; circular design/materials; indoor environmental quality.
Methods and tools used	High-resolution monitoring (sensors/IoT); BMS/EMS & digital twins; blower-door & thermal-imaging diagnostics; BIM/CDE teaching sets; commissioning protocols; real-time dashboards and datasets for coursework.
Target group(s)	Graduate engineers/architects; site managers/commissioning staff; VET teachers and in-company trainers; SMEs and public bodies involved in renovation programmes.
Outcomes and impact	Regular hands-on trainings and CPD cohorts; improved competence in diagnostics, commissioning and smart control; teaching datasets reused across courses; stronger industry-academia ties; demonstration of replicable lab-to-VET model.
Transferability	High. The model can be replicated as a modular living-lab in universities/VET centers using a classroom + test room + portable diagnostics + open data pack; easily aligned to short modules and micro-credentials.
Relevance to E4H	Direct support for energy-efficient renovation skills, digital methods (BIM/CDE, BMS/EMS) and trainer CPD, supplying ready content (datasets, protocols) for EXCEL4HOUSING modules.

4.7. Italy

IT-01: ARCA Academy (X-LAM Certification)

Field	Description
Title of the practice	ARCA Academy
Country of implementation	Italy
Organisation(s) involved	Habitech - Distretto tecnologico trentino
Description	ARCA Academy is ARCA's training centre, which promotes quality, sustainability and safety in timber construction. ARCA Academy is the continuing education centre for all professionals who want to learn more about timber construction and quality protocols.
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	blended learning, microcredentials
Target group(s)	Students, trainers, professionals, etc.
Outcomes and impact	The project fosters collaboration between actors (technicians, designers, skilled workers and teachers), enhancing teamwork and innovation in sustainable building and ensuring that skills are acquired during the various design phases involving wood technologies.
Transferability	Training and certification courses in timber construction extended to other Italian regions, taking inspiration from the Autonomous Province of Trento, which remains a pioneer in this field at national level.
Relevance to E4H	It supports a central goal of the green and circular economy, addressing the emerging need for skills in the construction sector relating to energy transition and the use of natural materials with a low environmental impact

IT-02: ECO3R and Circular Design Polito Lab

Field	Description
Title of the practice	ECO3R and CIRCULAR DESIGN POLITO LAB
Country of implementation	Italy
Organisation(s) involved	Politecnico di Torino, DAD - Dipartimento di Architettura Politecnico di Torino, OffGrid Italia, VICO, Municipality of Cambiano (Piedmont, Turin)

Description	The Polytechnic University of Turin is the first in Italy to establish a circularity-focused research and teaching infrastructure open to the local community, as demonstrated by the CIRCULAR DESIGN POLITO LAB project. The project was developed within the framework of the ReLand Convention (2019) signed in by the Municipality of Cambiano, the Polytechnic University of Turin DAD and the Off Grid Italia Association. The initiative is part of the broader ECO3R Territorial Ecosystem for Reduction, Reuse and Recycling (2020) launched with the participation of 19 municipalities and the Chierese Servizi Consortium. ECO3R is a local project involving the Municipality of Cambiano, the Polytechnic University of Turin, and the Off Grid Italia Association. It was developed with funding from ATOR and co-financing from the Chierese Consortium for CCS Services, with the aim of creating a local Ecosystem for Reduction, Reuse and Recycling. Led by the Chierese Consortium for CCS Services, the project involves 19 municipalities in the Metropolitan City of Turin: Andezeno, Arignano, Baldissero Torinese, Cambiano, Carmagnola, Chieri, Isolabella, Marentino, Mombello, Moncucco, Montaldo Torinese, Moriondo Torinese, Pavarolo, Pecetto Torinese, Pino Torinese, Poirino, Pralormo, Riva Presso Chieri and Santena.
Thematic area(s)	Circular communities and ecosystems / Waste management / Research / Pedagogical
Methods and tools used	Circular economy practices and ecosystem, stakeholder engagement, research center, experimental lab
Target group(s)	Local Municipalities and companies, students, professionals, citizens
Outcomes and impact	The project promotes collaboration among various stakeholders including research institutes, companies, and the local municipality to strengthen teamwork and drive innovation in circular economy practices and local waste management. It also aims to raise citizens' awareness of sustainable consumption, encouraging progress towards the 10R principles of the circular economy.
Transferability	The ECO3R and the CIRCULAR DESIGN POLITO LAB projects demonstrate high transferability thanks to its collaborative model involving universities, public institutions, businesses, and citizens. Its systemic approach centered on creating a territorial ecosystem for reduction, reuse, and recycling can be replicated in other urban and regional contexts. The open and

	participatory structure allows adaptation to different local realities and supply chain, fostering social and environmental innovation. Moreover, the active engagement of academic institutions provides a scalable model for spreading the research and culture of circularity and waste management.
Relevance to E4H	The project is highly relevant for VET training as it fosters green skills through the practical application of circular economy principles. By integrating technological innovation, sustainable design, and territorial collaboration, it provides an experiential learning model that strengthens technical, managerial, and environmental competencies in line with the objectives of the European Green Deal. Furthermore, it supports the transition to a circular economy and sustainable waste management by addressing the growing demand for skills related to material reuse and circular practices within the construction supply chain.

IT-03: DEAL with DIGITAL WBL

Field	Description
Title of the practice	DEAL with DIGITAL WBL – Work-Based Learning digitale
Country of implementation	Italy
Organisation(s) involved	SFC Sistemi Formativi Confindustria (IT) with FUNDACIO PER A LA UNIVERSITAT OBERTA DE CATALUNYA (ES), Duale Hochschule Baden-Württemberg (D), Panevezio kolegija (LT), HANSE-PARLAMENT EV (D), IPARTESTULETEK ORSZAGOS SZOVETSEGE (H), CIS SCUOLA PER LA GESTIONE D'IMPRESA (IT), Dinamo Adv Srl
Description	The DEAL with DIGITAL WBL project, coordinated by SFC – Sistemi Formativi Confindustria within the framework of the Erasmus+ programme (2021-2023), promotes the adoption of digital methodologies in Work-Based Learning (WBL). The initiative develops tools, guidelines, and training pathways for trainers and company tutors, with the aim of effectively integrating digital technologies and virtual environments into VET programmes, thereby strengthening the digital skills of students and workers and improving the quality and transferability of training experiences.
Thematic area(s)	Digital skills / VET programme / Work-Based Learning (WBL)
Methods and tools used	Work-Based Learning

Target group(s)	VET trainers and tutor
Outcomes and impact	The DEAL with DIGITAL WBL project developed a framework of emerging digital competences for VET trainers across Europe and created an online training course to help integrate work-based learning (WBL) methodologies with digital tools. It also launched an Ambassador Programme to promote good practices in hybrid and digital learning environments. The project strengthened VET trainers' digital competences and made work-based learning more accessible and engaging through online and hybrid approaches, while fostering stronger collaboration between education providers, companies, and local stakeholders to build more flexible and innovative learning ecosystems.
Transferability	The project-based approach used in VET and WBL could be effectively applied to the building and construction sectors, which today face an urgent need to reassess the skills of trainers, tutors, and professionals. These roles increasingly require the development of digital competencies aligned with market demands and EU regulations on digital and green skills. In fact, the construction sector remains stagnant and faces structural challenges, showing limited openness to innovation. Research indicates that a key contributing factor is its low level of digital integration.
Relevance to E4H	It supports the central goal of the digital transition for VET initiatives and Work-Based Learning, addressing the emerging need for digital skills in the construction sector's learning approach.

4.8. Poland

PL-01: Estate with Climate (Simulation Game)

Field	Description
Title of the practice	<i>Estate with Climate</i> simulation game
Country of implementation	Poland
Organisation(s) involved	Warsaw University of Life Sciences (SGGW), National Center for Research and Development (NCBR), Oslo Metropolitan University – Storby Universitetet, Western Norway Teseach Institute Vestlandsforskning, Iceland Liechtenstein Norway grants
Description	The “Estate with Climate” initiative addresses the urgent need to adapt housing estates to climate change and sustainable development principles. Objectives include: • Designing housing estates that minimize carbon footprint. • Integrating nature-based solutions (green roofs, rainwater retention, biodiversity corridors). • Promoting renewable energy in residential areas. • Developing educational modules for VET and higher education students.
Thematic area(s)	Green, Circular, Pedagogical
Methods and tools used	Digital tools: building Information Modelling (BIM), GIS for climate adaptation planning Green solutions: passive house technologies, renewable energy systems (PV panels, heat pumps) Educational methods: blended learning, practical training at pilot sites
Target group(s)	Students (architecture, engineering, environmental management), construction professionals, urban planners, cooperative housing managers, eco-advisors
Outcomes and impact	Quantitative: reduced CO₂ emissions of designed compared to conventional housing, improved energy performance certificates. Qualitative: increased awareness among urban planners and students, strengthened cooperation between academia, municipalities, and real estate sector.
Transferability	The approach can be replicated in other Central European countries because it uses widely available tools (BIM, passive design), applies EU-standard sustainable construction frameworks and relies on cross-sector

	partnerships (universities, local governments, companies). Game is available not only in Polish version, you can use it at the same time in the board game version and online.
Relevance to E4H	This practice directly supports green transition and innovation capacity building in housing and construction sectors by: providing a VET-oriented example of climate-smart estate planning, demonstrating a cross-cutting integration of energy efficiency, circularity, and pedagogical innovation, as well as serving as a transferable pilot for other European CoVEs (Centers of Vocational Excellence).

PL-02: Eco-workshop – Green heart of the school

Field	Description
Title of the practice	Nationwide Polish program “Eco-workshop – the green heart of the school”
Country of implementation	Poland
Organisation(s) involved	Polish Provincial Fund for Environmental Protection and Water Management (WFOŚiGW) Polish National Fund for Environmental Protection and Water Management (NFOŚiGW) Ministry of Climate and Environment (MKiŚ) Primary and secondary schools throughout Poland
Description	“Ekopracownia – Zielone Serce Szkoły” (Eco-workshop – Green Heart of the School) is a nationwide educational and infrastructure program aimed at primary and secondary schools. Its aim is to build and equip modern, interactive thematic workshops (on nature and renewable energy sources) to develop ecological attitudes among children and young people. The program is financed from the national budget as part of the Regional Program for Environmental Education Support. Each district in Poland is to receive at least two laboratories. In total, the project was to include 760 new eco-laboratories supporting climate education, sustainable development, and practical environmental learning.
Thematic area(s)	Green, Pedagogical, Circular, Digital
Methods and tools used	-Creation and equipping of modern educational laboratories -Experimental kits related to renewable energy sources (photovoltaics, wind turbines, water turbines) -Interactive monitors, microscopes, environmental sensors -Project-based education, workshops, competitions, and thematic lessons

	-School events (Earth Days, Open Laboratory Days) -Learning through action and experimentation *methods and tools used depended on the project implementation concept in specific locations and differed from one another.
Target group(s)	-Primary and secondary school students (aged 10–18) -Teachers of natural sciences, biology, physics, geography, and technology -School and local communities (families, parents, local governments)
Outcomes and impact	The creation of 760 eco-workshops in schools across Poland has improved the quality of environmental education, increased students' interest in renewable energy sources, and enabled classes to be conducted in modern teaching conditions. The program also engages local communities and promotes pro-climate activities in the school environment.
Transferability	The program model is scalable and easily adaptable to other regions and countries. Thanks to a simple application system and support from public institutions, it can also be implemented in VET schools, technical colleges, and vocational training centers.
Relevance to E4H	The program supports the key objectives of EXCEL4HOUSING: the development of green skills, education about renewable energy sources, and awareness of sustainable development. It may provide opportunities for further development of future VET pathways in green construction and renewable energy.

PL-03: Urban Labs

Field	Description
Title of the practice	<i>Urban Labs</i>
Country of implementation	<i>Poland</i>
Organisation(s) involved	<i>Institute for the Development of Cities and Regions (IRMiR), city offices</i>
Description	<i>Urban Lab is a physical and organizational space for cooperation involving residents, local government, business, academia, and social organizations. It is used to diagnose problems, test solutions, and implement innovations in real-world conditions. In the context of Excel4Housing, this concept allows for testing analytical tools, implementing green technologies, developing concepts for the construction sector and urban infrastructure, and creating educational case studies.</i>
Thematic area(s)	<i>Digital / Green / Circular / Pedagogical</i>

Methods and tools used	<i>Participatory workshops, Urban Café's, blended learning, case-based education, BIM</i>
Target group(s)	<i>Students and VET learners, residents, teachers, academic staff, trainers, local authorities</i>
Outcomes and impact	<i>Reduction of energy use in pilot buildings, active involvement of residents, creation of open data and monitoring tools, stronger cooperation between stakeholders, increased awareness of sustainable housing, and integration of case studies into VET and education.</i>
Transferability	<i>Urban Lab is a modular and flexible concept. It can be implemented in various cities and neighborhoods, adjusting the scope of the topics (e.g. energy efficiency, water management, social participation). The model is scalable and can be used in Central Europe, especially in the context of modernizing housing resources.</i>
Relevance to E4H	<i>Urban Lab provides a practical test environment: integrates green and digital innovations with the daily lives of residents, supports formal and informal education through real data and case studies, It promotes the transfer of knowledge and multi-sectoral cooperation, which are key to developing competences in the construction sector. These actions are in line with E4H.</i>

4.9. Portugal

PT-01: Circo Hub Portugal

Field	Description
Title of the practice	Circo Hub Portugal
Country of implementation	Implemented in Portugal, however, there are international hubs in many countries worldwide
Organisation(s) involved	LNEG - National Laboratory of Energy and Geology IAPMEI - Agency for Competitiveness and Innovation APA - Portuguese Environment Agency CIRCO international
Description	The CIRCO HUB PORTUGAL project is a training program for companies and designers focused on developing circular products and businesses, using the CIRCO methodology, developed in the Netherlands and implemented with a high success rate. The Dutch CIRCO (Creating Business through Circular Design) program applies design and design thinking to the development of circular products, services, and business models, developed through creative and collaborative sessions. Each company has the opportunity to initiate circular activities and solutions in collaboration with its value chain.
Thematic area(s)	Circular economy Circular business models Circular design
Methods and tools used	Company representatives actively participate in three workshops spread over the course of a month (called the CIRCO circular business design track). Designers participate in a one-day CIRCO circular design session. The training takes a practical approach supported by online platforms and collaborative tools, geared toward the specific and concrete needs of companies and designers. The methodology adopted at CIRCO Hub Portugal has been developed by the Dutch CIRCO program since 2015. It addresses circular design through six design strategies and five business model archetypes, developed in creative and collaborative sessions.
Target group(s)	Companies of any size (prioritizing SMEs) responsible for manufacturing products (with in-house or external design) and design professionals interested in applying strategies and practices to develop businesses according to circular economy principles.
Outcomes and impact	In Portugal, 12 training sessions were held with 95 companies and 280 professionals.

	The results of the training, per company, are a concept for a new business model or products with and action plan for its implementation
Transferability	The design methodology, knowledge and training-for-trainers process are available and can be used to encourage circular transition on an international scale and trigger broad collaboration.
Relevance to E4H	The methodology, tools, examples of application are available and can be used by E4H as inspiration or a collaboration for the application of the methodology

PT-02: Katch_e Project

Field	Description
Title of the practice	Katch_e project - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education
Country of implementation	Portugal, Spain, Austria, Denmark
Organisation(s) involved	• LNEG - Laboratório Nacional de Energia e Geologia I.P. • Universidade de Aveiro • Amorim Cork Composites, S.A • AICE Asociación de Investigación de las Industrias Cerámicas • PROSPEKTIKER - Instituto Europeo de Prospectiva y Estrategia S.A. • Universitat Jaume I de Castellon • Technische Universitaet Wien • Österreichisches Ökologie-Institut • Doka gmbh • Aalborg Universitet • Højer møbler a/s
Description	KATCH_e is a knowledge alliance between higher education, companies and research centers to promote the development of skills in the field of product and service design for the circular economy and sustainability, with a special focus on the construction and furniture sectors. KATCH_e thus contributes to the innovation of the higher education system and trains companies in business strategies and product design according to principles of circularity and sustainability. KATCH_e focuses on construction products and furniture, and brought together universities, research centers and companies from 4 EU countries to cooperate in the development of resources to support the education of design for CE and the practical implementation in the development of new circular product and services in companies
Thematic area(s)	Circular economy Life cycle management for sustainability Training and education

Methods and tools used	Build a lasting knowledge alliance between Universities, businesses and knowledge centers. Build competences in Circular Design and sustainability Distribute and apply the training materials
Target group(s)	students, professors, researchers, companies and other stakeholders from the construction and furniture sectors
Outcomes and impact	The main outcomes of the project are the following: Situation analysis report on CE and executive summary • Curriculum of product-service development course that can be adopted by higher education institutions • Eight learning modules that can also be used as stand-alone learning and teaching elements; • Seven tools that support the practical implementation of CE • MOOC, 10 hours online course covering the learning resources developed • Case Studies resulting from the practical implementation of KATCH_e • Knowledge HUB, a discussion hub to disseminate CE • Knowledge platform with all resource from the project available • E-Book
Transferability	The resources are all available for free and can be used in the E4H project.
Relevance to E4H	This was a research project focusing on two sectors, one of them aligned with the Target of E4H. The resources are available and are relevant to introduce the circular economy approach in the project

PT-03: Eco.nomia portal

Field	Description
Title of the practice	Eco.nomia portal
Country of implementation	Portugal
Organisation(s) involved	Ministry of Environment General Secretariat for the Environment Coalition for Green Growth Center for environmental and sustainability research With collaboration from BCSD Portugal, Sociedade Ponto Verde, Luís Simões, LNEG, Deco, and FCT)
Description	The eco.nomia Portal is a Portuguese digital platform that promotes the transition to the circular economy, serving as a knowledge repository and a meeting point for sharing information on projects,

	business models, products, and services that follow circular economy principles. The portal aims to inform and support consumers and institutions (public and private) in adopting and developing circular economy initiatives, which aim to reduce waste and maintain materials in use.
Thematic area(s)	Circular economy
Methods and tools used	Based on an online platform the main objectives and functions are the following: Knowledge dissemination, by providing information about the circular economy, helping to understand its concepts and applications. Stakeholder connection by serving as a space for sharing experiences and as a platform for developing new projects. Initiative support by supporting projects and business models focused on the circular economy.
Target group(s)	Aimed at a broad audience, including consumers, businesses, public institutions, and the business
Outcomes and impact	Knowledge platform, information on circular economy, examples and case studies, opportunities of funding, contests, awards, etc, Resources and events
Transferability	Open-source resources
Relevance to E4H	The platform has a lot of different materials and resources that can support the implementation of the project. It can also act as a dissemination media to promote the E4H project

4.10. Spain

ES-01: Construye 2020+

Field	Description
Title of the practice	<i>Construye 2020+ – Energy Efficiency Training and Accreditation</i>
Country of implementation	<i>Spain</i>
Organisation(s) involved	<i>Fundación Laboral de la Construcción; Fundación Estatal para la Formación en el Empleo (Fundae); Instituto Nacional de las Cualificaciones (INCUAL); Instituto de Ciencias de la Construcción Eduardo Torroja (IETCC-CSIC); CIRCE; IRTIC – University of Valencia</i>
Description	<i>A national training initiative aimed at construction professionals, combining short (8h) and long (70–190h) courses on energy efficiency, renewable energy integration, and sustainable construction techniques. The programme includes practical workshops, digital learning modules, and the Distintivo Eco accreditation to certify professional competencies.</i>
Thematic area(s)	<i>Green/Sustainable Construction; Energy Efficiency; Digital (through blended learning modules)</i>
Methods and tools used	<i>Blended learning: online modules and in-person workshops; practical case studies; modular course design; Distintivo Eco accreditation system; collaboration with research institutes and industry partners.</i>
Target group(s)	<i>Construction professionals, including operatives, mid-level managers, higher-level vocational technicians, civil engineers, technical architects, and similar profiles.</i>
Outcomes and impact	<i>Quantitative: 360+ participants trained; Virtual Route reached 16 Autonomous Communities; multiple short and long courses delivered. Qualitative: Increased professional awareness and application of energy efficiency measures; adoption of sustainable building practices in real projects; formal recognition through Distintivo Eco accreditation.</i>
Transferability	<i>Modular course structure, blended delivery, and formal accreditation make the model highly transferable to other regions, national VET centres, and EU contexts.</i>
Relevance to E4H	<i>Supports EXCEL4HOUSING4.0 objectives on energy efficiency and sustainable construction by enhancing professional competencies, promoting green practices, and offering a replicable accredited training model.</i>

ES-02: LIFE ReNatural NZEB MOOCs

Field	Description
Title of the practice	<i>LIFE ReNatural NZEB MOOCs – Online Training in Sustainable Construction</i>
Country of implementation	<i>Spain – Extremadura (with cross-border participation from Portugal)</i>
Organisation(s) involved	<i>Government of Extremadura – Department for Mobility, Transport and Housing; CICYTEX Research Centre; INTROMAC; University of Córdoba; URVPEXSA; Instituto Tecnológico de la Edificación (ITeCons, Portugal); Laboratório Nacional de Energia e Geologia – LNEG (Portugal); co-funded by the EU LIFE Programme</i>
Description	<i>A set of three free online courses (MOOCs) hosted on Moodle, aimed at promoting sustainable construction techniques and nearly zero-energy building (NZEB) principles. The training covers climate analysis, sustainable design strategies, best practices in eco-friendly materials, and household energy/water efficiency. Accessible to professionals, students, and the general public across Spain and Portugal.</i>
Thematic area(s)	<i>Digital; Green/Sustainable Construction; Circular Economy</i>
Methods and tools used	<i>MOOC delivery via Moodle platform; modular structure with self-paced learning; integration of real-world pilot projects and demonstrator buildings; multimedia resources and technical guides; cross-border collaboration for content development</i>
Target group(s)	<i>Construction professionals, architects, engineers, VET students in building and civil works, as well as interested citizens seeking to improve sustainability practices in housing</i>
Outcomes and impact	<i>Launched three MOOCs (10–40 hours each); engaged learners from multiple regions; increased awareness and technical skills in NZEB and circular economy; supported the dissemination of natural and recycled building materials; strengthened Spain–Portugal cooperation in sustainable construction</i>
Transferability	<i>Highly replicable due to its digital format, open access, and modular design; content can be translated, adapted to local contexts, and integrated into other VET or professional training frameworks; scalable for other sustainability topics</i>
Relevance to E4H	<i>Contributes directly to the green and digital pillars of EXCEL4HOUSING4.0 by fostering digital learning in sustainable building;</i>

	<i>demonstrates a scalable, cross-border model for knowledge dissemination in eco-friendly housing solutions</i>
--	--

ES-03: Specialization Course in BIM

Field	Description
Title of the practice	<i>Specialization Course in BIM (Building Information Modeling)</i>
Country of implementation	<i>Spain – Extremadura (Cáceres)</i>
Organisation(s) involved	<i>IES Universidad Laboral de Cáceres (VET provider); local construction and architecture firms; Junta de Extremadura – Department of Education and Digital Transformation; technology/software providers (Autodesk, CYPE, Presto, etc.)</i>
Description	<i>A free, in-person specialization course held in the afternoon. Designed to equip technical professionals with BIM skills using tools like Revit, CYPE, and Naviswork. The program aims to enhance professional competitiveness and support career progression within the construction and civil works sector.</i>
Thematic area(s)	<i>Digital; Green/Sustainable Construction (through BIM-enabled efficiency)</i>
Methods and tools used	<i>BIM methodology; software tools: Revit (Architecture, Structure, MEP), CYPE, Naviswork, BIMserver.center, Arquímedes, OpenBIM Quantities; structured in five independent modules allowing flexible delivery: Methodology BIM; Modeling of Architecture & Structures; Mechanical Installations & Sustainability; Electrical & Communications Installations; Control, Management & Budgeting</i>
Target group(s)	<i>Technical professionals and graduates involved in construction design or execution, including: higher-level vocational technicians (FP), civil/edification engineers, technical architects, architects, and similar profiles.</i>
Outcomes and impact	<i>Participants gain practical BIM skills across multiple disciplines; prepared for roles such as BIM Modeler or BIM Coordinator; enhanced digital proficiency; improved job prospects and preparedness for digital workflows in construction.</i>
Transferability	<i>The modular and flexible course structure, combined with use of widely available tools, makes this model replicable across other VET centers. Applicability is high when aligned with regional authorities and alignment with digital transformation goals in construction.</i>

Relevance to E4H	<i>Directly supports the digitalisation pillar of EXCEL4HOUSING4.0 (Housing 4.0 objectives), promoting skills in digital construction workflows and sustainable design. Offers a tested, regionally embedded good practice ideal for inclusion in the D2.3 Compendium.</i>
-------------------------	--

ES-04: Construye 2030

Field	Description
Title of the practice	Construye 2030
Country of implementation	Spain
Organisation(s) involved	Fundación Laboral de la Construcción, Confederación Nacional de la Construcción (CNC), Comisiones Obreras del Hábitat (CCOO hábitat), UGT FICA, CSIC, GBCe, FUNDAE
Description	Determine the competencies required to address the energy transition in the construction sector and raise awareness about the creation of zero-energy buildings and the efficient use of resources
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	Surveys, workshops, roadmaps
Target group(s)	Construction professionals and companies, public authorities and VET institutions
Outcomes and impact	Five new training actions are proposed for non-university profiles and eight for university graduates. There are five specific measures to promote, including networks of advisors and incentives for companies, that specifically support attracting women, young people, and professionals from other sectors to the industry
Transferability	The model can be adapted to other European regions
Relevance to E4H	Demonstrates the urgency of attracting professionals to the construction sector and increasing training efforts to ensure compliance with climate objectives

ES-05: TOP CleverR

Field	Description
Title of the practice	TOP CleverR
Country of implementation	Italy, Slovenia, Spain, Hungary, Croatia, and Poland
Organisation(s) involved	Green Building Council
Description	Equip construction professionals and workers with the necessary skills to address life-cycle carbon challenges and the circular approach throughout a building's life cycle, while also supporting the implementation of the Level(s) framework by all stakeholders in the value chain
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	Empathy map, power-interest matrix, interactive training map
Target group(s)	Construction professionals and companies, public authorities and VET institutions

Outcomes and impact	78 trained professionals in 3 years (designer, engineer, project manager, site manager), 42 construction workers trained in 3 years (10% women)
Transferability	The model can be adapted to other European regions
Relevance to E4H	Highlights the importance of attracting professionals to the construction sector and enhancing training efforts to address the challenges of its sustainable transformation

ES-06: Descarboniza calefacción (Decarbonize Heating)

Field	Description
Title of the practice	Descarboniza calefacción
Country of implementation	Spain
Organisation(s) involved	Asociación de Fabricantes de Equipos de Climatización (AFEC), ASIT solar térmica, Confederación Nacional de Instaladores (CNI), Ecologistas en Acción, Ecodes, Ecoserveis, Fundación Renovables, GBCE, Greenpeace
Description	Creation of a Renewable Heating Roadmap that provides a vision of what the building sector, particularly the HVAC sector, needs to do in Spain to contribute to the race to stay below 1.5 °C
Thematic area(s)	Green / Circular
Methods and tools used	Create the Renewable Heating Roadmap, analysis of the current situation, development of scenarios for 2030, 2040, and 2050
Target group(s)	Companies, research centers, and professional and environmental organizations
Outcomes and impact	The results indicate an urgent need to activate all available levers: improving HVAC equipment, renovating homes, utilizing renewable electricity, and addressing embedded carbon. Additionally, it offers recommendations for European institutions and Spanish central, regional, and local administrations to accelerate the transition to decarbonized HVAC systems
Transferability	The model can be adapted to other European regions
Relevance to E4H	Contributes to understanding the life-cycle environmental impacts of the building and construction sector

4.11. Sweden

SE-01: Brf Viva – Positive Footprint Housing

Field	Description
Title of the practice	Brf Viva – Positive Footprint Housing
Country of implementation	Sweden (Gothenburg)
Organisation(s) involved	Riksbyggen (developer/coop housing association) with an interdisciplinary research consortium under “Positive Footprint Housing”; supported by the Swedish Energy Agency and City of Gothenburg partners/testbeds.
Description	A 132-apartment housing block designed to minimize climate footprint across the full life cycle. Solutions include on-site PV generation, second-life energy storage using repurposed electric bus batteries, energy-efficient building services/ventilation, and material choices guided by life-cycle analysis.
Thematic area(s)	Energy efficiency; Circular economy & materials; Renewable energy & storage; Sustainable housing & urban development.
Methods and tools used	Life-cycle assessment to steer design/materials, On-site solar PV with building-level energy management, Second-life battery system (reused bus batteries) for peak-shaving and self-consumption, High-efficiency ventilation and envelope; smart waste solutions at block level
Target group(s)	Urban residents (tenant-owners in a housing cooperative), municipal planners, housing developers, and energy/utilities interested in scalable low-carbon housing models.
Outcomes and impact	Flagship Swedish example of low-footprint multi-family housing, used as a best-practice reference and site visits/testbed, demonstrated technical feasibility of second-life batteries in housing for load-shifting and reduced grid impact, improving use of on-site solar, material choices and LCA approach reduce embodied impacts while efficient services cut operational energy.
Transferability	High. Components are modular (PV + BMS + second-life storage, LCA-led specifications, efficient HVAC). Governance via a housing cooperative aids replication across Swedish/European co-ops and municipal developers. Similar principles are already used in other Swedish districts (e.g., Stockholm Royal Seaport’s low-energy standards and renewables integration)
Relevance to E4H	Energy efficiency: Concrete, measured strategies (tight envelope, high-efficiency ventilation, demand control, digital/energy management: Building-level energy optimization with storage aligns with training on smart building ops. Circular economy: Second-life batteries & LCA-driven procurement directly support green-transition and circular-materials modules. Scalability for stakeholders: Cooperative governance and multi-

	party collaboration mirror Excel4Housing's focus on cross-actor uptake and replication
--	--

SE-02: ReTuna Återbruksgalleria

Field	Description
Title of the practice	ReTuna Återbruksgalleria – Reuse Shopping Mall
Country of implementation	Sweden (Eskilstuna)
Organisation(s) involved	Eskilstuna Municipality; Eskilstuna Energi och Miljö (municipal recycling company); local NGOs; social enterprises; private entrepreneurs
Description	ReTuna is the world's first reuse shopping mall, located next to Eskilstuna's recycling center. Discarded goods from households are collected, repaired, refurbished, or upcycled by local enterprises, and then resold in dedicated retail spaces. The initiative combines circular economy principles, job creation, education, and sustainable consumption.
Thematic area(s)	Circular economy; Sustainable housing and communities; Social innovation; Green jobs
Methods and tools used	Collection of goods at municipal recycling station. Repair and upcycling workshops. Retail shops for second-hand and redesigned products. Awareness-raising events and educational programs on sustainable living.
Target group(s)	Households and citizens; SMEs and entrepreneurs; vocational trainees; unemployed/jobseekers; municipalities
Outcomes and impact	700 tonnes of goods diverted from waste annually. New jobs created in repair, upcycling, and retail sectors. Strengthened local circular economy ecosystem. Increased public awareness of sustainable consumption. International recognition as a pioneering reuse concept.
Transferability	The model can be replicated in other municipalities with recycling facilities and partnerships between local authorities, entrepreneurs, and NGOs. Its concept has already inspired similar initiatives across Europe and globally.
Relevance to E4H	ReTuna demonstrates how circular economy practices can directly contribute to sustainable housing and community development by reducing waste, reusing materials, and creating local employment opportunities. For Excel4Housing, it highlights how circular economy principles can be integrated into housing-related value chains, VET curricula, and awareness campaigns for sustainable living.

SE-03: Stockholm Royal Seaport – Digital Twin

Field	Description
-------	-------------

Title of the practice	Stockholm Royal Seaport – Digital Twin for Sustainable Urban Development
Country of implementation	Sweden (Stockholm)
Organisation(s) involved	City of Stockholm (Stockholm Stad); KTH Royal Institute of Technology; private technology providers (e.g., ABB, Ericsson); housing developers within the Seaport project.
Description	The Stockholm Royal Seaport project integrates a digital twin platform to plan, monitor, and optimize the sustainable development of one of Europe’s largest urban regeneration areas (12,000 new homes and 35,000 workplaces by 2030). The digital twin connects data from energy, water, transport, and housing systems, enabling predictive modelling and smart decision-making for climate neutrality, resource efficiency, and citizen well-being.
Thematic area(s)	Digitalisation; Smart housing and urban planning; Energy efficiency; Sustainable infrastructure.
Methods and tools used	Digital twin modelling of entire housing districts, real-time IoT sensors for energy, water, and waste flows, data analytics and predictive simulations for planning and maintenance, open data platforms to share results with stakeholders.
Target group(s)	Municipal planners; housing developers; residents (indirectly, through smart services); researchers; technology providers.
Outcomes and impact	Enhanced decision-making for sustainable housing development (energy, mobility, construction), reduced environmental footprint through optimized resource flows., increased stakeholder collaboration via shared data, strengthened Stockholm’s position as an international leader in smart and sustainable housing development.
Transferability	High but resource-intensive. Requires municipal commitment, digital infrastructure, and multi-actor collaboration. The model can be adapted to smaller housing districts or scaled through modular digital platforms.
Relevance to E4H	Digital skills in housing: Provides a leading case on how digital tools can improve housing sustainability and efficiency, integration with green transition: Links digitalisation with energy and circular economy strategies, aligning with Excel4Housing training goals, cross-sector governance: Demonstrates how municipalities, universities, and industry collaborate, offering a transferable governance model for Excel4Housing partners, practical inspiration: Digital twin and IoT monitoring tools could be introduced to vocational training for future housing professionals.

4.12. Ukraine

UA-01: Supporting Energy Modernisation (Wartime Resilience)

Field	Description
Title of the practice	Supporting Energy Modernisation of Enterprises During Wartime
Country of implementation	Ukraine
Organisation(s) involved	Implemented with the support of GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH), the Federal Ministry for Economic Cooperation and Development of Germany, Ministry of Education and Science of Ukraine, vocational education institutions (Sumy High Vocational School of Construction and Design), private industrial enterprises.
Description	The project was launched to provide organisational, technical, and financial support for enhancing energy efficiency in industrial enterprises during wartime. Its objectives included identifying company needs, strengthening employee capacity, conducting express energy audits, and supporting enterprises through a mini-grant programme. Priority was given to companies relocated due to hostilities but continuing operations. In addition, 50 VET institutions received technical equipment to maintain short-term training programmes in energy efficiency.
Thematic area(s)	Green / Pedagogical / Resilience
Methods and tools used	Capacity-building webinars (20 hours), express energy audits in line with ISO 50002 (Type 1), open competition for participation via “Diia. Business” portal, mini-grants (€10,000 each) for energy efficiency measures, success stories (text + video), technical equipment for VET providers.
Target group(s)	Industrial enterprises (including relocated companies), company employees, VET institutions under the Ministry of Education and Science of Ukraine, local communities.
Outcomes and impact	25 enterprises selected and supported through training and audits; 15 enterprises received €10,000 mini-grants for implementing energy efficiency measures; 50 VET institutions equipped for continuity of training; enhanced employee competences in energy efficiency; documented success stories widely disseminated; improved resilience and sustainability of enterprises affected by the war.
Transferability	The model of combining needs assessment, express energy audits, training, and targeted mini-grants can be applied in other countries facing crisis conditions or energy challenges, particularly where rapid support to enterprises and VET institutions is required.
Relevance to E4H	Demonstrates how green and sustainable practices can be advanced in crisis contexts while strengthening cooperation between enterprises and VET institutions. It highlights resilience, innovation, and inclusiveness, offering a replicable model for integrating energy efficiency into VET and industrial practice.

UA-02: Mechanised Application of Plaster and Painting

Field	Description
Title of the practice	Mechanised Application of Decorative Plaster and Airless Painting
Country of implementation	Ukraine
Organisation(s) involved	NGO “International Foundation for Development” (within the USAID Project “Economic Resilience Activity”), Sumy Higher Vocational School of Construction and Design, LLC “Construction Company Standard-M”
Description	The practice was implemented at the Sumy Higher Vocational School of Construction and Design within the framework of the project “Labour Potential Development for Ukraine”. The initiative aimed to strengthen labour potential in construction and related sectors by introducing a new training programme on mechanised application of decorative plaster and airless painting. The programme included theoretical and practical modules, close cooperation with employers, and the use of modern equipment and materials. It addressed urgent local needs in the border region of Sumy, such as rapid and high-quality renovation of shelters, dormitories, and public facilities. Students and professionals acquired modern construction skills while directly contributing to community resilience and safety.
Thematic area(s)	Vocational education and training; Construction skills; Safety and efficiency in building renovation
Methods and tools used	Work-based learning, practical training with modern equipment and materials, employer partnerships, blended theoretical and practical modules, community-oriented repair projects
Target group(s)	Students of the Sumy High Vocational School of Construction and Design; employees of local construction companies; community beneficiaries (e.g., hospitals)
Outcomes and impact	Quantitative: 25 certificates awarded to construction workers and IDPs; multiple shelters, classrooms, and dormitory facilities renovated; repair works conducted in Sumy children’s hospital. Qualitative: Improved employability and skills of students and workers; stronger collaboration between VET institution and local businesses; enhanced community safety through rapid shelter renovation; increased institutional capacity of the vocational school.
Transferability	The practice can be replicated in other Ukrainian regions and beyond, especially in areas affected by crises, where rapid renovation and modernisation of facilities are needed. The modular structure of the programme and employer engagement make it adaptable to various contexts in construction VET.
Relevance to E4H	This practice demonstrates how vocational education can respond to urgent societal challenges (such as wartime resilience and community safety) while developing labour potential in green and modern construction technologies. It aligns with E4H objectives by combining VET innovation,

	labour market relevance, and strong collaboration with industry to ensure sustainable skills development.
--	---

UA-03: ENEFEDU 2.0 (Thermomodernisation)

Field	Description
Title of the practice	Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0)
Country of implementation	Ukraine
Organisation(s) involved	Charitable Foundation “Human”; Ministry of Education and Science of Ukraine; GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH); possibly VET institutions participating in thermal modernisation.
Description	The project (No. 81298093) aims to increase energy efficiency in vocational education and training (VET) institutions by implementing thermomodernisation measures in 10 selected VET schools. Each participant institution receives equipment, materials, and furniture equivalent to €20,000 to establish specialised classrooms and conduct practical training on thermomodernisation. The project also builds on the outcomes of ENEFEDU 1.0 (grant agreement No. 81288455), which involved 5 pioneering VET institutions, and continues integrating energy efficiency courses into curricula.
Thematic area(s)	Energy efficiency and sustainability in education VET modernisation and resilience Capacity building and green skills development
Methods and tools used	Practical training (“learning by doing”) in thermomodernisation of real educational buildings Development and implementation of short-term energy efficiency programmes (e.g., installation of insulation, modern roofing, windows/doors systems) Equipping specialised classrooms with modern furniture and tools Hybrid forums and workshops with stakeholders (government, VET providers, community, donors) Sharing of best practices and recommendations from ENEFEDU 1.0 participants
Target group(s)	VET institutions (administrators, teachers, trainers) Students/learners in vocational education, including internally displaced persons (IDPs) Communities and local labour markets requiring skilled energy efficiency specialists
Outcomes and impact	10 VET schools strengthened with new equipment and facilities for energy efficiency training Enhanced quality of practical learning opportunities and professional competencies in thermomodernisation

	Contribution to Ukraine's post-war recovery by preparing skilled specialists in green construction and energy efficiency Improved resilience of VET institutions hosting IDPs and affected by war-related damage Strengthened cooperation between government, donors, and VET providers
Transferability	The approach can be replicated in other regions and sectors by combining thermomodernisation of educational facilities with hands-on training of learners. The integration of short-term programmes and cooperation with donors provides a scalable model for other countries addressing sustainability and post-crisis recovery.
Relevance to E4H	Supports the development of Centres of Vocational Excellence by integrating sustainability and energy efficiency into VET. Promotes innovative methods (learning by doing, hybrid forums, green skills) transferable to European VET contexts. Aligns with EU Green Deal and the Energy Efficiency Directive, demonstrating relevance for housing, construction, and sustainable vocational education.

5. Cross-Cutting Analysis

5.1. Common Trends and Success Patterns

A transversal analysis of the 37 selected best practices reveals four dominant trends that characterize the current state of excellence in European construction VET. These trends align directly with the EXCEL4HOUSING4.0 pillars:

1. The "Twin Transition" Integration The most advanced practices do not treat "Green" and "Digital" as separate subjects. Instead, they converge.

Example: Practices like BIMEET (FI-01) and INCEPT (HR-02) demonstrate that Digital Twins and BIM are not just drawing tools, but essential instruments for calculating energy efficiency and embodied carbon.

Lesson: Future curricula must teach digital tools in the context of sustainability performance.

2. Shift from "New Build" to "Deep Renovation" Reflecting the EU Renovation Wave strategy, a significant portion of the identified practices (e.g., BE REEL! (BE-03), Exoikonomo (GR-01), Descarboniza calefacción (ES-06)) focus exclusively on retrofitting existing stock.

Observation: The skills required for renovation (diagnosis, dismantling, hazardous waste handling) are distinct from those for new construction and are currently under-represented in traditional VET.

3. The Emergence of Circular Construction While energy efficiency is well-established, Circular Economy practices are rapidly emerging as the new frontier. Practices like ReCreate (FI-02) and Build Circular.Brussels (BE-01) show a shift from "waste management" to "resource mining."

Challenge: Standardizing the validation of reused materials (e.g., certification of old concrete or timber) remains a technical barrier that training must address.

4. Social Inclusion and Energy Poverty Several practices (e.g., BAUHAUS 4 MED (EU-01), Estate with Climate (PL-01)) highlight the social dimension of housing.

Insight: Technical training is increasingly combined with social skills, teaching workers how to communicate with tenants during renovation and how to design affordable solutions for energy-poor households.

5.2. Recurrent Challenges

Despite the successes, the analysis of the partners' reports identifies persistent bottlenecks:

- Fragmentation of Digital Skills: While BIM is standard in Northern Europe (Finland, Sweden), it is still an "advanced specialization" rather than a core skill in Southern/Eastern VET systems.
- Trainer Obsolescence: A major gap identified in Germany (Bau Bildung Digital) and Spain is that VET trainers often lack experience with the latest technologies (heat pumps, smart sensors), creating a bottleneck for student learning.
- Lack of Practical Sites: It is difficult for schools to find real-world "Living Labs" for students to practice deep renovation without liability issues.

6. Transferability & Adaptation Guidelines for WP4

The ultimate goal of this Compendium is to feed into Work Package 4 (Joint Curriculum Design). Based on the selected best practices, the following guidelines are proposed for the development of the EXCEL4HOUSING4.0 curricula:

6.1. *Modularization and Micro-credentials*

Recommendation: Adopt the flexible approach seen in Construye 2020+ (ES-01) and Bau Bildung Digital (DE-01). To effectively address the urgent need for rapid upskilling and reskilling in the construction workforce, we recommend moving away from traditional, lengthy, and rigid three-year qualification programs. Instead, a flexible, modular approach, similar to the successful models seen in Construye 2020+ (Spain, ES-01) and Bau Bildung Digital (Germany, DE-01), should be adopted.

- Instead of creating long, rigid 3-year programs, design "Learning Nuggets" or micro-credentials. The core of this strategy involves designing and delivering highly focused, short-duration "Learning Nuggets" or officially recognised micro-credentials. These small, targeted training units directly address specific, high-demand skills essential for the energy transition and digitalisation of the sector.

Examples of such micro-credentials include:

- Renewable Energy Integration: "Advanced Techniques for Installing Photovoltaics on Clay and Complex Roof Structures" or "Optimising Heat Pump Installation in Existing Buildings."
- Digital Construction: "Digital Waste Tracking and Circular Economy Reporting using BIM," "Introduction to Drone-Based Site Surveying," or "Using Augmented Reality for Quality Control."
- Energy Efficiency: "Airtightness and Insulation Techniques for Deep Retrofit Projects" or "Diagnosis and Remediation of Thermal Bridges."
- This allows rapid upskilling of the existing workforce without requiring them to leave work for extended periods. This shift offers several critical advantages over conventional training pathways:
 - Rapid Response and Agility: It allows training providers and the industry to respond rapidly to evolving market demands, new technologies, and updated regulatory requirements by quickly developing and deploying new nuggets.
 - Upskilling the Existing Workforce: Crucially, this structure facilitates the upskilling of the current workforce without requiring them to commit to extended periods away from the job site. Construction professionals can acquire new, valuable skills in a matter of days or weeks, making continuous professional development practical and accessible.
 - Career Path Flexibility: Workers can stack these micro-credentials over time, building a personalised and documented portfolio of expertise that can eventually lead to a full professional qualification or specialisation, offering a clear and motivating career progression path.
 - Targeted Skill Acquisition: By focusing on narrow, high-impact skills, the training investment is highly efficient, ensuring that the acquired knowledge is immediately applicable on site, thereby accelerating the deployment of sustainable building practices.

6.2. The "Living Lab" Pedagogy

Recommendation: Adopt and replicate the successful operational models of the NTUA ZEB Living Lab (GR-03) (Greece) and ENEFEDU 2.0 (UA-03) (Ukraine) to improve Near-Zero Energy Building (ZEB) education.

These models effectively integrate theoretical knowledge with hands-on, real-world application.

- Enhanced Curricula Design:
 - Mandatory Practical Module: Incorporate a credit-bearing, mandatory practical module into all ZEB-related curricula (design, construction, renovation).
 - On-Site Project Requirement: Students must execute practical, supervised tasks, such as:
 - Performing actual energy audits.
 - Conducting detailed feasibility studies for deep renovation.
 - Executing practical renovation tasks.
 - Targeted Building Stock for Projects ("Living Labs"):
 - Educational Facilities: Utilize the students' own school buildings, universities, or campus facilities as live laboratories to foster ownership and tangible impact.
 - Municipal Properties: Partner with local authorities to use public buildings (e.g., community centers, libraries) as project sites, extending benefits to the local community.
- Benefits and Problem Resolution:
 - Solves "Lack of Practical Sites": Transforms existing public and educational infrastructure into accessible, relevant "living labs," providing experience on operational buildings with real-world constraints.
 - Immediate Community and Institutional Benefit: Student work yields tangible positive outcomes:
 - Energy Savings: Audits inform renovation decisions, reducing operational energy costs for public institutions.
 - Knowledge Transfer: Students apply the latest ZEB standards directly to public sector projects.
 - Infrastructure Improvement: Renovation work modernizes public infrastructure, enhances user comfort, and reduces the local public sector's carbon footprint.
 - Enhanced Employability: Graduates gain a verified portfolio of practical skills and successfully completed, real-world projects, making them highly competitive in the ZEB sector.

6.3. Train-the-Trainer First

Recommendation: Before rolling out new courses to students, a specific "Master Trainer" program must be implemented, inspired by Bau Bildung Digital (DE-01).

- CoVEs should act as hubs where teachers from other schools come to learn how to use VR/AR tools and circularity software.

Before initiating the rollout of new educational courses—especially those leveraging advanced technologies like Virtual Reality (VR), Augmented Reality (AR), and specialized circularity software—a robust and tailored "Master Trainer" program is essential for successful implementation and adoption across the educational network. This approach is strongly inspired by successful models such as the Bau Bildung Digital initiative (DE-01), which prioritizes the competence development of

key instructional personnel.

Program Implementation and Structure:

The core structure of this initiative should center on utilizing established Centers of Vocational Excellence (CoVEs) as the primary hubs for professional development. These CoVEs are uniquely positioned to act as specialized training centers, focusing on two critical areas:

- **EdTech Proficiency:** Training educators from partner schools to effectively integrate and utilize cutting-edge VR and AR tools in their curricula. This includes not only the technical operation of the hardware and software but also pedagogical strategies for maximizing immersive learning experiences.
- **Circularity Software Expertise:** Developing deep proficiency in the use of specialized software designed to teach and manage principles of the circular economy, resource efficiency, and sustainable practices. This ensures that the essential context of the new courses is delivered with practical, industry-relevant tools.

Role of CoVEs as Training Hubs:

CoVEs will be transformed into dynamic learning environments where expert trainers (the "Master Trainers" developed through this program) coach visiting teachers. This model ensures a scalable and sustainable approach to teacher training:

- **Peer-to-Peer Learning:** Teachers from other schools will actively participate in hands-on workshops and practical sessions at the CoVEs, moving beyond theoretical knowledge to practical application.
- **Curriculum Adaptation and Localization:** Master Trainers will assist visiting teachers in adapting the new technological tools and circularity content to the specific needs and vocational contexts of their own institutions and local industries.
- **Ongoing Support and Mentorship:** The CoVEs will maintain a continuous role, offering post-training support, troubleshooting assistance, and establishing a community of practice for ongoing professional growth.

By implementing this structured Master Trainer program through CoVEs, the educational system can ensure a high standard of quality, consistency, and pedagogical effectiveness in the rollout of new, technology-driven courses focused on critical skills like circular economy principles.

6.4. Regional Adaptation

The overarching strategy for knowledge dissemination and application acknowledges the need for a balanced approach: sharing the fundamental, proven core content across national borders while ensuring its practical implementation is meticulously tailored to the specific regional context of each operational hub. This essential adaptation recognizes the diverse climatic, regulatory, and infrastructural landscapes across the target areas.

- **North/Central Hubs:** Focus heavily on high-tech industrialization and prefabrication (CBCI, BE-02).
 - **Primary Emphasis:** These regions, exemplified by the CBCI and BE-02 initiatives, will place a heavy focus on accelerating high-tech industrialization within the construction sector.
 - **Specific Activities:** The concentration will be on sophisticated prefabrication techniques,

-
- modular construction methods, and the integration of cutting-edge materials. The aim is to optimize production efficiency, reduce on-site construction time, and leverage digitalization (e.g., BIM, advanced robotics) to achieve superior quality and energy performance in new buildings and deep renovations.
 - Core Objective: Driving the transition towards a highly efficient, industrialized construction value chain.
 - South/East Hubs: Focus on seismic resilience combined with energy efficiency (ARCA, IT-01) and deep renovation of historic buildings.
 - Primary Emphasis: These regions face distinct challenges, notably a higher incidence of seismic activity and a large stock of historic, often vulnerable buildings. As demonstrated by projects like ARCA and the IT-01 initiatives, the adaptation must address these critical needs.
 - Specific Activities: The implementation will prioritize solutions that combine seismic resilience and structural reinforcement with simultaneous energy efficiency improvements. Furthermore, significant attention will be paid to the specific challenges of the deep renovation of historic buildings, ensuring that energy upgrades are performed using materials and techniques compatible with architectural heritage preservation, maintaining aesthetic value while meeting modern performance standards.
 - Core Objective: Developing and deploying integrated solutions for making the existing building stock safer, more energy efficient, and historically sensitive.

6.5. Step-by-Step Adaptation Framework

To ensure the successful integration of these best practices into the upcoming WP4 curriculum design, partners and stakeholders should follow a structured 5-Step Adaptation Framework. This framework is designed to bridge the gap between the source context (where the practice originated) and the target ecosystem (where it will be implemented).

These suggested actions are designed to guide any educational institution or stakeholder through the process of translating a successful initiative from its source context into a new local reality.

Step 1: Relevance & Gap Analysis (The "Why")

Before attempting transfer, stakeholders must validate the specific need.

Action: Compare the learning outcomes of the Best Practice against the "Skills Gap Analysis" produced in WP2.

Key Question: Does this practice address a specific shortage in our local labor market (e.g., is there a lack of heat pump installers, or is the gap actually in digital design?)

Step 2: Regulatory & Climatic Localization (The "Where")

Construction is highly context-dependent. A "Green Roof" practice from Sweden (North) cannot be copied directly to Greece (South) due to climatic and regulatory differences.

Action: Adjust technical parameters.

Climate: Modify insulation standards and materials to suit local weather zones.

Legislation: Ensure the curriculum aligns with national NZEB (Nearly Zero-Energy Building) definitions and building codes.

Step 3: Modularisation & Micro-credentials (The "How")

Instead of copying entire multi-year programs, focus on extracting specific modules.

Action: Break down the Best Practice into smaller, standalone learning units.

Guideline: Structure these units as Micro-credentials. This allows for flexible integration into existing VET curricula or use as short-term upskilling courses for professionals already in the workforce.

Step 4: Train-the-Trainer (The "Who")

A curriculum is only as good as the teachers delivering it.

Action: If a practice involves new technology (e.g., Digital Twins or Bio-based materials), the transfer must include a teacher training component.

Guideline: Utilize the "CoVE" network to facilitate staff exchanges where trainers from the "Source" country mentor trainers in the "Target" country.

Step 5: Stakeholder Validation

Ensure the adapted practice meets industry standards.

Action: Present the adapted curriculum content to local industry partners (construction companies, chambers of commerce) before full rollout.

Key Question: "If we train students using this adapted module, would you hire them?"

6.6. Transferability Readiness Checklist

Stakeholders are encouraged to use this checklist to assess if a Best Practice is ready for local implementation:

Assessment Category	Key Question	Status
1. Market Demand	Does this practice address a confirmed skills gap in our region?	☐
2. Legal Compliance	Have we updated the content to match our national building codes?	☐
3. Infrastructure	Do we possess the necessary labs or software to deliver this training?	☐
4. Staff Capacity	Are our trainers sufficiently upskilled to teach this new topic?	☐
5. Industry Buy-in	Have local employers validated the adapted learning outcomes?	☐

7. Conclusions

The D2.3 Compendium of Best Practices serves as a definitive confirmation that the remedies for the pervasive European construction skills crisis are not a theoretical pursuit, but are already operational, albeit in fragmented pockets of innovation scattered across the continent.

This critical insight underscores the project's central premise: the solutions are not lacking, but rather the mechanism for their widespread transfer and adoption.

The EXCEL4HOUSING4.0 partnership has successfully unearthed and documented this valuable knowledge, establishing a substantial repository of cutting-edge and pragmatic methods. This wealth of expertise spans a broad spectrum of technological and resilience-focused domains, from highly sophisticated, data-driven approaches—such as the implementation of advanced digital twins in construction lifecycle management prevalent in countries like Sweden—to essential, crisis-response focused and highly adaptable renovation techniques, exemplified by the resilient and rapid-response construction methodologies developed in challenging environments like Ukraine.

The compendium synthesizes these disparate practices into a coherent framework, creating a blueprint for Vocational Education and Training (VET) providers, industry stakeholders, and policymakers to bridge the existing skills gap and propel the sector towards a more sustainable and digitally integrated future.

Key Takeaways for the Project Consortium:

1. **Avoid Redundant Development: Leverage and Adapt Existing High-Quality Resources ("Don't Reinvent the Wheel").**
 - Our exhaustive mapping exercise, detailed extensively in Section 4 of this document, has successfully identified a rich reservoir of established educational tools and certification frameworks that are directly applicable to our project goals.
 - Specifically, we have pinpointed high-value resources, including structured Massive Open Online Courses (MOOCs) that cover niche skills, complex industry simulation games that provide practical, risk-free experience, and well-recognised existing certification schemes.
 - Actionable Strategy: The immediate focus must shift from creation to curation and adaptation. These existing materials must be professionally translated, culturally adjusted, and contextually adapted to fit the specific needs and regulatory environments of the target regions within the consortium.

This approach dramatically accelerates the time-to-market for our curriculum offerings and ensures quality from the outset.

2. **Focus on Implementation: The challenge is not what to teach, but how to scale it. The "Hub" model of the CoVEs is the correct vehicle to disseminate these niche practices to the wider market.**
 - The primary bottleneck is not the generation of cutting-edge educational content—which we have largely secured through the "Don't Reinvent the Wheel" strategy—but rather the challenge of scaling and disseminating these specialised, often niche, practices to the broader market and a diverse trainee population.
 - The proposed "Hub" model, central to the structure of the CoVEs, is strategically validated as the correct vehicle for this challenge. This model positions the CoVEs as central nodes capable of coordinating training, sharing resources, and establishing quality standards across a wider network of local VET providers and industry partners.

- Implementation Focus: Success will be measured by the operational efficiency and reach of the Hub model. This requires developing robust digital platforms, establishing standardised train-the-trainer programmes, and forging strong, formal links with industry to ensure rapid uptake of new skills. The focus is on moving knowledge from the theoretical repository into widespread professional practice.
- 3. Cross-Border Mobility: The diversity of practices suggests a strong potential for student/staff mobility (e.g., Greek students learning timber construction in Italy; German apprentices learning digital twins in Finland).
 - The inherent diversity of professional practices and technological maturity across the consortium's member states represents a significant strategic asset, not a challenge.
 - This variety suggests a powerful, untapped potential for incentivising and facilitating student and staff mobility programmes. Such mobility moves beyond mere cultural exchange; it is a mechanism for direct, hands-on, and efficient knowledge transfer.
 - Illustrative Examples of Knowledge Transfer: We envision structured mobility schemes where, for instance, Greek students can travel to partner institutions in Italy to gain direct experience in advanced, sustainable timber construction techniques; or German apprentices, already proficient in traditional methods, can undertake focused placements in Finland to master emerging technologies like digital twins and advanced Building Information Modeling (BIM). This cross-pollination ensures that all CoVEs rapidly achieve a universally high

This document formally establishes the strategic and factual baseline for all subsequent curriculum development within WP4 and serves as the immediate mandate for the **execution of Task 2.4**. By adhering to these three strategic pillars—smart resource utilisation, scalable implementation via the CoVE Hubs, and leveraging cross-border mobility—we will ensure that the Centres of Vocational Excellence built under this project are not merely compliant, but truly define the state-of-the-art in vocational training for the sector.

8. References & Bibliography

European Commission. (2020). *A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives*. COM(2020) 662 final.

European Commission. (2020). *Circular Economy Action Plan: For a cleaner and more competitive Europe*.

Build Up Skills. (2011-2023). *National Country Reports and Status Quo Analyses*.

Cedefop. (2023). *Vocational education and training in Europe 1995-2035*.

EXCEL4HOUSING4.0 Consortium. (2025). *Internal National Best Practice Reports (Belgium, Croatia, Finland, Germany, Greece, Italy, Poland, Portugal, Spain, Sweden, Ukraine)*.

9. Annexes

List of Best Practices

Annex 1: Build Circular.Brussels (BCB) : Circular Construction Training & Support

Best practice summary

Field	Description
Title of the practice	Build Circular.Brussels (BCB) : Circular Construction Training & Support
Country of implementation	Belgium — Brussels-Capital Region.
Organisation(s) involved	Brussels Environment/Leefmilieu Brussel (training offers & technical content); CDR – Centre de Référence Construction (sectoral reference centre running construction trainings); efp/Bruxelles Formation (VET provider delivering modules); ecobuild.brussels (regional sustainable construction cluster & outreach); hub.brussels (enterprise support).
Description	BCB is a regional programme that trains and assists construction professionals to implement circular methods (e.g., reuse inventories, selective dismantling, materials reuse, waste minimisation, digitalisation of renovation). It combines free themed courses & seminars, tailored one-to-one support, and sector tools (guides, checklists) to convert circular ambitions into site-level practice .
Thematic area(s)	Green / Circular / Pedagogical (applied training in construction).
Methods and tools used	>50 free training programmes (e.g., circular site management, wood reuse, digitalisation of renovation); targeted support (>30 support types across 8 themes) ; Guide Bâtiment Durable knowledge base; Reuse inventory method; Circular Built project-monitoring tool; sector platforms like Opalis (reclaimed materials) and reuse.brussels (methods & manuals).
Target group(s)	SMEs and contractors , demolition/renovation firms, architects/engineers , public clients/municipalities, trainers and VET learners engaged via CDR/efp activities.
Outcomes and impact	Documented scale & offer : >50 free courses available to workers; BCB offers >30 tailored support types in 8 areas (e.g., waste & reuse). Broader sector capacity: in earlier push years, 3,542 construction workers trained in Brussels with 73,359 training hours (sector data from Constructiv, illustrating training intensity in the

	region). 41+ circular-economy business support offers are currently available region-wide.
Transferability	Highly transferable to regions with: (i) a sectoral reference centre (or equivalent), (ii) public environment/skills agencies, (iii) an industry cluster for outreach, and (iv) a toolkit (guides, inventories, platforms). The BCB architecture (courses + bespoke support + tooling) can be scaled or modularised.
Relevance to E4H	Offers a ready-made model to integrate circular skills in VET: co-develop training with reference centres, require site-based application (reuse inventories, dismantling), and anchor curricula in regional tools (Guide Bâtiment Durable, Circular Built). Strong match to Energy Efficiency/Sustainable Housing and Circular Economy strands of EXCEL4HOUSING4.0.

Introduction

This report documents Build Circular.Brussels (BCB) as a best practice because it operationalises circular construction skills through structured VET-adjacent training, sector tools, and on-site support for companies and workers in the Brussels region. Evidence comes from official programme pages and partner sites (Brussels Environment/Leefmilieu Brussel, the CDR Construction reference centre, efp/Bruxelles Formation, ecobuild.brussels cluster) and EU circular-economy case summaries.

The construction sector in Brussels, as in much of Europe, is one of the main consumers of raw materials and producers of waste. Estimates show that **construction and demolition activities account for over 30% of the total waste generated in the Brussels-Capital Region**. This presents both a challenge and an opportunity: the challenge of reducing waste and emissions, but also the opportunity to train a new generation of professionals capable of designing and implementing sustainable, circular solutions.

The **Build Circular.Brussels (BCB)** initiative was launched as a direct response to this reality. It is not a short-term project, but a **regional programme** that integrates training, enterprise support, and applied tools in a coherent system. Its aim is to **equip construction professionals and companies with the skills and resources they need to embed circular economy principles into everyday practice**.

What sets BCB apart is its **holistic approach**. Circularity is not presented as an optional add-on or specialist niche, but as an integral part of site management, renovation, and vocational education. The programme rests on three mutually reinforcing pillars:

- **Training courses** – free, practical, and tailored to specific trades, ensuring that both VET learners and experienced professionals can access relevant content.
- **Tailored support** – one-to-one coaching and mentoring for SMEs and professionals across eight priority themes, from selective dismantling to digital renovation.
- **Sectoral tools and platforms** – practical resources such as guides, digital inventories, and material marketplaces that anchor circular methods into daily work.

This structure ensures that learners move from **awareness** (through training) to **implementation** (through tools and tailored support), thereby closing the common gap between policy ambitions and workplace practice.

Definition and Criteria for Best Practices

Within the EXCEL4HOUSING4.0 framework, a best practice is defined as:

An initiative that demonstrates measurable results in equipping learners and professionals with green and digital skills, shows clear innovation in its approach, and has strong potential for transfer to other European VET contexts.

The **Build Circular.Brussels** initiative fulfils this definition in multiple ways:

- **Wide reach** – Thousands of workers have already participated, and hundreds of SMEs have benefited from tailored support.
- **Innovation** – It does not stop at training but links learning with **digital tools and reuse platforms**, ensuring real-life application.
- **Sustainability** – It is embedded in the **Brussels Regional Programme for Circular Economy (RPCE)**, guaranteeing long-term policy and budgetary support.
- **Transferability** – Its modular “three-pillar” design can be adapted in other regions with a sectoral training centre, a supportive public agency, and an industry cluster for outreach.

Presentation of the Best Practice

- **Title of the Practice:** Build Circular.Brussels (BCB): Circular Construction Training & Support
- **Country/Region and Partners Involved:** Belgium – Brussels-Capital Region. Partners include:
 - o Brussels Environment – providing policy direction, technical content, and coordination.
 - o CDR Construction – the sectoral reference centre delivering training and linking with industry.
 - o efp/Bruxelles Formation – public VET providers offering structured modules.
 - o ecobuild.brussels – a cluster connecting sustainable construction firms and disseminating results.
 - o hub.brussels – supporting SMEs and entrepreneurs with business services.

Brief Description

BCB is a regional initiative designed to help construction companies and professionals put circular methods into practice. It offers free courses, tailored support, and practical tools that make circular practices—such as selective dismantling, materials reuse, and digital site monitoring—both accessible and feasible.

Objectives and Challenges Addressed

- **Objectives:**

- Reduce construction and demolition waste, one of the largest waste streams in the region.
- Equip SMEs and workers with concrete, usable skills in reuse, dismantling, and procurement.
- Align vocational training with EU priorities such as the Green Deal and the Circular Economy Action Plan.

- **Challenges:**

- SMEs often lack time, resources, and knowledge to adopt new practices.
- Reuse markets are fragmented and underdeveloped, requiring awareness and technical guidance.
- VET curricula risk lagging behind policy ambitions if not regularly updated.

Methodology / Approach Implemented

- Delivery of **more than 50 free training modules**, covering topics such as circular site management, wood reuse, and renovation digitalisation.
- Provision of **tailored one-to-one support** for SMEs, offering over 30 types of assistance across 8 thematic areas.
- Deployment of **sectoral tools**, including:
 - *Guide Bâtiment Durable* – a knowledge base with technical guidelines.
 - *Opalis* – a digital marketplace for reclaimed materials.
 - *reuse.brussels* – manuals and methods for dismantling and reuse.
 - *Circular Built* – a project monitoring tool for circular building.
- Outreach through **ecobuild.brussels**, ensuring SMEs, architects, and municipalities are actively engaged.

Outcomes and Demonstrated Impact

- Training delivery: Over 50 courses made freely available; 3,542 workers trained with 73,359 training hours (Constructiv data).
- Enterprise support: More than 30 types of tailored services delivered to SMEs.
- Ecosystem building: Over 41 circular business support services now available region-wide.
- Sectoral change: Evidence of growing adoption of reuse practices, stronger linkages between VET training and on-site practice, and increased SME awareness.

Key Success Factors

- Strong policy anchoring within the Brussels Regional Programme for Circular Economy.
- A multi-actor partnership, ensuring that VET, industry, and public authorities work together.
- Accessibility of training, which is free of charge and practice-oriented.
- Integration with real-life tools and platforms, ensuring that training outcomes are directly applicable.

Replicability and Transferability Potential

The model is highly adaptable to other contexts, provided there is:

1. A **sectoral training centre** or equivalent structure.
2. A **public agency** willing to fund and coordinate training.
3. An **industry cluster** capable of engaging SMEs.
4. A set of **practical tools** (guides, platforms, inventories) to anchor learning.

Regions could start by implementing only the training pillar, later adding tailored support and digital tools as capacity grows.

Lessons Learned

- Linking training to practical tools such as reuse inventories significantly boosts uptake.
- SMEs benefit most from individualised support, beyond classroom learning.
- Embedding initiatives in long-term policy frameworks ensures sustainability.
- Trainer upskilling is essential: VET professionals need to master circular practices themselves before teaching them.

Cross-Cutting Analysis

- **Common Trends:** Successful practices combine **theory with practice**, using applied tools to make concepts tangible.
- **Recurrent Challenges:** SMEs' limited resources and cultural resistance to change; the need to adapt tools to company size and context.
- **Implications for Skills Development:** Circular skills must be integrated into both **initial VET** and **continuing professional development**, ensuring that young learners and experienced workers are equally equipped.
- **Recommendations for Transfer:**
 - Pair training offers with **digital and practical tools**.
 - Use **industry clusters** as trusted intermediaries for outreach.
 - Secure **long-term funding and policy alignment** to avoid short-lived pilot projects.
 - Collect and share **quantitative data** on training uptake and outcomes.

Conclusions and Recommendations

The Build Circular.Brussels programme demonstrates how **circular economy ambitions can be translated into an integrated training and support system**. For EXCEL4HOUSING4.0, it is particularly valuable because it:

- Embeds VET within a wider **policy and industry framework**.
- Combines both **initial vocational training and lifelong learning**.
- Uses **tools and digital platforms** to ensure that training translates into practice.

Recommendations:

- Other regions should adopt the **three-pillar model** (training, support, tools) as a coherent structure.
- Ensure that VET centres are actively involved in regional sustainability strategies.
- Invest in both **group-based training** and **tailored SME support** to maximise impact.

Dissemination Plan

The BCB practice will be widely disseminated to maximise learning and transferability:

- **Erasmus+ channels:** EPALE, Erasmus+ Project Results platform.
- **Circular economy networks:** European Circular Economy Stakeholder Platform (ECESP).
- **Sector events:** EU Sustainable Energy Week, Build Up Skills workshops.
- **Publications:** Case studies on Brussels Environment, CDR, and partner websites.
- **Peer learning:** Study visits, webinars, and workshops with VET providers and construction clusters in other regions.

References

Brussels Environment. (2019). Guide Bâtiment Durable [Sustainable Building Guide]. Retrieved from <https://www.guidebatimentdurable.brussels>

Brussels Regional Government. (2016). Programme Régional en Économie Circulaire (PRCE) [Regional Programme for a Circular Economy]. Brussels: Government of the Brussels-Capital Region. Retrieved from <https://circulareconomy.europa.eu/platform/en>

Ellen MacArthur Foundation. (2020). Regional Programme for a Circular Economy – Brussels [Case study]. Retrieved from <https://www.ellenmacarthurfoundation.org>

Interreg Europe. (2021). Be Circular Be Brussels: Good Practice Example. Retrieved from <https://www.interregeurope.eu/good-practices/be-circular-be-brussels>

Annex 2: CBCI (Circular Biobased Construction Industry) — Integrated Circular & Biobased Construction Innovation

Best practice summary

Field	Description
Title of the practice	CBCI (Circular Biobased Construction Industry) — Integrated Circular & Biobased Construction Innovation
Country of implementation	Belgium (Ghent region, KU Leuven campus) + cross-border (NL, UK) within the Interreg / territorial cooperation umbrella (Circularbuilt)
Organisation(s) involved	KU Leuven (Belgium), WTCB / Embuild Vlaanderen, Kamp C (BE), Avans University (NL), HZ University (NL), project partners from the Netherlands and UK, local municipalities, contractors, prototyping labs, researchers (Circularbuilt)
Description	CBCI investigates efficient and biobased use of raw materials in construction, reducing CO ₂ and material throughput by designing and applying circular / bio-based solutions in real building cases (living labs). The project prototypes components, works with procurement frameworks, conducts co-creation with stakeholders, and monitors life cycle performance. The aim is to move beyond isolated demonstrations to embedded systemic change. (Circularbuilt)
Thematic area(s)	Circular / Green / Sustainable construction / Innovation / Pedagogical (research-to-practice)
Methods and tools used	Living labs (real building projects) as testbeds; prototype development of façade units, plug-in modules, HVAC modules, etc.; tendering and procurement frameworks designed for circular & biobased ambition; co-creation workshops; performance monitoring (life cycle assessment, CO ₂ metrics); collaboration with labs and makerspaces (e.g. SPARK Maker Space, WTCB). (Circularbuilt)
Target group(s)	Construction professionals, architects, engineers, material producers; public procurers; VET / technical education programs; municipalities and policy actors; researchers and innovators.
Outcomes and impact	- Deployment of two living lab projects : <i>KU Leuven campus expansion (Belgium)</i> and <i>Emergis health care facility expansion (NL)</i> using circular and biobased components. (Circularbuilt) - Prototypes of façade elements and

	modular systems developed and tested in real conditions. (Circularbuilt) - Creation of white papers / procurement guidelines for circular & biobased tenders. (Circularbuilt) - Stakeholder engagement: over 20 observer partners, many local actors in Belgium and Netherlands. (Circularbuilt) - Knowledge sharing and dissemination of project lessons across regions.
Transferability	The CBCI architecture (living labs + prototype development + procurement frameworks + stakeholder co-design) is transferable to other regions provided there is institutional capacity to run living labs, collaboration between education/institutions and industry, and willingness from public procurement bodies to adopt innovation in tenders. The components and prototypes can be adapted to local material ecosystems and regulatory environments.
Relevance to E4H	CBCI offers a template for integrating experiential, real-world construction projects into VET or CoVE curricula: learners can engage in prototype design, performance monitoring, circular procurement. It directly complements EXCEL4HOUSING4.0's goals in sustainable and circular housing by showing how materials, bio-based systems, and procurement approaches can be innovated in practice, not just theory.

Introduction

Across Europe, the push toward circular and bio-based construction is gaining momentum, yet the built environment often remains locked in linear models of resource use and disposal. The **CBCI (Circular Biobased Construction Industry)** project was launched to catalyse change: to embed circular and biobased thinking not just in design, but in procurement, construction methods, supply chains, and stakeholder practices across regionally connected areas (Belgium, Netherlands, UK, etc.).

CBCI aims to demonstrate how integrated, cross-disciplinary projects — including living labs, co-creation, prototype development, and stakeholder engagement — can accelerate the shift to circular / bio-based construction. Unlike many short-term pilots, this project sought to work at **scale and systemically**: combining technical innovation, policy dialogue, procurement strategies, and education/training to support a holistic transition.

For the purposes of EXCEL4HOUSING4.0, CBCI is especially valuable as a best practice because it:

- Deals directly with **materials, supply chains, and procurement**, not just end-of-life reuse.
- Uses **living lab projects** to test bio-based and circular solutions in real buildings.
- Combines **knowledge institutions, governments, industry, and VET/training actors** in the same consortium.

-
- Offers lessons in scaling, stakeholder alignment, and integration of technical, regulatory, and educational dimensions.

The **Circular Biobased Construction Industry (CBCI)** project was developed under the Interreg 2 Seas programme as a response to the pressing need to move circular and biobased construction from niche experiments to mainstream practice. The project recognised that barriers were not only technical but also structural: public procurement criteria often lock actors into linear approaches, standards for biobased materials remain underdeveloped, industry players are cautious about risk, and VET systems rarely integrate emerging circular practices into curricula.

To address these issues, CBCI adopted a strategy that combines **living labs**, **procurement innovation**, and **prototype feedback loops**. By testing solutions in real buildings and embedding lessons directly into procurement and training, the project ensured that results were not theoretical but ready for wider adoption.

Definition and Criteria for Best Practices

Within EXCEL4HOUSING4.0, a best practice is an initiative that:

- Delivers **tangible and evidence-based results** in green and digital skills or sustainable building methods.
- Demonstrates **innovation** by combining technical, institutional, and educational elements.
- Provides **transferability** so that other regions or training systems can replicate or adapt the model.

CBCI clearly qualifies as a best practice. It has implemented **real building cases**, developed **prototypes** of circular and biobased elements, introduced **procurement lessons**, and achieved **stakeholder alignment** across Belgium, the Netherlands, and the UK.

Presentation of CBCI

- **Title of the Practice:** Circular Biobased Construction Industry (CBCI)
- **Country/Region and Partners:** Belgium (KU Leuven, WTCB, Embuild Vlaanderen, Kamp C) alongside Dutch and UK partners, with a network of observer organisations across BE/NL.

-
- **Brief Description:** CBCI is a multi-year, multi-stakeholder initiative that develops, tests, and disseminates circular and biobased construction solutions. It works through living labs, prototype elements, and procurement strategies, providing a systemic approach to innovation in the construction sector.

Objectives and Challenges

Objectives:

- Reduce embodied carbon and material use through circular and biobased practices.
- Create procurement systems that enable and reward innovation.
- Integrate circular solutions into real building projects to prove their feasibility.

Challenges:

- Rigid regulations and procurement rules limiting experimentation.
- Risk aversion among public and private clients.
- The need for cross-sector coordination between designers, contractors, and material producers.
- Lack of awareness and integration in education and training pathways.

Methodology and Approach

CBCI worked by combining applied research, demonstration, and education:

- **Two living lab projects** were selected: the KU Leuven campus (Belgium) and the Emergis healthcare facility (Netherlands).
- Stakeholders (architects, suppliers, municipalities) co-created the solutions, ensuring buy-in and practical alignment.
- Prototypes were developed for façade modules, plug-in components, and reusable systems, tested under real conditions.
- Procurement frameworks were redesigned to allow circular and biobased criteria to be integrated into tenders.
- Continuous monitoring (life cycle assessment, CO₂ footprint, functional performance) was carried out, with findings fed back into design and training.

Outcomes and Demonstrated Impact

- Two **living lab projects** applying prototypes in real settings.
- Prototypes developed and tested, showing the feasibility of circular/biobased solutions.
- White papers and procurement guidelines documenting lessons learned for public clients.
- Engagement of more than 20 observer organisations and industry actors.
- Knowledge exchange across Belgium, the Netherlands, and the UK, ensuring that lessons were disseminated beyond pilot sites.

Key Success Factors

- Integration of demonstration projects with procurement innovation.
- A strong consortium linking academia, VET, industry, and public bodies.
- The use of real-life settings (living labs) bridging theory and practice.
- Institutional commitment to prototyping and knowledge sharing.

Replicability and Transferability

The CBCI model can be applied in other regions by:

- Selecting local **living lab projects** such as public buildings or renovation sites.
- Aligning them with **procurement experimentation** that allows circular criteria.
- Creating partnerships across VET, universities, municipalities, and SMEs.
- Building feedback loops so that monitoring and evaluation inform practice and curricula.

Lessons Learned

- Innovation flourishes when **procurement rules are flexible** and support circular criteria.
- **Prototypes must be tested in real contexts** to reveal practical limitations and adaptations.
- Living labs generate visibility and attract stakeholder interest, making adoption easier.
- VET institutions must be involved, allowing learners to engage directly in prototype design, testing, and monitoring.

Cross-Cutting Analysis

CBCI demonstrates patterns common to other successful best practices: the need to combine **demonstration, tools, and learning** into one coherent process. Yet it also highlights the recurrent barriers of procurement risk aversion, regulatory uncertainty, and the difficulty of scaling prototypes into mainstream components.

For VET, the project underlines the importance of **hands-on exposure**: learners and trainers should work directly with new materials, life cycle assessment tools, and circular procurement methods. Curricula must therefore expand to cover not only construction techniques but also sustainability metrics and policy literacy.

Recommendations for Transfer:

- Begin with **small-scale pilot living labs** in public buildings to reduce risk.
- Work closely with procurement departments to design flexible criteria.
- Involve VET students and trainers early in prototyping cycles.
- Publish monitoring results openly to build trust and reduce hesitation among new adopters.

Conclusions and Recommendations

CBCI demonstrates how combining **innovation, policy, demonstration, and stakeholder collaboration** can move circular and biobased construction beyond isolated pilots. For EXCEL4HOUSING4.0, this model is highly relevant: it shows how learners can be integrated into real projects, how CoVEs can partner with municipalities, and how procurement can be used as a lever for change.

Recommendations:

- Use living labs as anchors for both curriculum and innovation.
- Align procurement with circular and biobased goals.
- Foster collaboration between VET providers, universities, municipalities, and industry clusters.
- Build strong monitoring and feedback mechanisms to ensure lessons learned are fed back into training and practice.

Dissemination Plan

CBCI's dissemination strategy included:

- Publishing results, white papers, and procurement frameworks in open access.
- Presentations at European construction and sustainability conferences.
- Thematic workshops and webinars for VET institutions and industry actors.
- Cross-border study visits to the living labs in Belgium and the Netherlands, enabling direct peer learning for other regions.

References

Circularbuilt. (n.d.). The CBCI-project: Circular biobased construction industry. Retrieved from <https://circularbuilt.be/cbci-project>

KU Leuven. (n.d.). CBCI, Circular Bio-based Construction Industry [Project page]. Retrieved from <https://research.kuleuven.be/portal/en/project/3E230120>

University of Bath. (n.d.). CBCI: Circular Bio-based Construction Industry. Retrieved from <https://www.bath.ac.uk/projects/cbci-circular-bio-based-construction-industry/>

Annex 3: BE REEL! – Belgium Renovates for Energy Efficient Living

Best practice summary

Field	Description
Title of the practice	BE REEL! – Belgium Renovates for Energy Efficient Living
Country of implementation	Belgium (Flanders, Wallonia, and cooperation in Brussels)
Organisation(s) involved	Flemish Energy and Climate Agency (VEKA), Service Public de Wallonie, Brussels partners, local municipalities, construction companies, training providers, housing associations, LIFE Programme (EU).
Description	BE REEL! is a LIFE Integrated Project (2018–2024) designed to accelerate Belgium’s long-term renovation strategy. It combines policy support, demonstration renovation projects, training of “renovation advisors,” innovative financing, and awareness raising to create a sustainable renovation wave. The project links national/regional strategies with municipal pilots and VET-related training for advisors and workers.
Thematic area(s)	Green / Energy Efficiency / Pedagogical
Methods and tools used	- 15-module training curriculum for “renovation advisors” (via LearnWorlds digital platform). - Demonstration projects in 5+ municipalities showcasing integrated renovations (insulation, HVAC, solar PV). - Policy guidelines and local authority support tools. - Innovative financing/business models to support deep renovation.
Target group(s)	Construction workers, renovation advisors, municipalities, local authorities, households (including vulnerable groups), VET trainers.
Outcomes and impact	- Demonstration projects in multiple municipalities. - 15-module curriculum developed and rolled out for renovation advisors. - Integration of renovation strategies into local authority planning. - Awareness campaigns reaching households across Belgium. - Strengthened ecosystem of renovation supply chain actors.
Transferability	Highly transferable: combines policy frameworks, practical demonstrations, and training . Other EU regions can adapt the renovation advisor training and replicate the municipality-based demonstration model. The use of digital platforms (LearnWorlds) enhances scalability.
Relevance to E4H	BE REEL! is highly relevant because it addresses the energy efficiency and sustainable housing strand of EXCEL4HOUSING4.0. It provides a model of

	how to integrate training (renovation advisors), policy alignment, and demonstration projects into one coherent package. It also offers lessons on engaging municipalities and households, ensuring that VET initiatives connect with real demand.	
--	---	--

Introduction

Belgium faces one of Europe’s most urgent energy renovation challenges: a large and outdated housing stock consuming far more energy than the EU average. Meeting climate neutrality targets requires not only technical solutions but also coordinated policy, innovative financing, skilled professionals, and informed citizens.

The **BE REEL! – Belgium Renovates for Energy Efficient Living** project (2018–2024), co-funded by the EU LIFE Integrated Programme, was launched to address this systemic challenge. It is not a single renovation initiative, but a **comprehensive national strategy in action**. BE REEL! brings together regional governments, municipalities, construction professionals, and training providers to accelerate the renovation wave across Flanders, Wallonia, and Brussels.

Its strength lies in a **multi-level approach**:

- **Demonstration projects** in cities such as Ghent, Antwerp, and La Louvière showcase deep renovations with insulation, HVAC, and renewable energy.
- A **15-module training curriculum for “renovation advisors”** builds the human capital needed to guide households and local authorities.
- **Innovative financial models and policy tools** reduce barriers and support scaling.
- **Citizen engagement and awareness campaigns** ensure that households, including vulnerable groups, are part of the renovation journey.

Belgium’s residential building stock suffers from low energy performance: the average energy use in Belgian homes is about **70% above the European average**. The **BE REEL!** project, financed under LIFE Integrated Projects (2018–2024), aims to transform this reality. Rather than focusing on isolated retrofit pilots, BE REEL! works across policy, municipalities, training, innovation, and demonstration to bring coherence to Belgium’s long-term renovation strategies.

The approach is to **create enabling conditions**: project-level demonstration, innovative financial models, capacity building for renovation advisors, and policy tools that support scaling. BE REEL! specifically engages municipal actors, households (including vulnerable groups), and construction / renovation professionals.

Definition and Criteria for Best Practices

Within EXCEL4HOUSING4.0, a best practice is defined as an initiative that:

- delivers measurable outcomes in green/digital skills or sustainable building performance,
- demonstrates innovation (technical, institutional, educational),
- and offers potential for replication in other regional or national contexts.

BE REEL! fits well because it:

- operates at **multiple levels** (policy, municipality, practice),
- implements **demonstration projects** in municipalities to test integrated renovation approaches,
- develops **training curricula** (renovation advisors) and capacity-building instruments,
- produces replication tools (policy, financial, technical) to scale beyond pilot zones.

Presentation of BE REEL!

- **Title of the Practice:** BE REEL! — Belgium Renovates for Energy Efficient Living
- **Country/Region & Partners:** Belgium (Flanders, Wallonia, cooperating with Brussels). Key partners include the Flemish Energy & Climate Agency (VEKA), Service Public de Wallonie (SPW), several municipalities (Ghent, Antwerp, Mechelen, Mouscron, La Louvière), and research / construction / training stakeholders.
- **Brief Description:** BE REEL! is a LIFE integrated project (LIFE16 IPC/BE/000005) that supports Belgium's long-term renovation strategies by combining **policy instruments, demonstration renovations, training, financial models, and capacity building**.

Objectives and Challenges Addressed

Objectives include:

- Establishing a framework to support the implementation of regional renovation strategies for Flanders and Wallonia.
- Designing, evaluating, refining, and demonstrating structural measures to increase renovation rates and improve energy performance in existing residential buildings.
- Enhancing capacity among public administrations and stakeholders via training, guidelines, and tools.
- Launching demonstration projects in municipalities to showcase integrated renovation (insulation, HVAC, PV) solutions.

Challenges confronted:

-
- The fragmented nature of renovation markets and the difficulty aligning multiple actors (municipalities, homeowners, contractors).
 - The need to develop innovative financial models to overcome upfront cost barriers.
 - The requirement to build capacity (skills, knowledge) across regions where renovation is slow.
 - Ensuring that demonstration results can inform policy and scale across regions.

Methodology / Approach Implemented

BE REEL! employs a multi-track approach, combining demonstration, capacity building, policy, and finance:

- **Demonstration projects in municipalities** — the project is active in cities such as Ghent, Antwerp, Mechelen, Mouscron, and La Louvière. These projects model integrated renovations (insulation, HVAC, solar PV) to serve as learning grounds.
- **Training / Capacity Building** — BE REEL! develops tools and training modules (e.g. “renovation advisors” curriculum) and uses digital platforms (“Courses” section on website) to disseminate learning.
- **Policy and financial instruments** — the project supports the creation of policy instruments and innovative business models to allow scaling and mainstreaming of renovation.
- **Stakeholder engagement & communication** — BE REEL! works with municipalities, citizen initiatives, contractors, and local administrations to build support and align actions.
- **Monitoring, evaluation, replication tools** — the project sets metrics to assess energy performance, GHG reductions, and tracks replication potential.

Outcomes and Demonstrated Impact

From publicly documented sources, BE REEL! has achieved:

- **Scale of renovation ambition:** The project plans to renovate **more than 8,000 dwellings** across its demonstration municipalities.
- **CO₂ emissions reduction:** In full operation, BE REEL! expects to reduce **over 18,600 tonnes CO₂ per year** via its actions.
- **Budget and scale:** The total project budget is approximately **€13,866,516**, with EU contribution of ~€8,319,910.
- **Municipal engagement:** The cities of Ghent, Antwerp, Mechelen, Mouscron, and La Louvière are active demonstration partners.

-
- **Pilot models:** Integrated renovation demonstrations (insulation, HVAC, PV) have been set up in these cities, serving as policy-learning grounds.

Key Success Factors

From the documented sources, the following elements contribute to BE REEL!'s success:

- **Strategic alignment with regional renovation plans** – BE REEL! supports and aligns with the long-term renovation strategies of Flanders and Wallonia, giving it legitimacy and policy anchoring.
- **Multi-level engagement** – the inclusion of municipalities, regional governments, local authorities, and construction professionals ensures that decisions are grounded in practice.
- **Demonstration in real municipal contexts** – renovating actual buildings in cities provides visible proof of feasibility and helps reduce perceived risk.
- **Capacity building and training tools** – offering courses and tools helps build local skills to sustain renovation efforts over time.

Replicability and Transferability Potential

BE REEL! is well-suited for replication in other regions or countries because:

- It integrates **policy, technical demonstration, training, and finance** in one coherent package, which reduces fragmentation.
- The **municipal demonstration model** can be adopted by cities in other housing contexts.
- Training modules and capacity-building tools can be adapted to local regulatory and technological contexts.
- Because BE REEL! operates across Flanders and Wallonia, it already demonstrates inter-regional coordination and learning, offering lessons for multi-region replication.

Lessons Learned

While detailed internal reflections would be in project reports, from public sources we can infer:

- Demonstration projects must be **well-chosen** (e.g. representative housing types) to maximize learning and credibility.
- Budget and financial instruments are critical: without supportive funding, many households will struggle with upfront costs.

-
- Training needs to reach multiple stakeholder levels (municipal staff, advisors, contractors) to ensure alignment.
 - Communication and citizen engagement are essential to encourage uptake of renovation among homeowners.

Cross-Cutting Analysis of BE REEL!

Common Trends and Success Patterns

Like other best practices, BE REEL! consolidates multiple approaches: demonstration, capacity building, policy tools, and stakeholder engagement — all in one strategic programme.

Recurrent Challenges

- Upfront investment and financing remain a barrier to deep renovation.
- Municipalities must balance many priorities; dedicated staff is needed.
- Ensuring that trained advisors and installers can scale beyond pilot areas.

Implications for Skills Development and VET

BE REEL! emphasizes the role of “**renovation advisors**” — professionals who can bridge technical, financial, and behavioral dimensions. VET programmes should incorporate training modules in energy diagnostics, retrofit planning, stakeholder engagement, and the use of renovation tools like “Quickscan” and “Building Passport” (used in Wallonia).

Conclusions and Recommendations

BE REEL! demonstrates how a national/regional-level integrated project can support the scaling of energy renovation by combining demonstration, training, policy support, and stakeholder engagement. For EXCEL4HOUSING4.0, it provides a robust example of bridging **policy-level ambition** and **on-the-ground capacity building**.

Recommendations for adopting or adapting BE REEL!-style approaches:

- Anchor projects within **regional or national renovation strategies**.
- Use municipal or city-level demonstration pilots as learning hubs.
- Develop training for renovation advisors or coordinators, integrated with local VET/continuing education.
- Pair demonstration and learning with financial instruments that reduce risk for homeowners.

-
- Ensure strong stakeholder engagement and citizen communication to build trust and participation.

Dissemination Plan

To maximize visibility and uptake, BE REEL! can be disseminated as follows:

- Publication of lessons learned, technical guidelines, and training curricula on the BE REEL! website and partner platforms.
- Presentations at European and national energy/renovation conferences.
- Webinars targeting municipalities, VET centres, and industry practitioners.
- Study visits to demonstration municipalities for peer learning.
- Integration into EU networks (e.g. LIFE, Renovation Wave, Covenant of Mayors) to widen reach.

References

European Commission. (n.d.). *Belgium Renovates for Energy Efficient Living (BE REEL!)*. LIFE Public Database. Retrieved October 7, 2025, from <https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE16-IPC-BE-000005/belgium-renovates-for-energy-efficient-living>

Annex 4: CRO Skills RELOAD

Best practice summary

Field	Description
Title of the practice	CRO skills RELOAD
Country of implementation	Croatia
Organisation(s) involved	University of Zagreb - Faculty of Civil Engineering, Green Building Council Croatia, Croatian Chamber of Trades and Crafts, Regional Energy Agency North, Association of Construction Engineering Schools of the Republic of Croatia
Description	The CRO Skills RELOAD project revitalized the National Qualification Platform and updated the National Roadmap to support national energy and climate goals. Developed under the Build Up Skills initiative, it targeted all renovation stakeholders—from decision-makers to future nZEB specialists—to promote the adoption of nZEB standards and sustainable construction. The project emphasized education and lifelong learning, building on previous initiatives to advance new skills development.
Thematic area(s)	Energy efficiency, Innovative VET methodologies and tools
Methods and tools used	blended learning, microcredentials, Work-Based Learning
Target group(s)	students, trainers, professionals, workers
Outcomes and impact	The CRO Skills RELOAD project's National Platform united key stakeholders from construction and education sectors. It developed Guidelines for continuous training across vocational, higher education, and lifelong learning to address skill gaps in energy efficiency. These Guidelines offer a clear plan to meet 2030 construction sector goals and have been officially endorsed for implementation.
Transferability	The CRO Skills RELOAD project's approach is highly transferable across the EU, addressing common challenges like an aging workforce, skills gaps, and decarbonization needs. By combining a multi-stakeholder platform with a National Roadmap and training Guidelines, it includes all renovation actors. This model can be replicated by establishing national platforms, developing tailored three-level training guidelines, and aligning with EU climate goals. Its holistic, scalable design adapts to different countries while preparing a skilled workforce for sustainable, energy-efficient construction.
Relevance to E4H	The CRO Skills RELOAD practice adds value by linking education and training to the construction sector's urgent green and digital transition needs. Through the National Qualification Platform and Roadmap, it ensures coordinated involvement of all stakeholders and official endorsement of guidelines. The practice modernizes VET with flexible, accessible methods aligned with labor market demands. Its scalable, holistic framework is transferable across Europe, helping upskill the workforce and support EU energy and climate goals.

Introduction

Between 2014 and 2020, only 0.7% of Croatia's building stock was renovated annually. Energy-inefficient buildings in the country account for 40% of energy consumption and 36% of CO₂ emissions, with approximately 30% of buildings classified as having the worst energy performance. Increasing the pace of energy renovations for existing buildings and promoting new nearly Zero Energy Buildings (nZEB) could significantly reduce energy use and emissions, helping Croatia meet its national and EU energy and climate targets for 2030. Achieving these goals requires a workforce skilled in new technologies, innovative renovation and construction methods, nZEB standards, contemporary construction materials, digitalization in building processes, and other factors critical to decarbonization.

The project was developed within the framework of the European initiative Build up Skills. CRO Skills RELOAD project aimed to revitalize the National Qualification Platform and enhance the National Roadmap to support national energy and climate objectives. The project addressed all stages of the renovation ecosystem—from policymakers, end users, material and equipment manufacturers, contractors, designers, and energy service providers to future nZEB specialists, including students. Its goal was to promote nZEB standards and sustainable construction as key drivers for decarbonization, emphasizing the importance of education and lifelong learning. The project built upon and scaled the achievements of previous BuildUP Skills initiatives, further supporting the development of new competencies in the sector.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.:

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria

Transferability

The practice developed through the CRO skills RELOAD project has high transferability potential because it addresses challenges that are common across the EU construction sector: an aging workforce, skills gaps in energy efficiency and digitalization, and the urgent need to meet decarbonization targets. The approach of combining a multi-stakeholder platform with a National Roadmap and concrete Guidelines for continuous training ensures that all relevant actors in the renovation ecosystem are included, from policymakers and education providers to workers and future specialists.

This model can be replicated in other national contexts by:

- Establishing a national platform that unites construction and education stakeholders, ensuring alignment with labour market needs.
- Developing guidelines tailored to national circumstances but based on the same three-level framework (vocational education, higher education, lifelong learning).
- Building on existing EU initiatives and aligning with EU climate and energy targets to ensure policy coherence and access to funding.

The strength of this practice lies in its holistic and scalable approach: it can be adapted to countries with different regulatory systems or labour market needs, while maintaining the core idea of preparing a skilled

workforce for energy-efficient, sustainable, and digitalized construction.

impact

As part of the CRO skills RELOAD project, the re-established National Platform brought together all recognized relevant stakeholders from the construction and education sectors (representatives of craftsmen, industry members, employers' associations, educational and vocational institutions, relevant public authorities, as well as civil society and the media).

Guidelines have been developed for the continuous training of construction workers and engineers in the field of energy efficiency. These Guidelines are oriented towards three levels of education for both the current and future workforce in the construction sector – vocational education, higher education, and lifelong learning in the form of training and retraining programs for employed and unemployed workers in occupations in demand.

Defined in this way, the Guidelines provide a concrete plan and necessary steps to overcome the identified gaps at all levels of professional qualifications in order to achieve the 2030 goals in the construction sector. As a result, the National Guidelines are endorsed by the relevant authorities and stakeholders, with an obligation for their implementation.

VET relevance

The practice introduces innovative VET methodologies which modernize training provision and make it more accessible, flexible, and aligned with labour market requirements.

replicability

The practice transferability across Europe adds further value, as it demonstrates a scalable and holistic framework for addressing common challenges: upskilling the workforce, closing skills gaps, and supporting the achievement of EU energy and climate goals.

innovation

Recent study with publications.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy Efficiency, Digitalization

- Title of the Practice

CRO Skills RELOAD

- Country/Region and Partner(s) Involved

University of Zagreb - Faculty of Civil Engineering, Green Building Council Croatia, Croatian Chamber of Trades and Crafts, Regional Energy Agency North, Association of Construction Engineering Schools of the Republic of Croatia

- Brief Description of the Practice

The CRO skills RELOAD project re-established the “National Qualification Platform” and improved the “National Roadmap” in order to achieve national energy and climate goals. The project acted on all segments of the renovation process ecosystem, with intention to adopt nZEB standard and sustainable construction as the key levers for achieving decarbonization goals with a special emphasis on the importance of education and lifelong learning.

- Objectives addressed:

to strengthen the skills and knowledge of the construction workforce in Croatia, re-establish a National Qualification Platform, and improve the National Roadmap in order to accelerate energy renovation, adopt the nZEB standard, and support national energy and climate goals through education, innovation, and lifelong learning.

■ Challenges addressed:

shortage of skilled workforce, very low renovation rate of the building stock, high share of energy-inefficient buildings, large percentage of buildings with the poorest energy performance, lack of widespread adoption of digital tools, new materials, and sustainable construction practices, need to align with Croatia's and EU's 2030 climate and energy goals.

■ Methodology / Approach Implemented:

- Stakeholder engagement – to ensure a comprehensive approach.
- Capacity building & training – development of training programs, curricula, and lifelong learning initiatives to upskill the workforce in nZEB standards, innovative construction methods, and digital tools.
- Knowledge transfer – building on and upscaling results of previous BuildUP Skills projects and similar initiatives.
- Practical demonstration – linking training with real renovation and construction projects to ensure applicability and hands-on learning.
- Monitoring & evaluation – continuous assessment of outcomes and feedback integration to improve implementation and long-term impact.

■ Outcomes:

- Upskilled workforce trained in nZEB standards, sustainable construction methods, and innovative renovation technologies.
- Re-established National Qualification Platform functioning as a central hub for coordinating skills development in the building sector arising from a thorough review of the analysis of the current situation in the construction sector in Croatia.
- Updated National Roadmap aligned with EU 2030 energy and climate targets.
- Improved collaboration between stakeholders.
- Enhanced educational capacity through lifelong learning programs and integration of new curricula for students and professionals.
- Knowledge transfer and scaling-up of previous BuildUP Skills results and best practices.
- Contribution to national decarbonization goals, with reduced energy consumption and CO₂ emissions in the building sector.

■ Demonstrated Impact (quantitative/qualitative)

Quantitative:

- Annual renovation rate projected to rise significantly above the current 0.7% baseline.
- Reduction in energy consumption and CO₂ emissions from buildings, directly contributing to Croatia's and EU's 2030 climate targets.
- Increased number of professionals certified in nZEB standards and sustainable construction methods.
- Measurable growth in participation across training programs and lifelong learning initiatives.

Qualitative:

- Strengthened capacity of the workforce to apply innovative technologies, digital tools, and sustainable building materials.
- Enhanced cooperation among key stakeholders – policy makers, academia, construction industry, and end-users.
- Establishment of a culture of continuous education and skills upgrading in the building sector.

■ Key Success Factors:

- Alignment with EU climate and sustainability goals.
- Comprehensive sector and workforce analysis.
- Strong stakeholder involvement across government, education, and industry.
- Data-driven identification of workforce needs.
- Integration of education measures with practical sector requirements.
- National Qualification Platform and Roadmap for coordination.

■ Replicability and Transferability Potential:

- Applicable to countries with similar construction and energy efficiency challenges.
- Platform and roadmap approach adaptable to other sectors.
- Workforce assessment methodology can be transferred to other education systems.

■ Lessons Learned:

- Need to improve vocational education's attractiveness.
- Strong industry-education collaboration is essential.
- Digital tools and energy efficiency technologies must be integrated into training.
- Monitoring and lifelong learning are crucial for skills development.
- Stakeholder engagement ensures effective implementation.

● **Cross-Cutting Analysis of Best Practices**

○ Common Trends and Success Patterns:

Key trends include promoting lifelong learning, bridging gaps between education and practical industry needs, and engaging stakeholders across vocational education, higher education, and professional training. Success patterns were observed in the use of data-driven workforce analysis, the establishment of a National Qualification Platform and Roadmap, integration of hands-on practical training with theoretical learning, clear assignment of responsibilities and resources, and continuous stakeholder engagement to ensure commitment and effective implementation.

○ Recurrent Challenges and Strategies for Overcoming Them.

- Shortage of qualified construction professionals / Re-launch National Platforms to coordinate stakeholders and workforce planning.
- Low EE/RES skills among workers / Develop National Roadmap with targeted training programs.
- Need for upskilling/retraining for nZEB and renovations / Introduce new qualifications and update existing programs.
- Fragmented education across vocational, higher, lifelong learning / Integrate all education levels to cover workforce needs.
- Adoption of new technologies (heat pumps, BIM, energy systems) / Include practical, tech-focused modules in training.

-
- Alignment with EU climate/energy policies / Plan training according to EU targets (REPowerEU, decarbonization).
 - Monitoring and evaluation / Implement mechanisms to track and adjust roadmap measures.
 - Stakeholder commitment / Continuous engagement to ensure acceptance and implementation.
 - Implications for Skills Development and VET.
 - Integrate energy efficiency and nZEB principles into vocational and higher education.
 - Link vocational, higher, and lifelong learning for workforce continuity.
 - Include hands-on training with digital tools and new technologies.
 - Align programs with EU and national climate/energy targets.
 - Engage stakeholders to ensure relevance and recognition of skills.
 - Implement continuous monitoring and evaluation to adapt to sector needs.
 - Recommendations for Practice Transfer and Adaptation.
 - Adapt the National Roadmap and platform approach to local contexts.
 - Customize training programs to workforce, education system, and regulations.
 - Promote hands-on and digital learning tools for practical skills.
 - Ensure stakeholder engagement and continuous monitoring for successful implementation.
-
- **Conclusions and Recommendations**
 - Synthesis of Key Findings from the compendium.
 - Croatia's construction sector faces a shortage of skilled professionals for energy-efficient and nZEB buildings.
 - Education and training programs are fragmented and need integration across vocational, higher, and lifelong learning.
 - Practical training with digital tools and renewable energy technologies is essential.
 - Strong stakeholder engagement and coordinated governance ensure effective skills development.
 - Continuous monitoring and evaluation are needed to adapt programs and meet EU and national climate targets.
 - Recommendations for future actions and projects in the field of VET and sustainable construction.
 - Strengthen and integrate education and training programs for EE, RES, and nZEB skills.
 - Upskill the workforce with hands-on and technology-focused training.
 - Replicate the National Roadmap and Platform approach in other regions/sectors.
 - Enhance collaboration among government, industry, and education.
 - Implement monitoring and feedback mechanisms for continuous improvement.
-
- **Dissemination Plan for the Compendium**
 - Strategies and channels for disseminating D2.3.
 - Distribute digitally via project and project partner platforms.
 - Present through workshops, webinars, and academic conferences.
 - Share highlights on social media and professional networks.
 - Reach stakeholders via email campaigns and newsletters.

- Integrate the Compendium into training courses and curricula.

Annex 5: Incept

In

Field	Description
Title of the practice	INCEPT
Country of implementation	Bulgaria, Croatia, Romania
Organisation(s) involved	New Bulgarian University, University of Architecture and Urbanism 'Ion Mincu' Bucharest, University of Zagreb - Faculty of Architecture
Description	The INCEPT Project developed and implemented a sustainable architecture curriculum within Master of Architecture programs to build students' digital and green skills in energy-efficient, low-carbon design. Aligned with Europe's green transition, key outputs include a compendium, lecture course, online training, and a Climate Neutral Building Design Atelier, all supported by a shared digital platform.
Thematic area(s)	Energy efficiency, Circular economy, Digitalisation, Innovative VET
Methods and tools used	blended learning, digital labs,
Target group(s)	(architecture) students, university lecturers, professionals
Outcomes and impact	The project aligns architecture education with Europe's green transition by integrating low- and zero-carbon design strategies into core curricula, supported by experience-based training. It delivers a future-oriented, climate-focused curriculum and fosters long-term digital collaboration between universities. The validated curriculum has been widely disseminated to maximize national and EU-level impact.
Transferability	The INCEPT Project is highly transferable, offering adaptable curricula and scalable outputs for sustainable built environment education. Through transnational, multi-sector collaboration and strong dissemination, its results can be applied across various countries and systems, especially those facing similar energy efficiency challenges.
Relevance to E4H	The INCEPT Project aligns closely with the goals of E4H, supporting the European Green Deal by addressing skill gaps in energy efficiency, sustainability, and digital innovation. It advances higher education reform through future-proof architecture curricula, promoting green and digital skills. INCEPT's transnational, interdisciplinary approach complements E4H by fostering cross-border collaboration, business-academia links, and scalable training outputs. Both projects contribute to a resilient, climate-neutral, and digitally advanced built environment across Europe.

Introduction

The INCEPT Project is a forward-looking educational initiative that aligns architectural training with the goals of the European Green Deal. By integrating sustainability, energy efficiency, and digital innovation into Master of Architecture programs, INCEPT addresses critical skill gaps in the built environment sector. Through transnational collaboration, interdisciplinary approaches, and scalable educational outputs, the project aims to equip future architects with the competencies needed to design climate-neutral, resilient, and inclusive buildings across Europe.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.:

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria

Transferability

INCEPT is highly transferable due to its joint, adaptable curricula addressing shared challenges in sustainable built environments. Its transnational, multi-sector cooperation and scalable outputs make it applicable across countries and education systems, especially those facing energy efficiency issues. Strong dissemination supports long-term collaboration locally and across Europe.

Impact

INCEPT advances climate-neutral, inclusive architecture education by integrating sustainable, energy-efficient design with interdisciplinary fields like urban planning and digital tech. It equips future architects with green and digital skills and fosters cross-sector collaboration to tackle the climate crisis.

VET

Relevance

INCEPT promotes practical, experience-based learning in sustainable architecture, with outputs like online courses and design ateliers that align education with industry needs. This strengthens VET pathways and prepares a skilled workforce for Europe's green and digital transitions.

Replicability

With its collaborative, adaptable framework, INCEPT's methods are scalable and replicable across Europe. Its focus on sustainability, multi-sector collaboration, and open knowledge exchange supports adoption in diverse contexts, aiding the broader green transition.

Innovation

INCEPT introduces future-focused architectural education emphasizing climate-neutral, socially inclusive design. Through hands-on, interdisciplinary learning, it builds green and digital skills, promoting sustainable building practices that reduce environmental impact and improve performance.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy efficiency, Circular economy, Digitalisation, Innovative VET methodologies and tools

- Title of the Practice

INCEPT Project

■ Country/Region and Partner(s) Involved

New Bulgarian University; University of Architecture and Urbanism 'Ion Mincu' Bucharest; University of Zagreb - Faculty of Architecture, Croatia

■ Brief Description of the Practice

As main objective INCEPT Project developed, validated and implemented a curriculum on sustainable architecture within the Master of Architecture programs at the participating universities, to provide knowledge and build digital and green skills of architecture students on the major principles of sustainability and energy efficiency in the design of different building typologies. The INCEPT Project aimed to align architectural education with Europe's green transition by equipping students with knowledge and tools for energy-efficient, low-carbon, and sustainable design. Its key outputs include a compendium, lecture course, online training course, and a Climate Neutral Building Design Atelier, supported by a digital learning platform for inter-university exchange.

■ Objectives addressed:

Developed, validated and implemented curriculum on sustainable architecture within the Master of Architecture programs at the participating universities, provided knowledge and built digital and green skills of architecture students on the major principles of sustainability and energy efficiency in the design of different building typologies.

■ Challenges addressed:

- **Outdated Curricula** of current Master of Architecture programs, making them unfit for addressing today's environmental challenges.
- **Skills Gap** of architecture students who often lack the necessary green and digital skills needed to design climate-neutral, energy-efficient, and inclusive buildings.
- **Lack of Transnational Cooperation:** Tackling the green transition requires collaboration across borders to share knowledge, best practices, and develop scalable educational models.
- **Disconnection Between Education & Professional Demands:** Architectural education must evolve in response to societal needs, technological trends, and the Sustainable Development Goals.
- **Support for National & EU Policies:** There is a need to align architectural education with national and EU climate policies, including the European Green Deal, which mandates zero-emission buildings by 2030.

■ Methodology / Approach Implemented:

The Project adopts a digital, interdisciplinary, and practice-oriented approach to embed sustainability and energy efficiency into Master of Architecture programs.

- **Curriculum Integration:** Focus on climate-neutral, inclusive, and energy-efficient design aligned with the EU Green Deal and SDGs.
- **Digital Tools & Platforms:** Use of BIM, life-cycle analysis tools, and a digital learning platform to enhance teaching, learning, and collaboration.
- **Work Package Structure:** Structured implementation through five work packages covering management, course development, hands-on atelier, application, and dissemination.
- **Skills Development:** Strengthening students' green and digital skills for sustainable building design.
- **International Collaboration:** Transnational cooperation among Southeast European universities ensures shared knowledge, innovation, and long-term partnerships.

■ Outcomes

The strategic outcome of INCEPT Project is the closer alignment between architecture education and the strategic energy and climate goals of the green transition in Europe. The project will integrate low- and zero-carbon tools and strategies in core architecture modules and complement them with experience-based training. This will enable the delivery of an innovative future-oriented curriculum to effectively address the need for a climate neutral, resilient and inclusive built environment. Another key outcome is the increase in opportunities for joint initiatives and exchange of knowledge and good practices digitally between the participating universities, thus, to ensure their long-term collaboration. The project validated and implemented a curriculum while ensuring broad dissemination at national and EU levels to maximize impact.

■ Demonstrated Impact (quantitative/qualitative)

Quantitative

- **3 partner universities** jointly developed and implemented a sustainable architecture curriculum.
- **4 key educational outputs** produced: compendium, lecture course, online training course, and Climate Neutral Building Design Atelier.
 - 175 students, 18 mentors and 8 guest lecturers were included in Climate Neutral Building Design Atelier implementation, at all three partner universities.
 - Over 250 participants during 4 modules of online training course.
- **1 digital learning platform** established for inter-university collaboration and knowledge exchange.
- **Multiple stakeholder groups** targeted, including academic staff, students, practitioners, government officials, and civil society.
- **Wider dissemination** ensured through established networks at **local, national, and EU levels**, increasing the number of potential beneficiaries.

Qualitative

- Strengthened alignment of architecture education with EU green and digital transition goals.
- Enhanced institutional capacity to deliver innovative, sustainability-focused curricula.
- Fostered long-term collaboration between universities, industry, and public stakeholders.
- Increased awareness and integration of low- and zero-carbon design strategies among future professionals.
- Promoted interdisciplinary and transnational cooperation in higher education.
- Empowered students with practical, transferable skills applicable in real-world sustainable building design.

■ Key Success Factors

Supporting digital and green capabilities of the higher education sector.

Promoting inter-connected higher education systems.

■ Replicability and Transferability Potential

This practice demonstrates strong replicability and transferability across Europe through its adaptable, sustainability-focused architecture curriculum and transnational collaboration model. Its scalable outputs, multi-sector engagement, and open-access resources enable easy integration into diverse educational and regional contexts, supporting broader adoption of green and energy-efficient design principles aligned with the European Green Deal.

■ Lessons Learned

- Integrating sustainability in architecture education requires strong digital and interdisciplinary support.

-
- Transnational collaboration enhances innovation and relevance.
 - Digital tools are essential for both teaching and project management.
 - Practice-based learning effectively builds green and digital skills.

- **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns

Across participating institutions, a strong trend is the integration of sustainability and digitalisation into architecture education through collaborative, transdisciplinary approaches. Successful practices include embedding real-world, climate-focused design challenges into curricula, using digital tools like BIM, and fostering strong university partnerships to co-develop content and share resources.

- Recurrent Challenges and Strategies for Overcoming Them.

Common challenges include varying levels of institutional readiness, gaps in digital infrastructure, and differing national education standards. These were addressed by adapting flexible, modular teaching methods, offering digital skills training for staff and students, and promoting open communication between partners to align goals and expectations.

- Implications for Skills Development and VET.

The project highlights the growing need for green and digital competencies in architecture and construction. Embedding these skills into VET and higher education enhances students' employability and aligns with EU climate goals. INCEPT's model supports the development of future-ready professionals equipped to lead the sustainable transformation of the built environment.

- **Conclusions and Recommendations**

Conclusions

The INCEPT Project demonstrates that integrating sustainability and digitalisation into architectural education is both necessary and achievable through transnational collaboration and interdisciplinary methods. Embedding real-life climate challenges and digital tools into learning significantly enhances students' skills and readiness to contribute to a climate-neutral built environment. Strong institutional cooperation and adaptive curriculum design were key to success.

Recommendations

Future VET and sustainable construction projects should prioritize cross-border partnerships, digital capacity building, and curriculum alignment with EU climate goals. Emphasis should be placed on developing modular, flexible training content, fostering hands-on, experience-based learning, and ensuring continuous upskilling of educators in green and digital competencies to meet evolving industry needs.

- **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.

Adopt a multi-channel, strategic communication approach to ensure wide visibility, stakeholder engagement, and long-term impact.

- web presence
- social media promotion
- events promotion: workshops and conferences

- target audiences

References

Incept Project. (2022). *Submitted application*. Internal use only.

Annex 6: BAUHAUS 4 MED - Testing New European Bauhaus Solutions for Deep Green Transformation of Cities and Regions in Euro-MED area

Field	Description
Title of the practice	BAUHAUS 4 MED - Testing New European Bauhaus Solutions for Deep Green Transformation of Cities and Regions in Euro-MED area
Country of implementation	Greece, Italy, Bosnia and Herzegovina and Bulgaria as institutional partners - testing city/region partners; Slovenia (Lead partner), Spain, Greece and Croatia as support expert partners; 1 international organization, with the seat in Belgium as international networking partner
Organisation(s) involved	E-institute (Slovenia), Region of Central Macedonia (Greece), SVEM (Marche Region, Italy), Crowdpolicy (Greece), Platoniq Foundation (Spain), Regional Government of Tuscany (Italy), Faculty of Architecture (Croatia), City of Sarajevo (Bosnia and Herzegovina), Burgas Municipality (Bulgaria), IFLA Europe (international organization, with the seat in Belgium)
Description	Building upon the success of the Interreg MED BLUE CROWDFUNDING project, project Euro-MED BAUHAUS tests innovative NEB solutions integrating sustainability, inclusion and aesthetic aspects into decision making process, for improvement of green living areas. Each of the 5 testing regions/cities identifies participative green community challenges, uses crowdsourcing to co-create solution ideas, run civic crowdfunding campaigns to co-finance solutions and use participative budgets to implement pilot solutions. Pilot solutions are focused on circular building materials, regenerated green urban spaces, green products, or green lifestyle. Combining crowdfunding, crowdsourcing and participative democracy principles, with aesthetic green architecture design resulting in citizens tailor-made solutions for better living results in a new “CROWDVOACACY” tool.
Thematic area(s)	Energy efficiency, Circular economy, Digitalisation, Innovative VET methodologies and tools
Methods and tools used	Project-Based Learning (PBL), Gamification, Flipped Classroom, Microlearning, Peer Learning
Target group(s)	In the executive phase, participants representing all Quintuple Helix sectors are actively involved. Engagement is extended to individuals from diverse generations, professional fields, identities, cultural backgrounds, and life experiences (based on NEB inclusivity value).

Outcomes and impact	Testing pilot projects are evaluated and valorised according to predefined criteria from EU BAUHAUS self-assessment tool measuring the impact of solutions on sustainability (climate goals, circularity, zero-pollution and biodiversity), inclusiveness (impact on society, diversity, equality, accessibility and affordability), and aesthetics (quality of experience and style beyond functionality). Based on transnational verification a toolbox has been created, composed of guidance to the transformational process, best example catalogue, lessons learned as well as digital tool for participatory processes. Guidelines have been developed for the continuous training of all participant representing all Quintuple Helix sectors, providing transdisciplinary approach and multi-level engagement, co-creation and co-design of transformative and scalable, locally grounded and context-sensitive public spaces, learning by doing etc.	
Transferability	The Euro-MED BAUHAUS transferability plan has been prepared to provide an easier assessment of the feasibility of transferring the project outputs and results to other regions and cities. First, the outputs have been transnationally rechecked to ensure they are in a “mainstreaming format” — reusable and ready to be transferred. Secondly, a list of actions has been prepared to enable further organisations to take up or upscale the outputs. Thirdly, a list of potential territories and partners has been developed for possible transfer.	
Relevance to E4H	The added value of the BAUHAUS4MED practice lies in its capacity to systematically connect people living in the same area, united by the public space they share, to create more sustainable, inclusive, and beautiful environments as , the project ensured a coordinated approach that involves all relevant stakeholders, from policymakers to practitioners. These spaces will eventually become their ‘borrowed’ ownership through gamification, flipped classroom methods, microlearning, mutual care, the desire to spend time together, and peer learning — not only in the executive phase but, more importantly, in the usage stage — in order to fulfil all the values of the New European Bauhaus (NEB) initiative and, consequently, the EU Green Deal. Moreover, the practice introduces innovative VET methodologies, which modernize training provision and make it more accessible, flexible, and aligned with contemporary EU policies and initiatives. By re-establishing existing abandoned places — thus preparing the ground and setting guidelines for new projects — the Bauhaus4MED project has ensured a coordinated approach that involves all relevant stakeholders, from policymakers to practitioners. This inclusive model guarantees not only the development of guidelines but also their endorsement and implementation by the responsible authorities. Its transferability across Europe adds further value, as it demonstrates a scalable and holistic framework for addressing common challenges faced by many regions: social and economic disadvantages, inequality, and related crime and security issues. Such areas often lack quality green spaces, which negatively affect human health and well-being and make them more vulnerable to the impacts of climate change, while supporting the overall achievement of the EU’s energy and climate goals.	

Introduction

The BAUHAUS4MED project has been developed within the framework of the New European Bauhaus (NEB) and the European Green Deal initiatives. It aims to revitalise and strengthen regional cooperation platforms and enhance participatory approaches that support sustainable urban and territorial transformation. The project addresses all dimensions of the built environment — from policymakers, designers, and construction professionals to citizens, educators, and learners — fostering a shared responsibility for creating sustainable, inclusive, and aesthetically enriched public spaces. Its goal is to promote NEB principles and sustainable construction as key drivers for decarbonisation, social inclusion, and cultural renewal, with a strong emphasis on education, lifelong learning, and innovative VET methodologies. Building upon and extending the achievements of previous European Green Deal and NEB-related initiatives, BAUHAUS4MED contributes to the development of new skills, collaborative practices, and transferable models that can be replicated across Mediterranean regions and beyond.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.:

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria

Transferability

The practice developed through the BAUHAUS4MED project demonstrates strong transferability potential across Europe, as it addresses challenges shared by many Mediterranean and EU regions. Its transnational, multi-sectoral cooperation and scalable outputs make it applicable across different countries and education systems—particularly those facing social inequalities, skills gaps in green and digital construction, and the need for inclusive community regeneration. Sustained dissemination supports long-term collaboration both locally and at the European level.

At the EU level, the project has contributed to the European Bauhaus Arena, has organized a Transnational Green Transformation Challenge Sprint, and hosted the “BAUHAUS4MED – Reconstructing the Future” Conference to share knowledge and inspire replication. Locally, five Green Transformation Living Lab Nodes have implemented Bauhaus Festivals and community events to engage citizens, decision-makers, and professionals in the green transition.

The project achieves this by:

- Establishing local and regional NEB platforms that connect urban, educational, and community stakeholders;
- Developing context-sensitive guidelines based on shared European frameworks but adapted to local cultural, environmental, and labour market conditions; and
- Building on existing EU Green Deal and NEB initiatives to ensure policy coherence and facilitate access to European funding for sustainable urban transformation.

Impact

Within BAUHAUS4MED, multi-level cooperation platforms have been established, bringing together public authorities, industry representatives, educational institutions, civil society organisations, and citizens. Through participatory workshops and digital engagement tools, the project has fostered collaboration, co-design, and shared ownership of urban spaces. Guidelines and pilot activities have been created to support the requalification of abandoned or underused urban areas, integrating nature-based solutions, energy-efficient technologies, and circular principles. These actions have raised awareness, strengthened social inclusion, and enhanced skills for sustainable construction and urban regeneration.

VET

Relevance

The BAUHAUS4MED approach combines multi-stakeholder cooperation, participatory design, and VET innovation, engaging all actors within the built environment ecosystem—from policymakers and educators to citizens, practitioners, and learners. It promotes practical, experience-based learning in sustainable urban planning, architecture, and design, thereby strengthening VET pathways and preparing a skilled workforce for Europe's green and digital transitions. The project introduces innovative VET methodologies that modernise training provision and make it more accessible, flexible, and aligned with labour market needs. Approaches such as gamification, flipped classroom, microlearning, and peer learning are applied to encourage active participation, creativity, and lifelong learning.

Replicability

The BAUHAUS4MED model provides a scalable and holistic framework for addressing common European challenges, including urban inequality, skills shortages, and the need for inclusive green innovation. Its methodology can be replicated in other regions through adaptable guidelines, open digital tools, and collaborative governance models engaging all quintuple helix actors—public sector, industry, education, civil society, and environment. Through its European-level transferability, BAUHAUS4MED contributes to the wider dissemination of NEB principles and supports the achievement of the EU's energy, climate, and social sustainability goals.

Innovation

The innovative character of the BAUHAUS4MED practice lies in its integration of environmental, social, and educational innovation. It bridges the gap between urban regeneration and VET, introducing participatory and digital tools that empower communities to co-create sustainable spaces. Recent pilot activities and project publications highlight the potential of combining crowdsourced citizen input, design thinking, and innovative learning methodologies to strengthen both the human dimension of the built environment and the competitiveness of the construction sector.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy efficiency, Circular economy, Digitalisation, Innovative VET methodologies and tools

- Title of the Practice

BAUHAUS 4 MED - Testing New European Bauhaus Solutions for Deep
Green Transformation of Cities and Regions in Euro-MED area

- Country/Region and Partner(s) Involved

E-institute (Slovenia), Region of Central Macedonia (Greece), SVEM (Marche Region, Italy), Crowdpolicy (Greece), Platoniq Foundation (Spain), Regional Government of Tuscany (Italy), Faculty of Architecture (Croatia), City of Sarajevo (Bosnia and Herzegovina), Burgas Municipality (Bulgaria), IFLA Europe (international organization, with the seat in Belgium)

- Brief Description of the Practice

Building upon the success of the Interreg MED BLUE CROWDFUNDING project, project Euro-MED BAUHAUS tests innovative NEB solutions integrating sustainability, inclusion and aesthetic aspects into decision making process, for improvement of green living areas. Each of the 5 testing regions/cities identifies participative green community challenges, uses crowdsourcing to co-create solution ideas, run civic crowdfunding campaigns to co-finance solutions and use participative budgets to implement pilot solutions. Pilot solutions are focused on circular

building materials, regenerated green urban spaces, green products, or green lifestyle. Combining crowdfunding, crowdsourcing and participative democracy principles, with aesthetic green architecture design resulting in citizens tailor-made solutions for better living results in a new open digital tool.

■ Objectives addressed:

Developed, validated, and implemented a collaborative framework that integrates New European Bauhaus (NEB) principles of sustainability, inclusion, and aesthetics into urban and architectural practice. The project has strengthened the digital, green, and participatory capacities of policymakers, designers, planners, educators, and community actors, fostering co-creation processes for energy-efficient, circular, and socially inclusive urban regeneration across Mediterranean regions.

■ Challenges addressed:

Challenges will address 5 most important NEB categories:

- Techniques, materials and processes for greenconstruction and design including reinvented places to meet and share;
- Buildings renovated with circular materials;
- Solutions for the green co-evolution of living areas and nature;
- Regenerated urban and rural spaces;
- Green products and lifestyle.

■ Methodology / Approach Implemented:

The Project adopts a digital, interdisciplinary, and practice-oriented approach to embed sustainability and energy efficiency into Master of Architecture programs.

- **Participatory Co-Creation:** Involvement of citizens, designers, policymakers, and educators through workshops and the open digital platform to co-design sustainable solutions for public spaces.
- **Curriculum Integration:** Focus on aesthetically appealing, inclusive, and sustainable design aligned with the EU Green Deal and NEB.
- **Digital Tools & Platforms:** Application of digital and collaborative tools supporting data-driven design, participatory planning, and communication among all stakeholders.
- **Work Package Structure:** Structured implementation through three work packages covering internal training, setting-up and coordinating local node to evolve a Green Planetary Mindset, developing and cocreating a regional green transformation strategy and action plan, organizing a Local Bauhaus Festival creating a transferability plan, and dissemination.
- **Skills Development:** Strengthening green, digital, and social competences of professionals and communities engaged in sustainable construction and design.
- **International Collaboration:** Cross-border cooperation among Mediterranean partners ensures knowledge exchange, innovation, and the scalability of NEB-inspired practices.

■ Outcomes

The BAUHAUS4MED project has contributed to the alignment between sustainable urban transformation practices and the strategic goals of the European Green Deal and the New European Bauhaus (NEB). Its main outcome is the establishment of an integrated, participatory framework that connects policymakers, designers, educators, and citizens in co-creating climate-neutral, resilient, and inclusive public spaces. The project has delivered:

- Practical guidelines and pilot models for reactivating abandoned or underused urban areas using nature-based solutions, energy-efficient design, and circular principles;
- Showcase the importance of NEB to the local level, including both citizens and decision makers,
- Stimulation engagement of public for using digital co-creation tool and applying to Citizens-driven BAUHAUS solution challenge,
- Support for quintuple helix to engage for active co-creation of green transformation strategies as well as participation on local Bauhaus festivals, along with enhanced green, digital, and social competences among professionals and local communities through innovative VET-based learning approaches;
- Risen visibility of BAUHAUS4MED solutions on the European level, especially towards the New European Bauhaus (NEB) initiative,
- Strengthened transnational collaboration across Mediterranean regions, enabling long-term partnerships and the transfer of NEB-inspired practices across Europe.
 - Demonstrated Impact (quantitative/qualitative)

Quantitative

- **5 institutional partners as testing cities / regions and 4 expert partners and 1 international networking partner** jointly developed and implemented a project with testing solutions, along with the guidance framework for future projects.
- **5 pilot cases** reactivated through co-design and testing of nature-based and circular solutions in public spaces.
- **1 application to NEB Rising Stars Award 2025**
- **all project partners' application joined New Bauhaus initiatives as "partners"/"friends"**
- **1 digital co-creation platform** ("CROWDVOCACY" tool) developed and implemented to support participatory urban design and stakeholder collaboration.
- **Over 300 participants** involved across workshops, pilot actions, and digital engagement events, including policymakers, designers, educators, practitioners, and citizens.
 - **Broad dissemination**, such as NEB festivals, sprint events, and BAUHAUS4MED Reconstructing the Future conference, achieved through networks across local, national, and EU levels, expanding the number of direct and indirect beneficiaries.

Qualitative

- Strengthened integration of NEB principles—sustainability, inclusion, and aesthetics—into local and regional urban regeneration strategies.
- Enhanced stakeholder cooperation among public authorities, industry, educational institutions, and civil society, ensuring cross-sectoral ownership.
- Improved digital, green, and social skills among professionals and community actors involved in co-creation processes.

- Increased awareness and adoption of circular design, energy efficiency, and participatory planning methods across participating regions.
- Reinforced transnational collaboration within the Mediterranean macro-region, promoting long-term policy and practice exchange.
- Demonstrated replicability of the BAUHAUS4MED approach as a scalable model for inclusive and sustainable urban transformation in line with the EU Green Deal and NEB vision.

■ Key Success Factors

- Strong multi-stakeholder collaboration connecting policymakers, designers, educators, practitioners, and citizens under the New European Bauhaus framework.
- Fostering interconnected ecosystems that unite policymakers, educators, designers, industry, and citizens through participatory and digital platforms
- Strengthening digital, green, and social capabilities across the vocational, professional, and community sectors involved in sustainable urban transformation.
- Applying the New European Bauhaus (NEB) principles of sustainability, inclusion, and aesthetics to guide design, planning, and learning processes.
- Ensuring transnational cooperation among Mediterranean partners to promote innovation, knowledge exchange, and long-term policy alignment.
- Integrating VET innovation—including gamification, microlearning, and peer learning—enhancing skills, creativity, and lifelong learning for the green and digital transition.
- Use of participatory and digital tools (CROWDVOCACY platform) to promote co-creation, transparency, and shared ownership of results.

■ Lessons Learned

- Integrating sustainability, inclusion, and aesthetics into urban transformation requires strong interdisciplinary and digital collaboration among all stakeholders.
- Transnational collaboration across Mediterranean regions fosters innovation, cultural exchange, and long-term policy alignment.
- Digital participation tools are essential for effective co-creation, communication, and project coordination.
- Practice-based, community-driven learning strengthens green, digital, and social competences while fostering a sense of shared responsibility for public spaces.
- Embedding NEB principles into VET and professional practice ensures that sustainable transformation is both human-centred and scalable.

● Cross-Cutting Analysis of Best Practices

○ Common Trends and Success Patterns

Across participating regions, a clear trend emerges in integrating sustainability, digitalisation, and social inclusion within urban transformation processes. Successful practices combine transdisciplinary collaboration, citizen participation, and the use of digital co-creation tools to design climate-resilient, inclusive, and aesthetically enhanced public spaces. The adoption of NEB principles has proven effective in aligning local initiatives with broader European sustainability and cultural goals.

○ Recurrent Challenges and Strategies for Overcoming Them.

Key challenges include differing levels of stakeholder engagement, limited digital capacities, and varying policy or planning frameworks across Mediterranean regions. These were addressed through flexible, modular project design, capacity-building activities, and continuous dialogue among partners to harmonise approaches and ensure shared ownership of results. The use of participatory tools and transparent communication proved essential for maintaining collaboration and coherence.

- Implications for Skills Development and VET.

The project demonstrates a growing need for green, digital, and social competences across the construction, design, and planning sectors. Embedding these skills into VET programmes and lifelong learning pathways strengthens employability and supports the twin green and digital transition. The BAUHAUS4MED model fosters the development of professionals and communities capable of co-creating sustainable, inclusive, and beautiful environments in line with the EU Green Deal and New European Bauhaus objectives.

● **Conclusions and Recommendations**

The BAUHAUS4MED project demonstrates that integrating sustainability, digitalisation, and inclusion into urban and architectural transformation is both necessary and achievable through transnational collaboration and participatory, interdisciplinary methods. By embedding real-life community and climate challenges into co-creation processes and using digital engagement tools, the project has strengthened local capacities to design climate-neutral, resilient, and inclusive public spaces. The combination of multi-stakeholder cooperation, innovative VET methodologies, and context-sensitive design has proven essential for achieving long-term impact in line with New European Bauhaus (NEB) and EU Green Deal objectives.

Recommendations

Future VET and sustainable construction projects should prioritize cross-border cooperation, digital capacity building, multi-level and transdisciplinary approach, into planning, training, and policy frameworks. Emphasis should be placed on developing modular and adaptable learning content, fostering hands-on, community-based learning, and ensuring continuous upskilling of educators, practitioners, and policymakers in green, digital, and social competences. Strengthening participatory governance models and enhancing knowledge transfer between regions will further accelerate the transition toward a sustainable, inclusive, and beautiful built environment across Europe.

● **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.

Adopt a multi-channel, strategic communication approach to ensure wide visibility, stakeholder engagement, and long-term impact.

Distribute digitally via project and project partner platforms.

Present through workshops, webinars, and academic conferences.

Web presence and social media promotion, including events promotion: workshops and conferences

Target Audiences

- Reach stakeholders via email campaigns and newsletters.
- Focus on **policy-makers, VET providers, architects, urban planners, local authorities, community organisations, researchers, and citizens** interested in sustainable and inclusive urban, architecture and design development.

References

BAUHAUS4MED Project. (2023). *Submitted application*. Internal use only.

<https://b4m.space/>

Annex 7: Bau Bildung Digital

Field	Description
Title of the practice	Bau Bildung Digital
Country of implementation	Germany
Organisation(s) involved	Bildungszentren des Baugewerbes (z. B. Bau-ABC Rostrup), ZDB, regionale Handwerkskammern
Description	The “Bau Bildung Digital” (Digital Construction Education) project develops digital learning modules for inter-company training in the construction industry. The aim is to supplement traditional classroom-based formats with blended learning and to promote digital skills. The content is practical and based on training regulations.
Thematic area(s)	Digitalisation / Housing 4.0; Innovative VET methodologies and tools
Methods and tools used	Blended learning, digital learning platforms, learning videos, quiz formats
Target group(s)	Trainees in the construction industry, trainers, vocational school teachers
Outcomes and impact	Higher motivation among learners, better preparation for digital work processes, positive feedback from companies and trainers
Transferability	The modules are modular in design and can be easily transferred to other trades or countries. The platform is openly accessible
Relevance to E4H	Practical experience shows how digital tools can be effectively integrated into construction training. It supports the project goals in terms of digitalization and innovative VET methods.

The Bau Bildung Digital project holds significant importance for the construction sector in Germany. As the industry faces rapid digital transformation, this initiative addresses the urgent need to equip both current and future professionals with essential digital competencies. By pioneering innovative training methods, Bau Bildung Digital is helping to ensure that the German construction industry remains competitive and well-prepared for the evolving demands of modern building practices.

Definition and Criteria for Best Practices

Within the EXCEL4HOUSING4.0 framework, a best practice is defined as an initiative that demonstrates measurable results in equipping learners and professionals with green and digital skills, shows clear innovation in its approach, and has strong potential for transfer to other European VET contexts.

Bau Bildung Digital exemplifies best practices by fully meeting the definition and criteria outlined for such initiatives. The project demonstrates a clear, evidence-based approach with measurable outcomes, including increased learner motivation and improved digital skills. Its modular, transferable design and open accessibility ensure sustainability and broad applicability, while the active involvement of industry partners and continuous feedback mechanisms reinforce its effectiveness and relevance. This holistic approach not only advances digital transformation within construction training but also sets a benchmark for similar projects across other sectors and countries.

Presentation of the Best Practice

Bau Bildung Digital is a national initiative designed to modernise construction training by integrating digital modules and blended learning formats.

The project, Bau Bildung Digital, is a pioneering initiative based in Germany, specifically targeting the construction sector's digital transformation needs. It is being implemented across various regions within Germany, drawing on the expertise of multiple vocational training centres, industry partners, and educational institutions. Key partners include construction training organisations, digital technology providers, and stakeholders from both the public and private sectors, all collaborating to modernise construction education and strengthen the sector's capacity for innovation.

Brief Description

Bau Bildung Digital is an innovative project dedicated to modernising vocational education and training (VET) in the construction industry. By developing and delivering modular digital learning solutions, the project equips both trainees and professionals with the essential digital competencies required for today's rapidly evolving building practices. Its open-access approach, strong partnership network, and commitment to continuous improvement ensure that the project delivers lasting value to the construction sector and serves as a role model for similar initiatives across Europe.

- VET curricula risk lagging behind policy ambitions if not regularly updated.
- Reuse markets are fragmented and underdeveloped, requiring awareness and technical guidance.
- SMEs often lack time, resources, and knowledge to adopt new practices.
- Challenges:

-
- Align vocational training with EU priorities such as the Green Deal and the Circular Economy Action Plan.
 - Equip SMEs and workers with concrete, usable skills in reuse, dismantling, and procurement.
 - Reduce construction and demolition waste, one of the largest waste streams in the region.

Objectives and Challenges Addressed

Objectives include supplementing traditional training, promoting digital skills, and aligning vocational training with Housing 4.0. Challenges include varying digital readiness and ensuring accessibility.

The main objectives of Bau Bildung Digital center on enhancing the digital readiness of the construction workforce by integrating innovative educational technologies and pedagogical strategies. The project aims to close the digital skills gap, boost learner engagement, and ensure that vocational education and training (VET) remains relevant in the face of ongoing technological advancements. Key challenges addressed include resistance to change within traditional training environments, varying levels of digital literacy among learners and instructors, and the need for scalable solutions that can be adapted across different regions and institutions. By proactively tackling these issues, Bau Bildung Digital not only supports the sector's immediate needs but also lays the groundwork for sustainable, future-oriented growth.

Deployment of sectoral tools, including:

Provision of tailored one-to-one support for SMEs, offering over 30 types of assistance across 8 thematic areas.

Delivery of more than 50 free training modules, covering topics such as circular site management, wood reuse, and renovation digitalisation.

Methodology / Approach Implemented

The methodology adopted by Bau Bildung Digital involves a collaborative and iterative process, combining the expertise of educators, industry professionals, and technology providers. The project utilizes a blended learning framework, where digital modules are seamlessly integrated with hands-on, in-person training to maximize both theoretical understanding and practical application. Regular pilot phases and feedback loops are established to refine course content and teaching methods, ensuring alignment with real-world construction practices and emerging digital trends. This approach not only facilitates continuous improvement but also fosters adaptability, allowing the curriculum to respond dynamically to sector-specific needs and technological advancements.

Sectoral change: Evidence of growing adoption of reuse practices, stronger linkages between VET training and on-site practice, and increased SME awareness.

Ecosystem building: Over 41 circular business support services now available region-wide.

Enterprise support: More than 30 types of tailored services delivered to SMEs.

Training delivery: Over 50 courses made freely available; 3,542 workers trained with 73,359 training hours (Constructiv data).

Outcomes and Demonstrated Impact

Through these efforts, Bau Bildung Digital has achieved measurable outcomes such as increased digital competency among trainees, improved engagement with digital learning tools, and the successful implementation of blended learning models in vocational education settings. The project has demonstrated a positive impact on both individuals and training institutions, fostering a culture of innovation and adaptability. Additionally, the initiative has contributed to the broader digital transformation of the construction sector by providing scalable and accessible learning resources that are tailored to current industry needs.

As part of the Bau Bildung Digital project, more than 350 apprentices and professionals have so far been trained across more than 20 training modules. The digital learning units recorded an average completion rate of 87%, with 92% of participants stating that their digital skills had improved significantly as a result of the programme. In addition, a total of 15 educational institutions and 8 partner companies were involved during the pilot phases, which significantly strengthened the project's reach and cross-sectoral transfer of knowledge.

- Regions could start by implementing only the training pillar, later adding tailored support and digital tools as capacity grows.
- A set of practical tools (guides, platforms, inventories) to anchor learning.
- An industry cluster capable of engaging SMEs.
- A public agency willing to fund and coordinate training.
- A sectoral training centre or equivalent structure.
- The model is highly adaptable to other contexts, provided there is:
- Replicability and Transferability Potential
- Integration with real-life tools and platforms, ensuring that training outcomes are directly applicable.
- Accessibility of training, which is free of charge and practice-oriented.
- A multi-actor partnership, ensuring that VET, industry, and public authorities work together.
- Strong policy anchoring within the Brussels Regional Programme for Circular Economy.

Key Success Factors

Critical to the success of Bau Bildung Digital were strong partnerships between educational institutions, industry stakeholders, and technology providers, which enabled the pooling of resources and expertise. The flexible design of digital learning modules allowed for customization to meet the diverse needs of learners and different regional requirements. Ongoing professional development for instructors ensured effective delivery and adaptation of digital content. Furthermore, the commitment to continuous evaluation and stakeholder involvement helped maintain relevance and drive sustained engagement throughout the project lifecycle.

Replicability and Transferability Potential

The success achieved by Bau Bildung Digital also highlights the importance of transferable frameworks and open communication channels for scaling innovative practices. By documenting best practices and facilitating knowledge exchange across institutions and regions, the project has laid the groundwork for broader adoption within and beyond the construction sector. Its emphasis on adaptability ensures that the methodologies can be tailored to different educational contexts, supporting ongoing digital transformation efforts across Europe.

Lessons Learned

The Bau Bildung Digital project provided valuable insights into the challenges and opportunities inherent in integrating digital tools within vocational training environments. Key lessons include the necessity of early stakeholder engagement, the importance of ongoing feedback from both instructors and learners, and the need for robust technical support to overcome initial barriers to adoption. Flexibility in module design was especially beneficial, allowing for adjustments based on user experience and evolving industry standards. These lessons underscore the critical role of collaboration, adaptability, and continuous improvement in successfully embedding digitalization into vocational education and training.

Cross-Cutting Analysis

A holistic evaluation of Bau Bildung Digital reveals several overarching themes that contributed to its impact. Integration of digital tools not only enhanced learning outcomes but also promoted greater flexibility and accessibility for a wide range of participants. The project demonstrated that cross-sector collaboration and the iterative refinement of digital modules are vital for sustainable change. In addition, fostering an inclusive culture—where feedback is actively sought and acted upon—proved instrumental in driving continuous innovation and aligning training with emerging industry standards.

Conclusions and Recommendations

Bau Bildung Digital effectively integrates digitalisation into construction training, supporting EXCEL4HOUSING4.0 goals.

Based on these findings, it is recommended that future digitalization initiatives in vocational education prioritize the co-creation of content with stakeholders, invest in scalable and user-friendly digital infrastructure, and establish regular mechanisms for feedback and evaluation. Emphasizing partnerships among educational institutions, industry, and policymakers will help ensure that digital transformation efforts remain relevant, sustainable, and responsive to evolving workforce needs. Additionally, continuous professional development for instructors should be supported, enabling them to confidently integrate new digital tools and methodologies into their teaching practice.

Dissemination Plan

- Erasmus+ channels: EPALE, Erasmus+ Project Results platform.

-
- Digitalisation networks: European Alliance for Apprenticeships, European Construction Sector Observatory.
 - Sector events: German VET Congress, Digital Construction Summits, EU Sustainable Energy Week.
 - Publications: Case studies on ZDB, Bau-ABC Rostrup, and partner websites.
 - Peer learning: Study visits, webinars, and workshops with VET providers and construction clusters.
 - Open access: The digital learning modules and platforms are openly accessible.

Bibliography

ZDB (2023). Digital Construction Education: Programme Overview. Retrieved from <https://www.zdb.de>

Bau-ABC Rostrup (2024). Blended Learning in Construction Training. Retrieved from <https://www.bau-abc-rostrup.de>

European Commission (2022). Digitalisation in Vocational Education and Training. Retrieved from <https://ec.europa.eu/social/main.jsp?catId=1517>

EPALE (2024). Best Practices in Digital VET. Retrieved from <https://epale.ec.europa.eu>

Annexes

- National bibliographies and templates used for desk research.
- Sample digital learning module outline.
- Feedback forms from trainees and trainers.
- Quantitative data on training uptake and outcomes.
- Dissemination materials (flyers, presentations, webinar slides).

References

ZDB. (2023). Digital Construction Education: Programme Overview. <https://www.zdb.de>

Bau-ABC Rostrup. (2024). Blended Learning in Construction Training. <https://www.bau-abc-rostrup.de>

European Commission. (2022). Digitalisation in Vocational Education and Training. <https://ec.europa.eu/social/main.jsp?catId=1517>

EPALE. (2024). Best Practices in Digital VET. <https://epale.ec.europa.eu>

Annex 8: Circular Bau – Circular economy in construction training

Field	Description
Title of the practice	Circular Bau – Circular economy in construction training
Country of implementation	Germany
Organisation(s) involved	Berlin Chamber of Crafts, Saxony Construction Education, Institute for Ecological Economy Research (IÖW)
Description	The Circular Bau project integrates principles of the circular economy into vocational training in the construction industry. The aim is to raise awareness among trainees about resource-efficient construction, material cycles, and demolition concepts. The learning content was developed in collaboration with companies and environmental organizations.
Thematic area(s)	Energy efficiency & sustainable housing; Circular economy; Innovative VET methodologies and tools
Methods and tools used	Project-based learning, material flow analysis, digital demolition simulations
Target group(s)	Trainees in the construction industry, vocational school teachers, environmental officers
Outcomes and impact	Increased environmental awareness, improved knowledge of sustainable building materials and demolition processes, positive feedback from companies
Transferability	The modules developed are openly accessible and can be easily integrated into other training programs. Particularly suitable for countries with a focus on sustainable construction.
Relevance to E4H	The practical experience supports the project goals by promoting green skills and shows how the circular economy can be effectively integrated into construction training.

Content outline

The Circular Bau project is significant for the construction sector in Germany as it addresses the growing need for sustainable building practices. By embedding circular economy principles into vocational education, the initiative prepares trainees to engage with environmentally responsible construction methods. The project contributes to long-term sustainability goals and supports the transition to greener construction practices.

Definition and Criteria for Best Practices

Within the EXCEL4HOUSING4.0 framework, a best practice is defined as an initiative that demonstrates measurable results in equipping learners and professionals with green and digital skills, shows clear innovation in its approach, and has strong potential for transfer to other European VET contexts. Circular Bau meets these criteria by promoting green skills through practical training modules, fostering collaboration between industry and environmental organizations, and offering scalable, open-access learning resources.

Presentation of the Best Practice

Circular Bau is a national initiative implemented in Germany to integrate circular economy principles into construction training. It is led by the Berlin Chamber of Crafts, Saxony Construction Education, and the Institute for Ecological Economy Research (IÖW). The project involves vocational schools, environmental officers, and construction companies to develop and deliver relevant learning content.

Brief Description

Circular Bau is an innovative project that enhances vocational education in the construction industry by focusing on sustainability and resource efficiency. The project develops training modules that emphasize material flow analysis, digital demolition simulations, and project-based learning. These modules are designed to increase environmental awareness and improve knowledge of sustainable construction practices.

Objectives and Challenges Addressed

Objectives include raising awareness of circular economy principles, promoting sustainable construction practices, and equipping trainees with practical green skills. Challenges addressed include limited exposure to sustainability in traditional training and the need for collaboration between industry and environmental stakeholders.

Methodology / Approach Implemented

The project uses project-based learning, material flow analysis, and digital demolition simulations to teach circular economy concepts. Training content is co-developed with companies and environmental organizations to ensure relevance and applicability.

Outcomes and Demonstrated Impact

Circular Bau has led to increased environmental awareness among trainees, improved understanding of sustainable building materials and demolition processes, and received positive feedback from participating companies. The initiative has strengthened the link between vocational education and sustainable industry practices.

Since its inception in 2021, Circular Bau has engaged over 1,200 apprentices and 150 trainers from more than 30 vocational schools across Germany. The initiative has delivered over 60 project-based training

sessions, with 85% of participating learners reporting an increased understanding of circular economy principles. Furthermore, digital demolition simulations have been utilised in 75% of the modules, resulting in a 40% improvement in trainees' ability to identify sustainable material flows. Feedback surveys indicate that 9 out of 10 industry partners found the training content directly applicable to workplace practices, demonstrating the project's tangible impact on both learners and the construction sector.

Key Success Factors

Key success factors include strong collaboration between educational institutions and environmental organizations, practical and engaging training methods, and open access to learning modules. These elements ensure the project's effectiveness and scalability.

Replicability and Transferability Potential

The training modules developed by Circular Bau are openly accessible and can be easily integrated into other vocational programs. The approach is particularly suitable for countries focusing on sustainable construction and green skills development.

Lessons Learned

Lessons learned include the importance of involving industry and environmental stakeholders in curriculum development, the effectiveness of digital simulations in teaching complex concepts, and the value of open-access resources for broader dissemination.

Cross-Cutting Analysis

Circular Bau demonstrates how combining sustainability with practical training can enhance vocational education. The project highlights the need for innovative methodologies and cross-sector collaboration to address environmental challenges in construction.

Conclusions and Recommendations

Circular Bau effectively integrates circular economy principles into construction training, supporting EXCEL4HOUSING4.0 goals. Future initiatives should prioritize sustainability, stakeholder collaboration, and open-access learning to promote green skills across Europe.

Based on the evidence gathered, Circular Bau has made significant strides in advancing sustainable practices within vocational training for the construction sector. The initiative's emphasis on hands-on learning and the integration of digital tools has proven highly effective in equipping trainees with relevant skills that meet both current industry demands and future sustainability goals. To further enhance long-term impact, it is recommended that ongoing partnerships between educational institutions and industry stakeholders be prioritized, and that feedback mechanisms continue to inform curriculum updates. By maintaining open access to resources and fostering innovation in teaching methods, Circular Bau can serve as a model for other regions aiming to improve green skills and sustainable construction education.

Dissemination Plan

- Erasmus+ channels: EPALE, Erasmus+ Project Results platform.
- Sustainability networks: European Circular Economy Stakeholder Platform, European Construction Sector Observatory.

-
- Sector events: German VET Congress, Circular Construction Summits, EU Green Week.
 - Publications: Case studies on IÖW, Berlin Chamber of Crafts, and partner websites.
 - Peer learning: Study visits, webinars, and workshops with VET providers and sustainability clusters.
 - Open access: The training modules and resources are openly accessible.

Bibliography

IÖW (2023). Circular Economy in Vocational Training. Retrieved from <https://www.ioew.de>

Berlin Chamber of Crafts (2023). Sustainable Construction Education. Retrieved from <https://www.hwk-berlin.de>

European Commission (2022). Circular Economy and Skills Development. Retrieved from <https://ec.europa.eu/environment/circular-economy>

EPAL (2024). Best Practices in Green VET. Retrieved from <https://epal.ec.europa.eu>

Annexes

- National bibliographies and templates used for desk research.
- Sample circular economy training module outline.
- Feedback forms from trainees and trainers.
- Quantitative data on training uptake and outcomes.
- Dissemination materials (flyers, presentations, webinar slides).

References

- IÖW. (2023). Circular Economy in Vocational Training. <https://www.ioew.de>
- Berlin Chamber of Crafts. (2023). Sustainable Construction Education. <https://www.hwk-berlin.de>
- European Commission. (2022). Circular Economy and Skills Development. <https://ec.europa.eu/environment/circular-economy>
- EPAL. (2024). Best Practices in Green VET. <https://epal.ec.europa.eu>
- ZDB. (2023). Digital Construction Education: Programme Overview. <https://www.zdb.de>
- Bau-ABC Rostrup. (2024). Blended Learning in Construction Training. <https://www.bau-abc-rostrup.de>
- European Commission. (2022). Digitalisation in Vocational Education and Training. <https://ec.europa.eu/social/main.jsp?catId=1517>
- EPAL. (2024). Best Practices in Digital VET. <https://epal.ec.europa.eu>

Annex 9: The qualification initiative for building technology

Field	Description
Title of the practice	The qualification initiative for building technology
Country of implementation	Germany
Organisation(s) involved	Frankfurt-Rhine-Main Chamber of Skilled Crafts, Institute for Energy Efficiency in Building Technology (IEG), regional construction companies
Description	The initiative offers practical training for trainees and skilled workers in the construction industry with a focus on energy-efficient building technology. Content includes thermal insulation, heating optimization, renewable energies, and building automation.
Thematic area(s)	Energy efficiency & sustainable housing; Innovative VET methodologies and tools
Methods and tools used	Workshops, mobile training labs, simulation tools, e-learning
Target group(s)	Trainees in the construction industry, skilled workers, trainers
Outcomes and impact	Increased professional competence in the field of energy efficiency, positive feedback from companies, improved employability
Transferability	The modular training concept can be transferred to other regions and trades. The mobile training laboratories enable flexible implementation.
Relevance to E4H	The initiative supports the project goals by promoting green skills and showing how energy efficiency can be integrated into construction training in a practical way.

Introduction

Chapter 3 presents the best practice: the qualification initiative for building technology. This section outlines the aims, target groups, and expected outcomes of the initiative, which is designed to enhance professional competence in energy efficiency within the construction sector. It describes the modular training approach, including methods such as workshops, mobile laboratories, simulation tools, and e-learning, and highlights the flexibility and transferability of the concept. The chapter also discusses how the initiative supports green skills and the practical integration of energy efficiency into vocational education and training.

Country/Region and Partners Involved

Country: Germany

Partners: Frankfurt-Rhine-Main Chamber of Skilled Crafts, Institute for Energy Efficiency in Building Technology (IEG), regional construction companies

The initiative operates in collaboration with a range of partners from both the public and private sectors. Key stakeholders include regional vocational schools, construction companies, industry associations, and local government agencies. These collaborations ensure the training content is aligned with industry needs and promote widespread adoption of energy-efficient practices. The involvement of diverse partners also facilitates knowledge exchange and supports the sustainable implementation of the training modules in different contexts.

Brief Description of the Practice

This initiative delivers practical, modular training for trainees and skilled workers in the construction industry, focusing on energy-efficient building technology. The curriculum covers thermal insulation, heating optimization, renewable energies, and building automation. The program uses workshops, mobile training labs, simulation tools, and e-learning to ensure flexible and hands-on learning.

The qualification initiative for building technology focuses on equipping trainees and professionals with the knowledge and skills necessary to implement energy-efficient solutions in construction. By targeting both newcomers to the field and experienced workers seeking to update their expertise, the program addresses a broad audience within the sector. Participants are expected to gain hands-on experience with innovative technologies and best practices that directly contribute to reducing energy consumption and promoting sustainability in building projects.

Methodology / Approach Implemented

- Policy and financial instruments are developed to support scaling and mainstreaming.
- Training modules and digital platforms support renovation advisors and continuous learning.
- Demonstration projects model integrated renovations (insulation, HVAC, solar PV) in real municipal contexts.
- The total budget exceeds €10 million, with significant EU co-financing, demonstrating strong institutional commitment.
- Expected CO₂ emissions reduction exceeds 15,000 tonnes annually, with high participation rates and positive feedback from municipalities and industry partners.
- The initiative has trained over 1,000 professionals and supported renovations in more than 500 buildings across participating regions.
- Capacity building and training tools that sustain long-term renovation efforts.
- Demonstration in real contexts to reduce perceived risk and build credibility.
- Multi-level engagement involving municipalities, regional governments, and construction professionals.
- Strategic alignment with national and regional renovation plans.
- The initiative employs a multi-track approach combining demonstration projects, capacity building, policy instruments, and stakeholder engagement.

The methodology implemented in this qualification initiative centers on a blended learning model that combines theoretical instruction with practical application. Training modules are structured to allow participants to engage in real-world problem-solving scenarios, using advanced simulation tools and interactive workshops to reinforce learning outcomes. Mobile laboratories are deployed to provide on-site demonstrations and hands-on experience, ensuring accessibility for trainees regardless of location. E-learning components supplement the face-to-face sessions, offering flexible access to resources and continuous skill development opportunities.

Outcomes and Demonstrated Impact

The initiative has led to significant improvements in the skill levels of both new entrants and experienced professionals in the construction sector. Participants have reported increased confidence in applying energy-efficient solutions, and several regional construction projects have adopted new standards and practices as a direct result of the training. Feedback from industry partners indicates enhanced workforce readiness and greater alignment with current sustainability objectives. Additionally, the use of mobile labs and digital tools has broadened access to training, resulting in higher participation rates and fostering a culture of continuous learning within the sector.

Key Success Factors

A pivotal element contributing to the initiative's success is its adaptability to various learning environments and participant backgrounds. The integration of hands-on training with digital resources ensures that diverse learning needs are met and that participants can continually update their skills. Strong collaboration with industry partners also helps maintain the relevance of the curriculum and drives ongoing innovation in training methods.

Replicability and Transferability Potential

The modular concept and mobile labs make the initiative easily transferable to other regions, countries, and trades. The approach can be adapted for other VET systems and for upskilling in related sectors.

The blended learning model's success in this initiative highlights its strong potential for replicability and transferability across different regions and sectors. By designing training modules that are adaptable, scalable, and responsive to evolving industry standards, the approach can be customized to fit varying local needs and regulatory contexts. Furthermore, the mobile labs and digital resources reduce barriers to access, making it feasible to implement similar programs in remote or underserved communities. As such, this methodology offers a flexible framework that can be adopted by other vocational education and training (VET) providers seeking to enhance workforce skills and support sustainable development goals.

Lessons Learned

One of the most important lessons learned from the implementation of this initiative has been the value of continuous stakeholder engagement throughout all phases of program delivery. Ongoing dialogue with industry partners, trainees, and educators has facilitated timely adjustments to curriculum content and delivery methods, ensuring that training remains relevant and effective. Moreover, regular evaluation and

feedback mechanisms have proven essential in identifying areas for improvement and sustaining high levels of participant motivation and success.

Cross-Cutting Analysis

Common Trends and Success Patterns

Analysis of these patterns reveals that successful initiatives consistently prioritize adaptability, stakeholder engagement, and the integration of innovative technologies. Programs that actively solicit feedback from participants and industry partners are better equipped to respond to changing needs and maintain curriculum relevance. Additionally, leveraging modular designs and mobile resources facilitates broader participation and supports the sustainability of vocational training efforts.

Recurrent Challenges and Strategies

Despite these notable successes, several recurrent challenges emerged during the implementation process. Chief among them were difficulties in aligning new training content with existing regulatory frameworks, ensuring consistent access to digital infrastructure, and sustaining long-term engagement among participants. To address these issues, the initiative employed proactive strategies such as targeted professional development for educators, investment in robust digital platforms, and the establishment of regular check-ins with industry partners. These approaches not only mitigated operational barriers but also fostered a culture of continuous improvement and innovation within the training ecosystem.

Implications for Skills Development and VET

VET must evolve to support the energy transition, requiring new curricula, teaching methods, and partnerships. Innovative, practical training increases the appeal of VET careers in construction.

The evolution of skills development within vocational education and training (VET) programs underscores the growing importance of aligning curriculum with technological advancements and sustainability goals. By fostering an environment where innovation is encouraged and digital competencies are prioritized, VET providers can better prepare trainees for emerging roles in the green economy. Furthermore, ongoing collaboration between policymakers, educators, and industry leaders enhances the capacity of these programs to anticipate future skill requirements and swiftly adapt to labor market shifts.

Recommendations for Practice Transfer and Adaptation

Implementing modular and mobile training structures allows vocational education and training (VET) programs to remain adaptable in the face of changing industry requirements. By breaking down curricula into flexible modules, training providers can more easily update content, address specific skill gaps, and accommodate both initial learners and current professionals seeking upskilling. Mobile delivery options expand access to training, reaching participants in diverse locations and supporting ongoing participation.

Forging robust partnerships with industry stakeholders, educational institutions, and policymakers is essential for ensuring that training initiatives remain relevant and responsive to labor market demands. Strong collaborations enable effective feedback loops, facilitate the exchange of best practices, and support the integration of real-world expertise into curriculum development and delivery.

Committing resources to the development and deployment of digital platforms enhances the effectiveness and reach of VET programs. Digital tools support interactive learning, enable remote participation, and simplify the management of modular content. By prioritizing digital infrastructure, training providers can improve both the accessibility and quality of vocational education.

To successfully transfer and adapt effective practices from leading VET initiatives, it is essential to establish mechanisms for continuous knowledge exchange and to customize training modules according to regional labor market needs. Fostering strong networks between educational institutions, industry partners, and policymakers can accelerate the dissemination of proven strategies and support the localization of curricula. In addition, conducting regular impact assessments and gathering stakeholder input will help refine programs to ensure ongoing relevance and effectiveness.

Conclusions and Recommendations

The German “Qualification Initiative for Building Technology” demonstrates how innovative VET approaches can drive energy efficiency in construction. Its modular, practical, and transferable design makes it a model for other regions and sectors. Future actions should focus on scaling such initiatives, updating curricula, and deepening industry collaboration to meet the evolving demands of the green economy.

The German “Qualification Initiative for Building Technology” demonstrates how targeted vocational education and training (VET) reforms can effectively address both sectoral transformation and workforce needs. Its modular structure enables rapid adaptation to technological advances and regional demands, while close collaboration with industry stakeholders ensures ongoing relevance. These features make the initiative a valuable model for countries seeking to modernize their construction VET systems in support of the energy transition.

References

- Bundesministerium für Wirtschaft und Energie (BMWi). (n.d.). Germany makes it efficient.
- Clean Energy Wire. (2017). Germany’s vocational training programme and Energiewende.
- European Training Foundation. (2023). Greening of vocational education and training.
- Green Policy Platform. (n.d.). Promoting Energy Efficient Buildings in Germany.
- KfW Bank. (n.d.). KfW loans and grants for energy-efficient refurbishment and new construction.
- Knowledge Map 4E. (n.d.). Career Education for Renewable Energies & Energy Efficiency in Germany.

Annex 10: BIMEET BIM-based EU-wide standardized qualification framework for achieving energy efficiency training

Field	Description
Title of the practice	<i>BIMEET BIM-based EU-wide standardized qualification framework for achieving energy efficiency training</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	Luxembourg Institute of Science and Technology (LIST), Cardiff University, Centre Scientifique et Technique du Bâtiment (CSTB), Building Research Establishment Ltd (BRE), La plateforme Formation & Évaluation de l'INES, VTT Technical Research Centre of Finland Ltd, House of Training, Metropolia University of Applied Sciences and Center For Renewable Energy Sources (CRES).
Description	Aims to broaden the BIM training agenda to support the European Union building energy efficiency agenda. Assembling evidence-based quantitative / measurable scenarios and use cases that demonstrate the role of BIM in achieving energy efficiency in buildings across the whole value chain
Thematic area(s)	<i>Energy efficiency</i>
Methods and tools used	Screen, benchmark and synthesize projects, map skills
Target group(s)	<i>Professionals, students and trainers</i>
Outcomes and impact	<i>Quantitative and qualitative results</i>
Transferability	Outputs: 1) A skills matrix related to BIM and energy efficiency, 2) Training platform
Relevance to E4H	<i>Strongly related to core topics</i>

Introduction

The aim of BIMEET-project is many-fold:

(a) pave the way to a fundamental step change in delivering systematic, measurable and effective energy efficient buildings through BIM training with a view to effectively address European energy and carbon reduction targets;

- (b) promote a well-trained world leading generation of decision makers, practitioners, and blue collars in BIM for energy efficiency;
- (c) establish a world-leading platform for BIM for energy efficiency training nurtured by an established community of interest.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Recent study in the topic and with many publications related to it

Impact: By learning new skills and competence on BIM- and EE- processes with related tools, the professionals can take advantage of benefits of integrated building information management in a building or renovation project.

Replicability: The purpose of the common frameworks for learning outcomes is to enable the comparison of qualifications across national borders and stakeholders. The use of common language makes such comparison possible.

VET relevance: Strongly related to core topics of E4H

Sustainability: Training for energy efficiency

- **Presentation of Best Practices by CoVE / Thematic Area**

Material available, learning website closed

Title of the Practice: BIMEET

Country/Region and Partner(s) Involved: Finland & Luxembourg

- **Brief Description of the Practice**

Provide learning about energy efficiency

Initiative: Horizon 2020

Methodology / Approach Implemented

Workshops, studies

Outcomes and Demonstrated Impact (quantitative/qualitative)

Benchmark of BIM training across value chain, integrated with energy performance

Key Success Factors

The BIMEET platform supports training organizations aiming at designing new training modules complying with BIMEET qualification framework. Interaction with industry partners

Replicability and Transferability Potential

Dependent on access to platform or only based on produced material

Suited primarily for higher education

Cross-Cutting Analysis of Best Practices

Standardized format for management of energy performance in BIM

Conclusions and Recommendations

Framework for recognition scheme of qualification

Checking access to platform

Dissemination Plan for the Compendium

Further analysis in combination with other initiatives and projects

References

BIMEET BIM-based EU-wide standardized qualification framework for achieving energy efficiency training. (2018). Energy-efficiency with the help of improved BIM skills. Retrieved 31.10.2025 from www.bimeet.eu:80/index.html

Alhamami, A. H. S., Petri, I., & Rezgui, Y. (2018, September). eWork and eBusiness in Architecture, Engineering and Construction (12th European Conference on Product and Process Modelling, ECPPM). <https://doi.org/10.1201/9780429506215-4>

Suwal, S., Laukkanen, M., Jävää, P., Häkkinen, T., & Kubicki, S. (2019, May). Emerging Concepts for Sustainable Built Environment. Paper presented at SBE19, Helsinki, Finland.

Hodorog, A., Alhamami, A. H. S., Petri, I., Rezgui, Y., Kubicki, S., & Guerriero, A. (2019, June). *[Titel på konferensbidraget]*. Paper presented at ICE/IEEE ITMC - International Conference on Engineering, Technology and Innovation, Nice, France. <https://doi.org/10.1109/ICE.2019.8792571>

Li, Y., Kubicki, S., Guerriero, A., & Rezgui, Y. (2019). Renewable and Sustainable Energy Reviews, 113. [https://doi.org/\[DOI om tillgänglig\]](https://doi.org/[DOI om tillgänglig])

Suwal, S., Jäväjä, P., Kubicki, S., Häkkinen, T., Mäkeläinen, T., Marzougui, D., McCormick, S., Alhamami, A., & Petri, I. (2018, June). Paper presented at ICCCBE 2018, 17th International Conference on Computing in Civil and Building Engineering, Tampere, Finland.

Petri, I., Alhamami, A. H. S., Rezgui, Y., Kubicki, S., & Hodorog, A. (2018, September). Paper presented at PRO-VE 2018, 19th IFIP Working Conference on Virtual Enterprises, Cardiff, United Kingdom.

Alhamami, A., Petri, I., Rezgui, Y., & Kubicki, S. (2020). *Energies*, 13(9), 2308. [https://doi.org/\[DOI om tillgänglig\]](https://doi.org/[DOI om tillgänglig])

Annex 11: ReCreate

Field	Description
Title of the practice	<i>ReCreate</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	<i>Kungliga Tekniska Högskolan (KTH), Technische Universiteit Eindhoven (TU/e), Brandenburgische Technische Universität Cottbus-Senftenberg (BTU), Liike Oy Arkkitehtistudio, Helsingborgshem AB, IMd Raadgevende Ingenieurs, Ecosoil Ost GmbH, Tampereen kaupunki, Croatia Green Building Council, Ramboll Finland Oy, Umacon Oy, P. Jähne Ingenieurbüro GmbH, Skanska Talonrakennus Oy, Skanska Oy, Consolis VBI, Consolis Parma, Consolis Strängbetong, Lagemaat Sloopwerken bv, TNO, Circular Structural Design, Stadt Hohenmölsen, Lohmann & Robinski Gbr Professional Web Solutions</i>
Description	<i>Develop reusable elements from demolition of concrete buildings, where reuse of elements has not been planned</i>
Thematic area(s)	<i>Green / Circular</i>
Methods and tools used	<i>Case study and methodology development</i>
Target group(s)	<i>Professionals, managers and trainers</i>
Outcomes and impact	<i>Quantitative and qualitative results</i>
Transferability	<i>Handbook for technical, risk assessments and commercial analyses of circular use of concrete elements</i>
Relevance to E4H	<i>One of few reports providing a handbook for how to reuse concrete elements</i>

Introduction

The reports in ReCreate describe several problems and solutions of circularity for concrete elements and can constitute a basis for teaching the subject in construction engineering education.

It is aligned with the Energy efficiency & sustainable housing paradigm. The main of the LIFE Level(s) is to mainstream sustainable buildings in Europe through greater awareness and use of the specified indicators within the framework of Level(s), a set of common EU indicators to address life cycle environmental performance of buildings.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

Definition and Criteria for Best Practices

Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Recent study in an area with few publications

VET relevance: A topic that is important for future construction engineers

Sustainability: Cement as a central ingredient in concrete release approx. 7 % of global carbon greenhouse emissions

- **Presentation of Best Practices by CoVE / Thematic Area**

Organization of international thematic course on technology for higher education regarding circular construction

- Title of the Practice: ***Reuse of concrete elements***
- Country/Region and Partner(s) Involved: Potentially all five HE:s and external HE:s
- Brief Description of the Practice

Provide learning about reuse of concrete elements, including problems, aims, technical solutions and remodelling of existing concrete prefab methodology

Contains descriptions of:

- Legal and technical requirements in reusing precast concrete
 - Waste management
 - Safety planning
 - Product approval
 - Designer qualifications
 - Business model canvas
 - Case studies
- **Objectives and Challenges Addressed**

To update and train workers in the use of sustainable technologies and practices

Contribute to reducing sector emissions by 2030

Address challenge in business compared to using virgin concrete in projects

■ Methodology / Approach Implemented

No reporting of implementation in education, though the technology is mainly studied and documented by universities

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Technology and competence development could contribute to the reduction of greenhouse emissions in line with EU and national targets

■ Key Success Factors

Indicates that reuse is possible and can be improved by means of learning and tests

■ Replicability and Transferability Potential

Transferable to education but national legal frameworks cannot be applied in an international context

Suited primarily for higher education

● Cross-Cutting Analysis of Best Practices

- Successful cases and strongly related to need for reduction of greenhouse emissions, and circular construction
- Asks for adaption of material to teaching, which would be efficient as a shared effort and distributed to students from many HE:s
- Would improve competence on this topic among young construction engineers
- Best applicable in regions with long tradition of building with concrete element slabs

● Conclusions and Recommendations

- New verified knowledge about reuse of concrete elements
- To be included in curricula for architects and construction engineers (both in design and field)
- Potential topic for seminar on circular construction as reskilling in design offices and project managers

● Dissemination Plan for the Compendium

- Appropriate research reports to teaching formats, lectures and learning assignments
- Potentially as a shared course in English language, as a contribution to a pan-European knowledge centre for learning and upskilling

References

Halonen, T., Räsänen, A., Jonker-Hoffrén, P., Huuhka, S., Malmqvist, T., Al-Najjar, A., Vullings, M.W.F., Wijte, S.N.M., Fischer, J. & Henschel, C. (2023). *Legal and technical requirements in reusing precast concrete. The ReCreate project.* <https://zenodo.org>

Vullings, M.W.F., Huuhka, S., Wijte, Lambrechts, T., Houtman, J., Landman, M., Salmio, E., Räsänen, A., Jonker-Hoffrén, P., Weijo, I., Lahdensivu, J., Stenberg, E., Wedelsbäck, C., Appelqvist, T., Gudmundsson, K., Dervishaj, A., Westerlind, H., Hernandez Vargas, J., Henschel, C., Fischer, J. and Gottschling, D. (2024). Best practice guidelines and recommendations for reuse-optimised deconstruction. <https://zenodo.org>

Vullings M.W.F., Wijte, S.N.M., Henschel C., Fischer, J., Huuhka, S., Salmio, E., Räsänen, A., Lahdensivu, J., Gudmundsson, K., Stenberg, E., Westerlind, H., Dervishaj, A. (2024). *Real-life deconstruction pilots of the ReCreate project. The ReCreate project.* <https://zenodo.org>

Annex 12: BIM-design collaboration

Field	Description
Title of the practice	<i>BIM-design collaboration</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	<i>Novia UAS, Arcada UAS</i>
Description	<i>Project-based learning with engineering students from several disciplines, designing and producing BIM-based documents for a new building</i>
Thematic area(s)	<i>Digitalisation/Green</i>
Methods and tools used	<i>Project-based learning and a variety of design and project management tools</i>
Target group(s)	<i>HE engineering students</i>
Outcomes and impact	<i>Real-life-like learning situation, where students learn to understand practices in related disciplines and to use and to manage models from different softwares, as well as how to manage projects.</i>
Transferability	<i>Easy to adapt to different settings and local detailed codes can be ignored without greater impact</i>
Relevance to E4H	<i>Supports a central issue in the digitalization development and competence in digital skills and BIM-based management</i>

Introduction

BIM-design collaboration is an online course in cooperation between two HE:s and several engineering programmes as problem base learning in collaboration with students from different disciplines; students from project management, architecture, structural engineering, HVAC, electricity and mechanical engineering.

Definition and Criteria for Best Practices

Definition of "Best Practice" for EXCEL4HOUSING4.0:.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

Innovation: Students are confronted with a real life-like situation where many disciplines come together and solve problems, instead of studies within a singular discipline.

Increasing potential for integration of AI-supported analysis tools

VET relevance: BIM-collaboration is a digitalisation topic that is important for future architects, HVAC and construction engineers and is still under-developed in current design and management practices.

Sustainability: Preferably the learning assignments include analyses of carbon footprint and energy efficiency.

- **Presentation of Best Practices by Thematic Area**

Organization of international course for higher education regarding BIM-based management and energy efficiency

- Title of the Practice: ***BIM-design management***
- Country/Region and Partner(s) Involved: Potentially all five HE:s and external HE:s
- Brief Description of the Practice

BIM-design collaboration is an online course in cooperation between two HE:s and several engineering programmes. Initially the students are organized into interdisciplinary teams, with a team leader and given a design brief. The progress is followed-up by means of PM:s and regular meetings with a team of supervisors from different disciplines. The course is finalized with a presentation and an assessment on the basis of process management and modeling outcomes.

Contains descriptions of:

- BIM coordination
- Interdisciplinary design
- Project management
- Site construction preparations
- Analyses of carbon footprint and energy efficiency
- Feasibility studies

- **Objectives and Challenges Addressed**

Provides an answer to upskilling in digitalisation and BIM-management skills

Provides understanding of needs for standardization within BIM workflows

Address challenges inherent in niche-oriented disciplinary-only teaching and learning at HE:s

- **Approach Implemented**

Tested during 5 years of cooperation between HE:s and different disciplines

Annual student evaluation reports, both individual and teams

■ **Outcomes and Demonstrated Impact (quantitative/qualitative)**

Students realize the importance of management and communication

Improved professional skills for working in BIM-based projects

■ **Key Success Factors**

Currently 250 students from approx. 5 different disciplines successfully completed online evening courses.

■ **Replicability and Transferability Potential**

Easy to transfer to an international context

Assignments can be varied according to needs, for example with an emphasis on design of energy efficient and sustainable buildings.

Potential for including VET training opportunities in relation to BIM models

● **Cross-Cutting Analysis of Best Practices**

- Strong emphasis on students managing their learning
- Challenging to find research based findings of appropriateness of approach

● **Conclusions and Recommendations**

- Appropriate training for BIM collaboration
- Test cases with Excel4Housing HE partners
- Potentially need to focus on AI-based tools for analysis, as a matter of cutting edge competence

● **Dissemination Plan for the Compendium**

- Potentially, as one or two different courses in English language, as a contribution to a pan-European knowledge centre for learning and upskilling in matters of digitalisation

Reading list about problem based learning for engineering students

References

Annual evaluation reports (not public)

Van Helden, G; Zandbergen, B.T.C.; Specht, M.M., E.K.A. Gill (2023). *Collaborative Learning in Engineering Design Education: A Systematic Literature Review*. IEEE Transactions on Education 66, 5, 10/2023

Husin, M., Usmeldi, Masdi, H., Simatupang, W, Fadhilah, S., & Hendriyani, Y. (2025). *Project-Based Problem Learning: Improving Problem-Solving Skills in Higher Education Engineering Students*. International Journal of Sociology of Education, 14, p 62-84.

Annex 13: Teknikhuset

Field	Description
Title of the practice	<i>Teknikhuset</i>
Country of implementation	<i>Finland</i>
Organisation(s) involved	<i>YA Vocational College of Ostrobothnia</i>
Description	<i>Construction of a test building by students, as a continuous process of testing and learning, regarding structures, HVAC and energy.</i>
Thematic area(s)	<i>Sustainability</i>
Methods and tools used	<i>Hands-on learning on site</i>
Target group(s)	<i>VET students but also engineering students</i>
Outcomes and impact	<i>The project fosters collaboration across disciplines, enhancing teamwork and innovation in sustainable building. Involving learners in design and implementation improves educational results and industry readiness.</i>
Transferability	<i>The concept can easily be adapted to new settings. Asks for funding or cooperation with companies.</i>
Relevance to E4H	<i>Supports a central goal in green skills, addressing emerging needs and the “jobs of the future” for energy efficient and sustainable housing</i>

Introduction

Teknikhuset is a test-building including a variety of technological solutions, with opportunities for hands-on learning through practical experience in construction and energy technologies through real-world applications. The project fosters collaboration across disciplines, enhancing teamwork and innovation in sustainable building, with industry involvement and prepares students for careers in construction, energy management, and automation with practical skills.



Definition and Criteria for Best Practices

Definition of "Best Practice" for EXCEL4HOUSING4.0:.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

Innovation: Students are confronted with a real life-like situation consisting of new technology, where many disciplines come together and solve problems, instead of studies within a singular discipline.

VET relevance: HVAC end energy solutions, including automation is a field of rapid development, and here there are opportunities to test new technology.

Sustainability: Reusing building materials significantly reduces construction waste and supports sustainability in construction projects. Integrating sustainable design and operations supports circular economy principles in modern construction. Energy-efficient systems reduce the building's carbon footprint by minimizing energy consumption during operation. Smart control mechanisms prevent unnecessary energy use, optimizing building performance and sustainability.

Designed for circular economy and adaptability.

- **Presentation of Best Practices by Thematic Area**

This type of test building can be adapted to all regions and provide learning opportunities both in engineering design and for installers, including testing of functionality and online-based analysis of performance.

- Title of the Practice: ***Teknikhuset***
- Country/Region and Partner(s) Involved: All partners can be involved

■ Brief Description of the Practice

Modular and Sustainable Construction.

Teknikhuset tests new building methods focusing on modular design and sustainability for modern housing and provides hands-on experience for students and professionals in modern construction and energy technologies

Self-supporting steel frame provides a robust and flexible structural foundation for modular elements integration. Modular elements allow easy replacement and customization to adapt to changing building needs. Automated Manufacturing Efficiency Serial production and automation reduce construction costs and improve efficiency significantly. Sustainable and Reusable Components Reusable components support environmental sustainability and circular economy principles in construction.

Energy systems are designed to minimize installation and maintenance costs while maximizing reliability and performance. Smart energy control mechanisms optimize energy production and consumption to use resources efficiently and reduce waste. Solar panels are seamlessly integrated into the roof, providing renewable energy and reducing dependency on fossil fuels. Predictive energy management, where energy use is adjusted in real-time based on needs and solar availability to enhance efficiency and reduce waste.

Integration of all systems enables real-time monitoring and control of energy, lighting, and climate in the building. The system adjusts automatically to changing usage patterns and occupant needs to optimize comfort and efficiency. Proactive maintenance automation supports maintenance tasks like filter replacements and leak detection to improve reliability and user experience

■ Objectives and Challenges Addressed

Provides training in new technology and sustainability concepts.

■ Approach Implemented

Tested since 2022. Teknikhuset serves as a learning environment fostering collaboration and practical technical training.

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Involving learners in design and implementation improves educational results and industry readiness. **67 students from YA-Vocational College of Ostrobothnia** working with the Teknikhuset project during 2019-2022.

- 25 construction students,
- 20 electrician students,
- 7 pipe fitter students,
- 10 surface painter students (Surface Treatment technology) and

-
- 5 interior decorator students.

- **Replicability and Transferability Potential**

Easy to transfer to another context

Assignments can be varied according to technology and learning goals.

- **Cross-Cutting Analysis of Best Practices**
 - Innovative learning environment with display of new technology and sustainable solutions.
- **Conclusions**
 - Can facilitate appropriate training for VET and HE students
- **Dissemination Plan for the Compendium**
 - Test cases in extreme (changed) climate and online access to operations data for analysis
 - Cooperation with companies in the fields of installations and automation

References

YA Vocational College of Ostrobothnia (2025). *TEKNIKHUSET, platsen där tekniken sätts på prov.*
<https://teknikportalen.fi/teknikhuset/>

YLE (2022). *Yrkesakademins teknikhus samlar många lösningar: "Vill man flytta ett eluttag eller tvättfat är det enkelt gjort".* <https://yle.fi/a/7-10023116>

Annex 14: Exoikonomo – Energy Efficiency Upgrading of Buildings

Field	Description
Title of the practice	Exoikonomo – Energy Efficiency Upgrading of Buildings
Country of implementation	Greece
Organisation(s) involved	Hellenic Ministry of Environment & Energy (MoEE); Managing Authority for Energy Programmes; Hellenic Development Bank (earlier cycles); regional authorities; energy auditors; licensed contractors.
Description	National grant scheme providing financial incentives and standardized procedures for deep energy renovation of residential buildings.
Thematic area(s)	Energy efficiency/nZEB renovation; digital processes (EPCs, e-platforms, smart controls); circular/low-carbon materials (through specifications).
Methods and tools used	Grant guidelines & technical specifications; digital application portal; energy audits (pre/post); EPC issuance; standard bill-of-quantities; QA/commissioning checks; eligible equipment lists (e.g., heat pumps, insulation, glazing, PV).
Target group(s)	Homeowners/HOAs; SMEs and contractors; energy auditors; engineers/architects/site managers; VET teachers/trainers supporting IVET/CVET.
Outcomes and impact	Hundreds of thousands of applications over successive calls; significant residential energy savings and EPC-class improvements; scale effects on contractor capacity and technician upskilling; diffusion of heat-pump and envelope skills. Over 180,000 households have benefited across cycles since 2011, achieving average primary energy savings of 35–40 %.” (source: MoEE summary reports 2024)
Transferability	High—programme design elements (eligibility rules, audit workflow, QA, digital portal, trainer CPD) can be replicated by VET providers and sector bodies to build short modules and micro-credentials.
Relevance to E4H	Direct pipeline for work-based learning, trainer CPD, and micro-credentials in envelope, HVAC/heat pumps, RES, smart

	controls, QA, and customer advisory skills.
--	---

Introduction

This case documents Exoikonomo programme as a national best practice for scaling deep energy renovation in Greek housing. The description is based on programme rules and technical specifications (multiple cycles since 2011, with latest to be the 2025 round), official policy documents (NECP), and sector sources. The practice was selected and structured using the EXCEL4HOUSING criteria and template to support VET curriculum design, teacher CPD, and micro-credential development.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).
 - **Relevance & impact:** Directly supports Greece's energy-efficiency and renovation goals, creating large-scale, measurable energy savings and strong, long-term demand for skilled construction professionals.
 - **Innovation:** Combines strict energy-performance targets (≥ 30 % primary-energy savings and ≥ 3 EPC classes), a fully digital application and verification system, and audited pre/post energy checks.
 - **Transferability & VET value:** The programme's clear workflow, technical standards and quality-assurance procedures can be easily adapted for modular training, micro-credentials and CPD in other regions.
 - **Sustainability:** Repeated funding cycles since 2011 ensure continuity, while each round (including 2025) strengthens specifications and skills requirements.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy efficiency & sustainable housing; Digitalization/Housing 4.0 (EPC registry, digital portal, smart controls); circular practices.

- **Title of the Practice:** Exoikonomo – Energy Efficiency Upgrading of Buildings

-
- **Country/Region and Partner(s) Involved:** Greece; Hellenic Ministry of Environment & Energy and managing bodies; energy auditors; licensed contractors; regional/municipal interfaces.
 - **Brief Description of the Practice:** National grant scheme for residential renovation (insulation, glazing, airtightness, heat pumps/HVAC, RES and smart controls), with digital applications, pre/post energy audits, and minimum performance thresholds (2025: $\geq 30\%$ primary-energy savings and ≥ 3 EPC classes).
 - **Objectives and Challenges Addressed**
 - **Objectives:** Cut household energy use/emissions; raise renovation depth; improve EPC quality; grow the domestic skills base (auditing, installation, commissioning, QA).
 - **Challenges:** Low renovation rates; fragmented micro-enterprise base; uneven installer competences; variable audit quality; limited teacher/trainer CPD capacity.
 - **Methodology / Approach Implemented**

Standardized four-step workflow: (1) pre-works audit & baseline EPC; (2) design/procurement; (3) installation & commissioning to technical specs; (4) post-works audit & EPC improvement verification. 2025 enhancements: strengthened digital portal, exclusion of previously subsidized homes, clearer specs to guarantee the EPC jump, and stricter QA (documentation and checks).
 - **Outcomes and Demonstrated Impact (quantitative/qualitative)**
 - **Scale:** High application and completion volumes across cycles; strong 2025 uptake in progress.
 - **Performance:** Verified energy savings and EPC upgrades; growing penetration of heat pumps, high-performance envelope systems, and smart controls.
 - **Workforce effects:** Ongoing demand for auditors, installers, supervisors, commissioners; expanded market for CPD.
 - **System effects:** Normalized quality-assured retrofit workflows; more data-driven planning and verification.
 - **Key Success Factors**
 - Clear, stable eligibility and performance rules linked to EPBD/NECP.
 - End-to-end digitalization (applications/EPC data).
 - Pre/post audit requirements with defined documentation.
 - Widely understood technical specifications for measures and commissioning.
 - A responsive training ecosystem (VET providers, chambers, CRES, manufacturers).
 - **Replicability and Transferability Potential**

High: a repeatable, performance-based grant scheme with integrated digital tools and audit/commissioning routines. Its technical specifications and QA processes can be directly adapted into short training modules and micro-credentials for workers, supervisors and VET trainers.

■ **Lessons Learned**

Key lessons from more than a decade of operation include:

- Comprehensive renovation—combining envelope, HVAC, and smart-control upgrades—achieves the best energy and comfort outcomes, provided that commissioning and verification are enforced
- Micro-enterprise realities demand modular, short-cycle training and strong trainer CPD.
- Effective client advisory helps avoid drop-outs and improves project quality.

● **Cross-Cutting Analysis of Best Practices**

○ **Common Trends and Success Patterns**

Exoikonomo demonstrates how clear policy direction, stable funding, and digitalized processes can jointly stimulate market demand and skills formation. Its long-running structure and 2025 updates reveal several success patterns that are relevant beyond Greece.

- **Policy-driven scale and continuity:** Successive calls since 2011, aligned with Greece's National Energy and Climate Plan (NECP) and the EU Renovation Wave, ensure stable funding and predictable demand for renovation skills.
- **Performance-based incentives:** Mandatory pre- and post-works audits, minimum 30 % energy savings and three-class EPC upgrades guarantee measurable outcomes and consistent quality.
- **Digitalization and transparency:** A fully digital application and monitoring system improves efficiency, supports reliable data collection and facilitates integration of EPC evidence into training content.
- **Integration with VET and CPD:** Close collaboration with VET providers, chambers and technical bodies enables rapid incorporation of technical specifications and quality standards into curricula, micro-credentials and continuing professional development.

○ **Recurrent Challenges and Strategies for Overcoming Them**

Running multiple funding cycles has highlighted structural and operational challenges that Greece continues to address. The 2025 Exoikonomo round reflects lessons learned and embeds strategies to overcome these barriers.

-
- **Administrative complexity and access:** Earlier rounds faced delays and uneven participation. A strengthened digital portal and simplified documentation now speed up applications and reduce dropouts.
 - **Capacity gaps in skilled labor:** High demand for qualified auditors, installers and commissioning specialists can outpace supply. The programme stimulates targeted VET modules, micro-credentials and CPD to widen the skilled workforce.
 - **Quality assurance and performance verification:** Variability in retrofit quality risked lower energy savings. Mandatory pre- and post-works audits, photo evidence and stricter commissioning protocols ensure compliance with the ≥ 30 % savings and three-class EPC upgrade requirement.
 - **Equity and affordability:** Low-income and vulnerable households risked exclusion. The 2025 cycle provides enhanced subsidies and tailored support to broaden participation.
- **Implications for Skills Development and VET**
- Exoikonomo illustrates how a large-scale, performance-based renovation programme drives continuous upskilling across Greece's construction workforce. The 2025 cycle (with stricter requirements of at least 30 % primary-energy savings and a three-class EPC upgrade) further intensifies these needs and provides a ready model for curriculum renewal and continuing professional development.
- **Green construction skills:** Competences in nZEB envelope methods, airtightness testing, high-efficiency HVAC and heat-pump installation, and renewable-energy integration, all underpinned by robust on-site quality assurance.
 - **Digital competences:** Proficiency in Building Information Modelling (BIM), common data environments, energy modelling and digital audit/commissioning tools that link applications, EPC data and verification steps.
 - **Circular-economy practices:** Knowledge of selective demolition, construction-and-demolition waste management, and material reuse, embedded in renovation workflows.
 - **Assessment and training innovation:** Capacity among VET teachers and in-company trainers for digital delivery, micro-credential design and practical on-site assessment, ensuring that training keeps pace with evolving technical standards.
- **Recommendations for Practice Transfer and Adaptation.**
- **Policy and funding alignment:** Ensure stable, multi-year financing and clear links to national energy and climate targets so that long-term renovation demand supports sustained skills development.
 - **Performance-based standards:** Adopt mandatory pre- and post-works audits, minimum energy-savings thresholds, and EPC-class upgrades to guarantee verifiable results and drive quality.
 - **Digital application and monitoring:** Implement a fully digital platform that links applications, EPC data, and verification, creating reusable data assets for VET

analytics and progress tracking while providing transparency and a rich dataset for training use.

- **Training and CPD integration:** Translate technical specifications, commissioning protocols and real project data into VET curricula, micro-credentials and continuing professional development for teachers and trainers.
- **Equity measures:** Include incentives or higher subsidy rates for low-income and vulnerable households to broaden participation and labour-market impact.

- **Conclusions and Recommendations**

- **Synthesis of Key Findings from the compendium.**

- **Long-term continuity matters:** Multi-cycle, policy-backed funding ensures stable demand for renovation skills and supports sustained VET investment.
- **Performance-based design delivers results:** Clear energy-saving thresholds, EPC-class improvements and rigorous pre/post audits secure measurable impacts and build public trust.
- **Digitalization accelerates uptake and transparency:** A fully digital application and monitoring system streamlines administration, reduces dropouts and generates data for training and evaluation.
- **Integrated VET and CPD are essential:** Converting technical standards and commissioning routines into micro-credentials and short modules ensures that workers, professionals and trainers can meet evolving requirements.
- **Inclusive access strengthens impact:** Adjusted subsidies for low-income and vulnerable households broaden participation and enhance social benefits.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

- **Expand modular and micro-credential training:** Develop short, practice-oriented modules in nZEB construction, airtightness diagnostics, HVAC/heat-pump systems, and digital project coordination to meet immediate labour-market needs.
- **Strengthen trainer CPD and digital pedagogy:** Invest in continuing professional development so VET teachers and in-company trainers can deliver up-to-date energy-efficiency, circular-economy and BIM content through digital platforms.
- **Deepen circular-economy skills:** Embed selective demolition, *construction-and-demolition (C&D) waste* management and material reuse in standard curricula and site practice.
- **Leverage digital tools and data:** Use real renovation data and EPC verification systems for case-based learning and on-site assessment.
- **Inclusive reach:** Provide targeted support and regional training hubs to involve low-income households and rural areas.

Bibliography

Centre for Renewable Energy Sources and Saving (CRES) - Energy Efficiency in Buildings – Exoikonomo Monitoring and Results 2023

http://www.cres.gr/cres/pages/projects/projects_GR/espaspa_1.html

- Hellenic Ministry of Environment & Energy / Bioclima portal. Exoikonomo 2025 Programme Announcement and Guidelines (January 2025).

<https://bioclima.gr/en/new-program-exoikonomo>

References

Hellenic Ministry of Environment & Energy. National Energy and Climate Plan (NECP) and Long-Term Renovation Strategy – policy framework underpinning Exoikonomo (2020)

https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pdf

- Ekathimerini. Latest energy efficiency upgrade subsidies program announced (January 2025).

<https://www.ekathimerini.com/economy/1257330/latest-energy-efficiency-upgrade-subsidies-program-announce>

Annex 15: CDWaste-ManageVET – Developing skills for sustainable construction and demolition waste management

Field	Description
Title of the practice	CDWaste-ManageVET – Developing skills for sustainable construction and demolition waste management
Country of implementation	Greece (national uptake through PEDMEDE/EKS under Greek pilot phase); transnational partnership (with pilots in Italy, Portugal, Romania, Spain, France)
Organisation(s) involved	Coordinator: Office de l’Environnement de la Corse (FR). Greek partners: PEDMEDE (Panhellenic Association of Engineers Contractors of Public Works, Greece); EKS – European Knowledge Spot (Greece); FORMEDIL (Italy); ISQ (Portugal); UPB – Universitatea Politehnica din București (Romania); FLC – Fundación Laboral de la Construcción (Spain).
Description	An Erasmus+ project addressing skills needs in construction and demolition waste (CDW) management, focusing on developing VET curricula, digital learning materials, and a training platform. The project promotes the circular economy in construction by upskilling workers and trainers in waste reduction, recycling, and resource-efficient site practices.
Thematic area(s)	Circular economy; waste management and recycling; digital learning in construction; sustainable resource management; occupational health and safety; environmental compliance; digital learning resources.
Methods and tools used	Industry-driven analysis; Best-practice handbook; competence matrix & curricula (with WBL); online training platform/VOOC; pilot training; webinars (e.g., Greece with PEDMEDE & EDA); basic assessment/validation guidance.
Target group(s)	Construction SMEs/contractors; site managers/supervisors; demolition crews & waste operators; engineers/technicians; VET providers and trainers; sector bodies/policy stakeholders.
Outcomes and impact	Introduced structured training on CDW prevention and management; produced a freely accessible e-learning platform; enhanced cooperation between VET providers and industry; improved awareness of EU waste directives; supported adoption of circular practices in Greek construction training. Pilot training in Greece was implemented through PEDMEDE and EKS, engaging SMEs and trainers from the construction and demolition sectors.

	Tangible outputs published (handbook, curricula, VOOC platform); pilot execution; at least 90 VET learners trained, 30 internships/mentorships; ≥18 VET providers expected to integrate modules; dissemination in GR/ES/RO/PT/IT (incl. national webinar in GR).
Transferability	High: modular, multilingual (EN/EL/IT/PT/RO/ES); EQF-aligned learning outcomes; WBL model; open online delivery—directly adaptable to national waste rules and VET systems. Its outputs are referenced in newer Erasmus+ and LIFE projects focusing on circular construction in Greece.
Relevance to E4H	Directly supports the project’s green transition focus. Provides a ready-to-use curricula, trainer resources, and a tested model for embedding circular-economy and waste-management competences into construction VET curricula, which can inform short modules and micro-credentials under EXCEL4HOUSING.

Introduction

The project followed a collaborative design-based approach involving VET providers, social partners, and construction industry associations. Needs analyses across partner countries identified major competence gaps in construction and demolition waste (CDW) management. Based on this, CDWaste-ManageVET developed an Erasmus+ training framework combining occupational standards, modular curricula, and online learning tools. The outputs were pilot-tested with trainers and SMEs to ensure adaptability and usability.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).
 - **Relevance & impact:** CDWaste-ManageVET directly addressed a core sustainability gap in Greece’s construction and demolition (C&D) sector by creating structured VET resources for waste management, recycling, and circular practices. The project strengthened Greece’s ability to meet EU

waste targets and improved professional competence in sorting, reuse, and resource-efficient construction processes—critical for the Renovation Wave and national Circular Economy Action Plan.

- **Innovation:** The project introduced an integrated online training platform combining theoretical modules, case studies, and self-assessment tools for C&D waste management. It developed standardized curricula and qualification profiles for construction workers, site managers, and VET trainers, linking environmental compliance with on-site operations. Its blended-learning format and multilingual open access model were new for the sector in Greece.
- **Transferability & VET value:** The training materials and competence framework are openly available and adaptable to national contexts. Greek VET providers can integrate the modules into IVET and CVET programmes, and the project's occupational profiles are compatible with EQF levels and ECVET units—facilitating modular micro-credential delivery and CPD for trainers.
- **Sustainability:** Outputs remain accessible via the project's digital platform and partner repositories (e.g. PEDMEDE, EKS). The tools continue to be used in new Erasmus+ and LIFE initiatives focusing on circular construction, proving institutional uptake and ensuring long-term relevance through integration in regular VET provision and professional associations' training schemes.

- **Presentation of Best Practices by CoVE / Thematic Area**

Circular economy & resource efficiency; site-level waste management; digital learning for VET; compliance & documentation.

- **Title of the Practice:** CDWaste-ManageVET – Vocational Education and Training for Construction & Demolition (C&D) Waste Management
- **Country/Region and Partner(s) Involved:** Greece (national relevance). Coordinator: Office de l'Environnement de la Corse (OEC), France. Partners: PEDMEDE – Panhellenic Association of Engineers Contractors of Public Works (Greece); EKS – European Knowledge Spot (Greece); FORMEDIL (Italy); ISQ (Portugal); UPB – Universitatea Politehnica din București (Romania); FLC – Fundación Laboral de la Construcción (Spain).
- **Brief Description of the Practice:** Erasmus+ project (2019–2022) that produced a competence framework, modular curriculum, trainer handbook

and open e-learning platform (OER) for C&D waste prevention, selective demolition, sorting, reuse/recycling logistics and regulatory compliance. Piloted with SMEs and trainers across partner countries.

■ Objectives and Challenges Addressed

- **Objectives:** Embed circular-economy skills in construction VET; professionalize C&D waste handling; support legal compliance; provide ready-to-use trainer resources and digital content.
- **Challenges:** Low awareness of CDW obligations; fragmented site practices; limited trainer capacity and SME time; variation in national classifications and procedures.

■ Methodology / Approach Implemented

Needs analysis → competence matrix (EQF-aligned) → modular curriculum and trainer toolkit → multilingual OER platform and blended courses → pilots/validation with workers, supervisors and trainers → refinement for IVET/CVET use.

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

- **Scale:** Pilots delivered in all partner countries; multi-hundred learner reach; trainer workshops completed.
- **Performance:** Standardized checklists and on-site routines for sorting, documentation and selective demolition.
- **Workforce effects:** Improved trainer readiness and SME uptake of waste-smart workflows.
- **System effects:** Public OER enables rapid integration into provider LMS and CPD schemes.

■ Key Success Factors

- Policy alignment with EU Waste Framework Directive
- Practical, modular design
- Open digital access
- Strong VET–industry partnership (e.g., PEDMEDE, FLC, FORMEDIL)
- Clear assessment rubrics and job-aids

■ Replicability and Transferability Potential

High. Materials are EQF-aligned, modular and multilingual; fit short courses/micro-credentials; low equipment needs; easy to adapt to national waste codes and municipal procedures.

■ Lessons Learned

Key lessons from multi-country implementation:

- **Tying to regulation & procurement:** Mapping modules to EU/national waste rules and referencing them in public tenders drives uptake.
- **Investing in trainers:** Mentor networks and ready-to-use rubrics/job-aids raise delivery quality and consistency.
- **Going modular & blended:** Short, mobile-friendly units plus brief workshops fit SME schedules and boost completion.
- **Closing the loop with data:** Simple tracking of sorted fractions and compliance reports feeds back into teaching and continuous improvement.
- **Localizing smartly:** Use EU-wide core content with short national annexes (waste codes, permits, municipal procedures).

● Cross-Cutting Analysis of Best Practices

○ Common Trends and Success Patterns

- **Policy-linked training works:** Tying learning outcomes to EU/CDW obligations speeds employer buy-in.
- **Modular OER scales quickly:** Open, bite-sized units fit SME schedules and LMS provider.
- **VET-industry co-design:** Sector bodies (chambers/associations) keep content practical and current.

These findings are consistent with other Erasmus+ circular construction projects such as BUILD UP Skills and BUS-League, reinforcing the role of OER and modular training.

Similar to other EU pilots, Greece's CDWaste-ManageVET implementation shows that policy-linked VET supports the growth of the employer participation and accelerates green upskilling.

○ Recurrent Challenges and Strategies for Overcoming Them

-
- **Regulatory variation:** Addressed by mapping EU core requirements + national annexes.
 - **SME engagement/time limits:** Short, blended modules; evening/online options; job-aids for supervisors.
 - **Digital readiness of providers:** OER platform with plug-and-play content; trainer mentoring sessions.
- **Implications for Skills Development and VET**
 - **Digital competences: Circular-economy competences:** Prevention, selective demolition, sorting, reuse logistics, and safe handling.
 - **Compliance & documentation:** Waste codes, traceability, manifests, reporting to local systems.
 - **Digital tools:** Basic material-flow tracking, photo evidence, QR/ERP links where available.
 - **Trainer CPD:** Blended delivery, practical assessment, and local adaptation to municipal procedures.
 - **Recommendations for Practice Transfer and Adaptation.**
 - **Map modules to national waste codes and municipal requirements; add short national annexes.**
 - **Offer as micro-credentials for workers/supervisors; recognize prior learning where possible.**
 - **Pair online theory with toolbox talks and site walk-throughs using the project checklists.**
 - **Formalize partnerships with sector associations and municipalities for outreach and validation.**
- **Conclusions and Recommendations**
 - **Synthesis of Key Findings from the compendium.**
 - **Clear standards + modular VET** can change site behavior at scale.
 - **Open digital resources** lower costs and raise adoption across providers.
 - **Industry partnership** is essential for relevance and long-term use.
 - **EQF-aligned outcomes** enable micro-credentials and CPD integration.
 - Recommendations for future actions and projects in the field of VET and sustainable construction.
 - **Embed CDW/circular modules as compulsory units in construction IVET/CVET.**

-
- Develop national micro-credentials (selective demolition lead, CDW supervisor)
 - Fund trainer CPD and onboarding of providers to the open digital platform.
 - Link training to public procurement (require certified CDW roles on renovation sites).
 - Use data from local waste systems to drive continuous improvement tasks in class.

Bibliography

Ministry of Environment & Energy (Greece). *National Waste Management Plan (ESDA 2020–2030)*.

https://environment.ec.europa.eu/system/files/2021-10/Greece_0.pdf

References

- CDWaste-ManageVET Project Website – Official portal and project overview.

<https://cdwaste-managevet.com>

- PEDMEDE (Panhellenic Association of Engineers Contractors of Public Works). CDWaste-ManageVET participation and national dissemination.

<https://pedmede.gr/en/cdwaste-managevet-developing-vet-for-addressing-construction-and-demolition-waste-management-skills-needs-2019-2023-erasmus-program/>

Annex 16: NTUA ZEB Living Lab – GR-Eco Building Living Labs (National Technical University of Athens)

Field	Description
Title of the practice	NTUA ZEB Living Lab – GR-Eco Building Living Labs (National Technical University of Athens)
Country of implementation	Greece
Organisation(s) involved	National Technical University of Athens (NTUA) – relevant Schools/Departments (architecture, mechanical/electrical engineering); collaborating ministries/municipalities on pilot activities; industry partners (manufacturers, ESCOs) for equipment and trials.
Description	A full-scale, instrumented building-as-lab for training, demonstration and research on nZEB/positive-energy performance, smart operation and circular solutions. It provides hands-on courses, CPD workshops, trainer upskilling, and access to datasets for case-based learning.
Thematic area(s)	Energy efficiency & nZEB renovation; digitalization & smart operation; measurement & verification; circular design/materials; indoor environmental quality.
Methods and tools used	High-resolution monitoring (sensors/IoT); BMS/EMS & digital twins; blower-door & thermal-imaging diagnostics; BIM/CDE teaching sets; commissioning protocols; real-time dashboards and datasets for coursework.
Target group(s)	Graduate engineers/architects; site managers/commissioning staff; VET teachers and in-company trainers; SMEs and public bodies involved in renovation programmes.
Outcomes and impact	Regular hands-on trainings and CPD cohorts; improved competence in diagnostics, commissioning and smart control; teaching datasets reused across courses; stronger industry-academia ties; demonstration of replicable lab-to-VET model.
Transferability	High. The model can be replicated as a modular living-lab in universities/VET centers using a classroom + test room + portable diagnostics + open data pack; easily aligned to short modules and micro-credentials.
Relevance to E4H	Direct support for energy-efficient renovation skills, digital methods (BIM/CDE, BMS/EMS) and trainer CPD, supplying ready content (datasets, protocols) for EXCEL4HOUSING modules.

Introduction

The NTUA ZEB Living Lab is a building-scale, instrumented facility used for training, demonstration and applied research on energy-efficient operation, smart controls and measurement-and-verification (M&V). It combines hands-on diagnostics (airtightness, thermal imaging, HVAC/heat-pump commissioning, IAQ monitoring) with digital workflows (BIM/CDE, BMS/EMS dashboards, data analytics), turning real performance data into learning activities for students, professionals and VET teachers/trainers. The lab addresses Greece's need for site-ready competences in renovation and operation of high-performance buildings and offers replicable modules and datasets suitable for micro-credentials and CPD under EXCEL4HOUSING.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).
 - **Relevance & impact:** The GR-Eco Building Living Lab directly supports Greece's energy-efficiency and circular-construction goals under the NECP and Renovation Wave, serving as a real-scale testing and learning environment for zero-energy and low-carbon design. Its experimental data and educational integration at NTUA demonstrate tangible impacts in bridging academia, industry, and VET—enhancing technical capacity in building-envelope performance, smart controls, and energy monitoring.
 - **Innovation:** The lab's concept combines digital monitoring, renewable-energy integration, and user-behaviour analysis in an operational building context. It enables students, researchers, and professionals to test advanced materials, building automation systems, and energy-efficiency strategies. This holistic, user-centred approach to energy performance—linking data analytics with comfort assessment—is unique in the Greek VET and higher-education landscape.
 - **Transferability & VET value:** The GR-Eco model is designed for scalability and replication across universities, research centres, and training institutions. The pedagogical framework, open-access data, and modular design can be incorporated into VET curricula and micro-credential courses

on nZEB construction, smart building management, and circular renovation. It also provides a platform for continuous professional development (CPD) for engineers and trainers.

- **Sustainability:** The Living Lab operates as a permanent NTUA facility embedded within national and EU research frameworks (e.g., Horizon Europe, LIFE), ensuring continuity and institutional support. Continuous data collection, external collaborations, and integration into student projects and VET activities reinforce its long-term sustainability and contribution to the national green-skills ecosystem.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy-efficient buildings; smart/digital operation; measurement & verification; circular construction.

- **Title of the Practice:** NTUA ZEB Living Lab – GR-Eco Building Living Labs
- **Country/Region and Partner(s) Involved:** Greece; NTUA (lead), with collaborations from ministries/municipalities and industry partners supplying systems and software.
- **Brief Description of the Practice:** A teaching-through-measurement facility that embeds diagnostics, commissioning and smart control into applied training, integrating BIM/digital twins and real operation data to bridge classroom and site.
- **Objectives and Challenges Addressed**
 - **Objectives:** Provide real-world training on nZEB operation; build capacity in M&V, commissioning and digital coordination; generate open datasets for curricula and micro-credentials.
 - **Challenges:** Limited access to monitored buildings; gaps in commissioning practice; uneven digital readiness in SMEs and among trainers.
- **Methodology / Approach Implemented**

Learning sequences couple pre-lab theory → instrumented experiments → on-site diagnostics → data analysis/reporting. Courses use standard protocols (blower-door, thermal bridges, HVAC tuning, IAQ), BIM/CDE workflows, and assessment rubrics tied to measured outcomes.
- **Outcomes and Demonstrated Impact (quantitative/qualitative)**

- **Training delivery:** recurring CPD/workshops for students, professionals and trainers.
- **Competence gains:** verified ability to run diagnostics, optimise HVAC/controls, and document M&V.
- **System effects:** reusable datasets and lab scripts embedded in provider courses; industry uptake of commissioning checklists.

■ Key Success Factors

- Real building with granular data
- Standardised protocols
- Integration of digital tools
- Strong industry/university collaboration
- Open teaching materials

■ Replicability and Transferability Potential

High: start with a minimal kit (test room, sensors, blower-door, IR camera, data logger), add dashboards and BIM models, and publish lab manuals + datasets to scale across VET centres/universities.

■ Lessons Learned

Hands-on diagnostics change behaviour fastest; measured evidence improves learning retention; trainer CPD is essential; small modular labs can deliver big skills gains without large capex.

● Cross-Cutting Analysis of Best Practices

○ Common Trends and Success Patterns

- **Learning by measuring:** students and professionals progress faster when data confirms envelope/HVAC performance.
- **Digital-first delivery:** BIM/CDE plus dashboards make coordination and QA teachable.
- **Reusable open content:** datasets and lab scripts allow scalable replication across providers.
- **Partnership model:** equipment vendors and municipalities help keep tools current and use cases realistic.

○ Recurrent Challenges and Strategies for Overcoming Them

-
- **Cost & maintenance:** use modular kits and service agreements; phase upgrades.
 - **Trainer capacity:** run train-the-trainer cycles and co-teach with lab engineers.
 - **Curriculum integration:** package labs as short, credit-bearing modules/micro-credentials aligned to EQF.
 - **Data handling/privacy:** use anonymized datasets and clear protocols.
 - **Implications for Skills Development and VET**
 - **Green construction skills:** airtightness/thermal-bridge mitigation; HVAC/heat-pump optimization; RES integration; IAQ control.
 - **Digital competences:** BIM/CDE, BMS/EMS tuning, digital twins, data analysis for M&V.
 - **Assessment innovation:** performance-based assessments using measured KPIs; rubrics for commissioning tasks.
 - **Trainer CPD:** digital pedagogy + lab operation + safety.
 - **Recommendations for Practice Transfer and Adaptation.**
 - Create a starter living-lab package (equipment list, SOPs, datasets, lab manuals).
 - Tie modules to public programmes (e.g., renovation schemes) for real case studies.
 - Issue micro-credentials (airtightness testing, HVAC commissioning, BMS optimization).
 - Establish regional hubs that share datasets and co-deliver trainer CPD.
 - **Conclusions and Recommendations**
 - **Synthesis of Key Findings from the compendium.**
 - Living-lab teaching bridges the last mile between theory and site practice.
 - Using measured performance as the learning anchor accelerates skill acquisition in energy efficiency and digital operation, produces reusable curricula assets, and is replicable at modest cost.
 - **Recommendations for future actions and projects in the field of VET and sustainable construction.**
 - Fund starter lab kits in regional VET centres/universities with a shared dataset library.
 - Mainstream performance-based assessments and micro-credentials linked to commissioning/M&V.
 - Expand trainer CPD in diagnostics, BIM/CDE and BMS/EMS.

-
- Connect living labs with municipal portfolios to generate continuous real cases.

Bibliography

- Sustainable NTUA. Energy saving actions (campus upgrades and pilot systems) <https://sustainability.ntua.gr/en/environmental-protection/sustainable-infrastructure/energy-saving-actions/>
- Sustainable NTUA. Online energy consumption measurement (campus dashboards and links to Living Lab & School of Mechanical Engineering) <https://sustainability.ntua.gr/en/environmental-protection/energy-management-and-co%E2%82%82-emission-reduction/online-energy-consumption-measurement/>

ERIGrid2 Project Consortium. *European Research Infrastructure Supporting Smart Grid and Smart Energy Systems Research (Horizon 2020)*.

Electric Energy Systems Laboratory (ICCS-NTUA) - ERIGrid 2.0

References

- ICCS-NTUA (Institute of Communication and Computer Systems). *Electric Energy Systems Laboratory (EESL) – Low Voltage Microgrid Infrastructure Description (ERIGrid Infrastructure)*. <https://erigrd2.eu/iccs-ntua/>
- ECE-NTUA / Smart RUE Research Group. Smart RUE (Smart Grids Research Unit) – Department of Electrical and Computer Engineering, National Technical University of Athens. <https://www.ece.ntua.gr/en/article/492>

Annex 17: ARCA Academy

Field	Description
Title of the practice	ARCA Academy
Country of implementation	Italy
Organisation(s) involved	Habitech - Distretto tecnologico trentino
Description	ARCA Academy is ARCA's training centre, which promotes quality, sustainability and safety in timber construction. ARCA Academy is the continuing education centre for all professionals who want to learn more about timber construction and quality protocols.
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	blended learning, microcredentials
Target group(s)	Students, trainers, professionals, etc.
Outcomes and impact	The project fosters collaboration between actors (technicians, designers, skilled workers and teachers), enhancing teamwork and innovation in sustainable building and ensuring that skills are acquired during the various design phases involving wood technologies.
Transferability	Training and certification courses in timber construction extended to other Italian regions, taking inspiration from the Autonomous Province of Trento, which remains a pioneer in this field at national level.
Relevance to E4H	It supports a central goal of the green and circular economy, addressing the emerging need for skills in the construction sector relating to energy transition and the use of natural materials with a low environmental impact.

Introduction

ARCA Academy has been selected as an Italian best practice, as it represents one of the few specialized VET programs focused on timber construction at national level and its certification. This case study is particularly relevant as it offers a concrete and transferable model that can inspire other regions and local administrations across the country.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- **Selection and Evaluation Criteria** (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

VET relevance: The ARCA Academy provides targeted training for professionals working in the timber construction supply chain. A professional training course in timber construction is relevant for sustainability because it promotes the use of a natural, renewable, and low-impact material. The academy focuses on developing specialised vertical skills and collaborates also with vocational schools to promote a culture of timber construction. The goal is to engage young students as future professionals from an early stage, encouraging them to train in this field before entering the workforce. This ensures they are well-prepared to meet the demands of the energy transition and evolving construction market skills requirements.

Sustainability: Training skilled professionals in wood construction and green certification helps to create more efficient, durable and environmentally friendly buildings, thereby making a concrete contribution to the ecological transition of the construction sector.

- **Presentation of Best Practices by CoVE / Thematic Area**

Circular economy & natural materials; Low carbon footprint buildings

- For each selected Best Practice (following the structure of the Template):

- Title of the Practice
ARCA Academy

- Country/Region and Partner(s) Involved
Italy

- Brief Description of the Practice

The ARCA system - including ARCA Academy -was established in the Province of Trento with the aim of certifying high-quality wooden buildings in terms of seismic safety, energy efficiency, durability and healthiness.

ARCA Academy is a training project that promotes collaboration among technicians, designers, skilled workers, and teachers, with the aim of developing expertise in sustainable timber construction. It is based on the experience of ARCA, which has defined the protocols behind its quality and sustainability certification. These protocols are explored in depth through technical regulations that form the core of the Academy's training path. Taking part in ARCA Academy means investing in professional development within a fast-growing market, while acquiring strong technical skills related to all phases

of design and construction. ARCA Academy allows students to acquire a specialised qualification for the growing field of timber construction and prefabrication. It offers a technical-practical approach: not only theory, but also workshops, real-life cases, and a final integrated design test. The training offer includes four courses: Basic course for technicians; Course for designers; Course for system installers, focusing on regulations, best practices, construction details, and technical solutions; Course for schools, aimed at bringing the culture of quality timber construction into technical and vocational secondary schools.

■ Objectives and Challenges Addressed

ARCA Academy created a broad network of local stakeholders (including companies, designers, and timber component manufacturers) to drive innovation in the timber construction sector toward zero-emission buildings.

■ Methodology / Approach Implemented

ARCA Academy is based on a blended training methodology, including digital and on demand attendance for the “basic course”. Moreover, the training has been split by modules that increase the knowledge and skill levels through a step-by-step approach. Trainees attending the whole training offer for designers (basic course, design fundamentals, design laboratory) can acquire the “ARCA Designer” accreditation in three different domains: i) Structures ii) Envelope efficiency iii) Sustainable construction.

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Since its launch in 2011, ARCA has raised awareness on timber construction by involving approximately 22.600 professionals in dedicated events, such as the “ARCA in Tour” initiative, conferences and hands-on webinars.

Thanks to the Academy, it trained hundreds of professionals and students (see below), whereas 10 national congress editions - including the 10th Anniversary one in 2021 - were organized over the years. Professionals engaged in dedicated events, conferences and raising awareness initiatives: 22.600

Trained professionals by ARCA Academy: 1.107

Trained students: 449

- | ■ Key | Success | Factors |
|-------------------------------------|---|---------------------|
| - Quality of training | Updated, clear courses based on recognized standards, focusing on safety, sustainability, and quality | content: protocols; |
| - Instructor | Trainers with practical experience who can share real cases and best practices; | expertise: |
| - Relevance to the target audience: | | |

Training programs designed to meet the concrete needs of architects, engineers, and timber construction professionals;
 - **Practical and hands-on experience:** Labs, workshops, and simulations to learn timber construction techniques and quality protocols in a concrete way;
 - **Content innovation:** Continuous update on new technologies about wood construction, and market trends;
 - **Networking and community:** Offering a dedicated space for professional exchange (companies, designers, wood product manufacturers, and plant engineers) with events, and discussion groups to strengthen a network in the sector.

■ **Replicability and Transferability Potential**

The ARCA Academy model is highly replicable as a training structure geared towards technical and professional qualifications in the sustainable construction sector. Its educational architecture, comprising progressive modules (a basic course, in-depth thematic studies and application workshops), as well as the integration of training, certification and professional networking, constitutes a scalable model that can be transferred to other areas of innovative construction.

■ **Lessons Learned**

Over the years, ARCA has promoted different partnerships at the national - and sometimes EU-level - to increase the visibility of its raising awareness and capacity building activities for professionals. This is the case, for example, of the recent partnership with Federazione Filiera Legno - a national entity representing the timber construction industry - to increase the number of digital and in-presence practical and awareness raising initiatives for professionals and technicians of the AEC sector.

● **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

Modular training structure:

The tiered pathway (Basic > Fundamentals > Workshop > Certification) is suitable for gradual progression of skills and adaptation to participants' different starting levels, providing a high level of training.

Integrated training, practice-oriented and certification approach:

ARCA combines technical training with practical case studies and the award of a high-quality mark for products or buildings. This link between expertise and official recognition could be transferred to other areas involving natural, bio-based or renewable materials in new constructions and energy retrofitting, thereby driving innovation in the green building sector.

Public-private

partnership:

The Arca Academy model fosters strong alignment between the supply and demand for skills by integrating the specific requirements of companies with the strategic vision of its initiators, which include the Autonomous Province of Trento, Trentino Sviluppo, the University of Trento, the CNR Institute for the Bioeconomy and businesses. Multiple local stakeholders are actively involved in co-designing training courses and the professional network, ensuring effective initiatives that generate concrete benefits for the region.

- Recurrent Challenges and Strategies for Overcoming Them.

Regulatory

framework

Challenges: Differences in local building codes, seismic regulations, and energy performance standards make it difficult to apply a uniform training and certification framework across different regions or countries.

Strategies: Continuous alignment with national and European standards (NTC, Eurocodes, UNI) and collaboration with professional orders to ensure legal recognition of training outcomes and professional credits (CFP).

Market

recognition

and

demand

Challenge: Limited awareness among clients, public administrations, and construction firms about the benefits of certified timber buildings could reduce the demand for ARCA-qualified professionals.

Strategies: Implementation of communication and outreach programs highlighting economic and environmental benefits of timber construction and creation of case studies and demonstrator buildings to showcase performance results.

Economic sustainability

Challenge: Ensuring the long-term financial and institutional sustainability of the Academy requires continuous enrollment, funding, and recognition.

Strategies: Diversification of funding sources (tuition fees, regional programs, EU projects, private sponsorships) and expansion toward international certification and e-learning to reach a broader audience.

Technological updating

Challenge: Rapid technological evolution in digital construction tools (BIM, LCA software, prefabrication systems) demands frequent updates to training and certification content.

Strategies: Ensure that the curriculum continuously integrates and updates BIM, digital fabrication and life-cycle assessment modules in line with new digital trends.

- Implications for Skills Development and VET.

- Shift toward specialized green skills (timber construction)
- Integration of technical and cross-disciplinary competences
- Work-based and experiential learning (theory and practice)

-
- Recommendations for Practice Transfer and Adaptation.

Adaptation to local regulations and resources:

ARCA standards are based on Italian regulations (NTC, UNI, Eurocodes) and reflect the national seismic and energy context. To be applied in other countries or regions, the protocol and educational content would require technical and regulatory adaptation. Such harmonization efforts would also contribute to enhancing mobility and employability across regions and EU member states.

Creation of institutional partnerships:

The value of ARCA certification stems from its recognition by public bodies and professional associations. In order to transfer this recognition elsewhere, local agreements must be in place to guarantee training credits, incentives, and market value. It would also be interesting to establish a network of “green construction academies” at a regional or national level to promote this approach to wood construction and certification.

Parallel development of a coherent production chain:

The success of ARCA depends on the presence in the territory of a short wood supply chain comprising forests, sawmills and X-Lam panel manufacturers. In areas where this supply chain is weak, the training model should be supplemented with initiatives to promote industrial development. The same observation applies if the model were to be transferred to other building areas involving natural, bio-based or renewable materials in new constructions and energy retrofitting.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

In conclusion, the experience of the ARCA Academy shows that integrated and modular training models, which combine theory and practice and connect diverse stakeholders, can effectively develop the skills needed for sustainable construction throughout the building's life cycle (design, worksite and construction). Evidence shows that such initiatives enhance professional capabilities and promote innovation ecosystems by linking education, certification and industrial competitiveness within the timber construction supply chain and all its participants.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Future actions in VET Training for the construction sector should focus on developing integrated ecosystems that support the green and digital transition. Central to this is promoting integrated skills frameworks combining green skills (energy efficiency, circularity, bio-based materials), digital skills (BIM and off-site manufacturing), and transversal skills (teamwork, project management, communication). Alignment with European frameworks like GreenComp and DigComp (2022) ensures consistency and comparability across national VET systems.

- **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.

To maximize visibility and uptake, Arca Academy could be disseminated as follows:

- Include in D2.3 Compendium of Best Practices for EXCEL4HOUSING4.0;
- Disseminate through VET networks, project presentation or conferences;
- Share best practices with other regional energy agencies and construction training providers;
- Teaching materials or operational guides.

Bibliography

(Comprehensive list of all consulted national, regional, and EU-level sources in APA style)

Not available

Annexes

(e.g., National bibliographies, templates used for desk research)

Not available

References

<https://www.arcacert.com/academy/>

Annex 18: ECO3R and CIRCULAR DESIGN POLITO LAB

Field	Description
Title of the practice	ECO3R and CIRCULAR DESIGN POLITO LAB
Country of implementation	Italy
Organisation(s) involved	Politecnico di Torino, DAD - Dipartimento di Architettura Politecnico di Torino, OffGrid Italia, VICO, Municipality of Cambiano (Piedmont, Turin)
Description	The Polytechnic University of Turin is the first in Italy to establish a circularity-focused research and teaching infrastructure open to the local community, as demonstrated by the CIRCULAR DESIGN POLITO LAB project. The project was developed within the framework of the ReLand Convention (2019) signed in by the Municipality of Cambiano, the Polytechnic University of Turin DAD and the Off Grid Italia Association. The initiative is part of the broader ECO3R Territorial Ecosystem for Reduction, Reuse and Recycling (2020) launched with the participation of 19 municipalities and the Chierese Servizi Consortium. ECO3R is a local project involving the Municipality of Cambiano, the Polytechnic University of Turin, and the Off Grid Italia Association. It was developed with funding from ATOR and co-financing from the Chierese Consortium for CCS Services, with the aim of creating a local Ecosystem for Reduction, Reuse and Recycling. Led by the Chierese Consortium for CCS Services, the project involves 19 municipalities in the Metropolitan City of Turin: Andezeno, Arignano, Baldissero Torinese, Cambiano, Carmagnola, Chieri, Isolabella, Marentino, Mombello, Moncucco, Montaldo Torinese, Moriondo Torinese, Pavarolo, Pecetto Torinese, Pino Torinese, Poirino, Pralormo, Riva Presso Chieri and Santena.
Thematic area(s)	Circular communities and ecosystems / Waste management / Research / Pedagogical
Methods and tools used	Circular economy practices and ecosystem, stakeholder engagement, research center, experimental lab
Target group(s)	Local Municipalities and companies, students, professionals, citizens
Outcomes and impact	The project promotes collaboration among various stakeholders including research institutes, companies, and the local municipality to strengthen teamwork and drive innovation in circular economy practices and local waste management. It also aims to raise citizens' awareness of sustainable consumption, encouraging progress towards the 10R principles of the circular economy.

Transferability	The ECO3R and the CIRCULAR DESIGN POLITO LAB projects demonstrate high transferability thanks to its collaborative model involving universities, public institutions, businesses, and citizens. Its systemic approach centered on creating a territorial ecosystem for reduction, reuse, and recycling can be replicated in other urban and regional contexts. The open and participatory structure allows adaptation to different local realities and supply chain, fostering social and environmental innovation. Moreover, the active engagement of academic institutions provides a scalable model for spreading the research and culture of circularity and waste management.
Relevance to E4H	The project is highly relevant for VET training as it fosters green skills through the practical application of circular economy principles. By integrating technological innovation, sustainable design, and territorial collaboration, it provides an experiential learning model that strengthens technical, managerial, and environmental competencies in line with the objectives of the European Green Deal. Furthermore, it supports the transition to a circular economy and sustainable waste management by addressing the growing demand for skills related to material reuse and circular practices within the construction supply chain.

Introduction

The project aims to promote strategies for developing circular economy communities in European cities, particularly focusing on medium-sized Italian cities, which are seen as key social and productive hubs. Transitioning the built environment toward circular systems (through circular buildings, materials, and products) is critical to reducing resource and energy impacts. The main challenge for the built environment to reduce its impacts in terms of natural resources and energy consumption could be achieved through the transition to a circular system, mainly based on circular infrastructures and buildings or circular products and materials [De Filippi and Carbone, 2021]. A model of circular ecosystems [Pietrulla, 2022], involving multiple interdependent actors with shared circular economy goals, is emerging but still lacks standardization. Building on this, the Department of Architecture and Design (DAD) at Politecnico di Torino, the private waste management company CCS, and 19 municipalities between Turin and Asti launched in 2020 the Eco3R project to establish a territorial CE ecosystem.

The project addresses the increasing environmental impact of global material consumption and waste production. Specifically, the construction industry is a major contributor to global energy-related emissions along the entire life cycle of buildings. In Piedmont, the largest quantity of waste comes from building sites and the production chain of building materials. In Piedmont, only 7% of special construction waste is actually reused in construction.

Eco3R, building on a previous ReLand project, investigates territorial potential for reuse, recycling, and waste reduction in a region of 125,647 residents over 434.56 km². The initiative integrates public and private actors to foster circular strategies at the local level.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an evidence-based, innovative, and transferable approach that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- **Selection and Evaluation Criteria** (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: The Eco3R project is unique at the national level in terms of circularity because it involves one of the most virtuous consortiums for waste separation in Italy activating a strong circular ecosystem. It also features a Repair Café laboratory where citizens can come daily to repair their objects and learn how to fix them. The area also has a web app for reuse, through which citizens exchange items and products instead of discarding them. Furthermore, the consortium is currently building a reuse center where citizens will be able to view furniture and objects left by others and exchange them for free.

VET relevance: The Circular Design Polito Lab approach fits into this context, bringing innovation to experimental teaching on circularity and waste management in the building industry. It creates a crossover between theoretical knowledge and hands-on experimental practice and research.

Impact: This project represents a key initiative in developing a circular economy ecosystem at the local level. By engaging 19 municipalities and numerous companies operating in waste management and construction, it influences a medium-sized urban area comprising 125,647 inhabitants over 434.56 km².

Sustainability:

The project defines medium and long-term strategies through the engagement of citizens, educational institutions, and business actors within the municipalities involved. Stakeholders were encouraged to collaboratively design pilot circular ecosystems exploring the reuse and recycling of materials deemed "non-waste" prior to their inclusion in waste collection systems, with the objective of discovering innovative applications for local community benefit.

- **Presentation of Best Practices by CoVE / Thematic Area**

Circular economy & natural materials; Low carbon footprint buildings

○ For each selected Best Practice (following the structure of the Template):

- Title of the Practice
ECO3R and CIRCULAR DESIGN POLITO LAB
- Country/Region and Partner(s) Involved
Italy
- Brief Description of the Practice

The “Circular Design Polito Lab” project (2024-2025) in Cambiano was initiated within the framework of the ReLand Agreement, signed in 2019 by the Municipality of Cambiano, the Politecnico di Torino DAD, and the Off Grid Italia Association. The initiative more broadly fits into the context of the Territorial Ecosystem for Reduction, Reuse, and Recycling ECO3R, launched in 2020, with the participation of 19 municipalities and the Chierese Services Consortium.

The project’s partner is Vico Srl, a company with many years of experience in environmental remediation and decommissioning, adopting circular economy as its mission and production model. The goal is to frame the development of an experimental circular architecture to host the lab activities by reusing decommissioned shipping containers and materials and components from buildings undergoing demolition. Inspired by the principles of the circular economy and the “10R” strategies, the project promotes the recovery and regeneration of materials and components as a model for architectural experimentation. Thus, the project is conceived as an open laboratory where learning, sustainability, and regeneration intertwine, generating value through the creation of an educational infrastructure that will give new life to resources that would otherwise become waste.

● Objectives and Challenges Addressed

The research-based ECO3R project, developed by DAD and all partners, aims to envision possible medium and long-term strategies and actions through the involvement of citizens, educational institutions, and business sectors across the nineteen municipalities covered by the consortium. Stakeholders were challenged to co-design pilot circular ecosystems that experiment with the reuse and recycling of objects classified as “non-waste” before they enter waste collection systems, with the aim of identifying new potential uses for local communities. Another specific goal was to provide a design support system to help the consortium develop future circular ecosystems.

The Circular Design Polito Lab initiative aims to be a research and educational infrastructure focused on circularity. This infrastructure includes a warehouse, workshops and innovative teaching spaces suitable for practice activities. The lab aims to disseminate and systematize the concept of the 10 Rs of the circular economy (Replace, Rethink, Reduce, Reuse, Repair, Renew, Rebuild, Repurpose, Recycle, and Recover). These principles provide a structured framework to optimize resource use and minimize the environmental impact of production and consumption, guiding both companies and citizens toward more responsible, sustainable, and regenerative practices.

■ Methodology / Approach Implemented

The programme comprises several projects with an extensive timeline, as well as different funding and partnership agreements, which provide solid foundations for the programme as a whole, ensuring its success and progressive development.

ReLand: (2017-2019)

Eco3R: (2021-ongoing)

Polito Circular design Lab (2022-ongoing)

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Observatory for the Circular Economy (Eco3R)

A design support system aimed at defining design principles and analyzing the supply chain of local materials. The Observatory maps specific circular economy strategies and examines national guidelines and regulations to ensure alignment with national and EU frameworks.

Process Map (Eco3R)

The map, developed as a guiding tool based on geo-referenced and socio-economic data, was designed for the ex-ante assessment of the territorial ecosystem. It illustrates key processes, the relationships among institutional actors, and potential material flows that could be integrated into a future local circular ecosystem.

This map was shared with the nineteen municipal administrators and technical staff involved in the project. It identifies the main companies in the area, categorizing them according to their production chains and the types of waste they generate. By doing so, the map has proven valuable in supporting municipalities and the CCS during the preliminary phase of identifying relevant actors and potential material supply chains that could eventually foster the creation of a local circular economy ecosystem.

Design guidelines

DAD created the design framework for the “Eco3R Laboratory,” a local experimental space dedicated to minimizing urban waste and facilitating educational activities with the participation of both citizens and schools.

Circular Design Polito Lab

The Lab, constructed entirely from decommissioned materials sourced from local demolition sites, will serve as a platform for experimental teaching methods centered on responsible, sustainable, and regenerative design and construction practices. It will provide valuable support to universities, students, and the local community.

■ Key Success Factors

The success of the project relies on several key factors. First, strong public and factories investment/engagement has been crucial in fostering the development of a local circular ecosystem. Active community participation has further supported the co-creation of solutions and strengthened local ownership of circular economy initiatives. Additionally, the institution of educational and non-conventional learning formats, developed in collaboration with the Circular Design Polito Lab, will promote knowledge sharing, innovation, and long-term capacity building among stakeholders.

■ Replicability and Transferability Potential

The project demonstrates strong replicability and transferability potential, as its methods and tools can be easily adapted to different national contexts. The project model is highly replicable as it defines a clear strategy for municipalities to adopt and implement. Among the different material and strategic outputs of this research, a key result is the creation of a network of municipalities that have become more aware of how Circular Economy (CE) processes can be generated locally and must involve collaboration among various actors. In this regard, the “Eco3R Observatory for the Circular Territorial Economy” project also focuses on boosting potential supply chains to foster new circular territorial economies. Eco3r has analyzed material flows and outlined possible strategies for industrial symbiosis and circular economy initiatives based on surveys of local industries. Among the most relevant findings, the presence of construction companies stands out, as they show interest in the construction supply chain and in strategies for material recovery or the use of secondary raw materials (SRM).

■ Lessons Learned

Throughout the different phases of the project, the importance of building a solid stakeholder ecosystem became clear. Engaging key stakeholders from the outset strengthened the overall project feasibility and created the necessary conditions to effectively scale the new concept at a national level.

● Cross-Cutting Analysis of Best Practices

- Common Trends and Success Patterns.

Public-private

partnership

A recurring success pattern of the project is the effective collaboration between public institutions, private companies/factories, and civil society actors. The initiative demonstrates how strategic public-private partnerships are essential to drive innovation in circular economy practices and building a circular ecosystem, leveraging complementary expertise and resources. The Municipality of Cambiano, Politecnico di Torino DAD, provides governance, educational capacity, and community engagement, while the private partner contributes technical knowledge and operational experience in material recovery and environmental remediation.

Shared commitment on circular economy and sustainability

The project highlights a strong shared commitment to circular economy and sustainability among all partners. This collaboration generates social, educational, and environmental value while fostering systemic change in urban regeneration. The feature is particularly significant in the Italian context, where awareness and implementation of circular economy principles remain limited compared to other European countries, making such partnerships crucial for advancing national sustainability practices.

○ Recurrent Challenges and Strategies for Overcoming Them.

Fragmentation of stakeholders

Challenges: Coordinating different institutions, universities, private companies and numerous consortia can cause delays in achieving results or defining common objectives.

Strategies: Define clear roles, shared objectives and regular communication between partners.

Awareness and cultural barriers

Challenges: In Italy, awareness and interest in circular economy principles is still low compared to other European countries, which can lead to resistance or poor participation from the community and local operators.

Strategies: Organise workshops, educational events and information campaigns to raise awareness among local communities and stakeholders about the socio-economic benefits of the circular economy.

Local supply chain and logistic

Challenges: Identifying and connecting the diverse local actors involved in material recovery and recycling. Multiple companies handle different types of materials and without a clear understanding of who does what, coordinating the supply chain becomes inefficient and fragmented. In addition, managing decommissioned materials and components required high-level logistics and a large amount of proper storage space.

Strategies: Developing a comprehensive map of local stakeholders who could participate in circular economy practices is key. Regular engagement with these stakeholders also helps to build trust and facilitate long-term partnerships.

Regulation Framework

Challenges: In Italy, there is no specific regulation for the reuse of construction materials and demolition waste, which slows down the implementation of such methodologies and creates confusion among professionals.

Strategies: Establishing close collaboration with local authorities and legal experts helps ensure compliance while identifying opportunities to streamline procedures. Clear understanding of the regulatory framework also supports project scalability and serves as a model for replicable best practices in urban regeneration and circular construction.

- Implications for Skills Development and VET.
- Shift toward specialized green skills (circular economy)

- Integration of technical and cross-disciplinary competences (architecture, engineering, environmental management, and logistics)
- Work-based and experiential learning (experimental lab)
- Bridges the gap between academia and industry (collaboration with companies)
- Recommendations for Practice Transfer and Adaptation.

Integration of digitalisation

Leveraging digital tools to support the collection and analysis of material flows between different entities and their logistics. By assigning an identity to materials, awareness and understanding of their life cycle is increased, facilitating reuse, reducing waste and minimising environmental impact.

Involvement of local stakeholders (businesses and factories)

Identify the key players in the area who are interested in specific construction supply chains, as well as strategies for recovering materials and using secondary raw materials, in order to increase economies of scale and take advantage of territorial proximity.

Memorandum of understanding (MoU)

Co-designing agreements to facilitate relations between local businesses and material recovery activities and offering common guidelines for “selective demolition” processes that recover almost all materials from construction sites and transform them into new products.

• **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The analysis of best practices highlights that successful circular design initiatives consistently integrate multi-stakeholder collaboration. The project, along all its different phases, demonstrates how partnerships between academic institutions, local authorities, and specialized companies can effectively mobilize technical expertise and regulatory knowledge in material reuse. The project also illustrates how an experimental lab setting can function as both a practical testing ground for regenerative design methods and an educational platform, fostering awareness and skills in sustainable construction.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Future actions in VET training for the construction sector should focus on developing integrated ecosystems that support the green, circular, and digital transition. These initiatives should promote integrated skills frameworks, combining green and circular skills with transversal competencies such as teamwork, project management, and communication. In this context, circularity is crucial to address resource scarcity and to capitalize on the vast quantities of construction waste available for reuse.

• **Dissemination Plan for the Compendium**

-
- Strategies and channels for disseminating D2.3.
 - Include in D2.3 Compendium of Best Practices for EXCEL4HOUSING4.0;
 - Disseminate through VET networks, project presentation or conferences;
 - Share best practices with other regional energy agencies and construction training providers;
 - Teaching materials or operational guides.

Bibliography

(Comprehensive list of all consulted national, regional, and EU-level sources in APA style)

- Pietrulla F., “Circular ecosystems: A review”, Dec. 2022.
Available at:
<https://www.sciencedirect.com/science/article/pii/S2772801322000276?via%3Dihub>
- Carbone C., De Filippi F., “ICT as innovative tools for circular planning in urban areas”, July 2021.
Available at:
https://www.researchgate.net/publication/355853166_ICT_as_innovative_tools_for_circular_planning_in_urban_areas

Annexes

(e.g., National bibliographies, templates used for desk research)

- <https://bachecadelriutilizzo.ccs.to.it/>
- <https://alvearia.net/il-modello-delle-10-r-per-capire-leconomia-circolare/>
- <https://www.ccs.to.it/home/Eco3R>

References

- Callegari G., Ricciardi G., Roccasalva G., Simeone P., “Territorial Ecosystem for circular economies: Eco3R research project”, (2023), pp.174-183. Proceeding of the 5th International Conference: *Recycling. Il valore della materia nella transizione ecologica del settore delle costruzioni*, Rome 26/05/2023).

Annex 19: DEAL with DIGITAL WBL – Work-Based Learning digitale

Field	Description
Title of the practice	DEAL with DIGITAL WBL – Work-Based Learning digitale
Country of implementation	Italy
Organisation(s) involved	SFC Sistemi Formativi Confindustria (IT) with FUNDACIO PER A LA UNIVERSITAT OBERTA DE CATALUNYA (ES), Duale Hochschule Baden-Württemberg (D), Panevezio kolegija (LT), HANSE-PARLAMENT EV (D), IPARTESTULETEK ORSZAGOS SZOVETSEGE (H), CIS SCUOLA PER LA GESTIONE D'IMPRESA (IT), Dinamo Adv Srl
Description	The DEAL with DIGITAL WBL project, coordinated by SFC – Sistemi Formativi Confindustria within the framework of the Erasmus+ programme (2021-2023), promotes the adoption of digital methodologies in Work-Based Learning (WBL). The initiative develops tools, guidelines, and training pathways for trainers and company tutors, with the aim of effectively integrating digital technologies and virtual environments into VET programmes, thereby strengthening the digital skills of students and workers and improving the quality and transferability of training experiences.
Thematic area(s)	Digital skills / VET programme / Work-Based Learning (WBL)
Methods and tools used	Work-Based Learning
Target group(s)	VET trainers and tutor
Outcomes and impact	The DEAL with DIGITAL WBL project developed a framework of emerging digital competences for VET trainers across Europe and created an online training course to help integrate work-based learning (WBL) methodologies with digital tools. It also launched an Ambassador Programme to promote good practices in hybrid and digital learning environments. The project strengthened VET trainers' digital competences and made work-based learning more accessible and engaging through online and hybrid approaches, while fostering stronger collaboration between education providers, companies, and local stakeholders to build more flexible and innovative learning ecosystems.
Transferability	The project-based approach used in VET and WBL could be effectively applied to the building and construction sectors, which today face an urgent need to reassess the skills of trainers, tutors, and professionals. These roles increasingly require the development of digital competencies aligned with market demands and EU regulations on digital and green skills. In fact, the construction sector remains stagnant and faces structural

	challenges, showing limited openness to innovation. Research indicates that a key contributing factor is its low level of digital integration.
Relevance to E4H	It supports the central goal of the digital transition for VET initiatives and Work-Based Learning, addressing the emerging need for digital skills in the construction sector's learning approach.

Introduction

Investments in the training of VET teachers and trainers aimed at improving their knowledge and ability to use Digital Technologies for learning are generally insufficient, as recently highlighted by the OECD (2021) and the ILO (2021). This shortfall is even more significant when we consider that the Next Generation EU priorities emphasize the need for technological infrastructures and the strengthening of Vocational Education and Training (VET) systems, in line with the objectives of the Digital Education Action Plan 2021–2027.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- **Selection and Evaluation Criteria** (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

VET relevance: The DEAL with Digital WBL project is highly relevant for VET as it promotes the innovation of work-based learning pathways by integrating digital tools and blended methodologies. It supports the development of advanced digital skills for trainers, enhancing the design, delivery, and assessment of training programs. The project aligns vocational education with current labor market needs, increasing students' employability. Furthermore, it fosters inclusion and accessibility, enabling a wider range of students to participate in WBL experiences, and strengthens cooperation between VET centers and enterprises, facilitating the exchange of good practices at the European level.

Transferability: The innovative approach, combined with the integration of digital work-based learning pathways, enhances training experiences and fosters the development of VR-based methodologies that go beyond current e-learning standards. These methodologies can be effectively transferred to VET education in the building sector.

- **Presentation of Best Practices by CoVE / Thematic Area**

Circular economy & natural materials; Low carbon footprint buildings

○ For each selected Best Practice (following the structure of the Template):

- Title of the Practice
DEAL with DIGITAL WBL – Work-Based Learning digitale
- Country/Region and Partner(s) Involved
Italy
- Brief Description of the Practice
The DEAL with DIGITAL WBL project, coordinated by SFC – Sistemi Formativi Confindustria promotes the adoption of digital methodologies in Work-Based Learning (WBL). The initiative develops tools, guidelines, and training pathways for trainers and company tutors, with the aim of effectively integrating digital technologies and virtual environments into VET programmes, thereby strengthening the digital skills of students and workers and improving the quality and transferability of training experiences. The consortium, led by SFC and composed of strategic partners including business associations, universities specializing in innovative pedagogy, and vocational training centers active in the fields of mechatronics and the green economy. The consortium works to enhance the capacity of VET trainers in Italy, Germany, Spain, Hungary, and Lithuania to apply innovative pedagogical approaches. The project provides a targeted training opportunity focused on the design of Digital Work-Based Learning (WBL) experiences.
- Objectives and Challenges Addressed
 - Develop a framework of emerging digital skills for VET trainers, necessary to innovate Work-Based Learning (WBL) methodologies as well as online laboratory and experiential learning;
 - Encourage VET trainers to acquire specific competences to design, deliver, assess, and certify skills learned through Digital Work-Based Learning experiences;
 - Develop a training pathway to enhance the digital skills of VET trainers, accessible online through the “Deal with Digital Work-Based Learning” platform, aimed at integrating the use of digital technologies into Work-Based Learning experiences;
 - Create stimulating and inclusive opportunities for the professional development of VET trainers;
 - Enrich and make more attractive for learners the training opportunities based on Digital Work-Based Learning;

- Innovate and enhance the tools for cooperation between training providers and enterprises, making Work-Based Learning experiences more accessible through digital tools.

■ **Methodology / Approach Implemented**

The main direct target group on which the partnership intends to act, in order to strengthen the ability to diversify Work-Based Learning (WBL) methodologies and make them more sustainable (also by expanding opportunities for remote WBL exchange and learning) is the VET trainer profile, whether coming from companies or from VET training centers.

■ **Outcomes and Demonstrated Impact (quantitative/qualitative)**

- A framework of innovative pedagogical approaches and an appropriate quality framework to support the digital transformation of work-based learning experiences (Guidelines for Designing Digital WBL & Remote Experiential Activity);

- A competence framework on emerging digital skills for the VET trainer needed to innovate Work-based Learning methodology, laboratory and experiential online learning (Emerging digital skills model for VET trainers and Blueprint for VET trainers' development of digital competences);

- A training course to enrich the digital skills of VET trainers, available at a distance on the "Deal with Digital Work-Based Learning" platform (Training course and e-learning platform – Cross-media learning platform);

■ **Key Success Factors**

- **Digital skills and trainers attitude**

The project highlights that having technologies is not enough: it is essential that teachers and trainers possess the mindset, emerging digital skills, and openness to innovation to effectively use digital work-based learning experiences;

- **Infrastructure and technological maturity**

One of the macro-factors indicated in the project "Guidelines" is the availability of connectivity, devices, and adequate digital infrastructure in VET centers in order to implement Digital WBL;

- **Innovation culture and network among stakeholders**

Support from the training organization (VET center/company), collaboration between centers, companies, and universities, and the sharing of digital practices and tools are considered success factors: the "networked community" is seen as an integral part of the model;

- **Adequate methodologies**

The project emphasizes that digital content, appropriate WBL teaching methodologies, and tools for assessing skills acquired digitally must be developed.

■ Replicability and Transferability Potential

The Digital Work-Based Learning (Digital WBL) approach can be effectively applied to the vocational training sector in construction by integrating digital tools and immersive technologies such as augmented reality, 3D simulations, and e-learning platforms into hands-on experiences on-site or in the laboratory. Trainers can guide students in acquiring specific technical skills, from reading plans to operating machinery, through virtual or blended exercises, while ensuring safety and process standardization.

■ Lessons Learned

Trainer preparation is essential for WBL programs. Investing in trainers' digital skills improves the quality and effectiveness of training, ensuring that new technologies are used to their full potential. However, it is important to remember that digital tools should complement, not replace, practical experience: technology can enhance learning but cannot fully substitute hands-on work. For this reason, blended approaches, combining digital and practical components, are often the most effective.

Inclusion and accessibility must be considered in every training project. Digital solutions can remove barriers for students in remote areas or with special needs, but careful design is necessary to ensure equitable access for all.

Close collaboration between VET centers and enterprises is also crucial. Such partnerships ensure that training is relevant, up-to-date, and aligned with the needs of the labor market.

● Cross-Cutting Analysis of Best Practices

○ Common Trends and Success Patterns.

Trainer development as a key leverage:
Targeted training programs for trainers generate a greater impact on VET practices;

Shared documentation and guidelines:
Blueprints, guidelines, and standardized digital materials facilitate replication in different contexts;

Active involvement of enterprises:
Close partnerships with companies to design concrete, digitally supported WBL experiences;

Communities of practice and ambassador program:
Creation of networks of "ambassador" trainers who disseminate best practices within VET.

○ Recurrent Challenges and Strategies for Overcoming Them.

Digital skills among trainers
Challenges: Not all VET trainers were initially comfortable with digital tools and online learning platforms.

Strategies: Providing structured training, webinars, and hands-on workshops to build digital competence.

Resistance to change in teaching methods

Challenges: Some trainers or institutions could be hesitant to adopt blended or fully digital WBL approaches.

Strategies: Demonstrating benefits, sharing success stories, and creating ambassador networks to foster adoption.

Aligning WBL with labor market needs

Challenges: Ensuring that digital WBL experiences matched the evolving skill demands of companies could be challenging.

Strategies: Continuous dialogue with companies ensured WBL content remained relevant and aligned with labor market needs.

Engaging students remotely

Challenges: Maintaining active participation in digital WBL modules requires some precautions.

Strategies: creating interactive and modular learning along with quiz.

○ **Implications for Skills Development and VET**

- Enhances learners' and trainers' skills, both digital and professional
- Modernizes VET delivery: more flexible, inclusive, and aligned with labor market needs
- Fosters continuous learning and cooperation between education and industry

○ **Recommendations for Practice Transfer and Adaptation**

Invest in trainer upskilling

Provide structured training and continuous support to ensure that trainers gain full familiarity with digital tools and WBL approaches. To ensure educational transferability within the construction industry value chain, it is important that this upskilling program is extended to all stakeholders in the value chain who will serve as trainers.

Conduct research on digital tools

Conduct a structured research study to identify which digital tools are essential for use in the construction process and related apprenticeships.

Involve businesses from the design stage onwards

Ensuring collaboration with partner companies in the sector is essential to guarantee that WBL experiences are relevant and respond to the needs of the real labour market. Specifically, for transferability in the

construction sector, ensure that the digital tools chosen reflect the needs and standards of the construction process.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The DEAL with Digital WBL project is an important initiative because it transforms VET by integrating digital technologies directly into work-based learning. The project equips learners with practical and up-to-date digital skills while giving educators the tools and methodologies to design and deliver technology-enhanced learning experiences. Beyond skill-building, it fosters closer collaboration between training institutions and workplaces, ensuring that education reflects real-world needs. By promoting innovation and digital culture within VET providers, the project helps prepare both students and educators for the evolving demands of digital skills within the modern labor market.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

To strengthen vocational training in sustainable construction, it is essential to integrate digital skills, combining innovative technologies and tools. It is also important to promote work-based learning and apprenticeships, allowing professionals and students to apply sustainable practices in real contexts through close collaboration with companies. Finally, curricula should be modular and flexible, able to quickly adapt to new regulations, technologies, and environmental challenges, including short courses and micro-credentials to support continuous professional development.

- **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.
To maximize visibility and uptake, DEAL with DIGITAL WBL project could be disseminated as follows:
 - Include in D2.3 Compendium of Best Practices for EXCEL4HOUSING4.0;
 - Disseminate through VET networks, project presentation or conferences;
 - Share best practices with other regional energy agencies and construction training providers;
 - Teaching materials or operational guides.

Bibliography

(Comprehensive list of all consulted national, regional, and EU-level sources in APA style)
Not available

Annexes

(e.g., National bibliographies, templates used for desk research)

All publications consulted are available at: <https://digitalwbl.com/results/>

References

<https://digitalwbl.com/>

Annex 20: Estate with Climate simulation game

Field	Description
Title of the practice	<i>Estate with Climate</i> simulation game
Country of implementation	Poland
Organisation(s) involved	Warsaw University of Life Sciences (SGGW), National Center for Research and Development (NCBR), Oslo Metropolitan University – Storby Universitetet, Western Norway Research Institute Vestlandsforskning, Iceland Liechtenstein Norway grants
Description	The “Estate with Climate” initiative addresses the urgent need to adapt housing estates to climate change and sustainable development principles. Objectives include: • Designing housing estates that minimize carbon footprint. • Integrating nature-based solutions (green roofs, rainwater retention, biodiversity corridors). • Promoting renewable energy in residential areas. • Developing educational modules for VET and higher education students.
Thematic area(s)	Green, Circular, Pedagogical
Methods and tools used	Digital tools: building Information Modelling (BIM), GIS for climate adaptation planning Green solutions: passive house technologies, renewable energy systems (PV panels, heat pumps) Educational methods: blended learning, practical training at pilot sites
Target group(s)	Students (architecture, engineering, environmental management), construction professionals, urban planners, cooperative housing managers, eco-advisors
Outcomes and impact	Quantitative: reduced CO₂ emissions of designed compared to conventional housing, improved energy performance certificates. Qualitative: increased awareness among urban planners and students, strengthened cooperation between academia, municipalities, and real estate sector.
Transferability	The approach can be replicated in other Central European countries because it uses widely available tools (BIM, passive design), applies EU-standard sustainable construction frameworks and relies on cross-sector partnerships (universities, local governments, companies). Game is available not only in Polish version, you can use it at the same time in the board game version and online.
Relevance to E4H	This practice directly supports green transition and innovation capacity building in housing and construction sectors by: providing a VET-oriented

	example of climate-smart estate planning, demonstrating a cross-cutting integration of energy efficiency, circularity, and pedagogical innovation, as well as serving as a transferable pilot for other European CoVEs (Centers of Vocational Excellence).
--	--

Introduction

The Game “Estate with Climate” was launched in 2022 as part of the Co-Adapt Project – ‘Communities for Climate Change Action’, ‘Communities for Climate Change Adaptation Action.’ This game helps to understand how to best adapt a housing estate to climate change. The case study will present this innovative housing and urban planning concept developed by the team from Warsaw University of Life Sciences (SGGW). The purpose of including this practice is to highlight how climate-responsive estate planning integrates sustainable energy, green construction, and social inclusion. The methodologies used include desk research (publications of the Capital City of Warsaw City Hall, SGGW and CoAdapt program), expert consultation, and alignment with E4H thematic areas. The game can help find practical solutions that may contribute to lowering the temperature in the summer, retaining water, improving the settlement’s microclimate, caring for biodiversity, and increase pollutant uptake.

- **Definition and Criteria for Best Practices**

- Definition of “Best Practice” for EXCEL4HOUSING4.0.
- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

A Best Practice in EXCEL4HOUSING is an innovative, effective, and transferable action that contributes to the green transition of the housing and construction sector, strengthens VET (vocational education and training) capacity, and promotes digital, sustainable, and circular approaches.

The practice can be adapted to different regions and contexts. The impact is measurable in environmental and educational aspects, as well as social benefits. In times of rapid development, it is important that the practice uses new technologies, processes, or pedagogical approaches. The practice ensures sustainability through long-term environmental and financial viability, strengthens VET relevance by directly integrating into training and upskilling programs, and demonstrates strong transferability with potential to be scaled or integrated into other CoVEs and projects.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.

-
- For each selected Best Practice (following the structure of the Template):
 - Title of the Practice
 - Country/Region and Partner(s) Involved
 - Brief Description of the Practice
 - Objectives and Challenges Addressed
 - Methodology / Approach Implemented
 - Outcomes and Demonstrated Impact (quantitative/qualitative)
 - Key Success Factors
 - Replicability and Transferability Potential
 - Lessons Learned

Thematic area: Green, circular, pedagogical, social awareness in education, energy efficiency in housing

Title: The “Estate with Climate” game

Region: developed in Poland but can be used in Poland as well as the rest of the Europe. In the online version players enter their postal code, and the game renders their estate as a 3D model. In the board game version the only thing players have to do strictly by themselves is to print the area of interest. This way it is possible to use the “Estate with Climate” game for almost every area.

Partners involved: game was developed by the team from Warsaw University of Life Sciences (SGGW) with help of many other subjects such as: Polish National Center for Research and Development (NCBR), Oslo Metropolitan University – Storby Universitetet, Western Norway Teseach Institute Vestlandsforskning, Iceland Liechtenstein Norway grants.

The CoAdapt project was created during the IdeaLab workshops, “Cities of the Future: Services and Solutions,” organized by the Polish National Center for Research and Development as the operator of the “Applied Research program” implemented under the EEA Financial Mechanism and the Norwegian Financial Mechanism for 2014-2021.¹

As part of the Co-Adapt project, a team of scientists has been collaborating with the City of Warsaw since 2022. The game “Osiedle z Klimatem” (Estate with Climate) was pilot-tested together on 6 different Warsaw housing estates. The workshops, attended by residents, experts from Warsaw universities, and experts from other institutions, had nearly 80 participants. Among them were residents, local leaders, community activists, and even “guerrilla gardeners.” The educational game proved to be an effective tool for consulting with different generations of residents. It

¹ CoAdapt, *Local community efforts to adapt to climate change*, <<https://coadapt.pl/aktualnosci/>> access 25.08.25

enabled them to listen to their needs and discuss, in consultation with experts, what actions are feasible to implement and what their climate, environmental, and social benefits are.²

In the times of global warming and dynamic climate changes, it is crucial to take care of the environment, sustainable development, and reducing CO2 emissions. The effects of climate change can be felt by city dwellers, where extreme weather events such as heat waves, heavy rainfall, and droughts are particularly severe. It is a serious simulation game, which serves as an innovative tool to engage urban residents in designing and implementing climate adaptation measures for their housing estates. The game is a tool that is meant to help plan and adapt living spaces to climate change by simulating the effects of implementing various solutions, including the simplest ones, in one's own neighborhood. Players can select from 40 nature-based solutions, such as rain gardens, absorption basins, climbing plants, trees, and flower meadows, then simulate their effects using embedded algorithms: assessing reductions in air temperature, improved air quality, rainwater retention, contributions to biodiversity, and cost-effectiveness.³



Figure 1. Computer game "Estate with Climate"

Some of the objectives and challenges addressed:

- Reduce environmental impact of residential areas
- Enhance resilience of housing to climate change
- Increase cooperation between academia, municipalities, and real estate
- Provide hands-on training for students and more.

² Urząd Miasta Stołecznego Warszawa, 2024, "Estate with Climate", residents adapting their surroundings to climate change, <<https://eko.um.warszawa.pl/-/gra-co-adapt>>

³ SGGW, Estate with Climate, <<https://osiedlezklimatem.sggw.edu.pl/?lang=en>> access 25.08.25

Methodology / approach implemented: The initiative applied a holistic and practice-oriented methodology that combined advanced digital tools, sustainable construction standards, and experiential learning. Building Information Modelling (BIM) and Geographic Information Systems (GIS) supported climate-adaptive estate design, while passive housing technologies, renewable energy systems, and water retention measures were embedded in the construction process. Educational activities included blended learning, site visits, and real-life design projects, ensuring direct involvement of students and professionals.

Outcomes and demonstrated impact: The project achieved tangible environmental and educational outcomes. Quantitatively, pilot designs demonstrated a reduction of CO₂ emissions compared to conventional housing estates and significantly improved building energy ratings. Qualitatively, the practice fostered collaboration between universities, municipalities, and developers, enhanced awareness of sustainable housing solutions, and embedded climate-smart modules into academic and VET curricula. The demonstrated impact shows both environmental gains and a strengthened innovation culture in vocational education.

Key success factors:

- Integration of research, practice, and training (cooperation between universities, institutes, local authorities, and the construction sector ensure knowledge exchange and practical application).
- Use of both digital and green technologies (combination of BIM, GIS, renewable energy, and passive designs creates an innovative and future-proof solutions).
- Stakeholder engagement (early involvement of municipalities, developers, residents, experts, and students increased ownership and acceptance of the outcomes).
- Alignment with EU policy frameworks (this initiative directly supports actions such as EU Green Deal, Fit for 55, and climate adaptation strategies).

Replicability and transferability potential: This approach is easily adaptable to other European urban contexts, not only for planning environment for construction, but also for educating when it comes to green transition. Actions in line with EU policy and pro-ecological actions ensure the possibility of applying the practice at the European level.

Lessons learned:

- stakeholders' involvement is crucial from the start,
- digital tools require for capacity building,
- education and practice conveyed in a more accessible way is a good solution if the recipients are a wide and diverse group,

-
- holistic approaches work best,
 - financial mechanism matters (the CoAdapt project is benefiting from €1.49 million in funding received from Iceland, Liechtenstein and Norway under the EEA Funds through the National Centre for Research and Development).
 - **Cross-Cutting Analysis of Best Practices**
 - Common Trends and Success Patterns.
 - Recurrent Challenges and Strategies for Overcoming Them.
 - Implications for Skills Development and VET.
 - Recommendations for Practice Transfer and Adaptation.

The practices collected for E4H demonstrate how climate-responsive housing and VET intersect. Several trends emerge:

- Integration of digital tools: BIM, GIS, energy simulations are becoming essential across all regions, enabling better design quality and measurable energy savings.
- Multi-stakeholder cooperation: municipalities, universities, institutes, and construction companies collaborate to accelerate innovation and ensure real-life application.
- Educational embedding: many practices link directly to curricula, training modules, or upskilling programs, ensuring continuity and workforce readiness.

Examples of actions:

- Ursynów, Warsaw – collecting rainwater from roofs and discharging it into the ground – retaining excess rainwater on site, large variety of vegetation;
- Copenhagen – used instead of lawn, flower meadows improve the microclimate, keep more moisture in the ground, increase biodiversity;
- Oslo – edible plants around buildings increase the proportion of greenery and improve the microclimate, promote biodiversity.

Challenges:

- Financial barriers: sustainable solutions often rely on EU funds or local incentives, with limited private-sector uptake. This means that not every entity has a chance to implement new solutions, especially smaller counties and municipalities.
- Capacity gaps: VET institutions frequently lack trainers with expertise in digital and climate-smart methods.
- Scaling difficulties: pilot projects show impact, but replication beyond the local level remains uneven.

Implications for VET are significant: new skillsets are required in climate adaptation planning, circular construction, and digital modelling. Best practices show that VET providers must evolve towards centers of excellence that link training with applied research and industry demand. When planning regional projects, support for smaller cities and municipalities should be taken into account, as they may need it more than developed cities and metropolises.

Recommendations for adaptation and transfer:

- Integration into VET Curricula: it is recommended to use the game as a blended learning tool in architecture, construction, and environmental courses.
- Scalability: it is possible to expand this tool beyond housing estates to include urban districts, schools, or industrial zones, making the tool versatile for different construction sectors.
- Adapting for students: development both basic scenarios for secondary VET students and advanced scenarios for higher education and professional training.
- Trainer support and guidelines: provide manuals and short e-learning courses to help teachers/trainers integrate the game into lessons and encourage peer-learning sessions where participants from different CoVEs can share experiences.
- Improvement: collect feedback from users to refine mechanics and learning outcomes, exploration and sharing knowledge will help make this game even more realistic.
- **Conclusions and Recommendations**
 - Synthesis of Key Findings from the compendium.
 - Recommendations for future actions and projects in the field of VET and sustainable construction.

Climate-responsive estate models like *Estate with Climate* are not isolated initiatives, but part of a broader European trend towards sustainable housing innovation.

Conclusions:

The *Estate with Climate* initiative shows that sustainable housing design can be successfully combined with education and training. It proves that VET and higher education can work together with municipalities and developers to create climate-friendly solutions. The practice demonstrates measurable environmental benefits, such as lower emissions and better energy performance, while also giving students and professionals practical skills. Its game-based approach makes learning engaging and adaptable to different regions.

Overall, *Estate with Climate* confirms that climate-smart housing can be scaled, transferred, and used as a strong example for other CoVEs in Europe.

Recommendations:

To build on the success of *Estate with Climate*, it is recommended to strengthen its use in vocational training by integrating the game and related methods into curricula. The tool should be adapted to different regional contexts, with localized data and language versions, so it can be applied across Europe. Greater cooperation between CoVEs, municipalities, and developers will help transfer the practice, while continued investment in trainer support and digital tools will ensure long-term impact.

- **Dissemination Plan for the Compendium**
 - Strategies and channels for disseminating D2.3.
- Academic and professional dissemination: Present findings at European housing and sustainability conferences, publish in journals, and host webinars with universities and research networks.
- VET and CoVE channels: Integrate case studies into training curricula, share through national VET platforms, and organize workshops for trainers.
- Policy level: Share key recommendations with ministries, local authorities, and EU-level bodies working on the Green Deal and Fit for 55.
- Digital outreach: Publish summaries and visual materials on social media, project websites, and the EXCEL4HOUSING knowledge hub.
- Practical demonstration: Organize study visits to pilot estates such as *Estate with Climate*, allowing other CoVEs and stakeholders to experience solutions first-hand.

Bibliography

CoAdapt, *Local community efforts to adapt to climate change*, <<https://coadapt.pl/aktualnosci/>> access 25.08.25
 Urząd Miasta Stołecznego Warszawa, 2024, "*Estate with Climate*", *residents adapting their surroundings to climate change*, <<https://eko.um.warszawa.pl/-/gra-co-adapt>>
 SGGW, *Estate with Climate*, <<https://osiedlezklimatem.sggw.edu.pl/?lang=en>> access 25.08.25

Annex 21: Nationwide Polish program “Eco-workshop – the green heart of the school”

Field	Description
Title of the practice	Nationwide Polish program “Eco-workshop – the green heart of the school”
Country of implementation	Poland
Organisation(s) involved	Polish Provincial Fund for Environmental Protection and Water Management (WFOŚiGW) Polish National Fund for Environmental Protection and Water Management (NFOŚiGW) Ministry of Climate and Environment (MKiŚ) Primary and secondary schools throughout Poland
Description	“Ekopracownia – Zielone Serce Szkoły” (Eco-workshop – Green Heart of the School) is a nationwide educational and infrastructure program aimed at primary and secondary schools. Its aim is to build and equip modern, interactive thematic workshops (on nature and renewable energy sources) to develop ecological attitudes among children and young people. The program is financed from the national budget as part of the Regional Program for Environmental Education Support. Each district in Poland is to receive at least two laboratories. In total, the project was to include 760 new eco-laboratories supporting climate education, sustainable development, and practical environmental learning.
Thematic area(s)	Green, Pedagogical, Circular, Digital
Methods and tools used	-Creation and equipping of modern educational laboratories -Experimental kits related to renewable energy sources (photovoltaics, wind turbines, water turbines) -Interactive monitors, microscopes, environmental sensors -Project-based education, workshops, competitions, and thematic lessons -School events (Earth Days, Open Laboratory Days) -Learning through action and experimentation *methods and tools used depended on the project implementation concept in specific locations and differed from one another.
Target group(s)	-Primary and secondary school students (aged 10–18) -Teachers of natural sciences, biology, physics, geography, and technology -School and local communities (families, parents, local governments)
Outcomes and impact	The creation of 760 eco-workshops in schools across Poland has improved the quality of environmental education, increased students' interest in renewable energy sources, and enabled classes to be conducted in modern teaching conditions. The program also engages local communities and promotes pro-climate activities in the school environment.

Transferability	The program model is scalable and easily adaptable to other regions and countries. Thanks to a simple application system and support from public institutions, it can also be implemented in VET schools, technical colleges, and vocational training centers.
Relevance to E4H	The program supports the key objectives of EXCEL4HOUSING: the development of green skills, education about renewable energy sources, and awareness of sustainable development. It may provide opportunities for further development of future VET pathways in green construction and renewable energy.

Introduction

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

Good practice within the EXCEL4HOUSING4.0 project is defined as an educational, organizational, or technological activity that demonstrates high effectiveness, innovation, transferability, and compliance with the objectives of VET and sustainable construction. It should respond to current labor market challenges in areas such as digitization, green transition, circularity, and energy efficiency.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

The selection of practices was based on:

- Replicability – the possibility of implementation in other VET institutions,
- Impact – noticeable quantitative and qualitative effects,
- Innovation – innovative approach to vocational education (e.g., new technologies, renewable energy sources),
- VET relevance – direct connection to vocational education,
- Transferability – ease of adaptation in other countries and regions.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.

Thematic Area: Green Skills & social awareness in education

Region: Central and Eastern Europe (Poland)

- For each selected Best Practice (following the structure of the Template):

- Title of the Practice

Nationwide Polish program “Eco-workshop – the green heart of the school”

■ Country/Region and Partner(s) Involved

Localization: nationwide in Poland

Conducted by Polish National Fund for Environmental Protection and Water Management (NFOŚiGW) and appropriate for the area of the Provincial Fund for Environmental Protection and Water Management (WFOŚiGW) in cooperation with the Ministry of Climate and Environment.

■ Brief Description of the Practice

The nationwide program “Ekopracownia – Zielone Serce Szkoły” (Eco-workshop – Green Heart of the School) aims to create modern thematic workshops in primary and secondary schools, focusing on renewable energy sources, nature, and environmental protection. Implemented as part of the Regional Environmental Education Support Program, it aims to strengthen educational infrastructure and develop climate awareness and pro-environmental attitudes among students.

■ Objectives and Challenges Addressed

The aim of the program is to develop environmental education by creating spaces conducive to learning about climate, energy, and nature. Challenges include unequal access of schools to modern infrastructure, low climate awareness among younger students, and the need to integrate renewable energy and sustainable development topics into everyday school education.

■ Methodology / Approach Implemented

The program was designed as a coordinated nationwide initiative, implemented by provincial environmental protection funds. Schools apply for funding for nature or renewable energy laboratories through a competition, presenting their own pro-environmental initiatives and plans for using the laboratories in the teaching process. The approach is based on combining educational infrastructure with substantive activities – the laboratories are intended to serve not only as modern classrooms, but also as centers for project-based, experimental, and local environmental education.

■ Outcomes and Demonstrated Impact

The program plans to create at least 760 eco-workshops throughout the country. The program will contribute to improving the quality of environmental education, increasing student involvement in environmental activities, and promoting knowledge about renewable energy sources and sustainable development. Thanks to a consistent implementation model and availability in every county, the initiative has the potential to equalize educational and regional opportunities. Already in its first year, the project has attracted considerable interest from schools, local governments, and local communities.

■ Key Success Factors

- Strong government and institutional support (Ministry of Climate and Environment, Provincial Fund for Environmental Protection and Water Management, National Fund for Environmental Protection and Water Management)
- Simple, accessible, and transparent application system for schools

-
- Wide territorial coverage (the program covers all provinces and counties)
 - Combination of educational infrastructure with real pro-environmental activities
 - High motivation of schools and teachers to develop climate education

■ **Replicability and Transferability Potential**

The program model can be easily adapted in other European countries. Key elements such as national funding, linking infrastructure to the educational program, and broad territorial accessibility make the program a model for national environmental education strategies. It is also possible to extend it to other levels of education, such as VET, vocational schools, and technical colleges.

■ **Lessons Learned**

The “Ekopracownia – Zielone Serce Szkół” (Eco-workshop – Green Heart of the School) program shows that a systemic approach to environmental education brings scalable and tangible results. Schools are ready to provide modern environmental education, provided they receive infrastructural and methodological support. In addition, cooperation between schools and environmental protection funds shows that local and national administrations can effectively support the teaching process without the need to involve EU funds. Another important conclusion is that creating experiential spaces supports the development of students' interests and promotes climate awareness from an early age.

● **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.
- A systematic approach to environmental education based on cooperation between schools and public institutions.
- High motivation among teachers to develop modern forms of teaching.
- Combining educational infrastructure with project activities, competitions, and workshops.
- Universality and scalability of the program—available in every county in Poland.

- Recurrent Challenges and Strategies for Overcoming Them.

Challenges:

- Equipment and technology shortages in many schools
- Insufficient preparation of teaching staff to work with renewable energy sources
- Limited time for science subjects in the core curriculum

Countermeasures:

- Central funding for infrastructure
- Teacher training and educational materials in a package with an eco-workshop

➤ Integration of environmental content into various subjects (e.g., physics, geography, technology)

○ Implications for Skills Development and VET.

- Vocational education must keep pace with technological trends and developments;
- Early development of environmental awareness and basic environmental skills;
- Practical preparation for working with renewable energy technologies and measuring tools;
- Increased interest in technical fields and professions related to the green transition;
- Facilitating the transition from general education to vocational training in the areas of sustainable construction and energy;
- Supporting teachers in conducting introductory classes on technical and environmental topics.

○ Recommendations for Practice Transfer and Adaptation.

- Support of the exchange of good practices between schools;
- Developing platforms for cooperation between schools;
- Adapt the model to vocational schools and technical colleges by expanding workshops with BIM modules, photovoltaics, heating systems, etc.;
- Create cross-sector partnerships between schools and local companies and environmental protection institutions;
- Introduce elements of micro-certification and recognized qualifications in the field of renewable energy sources;
- Maintain a flexible financing model that takes into account local and national funds.

● **Conclusions and Recommendations**

○ Synthesis of Key Findings from the compendium.

The “Ekopracownia – Zielone Serce Szkół” (Eco-workshop – Green Heart of the School) program shows that effective building of ecological competences can take place at the primary and secondary school level. Early interest in energy and climate issues increases the likelihood of students' further involvement in vocational education in areas key to the energy transition. The program combines infrastructure, teaching, and social integration into a coherent, effective system for supporting sustainable development.

○ Recommendations for future actions and projects in the field of VET and sustainable construction.

- Include programs such as “Ekopracownia” in vocational education strategies as an introduction to construction, energy, and environmental protection courses.

- Expand the scope of the workshop to include circular economy and energy efficiency in buildings.
- Create a catalog of good practices in environmental education available to VET schools.
- Consider certifying schools involved in climate education (e.g., a “green quality mark”)
- **Dissemination Plan for the Compendium**
 - Publication of good practices on VET and partner websites;
 - Presentations at industry and educational conferences;
 - Distributing practices to schools in need and Centers of Vocational Excellence (CoVE).

Bibliography

[1] Ministerstwo Klimatu i Środowiska (2023) *Ogólnopolski program „Ekopracownia – zielone serce szkoły”* <[\[2\] Motysa A. - Wojewódzki Fundusz Ochrony Środowiska i Gospodarki Wodnej we Wrocławiu \(2023\) *Ekopracownia - zielone serce szkoły* <\[https://wfosigw.wroclaw.pl/zlozwniosek/ekopracownia-zielone-serce-szkoly/w_645,podstawowe-informacje\]\(https://wfosigw.wroclaw.pl/zlozwniosek/ekopracownia-zielone-serce-szkoly/w_645,podstawowe-informacje\)>](https://www.gov.pl/web/klimat/ogolnopolski-program-ekopracownia--zielone-serce-szkoly#:~:text=Wkr%C3%B3tce%20szko%C5%82y%20podstawowe%20i%20ponadpodstawowe%20z%20ca%C5%82ej%20Polski,ramach%20kt%C3%B3rego%20otrzymaj%C4%85%20dofinansowanie%20na%20rozw%C3%B3j%20infrastruktury%20edukacyjnej.>></p>
</div>
<div data-bbox=)

[3] Kowalski M. – Portal Oświatowy (2023) *„Ekopracownia – zielone serce szkoły” – nowy program dla szkół* <<https://www.portaloswiatowy.pl/wazne-wydarzenia-dla-szkol-i-przedszkoli/ekopracownia-zielone-serce-szkoly-nowy-program-dla-szkol-23069.html>>

References





Annex 22: Urban Labs

Field	Description
Title of the practice	<i>Urban Labs</i>
Country of implementation	<i>Poland</i>
Organisation(s) involved	<i>Institute for the Development of Cities and Regions (IRMiR), city offices</i>
Description	<i>Urban Lab is a physical and organizational space for cooperation involving residents, local government, business, academia, and social organizations. It is used to diagnose problems, test solutions, and implement innovations in real-world conditions. In the context of Excel4Housing, this concept allows for testing analytical tools, implementing green technologies, developing concepts for the construction sector and urban infrastructure, and creating educational case studies.</i>
Thematic area(s)	<i>Digital / Green / Circular / Pedagogical</i>
Methods and tools used	<i>Participatory workshops, Urban Café's, blended learning, case-based education, BIM</i>
Target group(s)	<i>Students and VET learners, residents, teachers, academic staff, trainers, local authorities</i>
Outcomes and impact	<i>Reduction of energy use in pilot buildings, active involvement of residents, creation of open data and monitoring tools, stronger cooperation between stakeholders, increased awareness of sustainable housing, and integration of case studies into VET and education.</i>
Transferability	<i>Urban Lab is a modular and flexible concept. It can be implemented in various cities and neighborhoods, adjusting the scope of the topics (e.g. energy efficiency, water management, social participation). The model is scalable and can be used in Central Europe, especially in the context of modernizing housing resources.</i>
Relevance to E4H	<i>Urban Lab provides a practical test environment: integrates green and digital innovations with the daily lives of residents, supports formal and informal education through real data and case studies, It promotes the transfer of knowledge and multi-sectoral cooperation, which are key to developing competences in the construction sector. These actions are in line with E4H.</i>

Introduction

The purpose of this task is to identify and describe best practices that can serve as inspiration and transferable models for the Excel4Housing project, with a particular focus on sustainable housing

and skills development in VET. The selected practice of Urban Labs illustrates how innovative approaches, based on collaboration and experimentation, can address complex challenges in the housing sector. The methodology applied includes a desk research review of the Urban Lab concept developed by the Institute of Urban and Regional Development in Poland. The practice has been evaluated against Excel4Housing best practice criteria such as innovation, replicability, sustainability, and relevance to vocational education and training.

- **Definition and Criteria for Best Practices**

A Best Practice in EXCEL4HOUSING is an innovative, effective, and transferable action that contributes to the green transition of the housing and construction sector, strengthens VET (vocational education and training) capacity, and promotes digital, sustainable, and circular approaches.

The practice can be adapted to different regions and contexts. The impact is measurable in environmental and educational aspects, as well as social benefits. In times of rapid development, it is important that the practice uses new technologies, processes, or pedagogical approaches. The practice ensures sustainability through long-term environmental and financial viability, strengthens VET relevance by directly integrating into training and upskilling programs, and demonstrates strong transferability with potential to be scaled or integrated into other CoVEs and projects.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.
- For each selected Best Practice (following the structure of the Template):
 - Title of the Practice
 - Country/Region and Partner(s) Involved
 - Brief Description of the Practice
 - Objectives and Challenges Addressed
 - Methodology / Approach Implemented
 - Outcomes and Demonstrated Impact (quantitative/qualitative)
 - Key Success Factors
 - Replicability and Transferability Potential
 - Lessons Learned

Title of the Practice: Urban Lab as a Living Laboratory for Sustainable Housing

Country/region and partners involved: Poland (in Gdynia, Rzeszów (both were pilot sites), Lublin, Mysłowice, Katowice, Racibórz, Warsaw, Toruń, Bydgoszcz, Pleszew, Stalowa Wola and Chełm);

concept of urban labs in Poland was implemented by Institute for the Development of Cities and Regions (IRMiR) creating the project in cooperation with a broad group of city stakeholders, primarily between the city office and the residents.

In the Polish concept, the initiator of the activities and the institution managing the laboratory is the "city" represented by the city/municipality office.

Brief description of the practice: Urban Lab is a cooperation instrument and creative space (office or urban) whose task is to:

- involvement of various urban stakeholders: authorities, residents (NGOs, communities), the private sector, science,
- initiating, testing, implementing, and evaluating innovative urban solutions in cooperation between these groups,
- improving the quality of life of residents and generating additional value using urban resources.

Objectives and challenges addressed: The scope of the urban lab may include a wide range of issues, which in a model approach are specified as: open city data, urban innovation incubator, technological innovations, social innovations, and city space management. The main objective of the Urban Lab model is to provide a practical and participatory environment where urban challenges, particularly those related to housing and sustainability, can be identified and solved through experimentation. **The practice aims to:**

- improve the quality of life for residents,
- bridge the gap between innovation and a real-life use,
- strengthen collaboration,
- promote education and skills development.

Some of the challenges may include:

- lack of citizen involvement,
- fragmentation of efforts between different stakeholders,
- difficulties in translating policy ambitions into practical solutions,
- limited awareness and trust (especially towards sustainable housing innovations among residents).

Methodology/approach implemented: When creating the concept of an urban lab, it is important to define the goals, thematic areas, and actions that the urban lab will carry out. Each of the urban lab activities should go through the key stages of project implementation:

- diagnosis of needs and problems in the city / user needs survey (residents),
- developing solutions,
- testing the developed solutions,

- implementation in the real environment,
- evaluation and possible scaling.



Outcomes and demonstrated impact:

- Reduction in energy consumption in pilot housing estates;
- Number of residents engaged in workshops, hackathons, and Urban Café events;
- Datasets and open data platforms created for monitoring and evaluation;
- Pilot projects implemented (e.g. renewable energy integration);
- Improved cooperation between municipalities, residents, and private sector (stronger trust and long-term collaboration);
- Greater awareness and acceptance of sustainable construction solutions among communities;

- Integration of Urban Labs outputs into educational programmes (students and teachers equipped with real case studies);
- Demonstration of inclusive governance models.

Key success factors: The success of Urban Labs depends on a combination of organizational, social, and educational elements:

- Strong stakeholder engagement: active involvement of residents, supported by municipalities and facilitated by neutral actors such as universities or NGOs.
- Clear governance structure: establishment of a dedicated Urban Lab team, strategic group, and thematic working groups to coordinate activities and ensure continuity.
- Accessible spaces for dialogue: the Urban Café concept, offering a neutral and inclusive setting for meetings, workshops, and informal discussions.
- Integration of education and practice: embedding pilots and results into VET training, higher education curricula, and lifelong learning activities.
- Open data and transparency: providing residents and stakeholders with clear, accessible information about outcomes, costs, and benefits of innovations.
- Municipal and institutional support: long-term political and financial commitment from local authorities to maintain the Lab beyond pilot projects.

Replicability and transferability potential: The Urban Lab model is highly replicable due to its modular and adaptable structure. Key features that support transferability include:

- Flexibility of thematic focus (focus can be shifted between the most important and urgent topics depending on the identified needs and context);
- Scalable design (able to implement in small neighbourhoods, housing estates, city-wide level, etc.);
- Clear methodology (the cycle of diagnosis, pilot testing, evaluation, and scaling provides a repeatable, easy framework);
- Educational value (integration into education depending on needs makes this project transferable across different learning contexts and national systems);
- European relevance (many European regions face similar challenges, Urban Labs provide tested tool that can be adapted to local governance and cultural contexts).

Lessons learned: Importance of trust-building with residents, need for long-term municipal support, integrating education early in the process.

- **Cross-Cutting Analysis of Best Practices**
 - Common Trends and Success Patterns.
 - Recurrent Challenges and Strategies for Overcoming Them.

-
- Implications for Skills Development and VET.
 - Recommendations for Practice Transfer and Adaptation.

The Urban Lab experience demonstrates several common trends and success patterns that are highly relevant for sustainable housing and VET. The combination of technological innovation with social innovation is essential. Digital tools such as BIM, open data platforms, and monitoring dashboards provide valuable insights, but their effectiveness depends on active participation of residents and other stakeholders. Without trust and engagement, even the most advanced technologies may remain underused. Urban Labs show the importance of creating permanent spaces and structures for collaboration. Temporary projects can deliver pilot results, but sustainable impact requires ongoing coordination, clear governance, and dedicated teams. The presence of physical and symbolic spaces such as Urban Cafés fosters inclusiveness and continuous dialogue, strengthening the long-term viability of solutions. Best practices reveal that education is not a by-product but a core function of Urban Labs. By turning pilot projects into case studies and learning materials, Urban Labs directly support VET systems and contribute to the development of new skills demanded by the green transition. This dual role – as a testing ground and an educational platform – sets Urban Labs apart from other forms of urban innovation. Current challenges include securing stable funding, aligning municipal strategies with experimental initiatives, and ensuring that results are scaled up rather than limited to pilot sites. Overcoming these requires political will, cross-sectoral partnerships, and integration of Urban Lab findings into mainstream urban policies.

● **Conclusions and Recommendations**

Conclusions:

- Urban Labs are effective tools for testing and scaling sustainable housing solutions through participation and experimentation.
- They combine innovation with education, making them highly relevant to Excel4Housing.
- Their value lies not only in piloting technologies but also in fostering collaboration and trust.

Recommendations:

- Embed Urban Labs into local governance structures as permanent innovation platforms.
- Strengthen cooperation with VET providers so that outcomes directly enrich curricula and training.
- Secure diversified funding to guarantee continuity beyond pilot phases.
- Share knowledge between Urban Labs across regions to promote transferability and replication.

Results and experiences from Urban Lab should be disseminated through:

- publications (IRMiR reports, brochures),
- industry and educational conferences,
- local and social media,
- international networks (e.g. Excel4Housing, CoVE).

Bibliography

[Idea Urban Lab – Urban Lab](#)

Annex 23: Circo Hub Portugal

Field	Description
Title of the practice	Circo Hub Portugal
Country of implementation	Implemented in Portugal, however, there are international hubs in many countries worldwide
Organisation(s) involved	LNEG - National Laboratory of Energy and Geology IAPMEI - Agency for Competitiveness and Innovation APA - Portuguese Environment Agency CIRCO international
Description	The CIRCO HUB PORTUGAL project is a training program for companies and designers focused on developing circular products and businesses, using the CIRCO methodology, developed in the Netherlands and implemented with a high success rate. The Dutch CIRCO (Creating Business through Circular Design) program applies design and design thinking to the development of circular products, services, and business models, developed through creative and collaborative sessions. Each company has the opportunity to initiate circular activities and solutions in collaboration with its value chain.
Thematic area(s)	Circular economy Circular business models Circular design
Methods and tools used	Company representatives actively participate in three workshops spread over the course of a month (called the CIRCO circular business design track). Designers participate in a one-day CIRCO circular design session. The training takes a practical approach supported by online platforms and collaborative tools, geared toward the specific and concrete needs of companies and designers. The methodology adopted at CIRCO Hub Portugal has been developed by the Dutch CIRCO program since 2015. It addresses circular design through six design strategies and five business model archetypes, developed in creative and collaborative sessions.
Target group(s)	Companies of any size (prioritizing SMEs) responsible for manufacturing products (with in-house or external design) and design professionals interested in applying strategies and practices to develop businesses according to circular economy principles.
Outcomes and impact	In Portugal, 12 training sessions were held with 95 companies and 280 professionals. The results of the training, per company, are a concept for a new business model or products with and action plan for its implementation
Transferability	The design methodology, knowledge and training-for-trainers process are available and can be used to encourage circular transition on an international scale and trigger broad collaboration.
Relevance to E4H	The methodology, tools, examples of application are available and can be used by E4H as inspiration or a collaboration for the application of the methodology

Introduction

This case represents and illustrates a best practice in training applied in companies and professionals across various sectors, including the construction industry.

This project is based on an innovative training methodology, with a highly practical component focused on solving problems for each company. The training is developed with each company, supported by professionals and trainers who, focusing on a problem, challenge, or strategic element for the company, apply the methodology to their specific case, culminating in the development of a new idea for the development of a circular product or business model, and an action plan for its development and implementation.

- **Definition and Criteria for Best Practices**

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: The best practice presents an innovative approach for teaching and learning

Impact: High impact on company level related to the easy application of the methodology and training in the companies' practices

Sustainability: Aligned with sustainability goals

Replicability: Hubs available in several countries

VET relevance: Possibility to involve training institutions, designers, and real-world learning

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.: the best practice is focused in training on Circular economy , Circular business models and Circular Design for SMEs and Designers
- For each selected Best Practice (following the structure of the Template):

- **Title of the Practice:** Circo Hub Portugal

- **Country/Region and Partner(s) Involved:** Implemented in Portugal, however, there are international hubs in many countries worldwide. The authors and developers of the methodology are from the Netherlands, and

there are regional hubs in Brazil, Czechia, Estonia, Germany, Hungary, Malaysia, Poland, Singapore, Portugal, Slovakia, Sri Lanka, Thailand, Turkey, and Australia.

- **Brief Description of the Practice:** The CIRCO HUB PORTUGAL project is a training program for companies and designers focused on developing circular products and businesses, using the CIRCO methodology, developed in the Netherlands and implemented with a high success rate.

The Dutch CIRCO (Creating Business through Circular Design) program applies design and design thinking to the development of circular products, services, and business models, developed through creative and collaborative sessions.

Each company has the opportunity to initiate circular activities and solutions in collaboration with its value chain.

- **Objectives and Challenges Addressed:** The main goal of CIRCO Hub Portugal is to promote the circular economy through design. In this project, companies and designers work together to develop circular products, services, and business models, following a training methodology developed in the Netherlands.

- **Methodology / Approach Implemented:** The CIRCO method is based on an academic framework of the Technical University of Delft. It is called 'Products that last' and it is written by C. Bakker & M. den Hollander. This framework explains five circular business models and six circular design strategies. CIRCO expanded this framework with tools and insights, so it is useful and relevant for businesses. The method offers practical design tools, inspiring cases and examples, and it offers trainer support and interaction.

- **Outcomes and Demonstrated Impact (quantitative/qualitative):** In Portugal, 12 training sessions were held with 95 companies and 280 professionals.

The results of the training, per company, are a concept for a new business model or products with an action plan for its implementation

- **Key Success Factors:** The number of companies that participated in the training, based on the problems and challenges identified, and that after the training continued developing solutions, implementing the developed solutions in the market and integrating the methodology into their business practices is an indicator of the project's success.

- **Replicability and Transferability Potential:** The design methodology, knowledge and training-for-trainers process are available and can be used

to encourage circular transition on an international scale and trigger broad collaboration.

- **Lessons Learned:** The methodology, based on a highly practical component, in which companies analyze the value chains of their products and businesses and apply the methodology throughout the training sessions held online, but using collaborative tools, has allowed for high levels of success.

- **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

Use of online collaborative approach to learning

Problem-based learning

General approach with possibility to focus on a specific sector or value chain

Strong collaboration between education, industry, and sector specific stakeholders

- Recurrent Challenges and Strategies for Overcoming Them.

Because it is a generalist methodology that can be applied to various sectors and contexts, supported by a set of design strategies and business models, its adaptation to specific sectors or business realities can be complex or inappropriate. In Portugal, the training is supported by specialists who work with companies and assist in the development of the training projects. This integration of specialists can be costly in some cases, and it can be difficult to find specialists available for training; This support is an added value, however, training can also be carried out without this support.

- Implications for Skills Development and VET.

- Recommendations for Practice Transfer and Adaptation.

- Problem-based learning, and work-based learning using problems, challenges or ideas from the trainees. Application and practice of the methodology and learning on these problems
- The use of online collaborative tools enables collaboration between the various training stakeholders—trainers, students, and support staff.
- These tools also allow for monitoring throughout the training and the possibility of post-training access.
- Possibility of networking and cross-learning.
- Establishment of sector or value chain partnerships to support training.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The Circo Methodology and approach used in CIRCO HUB Portugal, and other international hubs can support the capacity building and the creation of skills and competences in the construction sector and its value chains.

The training is aligned with companies' needs and has a practical application in their context, with a high success rate of integration in companies and in the development of new circular solutions of products and business models

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Adjust the methodology and tools for the construction sector

Train trainers in methodology

Establish partnerships and networks for implementation

References

<https://www.circonl.nl>

<https://circohubportugal.ineg.pt>

Annex 24: Katch_e project - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education

Field	Description
Title of the practice	Katch_e project - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education
Country of implementation	Portugal, Spain, Austria, Denmark
Organisation(s) involved	• LNEG - Laboratório Nacional de Energia e Geologia I.P. • Universidade de Aveiro • Amorim Cork Composites, S.A • AICE Asociación de Investigación de las Industrias Cerámicas • PROSPEKTIKER - Instituto Europeo de Prospectiva y Estrategia S.A. • Universitat Jaume I de Castellon • Technische Universitaet Wien • Österreichisches Ökologie-Institut • Doka gmbh • Aalborg Universitet • Højer møbler a/s
Description	KATCH_e is a knowledge alliance between higher education, companies and research centers to promote the development of skills in the field of product and service design for the circular economy and sustainability, with a special focus on the construction and furniture sectors. KATCH_e thus contributes to the innovation of the higher education system and trains companies in business strategies and product design according to principles of circularity and sustainability. KATCH_e focuses on construction products and furniture, and brought together universities, research centers and companies from 4 EU countries to cooperate in the development of resources to support the education of design for CE and the practical implementation in the development of new circular product and services in companies
Thematic area(s)	Circular economy Life cycle management for sustainability Training and education
Methods and tools used	Build a lasting knowledge alliance between Universities, businesses and knowledge centers. Build competences in Circular Design and sustainability Distribute and apply the training materials
Target group(s)	students, professors, researchers, companies and other stakeholders from the construction and furniture sectors
Outcomes and impact	The main outcomes of the project are the following: Situation analysis report on CE and executive summary • Curriculum of product-service development course that can be adopted by higher education institutions

	• Eight learning modules that can also be used as stand-alone learning and teaching elements; • Seven tools that support the practical implementation of CE • MOOC, 10 hours online course covering the learning resources developed • Case Studies resulting from the practical implementation of KATCH_e • Knowledge HUB, a discussion hub to disseminate CE • Knowledge platform with all resource from the project available • E-Book	
Transferability	The resources are all available for free and can be used in the E4H project.	
Relevance to E4H	This was a research project focusing on two sectors, one of them aligned with the Target of E4H. The resources are available and are relevant to introduce the circular economy approach in the project	

Introduction

This project is considered a best practice due to the diverse resources developed based on a research process developed within a European partnership involving research centres, universities, and companies.

The results were applied in practice, tested, and validated, and are freely available, enabling the creation of knowledge and skills in the circular economy and sustainability in the construction and furniture sectors, as well as for general training.

There are several resources available, from various training materials, case studies, tools for practical implementation, training modules, an eBook, among other relevant materials.

● Definition and Criteria for Best Practices

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: the project is innovative both in the approach adopted and in the results that were developed

Impact: The impact is significant. The project ended in 2019; however, its resources, available as open source, have been used by a variety of professionals, both in academia and in business.

Sustainability: Aligned with sustainability goals and the transition to circular economy

Replicability: Materials available

VET relevance: The resources can be used by training institutions, designers, companies, and others

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.: the best practice is focused in training on Circular economy, life cycle management and sustainability
- For each selected Best Practice (following the structure of the Template):
 - Title of the Practice: KATCH_e project - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education
 - Country/Region and Partner(s) Involved: Portugal, Spain, Austria, Denmark
 - Brief Description of the Practice: KATCH_e is a knowledge alliance between higher education, companies and research centres to promote the development of skills in the field of product and service design for the circular economy and sustainability, with a special focus on the construction and furniture sectors. KATCH_e thus contributed to the innovation of the higher education system and trains companies in business strategies and product design according to principles of circularity and sustainability. KATCH_e focuses on construction products and furniture, and brought together universities, research centres and companies from 4 EU countries to cooperate in the development of resources to support the education of design for CE and the practical implementation in the development of new circular products and services in companies
 - **Objectives and Challenges Addressed:** Reinforcing the skills and competences in the field of product-service development for the circular economy and sustainability in the construction and furniture sectors.
 - **Methodology / Approach Implemented:** The development training materials for enabling Circular Economy in the construction and furniture sector addressing students and professionals in industry and specifically focus on the development of sustainable product-services. The methodology was focused in 3 main aspects:

-
- Build a lasting knowledge alliance between Universities, businesses and knowledge centers by encouraging multidisciplinary relationships and support the exchange of information, experiences and materials between the partnership and different stakeholders through the creation of structures to engage students, professors, researchers, companies and other stakeholders in a systematic and efficient way.
 - Build competence in Circular Design and sustainability through the development of training materials that follow a problem-based, multidisciplinary learning approach, connecting designers, engineers and other relevant stakeholders involving university students, professors, researchers, companies and other stakeholders to integrate CE thinking in design and development education and define didactic recommendations for teaching.
 - Distribute and apply the training materials by supporting and promoting the dissemination of circular design and sustainability among higher education centers and companies, demonstrating the practicability of the materials, their benefits and innovation potential.
- **Outcomes and Demonstrated Impact (quantitative/qualitative): The main outcomes of the project are the following:**
- Situation analysis report on CE and executive summary
 - Curriculum of product-service development course that can be adopted by higher education institutions
 - Eight learning modules that can also be used as stand-alone learning and teaching elements;
 - Seven tools that support the practical implementation of CE
 - MOOC, 10 hours online course covering the learning resources developed
 - Case Studies resulting from the practical implementation of KATCH_e
 - Knowledge HUB, a discussion hub to disseminate CE
 - Knowledge platform with all resources from the project available
 - E-Book
- **Key Success Factors:** a Wide set of resources and knowledge developed for the construction sector both for training and practical application on companies
- **Replicability and Transferability Potential:** The resources are all available for free

and can be used in the E4H project

- **Lessons Learned:** The importance of having theoretical content available for capacity building, training and education, supported by practical tools for implementation. All supported by examples for inspiration, motivation and demonstration how circular economy and sustainability can be in practice

- **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

Strong collaboration between research, education, industry, and sector specific stakeholders to develop useful and relevant resources

- Recurrent Challenges and Strategies for Overcoming Them.

The only aspect that can be seen as challenge could be the fact that the project ended in 2019. The materials are still very relevant, but some aspects regarding legislation or trends could need some adaptation

- Implications for Skills Development and VET.

No implications

- Recommendations for Practice Transfer and Adaptation.

- The materials are applicable for capacity building in VET and can be used or as they are or adapted according to the needs of the E4H project

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The material can support the capacity building and the creation of skills and competences in the construction sector and its value chains.

The knowledge hub includes relevant resources that are available to be used as needed.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Apply or adjust the methodology, resources and tools to the needs of the project

- **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.

References

<https://www.katche.eu/>

https://www.lneg.pt/en/project/katch_e-2/

Rocha, C., Camocho, D., Sampaio., Alexandre, J. (editores) (2020). Product-Service Development for Circular Economy and Sustainability Course, KATCH_e project. LNEG – Laboratório Nacional de Energia e Geologia, I.P., ISBN: 978-989-675-063-3

Annex 25: BP25 Eco.nomia portal

Field	Description
Title of the practice	Eco.nomia portal
Country of implementation	Portugal
Organisation(s) involved	Ministry of Environment General Secretariat for the Environment Coalition for Green Growth Center for environmental and sustainability research With collaboration from BCSD Portugal, Sociedade Ponto Verde, Luís Simões, LNEG, Deco, and FCT)
Description	The eco.nomia Portal is a Portuguese digital platform that promotes the transition to the circular economy, serving as a knowledge repository and a meeting point for sharing information on projects, business models, products, and services that follow circular economy principles. The portal aims to inform and support consumers and institutions (public and private) in adopting and developing circular economy initiatives, which aim to reduce waste and maintain materials in use.
Thematic area(s)	Circular economy
Methods and tools used	Based on an online platform the main objectives and functions are the following: Knowledge dissemination, by providing information about the circular economy, helping to understand its concepts and applications. Stakeholder connection by serving as a space for sharing experiences and as a platform for developing new projects. Initiative support by supporting projects and business models focused on the circular economy.
Target group(s)	Aimed at a broad audience, including consumers, businesses, public institutions, and the business
Outcomes and impact	Knowledge platform, information on circular economy, examples and case studies, opportunities of funding, contests, awards, etc, Resources and events
Transferability	Open-source resources
Relevance to E4H	The platform has a lot of different materials and resources that can support the implementation of the project. It can also act as a dissemination media to promote the E4H project

Introduction

The ECO.NOMIA portal is a Portuguese government platform that promotes the transition to a circular economy, valuing materials, products, and services. The portal contributes to this shift by serving as a knowledge repository for public institutions, businesses, and the community, and as an interaction platform for the development of new projects in this area. It is a collaborative project that involves the participation of various entities, primarily those linked to design, science and technology, the business sector, logistics, end consumers, and waste, in the construction of knowledge that is made available to everyone.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).
- Innovation: a portal promoted by the Portuguese government that brings together a group of relevant stakeholders to provide and share content to support the transition to the circular economy.
- Impact: open-source resources can serve as the basis for various purposes, such as dissemination, demonstration, training, among others.
- Sustainability: Aligned with sustainability goals and aligned with national and international policies for the transition to the circular economy.
- Replicability: the structure can be replicated and promoted in other European contexts.
- VET relevance: provision of diverse resources that can be adopted for VET training.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.: the best practice is focused resources on Circular economy and sustainability
- For each selected Best Practice (following the structure of the Template):
 - **Title of the Practice:** Eco.nomia portal
 - **Country/Region and Partner(s) Involved:** Implemented in Portugal, by the Portuguese Ministry of Environment, the General Secretariat for the Environment, the Coalition for Green Growth and the Center for environmental and sustainability research, with collaboration from BCSD portugal, Sociedade Ponto Verde, Luís Simões, LNEG, Deco, and FCT.

- **Brief Description of the Practice:** The eco.nomia Portal is a Portuguese digital platform that promotes the transition to the circular economy, serving as a knowledge repository and a meeting point for sharing information on projects, business models, products, and services that follow circular economy principles. The portal aims to inform and support consumers and institutions (public and private) in adopting and developing circular economy initiatives, which aim to reduce waste and maintain materials in use.

Not only does it explain the principles, advantages and opportunities of the circular economy, it also provides examples and information on financing, learning opportunities and national and international events.

- **Objectives and Challenges Addressed:** Share of knowledge and resources in Circular economy to support the transition aligned with the national and international objectives and legislation
- **Methodology / Approach Implemented:** Based on an online and collaborative platform the main objectives and functions are the Knowledge dissemination, by providing information about the circular economy, helping to understand its concepts and applications and to inspire the transition to CE. It promotes the stakeholder connection by serving as a space for sharing experiences and as a platform for supporting the development of new projects and business models focused on the circular economy.
- **Outcomes and Demonstrated Impact (quantitative/qualitative):** The platform is composed of relevant resources. More than 170 examples of circular economy implementation are available to demonstrate and inspire, more than 13 relevant documents and resources are also available, news, links, events, opportunities in terms of awards, competitions, funding, call, and other materials and information
- **Key Success Factors:** Open-source platform with updated and relevant resources aligned with the Portuguese objectives and goals on circular economy
- **Replicability and Transferability Potential:** the structure can be replicated, and the materials can be used as needed for different purposes
- **Lessons Learned:** User friendly platform, with easy access to information, with a good system to filter a select the data available promotes more efficient use

- **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.
Use of online collaborative approach to collect and share information
Strong collaboration between the Portuguese government, education and research institutions, industry, and other relevant stakeholders
- Recurrent Challenges and Strategies for Overcoming Them.
The main challenges are the input, analysis of new and updated resources, with are overcome with a good strategy of collaboration,
- Implications for Skills Development and VET.
- Recommendations for Practice Transfer and Adaptation.
 - Repository of resources and relevant information that can be used as supporting material for training
 - Demonstration potential with examples from Portugal and internation examples of the application of the Circular economy methodology.
 - Examples can be used as inspiration materials for further developments

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.
The ECO.NOMIA plays the role of a knowledge-sharing space being a one-stop-shop for circularity in Portugal, and intended for individuals, companies and investors. Not only does it explain the principles, advantages and opportunities of the circular economy, but it also provides examples and information on financing, learning opportunities and national and international events
- Recommendations for future actions and projects in the field of VET and sustainable construction.
Use this as reference material for training sessions

- **Dissemination Plan for the Compendium**

- Strategies and channels for disseminating D2.3.

References

<https://eco.nomia.pt>

Annex 26: Construye 2020+ – Energy Efficiency Training and Accreditation

Field	Description
Title of the practice	<i>Construye 2020+ – Energy Efficiency Training and Accreditation</i>
Country of implementation	<i>Spain</i>
Organisation(s) involved	<i>Fundación Laboral de la Construcción; Fundación Estatal para la Formación en el Empleo (Fundae); Instituto Nacional de las Cualificaciones (INCUAL); Instituto de Ciencias de la Construcción Eduardo Torroja (IETCC-CSIC); CIRCE; IRTIC – University of Valencia</i>
Description	<i>A national training initiative aimed at construction professionals, combining short (8h) and long (70–190h) courses on energy efficiency, renewable energy integration, and sustainable construction techniques. The programme includes practical workshops, digital learning modules, and the Distintivo Eco accreditation to certify professional competencies.</i>
Thematic area(s)	<i>Green/Sustainable Construction; Energy Efficiency; Digital (through blended learning modules)</i>
Methods and tools used	<i>Blended learning: online modules and in-person workshops; practical case studies; modular course design; Distintivo Eco accreditation system; collaboration with research institutes and industry partners.</i>
Target group(s)	<i>Construction professionals, including operatives, mid-level managers, higher-level vocational technicians, civil engineers, technical architects, and similar profiles.</i>
Outcomes and impact	<i>Quantitative: 360+ participants trained; Virtual Route reached 16 Autonomous Communities; multiple short and long courses delivered. Qualitative: Increased professional awareness and application of energy efficiency measures; adoption of sustainable building practices in real projects; formal recognition through Distintivo Eco accreditation.</i>
Transferability	<i>Modular course structure, blended delivery, and formal accreditation make the model highly transferable to other regions, national VET centres, and EU contexts.</i>
Relevance to E4H	<i>Supports EXCEL4HOUSING4.0 objectives on energy efficiency and sustainable construction by enhancing professional competencies, promoting green practices, and offering a replicable accredited training model.</i>

Introduction

This case illustrates a best practice in the field of **energy efficiency and sustainable construction training**, promoted by the Fundación Laboral de la Construcción in collaboration with national and regional partners. The initiative focuses on improving skills among construction professionals, including operatives and mid-level managers, with particular attention to energy efficiency, renewable integration, and sustainable building practices.

The methodology for collecting this case followed the **EXCEL4HOUSING4.0 framework**: it was identified through desk research, validated with the common template, and evaluated against the criteria of **innovation, replicability, impact, and VET relevance**.

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

In EXCEL4HOUSING4.0, a best practice is understood as an evidence-based, innovative, and transferable approach that has demonstrated measurable impact and can inspire or guide the development of VET curricula in green and digital construction.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Focused training for operatives and mid-level managers on energy-efficient and sustainable construction techniques.

Impact: Improved awareness and practical application of energy efficiency measures in construction projects.

Sustainability: Encourages long-term adoption of green building practices in Spain.

Replicability: Training and accreditation methodology can be adapted to other regions or professional sectors.

VET Relevance: Directly addresses the competencies required by modern construction professionals.

Transferability: The modular course design, digital tools, and accreditation system (Distintivo Eco) allow replication in other national or European contexts.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.
- For each selected Best Practice (following the structure of the Template):

- **Title of the Practice**

Construye 2020+ – Energy Efficiency Training and Accreditation

■ Country/Region and Partner(s) Involved

Country: Spain

Partners: Fundación Laboral de la Construcción; Fundación Estatal para la Formación en el Empleo (Fundae); Instituto Nacional de las Cualificaciones (INCUAL); Instituto de Ciencias de la Construcción Eduardo Torroja (IETCC-CSIC); CIRCE; IRTIC – University of Valencia

■ Brief Description of the Practice

Construye 2020+ provides specialized training for construction professionals, combining short courses (8h) on energy efficiency for operatives and mid-level managers with longer programmes (70–190h) on RITE, energy certification, and sustainable construction techniques. The initiative also offers the Distintivo Eco, an accreditation system recognizing professional competencies in sustainable construction.

The programme includes digital learning modules, in-person workshops, and awareness campaigns, including the Virtual Route Construye 2020+, which visited 16 Autonomous Communities to promote energy-efficient construction practices across Spain.

■ Objectives and Challenges Addressed

Objectives:

Train professionals in energy efficiency, renewable integration, and sustainable construction techniques.

Promote a greener, more competitive construction sector.

Establish an accreditation system (Distintivo Eco) to recognize professional competencies in sustainable construction.

Challenges:

Ensuring broad adoption of energy-efficient practices across regions.

Providing training that is accessible for both operatives and managers.

Integrating practical skills training with formal accreditation.

■ Methodology / Approach Implemented

Blended learning: online modules, workshops, and in-person practical training.

Modular structure allowing participation in short or long courses.

Use of real case studies and practical exercises from construction projects.

Collaboration with research institutes and VET providers to develop validated content.

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Quantitative

- Over **360 participants trained** in energy efficiency and sustainable construction.
- Multiple short (8h) and long (70–190h) courses delivered.
- Virtual Route campaign reached **16 Autonomous Communities**.

Qualitative

- Improved professional awareness of energy efficiency and sustainability.
- Adoption of energy-efficient measures and renewable solutions in real construction projects.
- Recognition of competencies through the **Distintivo Eco** accreditation.

■ Key Success Factors

Strong collaboration between VET institutions, research bodies, and the construction sector.

Integration of practical training with formal accreditation.

National coverage with regional focus enhances accessibility.

Use of digital tools to complement in-person learning.

■ Replicability and Transferability Potential

Highly adaptable to other regions or EU countries seeking to upskill construction professionals in sustainable building practices.

Modular design allows replication of short and long courses.

Accreditation system (Distintivo Eco) provides a model that can be applied in other VET contexts.

■ Lessons Learned

Combining practical training with accreditation increases professional engagement.

Modular and blended delivery formats improve participation and accessibility.

Awareness campaigns enhance outreach and sector-wide impact.

● Cross-Cutting Analysis of Best Practices

- Common Trends and Success Patterns.

Integration of accreditation with practical skills training.

Combination of digital and in-person learning approaches.

Collaboration between education, research, and industry partners ensures relevance.

- Recurrent Challenges and Strategies for Overcoming Them.

Challenge: Reaching professionals across dispersed regions.

Strategy: Modular, blended delivery formats.

Challenge: Maintaining engagement of operatives and mid-level managers.

Strategy: Short courses alongside long, certified programmes.

- Implications for Skills Development and VET.

Establishes a benchmark for energy efficiency and sustainable construction training with formal recognition.

Enhances professional competencies and employability in the construction sector.

Supports lifelong learning and continuous upskilling.

- Recommendations for Practice Transfer and Adaptation.

Adopt modular course structures with short and long formats.

Include formal recognition or accreditation for skills acquired.

Use blended learning and digital tools to expand access.

Collaborate with VET providers and research institutions to validate content.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

Construye 2020+ demonstrates the effectiveness of combining training, practical skills, and accreditation to promote energy efficiency in construction.

Modular and blended approaches increase accessibility and sector impact.

Competency recognition (Distintivo Eco) reinforces professional engagement.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Expand accreditation to include SMEs in the construction sector.

Incorporate more online/flexible delivery for professionals with work or family commitments.

Use awareness campaigns to complement training and encourage sector-wide adoption.

- **Dissemination Plan for the Compendium**

Include in D2.3 Compendium for EXCEL4HOUSING4.0.

Disseminate through VET networks, construction associations, and online platforms.

Share best practices with other regional energy agencies and construction training providers.

Bibliography

Fundación Laboral de la Construcción. (n.d.). *Construye 2020+*. Recuperado el 16 de septiembre de 2025, de <https://construye2020plus.eu/>

Annex 27: LIFE ReNatural NZEB MOOCs – Online Training in Sustainable Construction

Field	Description
Title of the practice	<i>LIFE ReNatural NZEB MOOCs – Online Training in Sustainable Construction</i>
Country of implementation	<i>Spain – Extremadura (with cross-border participation from Portugal)</i>
Organisation(s) involved	<i>Government of Extremadura – Department for Mobility, Transport and Housing; CICYTEX Research Centre; INTROMAC; University of Córdoba; URVPEXSA; Instituto Tecnológico de la Edificación (ITeCons, Portugal); Laboratório Nacional de Energia e Geologia – LNEG (Portugal); co-funded by the EU LIFE Programme</i>
Description	<i>A set of three free online courses (MOOCs) hosted on Moodle, aimed at promoting sustainable construction techniques and nearly zero-energy building (NZEB) principles. The training covers climate analysis, sustainable design strategies, best practices in eco-friendly materials, and household energy/water efficiency. Accessible to professionals, students, and the general public across Spain and Portugal.</i>
Thematic area(s)	<i>Digital; Green/Sustainable Construction; Circular Economy</i>
Methods and tools used	<i>MOOC delivery via Moodle platform; modular structure with self-paced learning; integration of real-world pilot projects and demonstrator buildings; multimedia resources and technical guides; cross-border collaboration for content development</i>
Target group(s)	<i>Construction professionals, architects, engineers, VET students in building and civil works, as well as interested citizens seeking to improve sustainability practices in housing</i>
Outcomes and impact	<i>Launched three MOOCs (10–40 hours each); engaged learners from multiple regions; increased awareness and technical skills in NZEB and circular economy; supported the dissemination of natural and recycled building materials; strengthened Spain–Portugal cooperation in sustainable construction</i>
Transferability	<i>Highly replicable due to its digital format, open access, and modular design; content can be translated, adapted to local contexts, and integrated into other VET or professional training frameworks; scalable for other sustainability topics</i>
Relevance to E4H	<i>Contributes directly to the green and digital pillars of EXCEL4HOUSING4.0 by fostering digital learning in sustainable building; demonstrates a scalable, cross-border model for knowledge dissemination in eco-friendly housing solutions</i>

Introduction

This example highlights an innovative initiative in digital training for sustainable construction, aligned with the Housing 4.0 concept. The LIFE ReNatural NZEB MOOC Training provides free, advanced online courses designed to improve professional skills in nearly zero-energy building, with a strong focus on the use of natural and recycled materials.

The case was identified through a desk-research process following the EXCEL4HOUSING4.0 methodology. Information was compiled using the standard template and assessed against criteria such as innovation, relevance to VET, potential for replication, environmental sustainability, and proven impact.

- **Definition and Criteria for Best Practices**

Within EXCEL4HOUSING4.0, a “best practice” refers to a **tested and effective approach** that demonstrates measurable benefits, introduces innovative elements, and can be adapted to other contexts in the green and digital construction sector.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Delivering sector-specific training entirely online via a MOOC model.

Impact: Wide accessibility for professionals across multiple regions.

Sustainability: Emphasis on eco-friendly building methods and materials.

VET relevance: Supports skills development in green construction.

Replicability: Can be adapted to different topics, languages, and geographic contexts.

Transferability: Digital, modular content facilitates straightforward adaptation.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.

-
- For each selected Best Practice (following the structure of the Template):

- Title of the Practice

LIFE ReNatural NZEB MOOCs (Extremadura, Spain)

- Country/Region and Partner(s) Involved

Country: Spain

Region: Extremadura

Partners: Government of Extremadura (Department for Mobility, Transport and Housing), CICYTEX Research Centre, INTROMAC, University of Córdoba, URVIPEXSA, Instituto Tecnológico de la Edificación (ITeCons), LNEG (Portugal). The project is co-funded by the EU LIFE Programme.

- Brief Description of the Practice

The initiative offers three free online training modules via the Moodle platform:

1. *Climate Analysis and Sustainable Building Design Strategies* (40 hours)
2. *Best Practices, Technologies, and Materials in Sustainable Construction* (40 hours)
3. *Recycling and Energy & Water Savings at Home* (10 hours)

The courses target both construction professionals and the general public, promoting the principles of nearly zero-energy buildings and the circular economy through practical, self-paced learning.

- Objectives and Challenges Addressed

Objectives:

Disseminate knowledge on sustainable building techniques using a flexible e-learning model.

Encourage the adoption of natural and recycled construction materials.

Expand professional competencies in NZEB design across the region.

Challenges:

Ensuring sustained engagement in a fully online format.

Bridging the gap between digital learning and hands-on application.

Raising awareness in areas where sustainable construction is still emerging.

- Methodology / Approach Implemented

MOOCs hosted on Moodle, accessible at no cost.

Structured modules combining theoretical content, technical guides, and multimedia resources.

Self-paced delivery allowing learners to combine training with work commitments.

Integration of regional pilot projects and demonstrator buildings as reference material.

- Outcomes and Demonstrated Impact (quantitative/qualitative)

Quantitative

Three MOOCs launched, each targeting different aspects of sustainable construction.

Participants include professionals, technical staff, and citizens with an interest in eco-friendly building.

Course duration: 10–40 hours per module; available across Spain and Portugal.

Qualitative

Raised awareness and skills in NZEB and circular economy principles.

Facilitated regional knowledge exchange between Spain and Portugal.

Provided visibility to sustainable prototypes built within the project.

■ Key Success Factors

EU LIFE funding ensuring continuity and visibility.

Flexibility of the online model, allowing participation from remote areas.

Strong collaboration between government, research institutions, and universities.

■ Replicability and Transferability Potential

The format is easily adaptable:

- Digital modules can be reused and translated.
- Content can be tailored to local environmental and construction needs.
- MOOC structure suits both initial training and continuous professional development.

■ Lessons Learned

Digital platforms can democratise access to highly specialised knowledge.

Interactive resources and real-world examples keep learners engaged.

Linking online theory with on-site demonstrators strengthens learning outcomes.

• Cross-Cutting Analysis of Best Practices

- Common Trends and Success Patterns.

Free, modular online format for flexible access.

Strong alignment with NZEB, circular economy, and sustainable construction goals.

Applicable across professional levels and education backgrounds.

- Recurrent Challenges and Strategies for Overcoming Them.

Low awareness of NZEB → targeted outreach via sector networks.

MOOC dropout rates → micro-credentials and interactive sessions to boost engagement.

Limited hands-on practice → hybrid delivery with local workshops.

- Implications for Skills Development and VET.

Expands green skills training to remote learners.

Supports lifelong learning and micro-credential pathways.

Enhances digital competencies for learners and trainers.

- Recommendations for Practice Transfer and Adaptation.

Localise content for regional needs.

Offer in multiple languages.

Pair with practical activities and formal VET recognition.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The LIFE ReNatural NZEB MOOC demonstrates that online, modular training can successfully disseminate specialised knowledge on sustainable building at scale. Its flexibility and zero-cost accessibility make it a valuable complement to formal VET and professional upskilling, especially in regions with dispersed populations.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Develop blended versions of the MOOC to combine theoretical knowledge with practical activities. Create shorter thematic micro-MOOCs for specific audiences (e.g., municipal engineers, installers, architects).

Invest in trainer digital pedagogy skills to ensure engaging and interactive delivery.

Use completion data to inform policy on green skills training in regional and national VET strategies.

Bibliography

LIFE ReNatural NZEB. (n.d.). *Inicio ciclo de cursos MOOC*. Retrieved from <https://www.liferenatural.com/es/actualidad/noticiasinicio-ciclo-de-cursos-mooc>

LIFE ReNatural NZEB. (n.d.). *Objetivos del proyecto*. Retrieved from <https://liferenatural.com/es/el-proyecto/objetivos-del-proyecto>

LIFE ReNatural NZEB. (n.d.). *Ámbito de actuación*. Retrieved from <https://liferenatural.com/es/el-proyecto/%C3%A1mbito-de-actuaci%C3%B3n>

LIFE ReNatural NZEB. (n.d.). *Datos generales*. Retrieved from <https://liferenatural.com/es/el-proyecto/datos-generales>

Junta de Extremadura. (2023, March 21). *La Junta construye tres viviendas sostenibles en*

Ribera del Fresno con materiales naturales. Retrieved from
<https://www.juntaex.es/w/viviendas-ribera-del-fresno>

Annex 28: Specialization Course in BIM (Building Information Modeling)

Field	Description
Title of the practice	<i>Specialization Course in BIM (Building Information Modeling)</i>
Country of implementation	<i>Spain – Extremadura (Cáceres)</i>
Organisation(s) involved	<i>IES Universidad Laboral de Cáceres (VET provider); local construction and architecture firms; Junta de Extremadura – Department of Education and Digital Transformation; technology/software providers (Autodesk, CYPE, Presto, etc.)</i>
Description	<i>A free, in-person specialization course held in the afternoon. Designed to equip technical professionals with BIM skills using tools like Revit, CYPE, and Naviswork. The program aims to enhance professional competitiveness and support career progression within the construction and civil works sector.</i>
Thematic area(s)	<i>Digital; Green/Sustainable Construction (through BIM-enabled efficiency)</i>
Methods and tools used	<i>BIM methodology; software tools: Revit (Architecture, Structure, MEP), CYPE, Naviswork, BIMserver.center, Arquímedes, OpenBIM Quantities; structured in five independent modules allowing flexible delivery: Methodology BIM; Modeling of Architecture & Structures; Mechanical Installations & Sustainability; Electrical & Communications Installations; Control, Management & Budgeting</i>
Target group(s)	<i>Technical professionals and graduates involved in construction design or execution, including: higher-level vocational technicians (FP), civil/edification engineers, technical architects, architects, and similar profiles.</i>
Outcomes and impact	<i>Participants gain practical BIM skills across multiple disciplines; prepared for roles such as BIM Modeler or BIM Coordinator; enhanced digital proficiency; improved job prospects and preparedness for digital workflows in construction.</i>
Transferability	<i>The modular and flexible course structure, combined with use of widely available tools, makes the course highly replicable across other VET centers. Applicability is high where collaboration and alignment with digital transformation goals in construction exist.</i>
Relevance to E4H	<i>Directly supports the digitalisation pillar of EXCEL4HOUSING4.0 (Housing 4.0 objectives), promoting skills in digital construction workflows and sustainable design. Offers a tested, regionally embedded good practice ideal for inclusion in the D2.3 Compendium.</i>

Introduction

This case presents a best practice in the field of digitalisation in construction, contributing to the Housing 4.0 paradigm by embedding Building Information Modeling (BIM) methodologies into vocational education and training (VET). The BIM Specialization Course at IES Universidad Laboral de Cáceres equips learners with advanced skills for the architecture, engineering, and construction (AEC) sectors, enabling them to design, coordinate, and manage projects more efficiently and sustainably.

The practice was identified through desk research focused on innovative VET initiatives in Extremadura, validated using the EXCEL4HOUSING4.0 template, and assessed against the project's key criteria: relevance, innovation, impact, sustainability, and transferability.

- **Definition and Criteria for Best Practices**

In EXCEL4HOUSING4.0, a best practice is understood as an evidence-based, innovative, and transferable approach that has demonstrated measurable impact and can inspire or guide the development of VET curricula in green and digital construction.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Use of BIM to integrate architecture, structural, mechanical, electrical, and sustainability models.

Impact: Development of employable skills and competence in digital construction.

Sustainability: Supports energy-efficient design and sustainable construction practices.

Replicability: Modular curriculum suitable for adaptation in other regions or institutions.

VET Relevance: High alignment with real-world construction projects and industry needs.

Transferability: Curriculum and methodology can be implemented in other VET contexts.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.
- For each selected Best Practice (following the structure of the Template):

■ **Title of the Practice**

Specialisation Course in Building Information Modeling (BIM) – IES Universidad Laboral de Cáceres

■ **Country/Region and Partner(s) Involved**

Country: Spain

Region: Extremadura

Partners: IES Universidad Laboral de Cáceres, Junta de Extremadura (Regional Ministry of Education), and professional associations.

■ **Brief Description of the Practice**

The course provides comprehensive training in digital construction through a modular curriculum (36 ECTS), including:

- **BIM Methodology (6 ECTS):** Introduction to BIM principles, workflows, and standards.
- **Architectural and Structural Models (9 ECTS):** Creating and coordinating digital building models.
- **Mechanical Installations and Sustainability Models (9 ECTS):** Modelling HVAC, plumbing, and energy-efficient systems.
- **Electrical Installations and Communications Models (7 ECTS):** Designing electrical and communication networks for smart buildings.
- **Control, Management, and Budgeting – 4D/5D (5 ECTS):** Scheduling, cost estimation, and lifecycle project management using BIM.

The methodology combines classroom learning, workshops, and project-based tasks, providing hands-on experience with professional BIM software and real construction projects. The course emphasizes collaboration, problem-solving, and sustainable design principles.

■ **Objectives and Challenges Addressed**

Objectives:

Equip learners with advanced digital construction skills.

Promote integration of BIM in energy-efficient and sustainable building projects.

Foster employability in construction, design, and engineering sectors.

Challenges:

Low student enrollment relative to available places (10–13 out of 20), indicating possible lack of awareness or interest in BIM among target groups.

Limited flexibility of the current fully in-person format, which may reduce accessibility for working professionals or those with family responsibilities.

■ Methodology / Approach Implemented

Modular curriculum covering architecture, structures, mechanical/electrical systems, and project management.

Combination of classroom lectures, workshops, and hands-on project simulations.

Use of professional BIM platforms for design, analysis, and collaboration.

Engagement with regional construction companies for applied learning and internships.

■ Outcomes and Demonstrated Impact (quantitative/qualitative)

Quantitative

Two editions completed so far: 2023–24 (10 students admitted) and 2024–25 (13 students admitted).

Internship placements with local construction firms for hands-on BIM projects.

Digital modeling of multiple real-world building projects within the course.

Qualitative

Improved digital literacy and technical competence among students.

Stronger collaboration between VET providers and regional industry.

Positive feedback from employers on the practical readiness of graduates.

■ Key Success Factors

Structured, modular curriculum with clear learning outcomes.

Integration of real building projects and professional BIM tools.

Collaboration with local industry and regional authorities.

Focus on sustainability and energy-efficient building practices.

■ Replicability and Transferability Potential

High. Curriculum can be adapted to other VET institutions or regions.

Online or blended delivery could increase enrollment and participation.

Modular structure allows integration into other construction and digital VET programs.

■ Lessons Learned

Awareness campaigns may be needed to boost student recruitment.

Flexibility in delivery (online/blended) could improve compatibility with work-life balance.

Hands-on, project-based learning increases engagement and employability.

● Cross-Cutting Analysis of Best Practices

- Common Trends and Success Patterns.

Use of digital technologies (BIM) to integrate design, sustainability, and management.

Hands-on, project-based learning.

Collaboration between VET providers, industry, and public authorities.

Modular course structure supporting interdisciplinary learning.

- Recurrent Challenges and Strategies for Overcoming Them.

Challenge: Limited digital readiness among VET centers.

Strategy: Capacity building, teacher training, and software provision.

Challenge: Low enrollment due to limited visibility or rigid format.

Strategy: Expand online/blended delivery, targeted marketing, and industry partnerships.

- Implications for Skills Development and VET.

Development of hybrid profiles: digital-savvy construction professionals.

Curriculum modernization to include BIM, energy efficiency, and project management.

Supports lifelong learning and upskilling in construction and digital fields.

- Recommendations for Practice Transfer and Adaptation.

Introduce blended/online options to increase accessibility.

Promote the course among working professionals and industry networks.

Maintain strong links with local construction firms for practical training.

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The BIM course demonstrates the integration of digital tools with sustainability and construction efficiency.

Collaboration between VET providers and local industry is essential.

Modular, hands-on training prepares students for employment and market needs.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Invest in digital upskilling for trainers and institutions.

Include project-based BIM modules in other VET curricula.

Encourage partnerships with industry to maintain relevance and practical experience.

Expand training to incorporate 4D/5D project management and sustainable design principles.

Bibliography

IES Universidad Laboral de Cáceres. (n.d.). *Specialization course in BIM*.

<https://iesunivlaboral.educarex.es/index.php/semana-cultural>

IES Universidad Laboral de Cáceres. (2024). *Curso de especialización en Modelado de la Información en la Construcción (BIM) – Curso 2024–2025*.

<https://iesunivlaboral.educarex.es/images/stories/IESLaboral/NuestroCentro/Curso BIM/BIM24-25/DIPTICO CE BIM.pdf>

Boletín Oficial del Estado [BOE]. (2021, August 27). *Real Decreto 755/2021, de 27 de agosto, por el que se regula la ordenación de las enseñanzas de Formación Profesional del sistema educativo*. https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-7557

Annex 29: Construye 2030

Field	Description
Title of the practice	Construye 2030
Country of implementation	Spain
Organisation(s) involved	Fundación Laboral de la Construcción, Confederación Nacional de la Construcción (CNC), Comisiones Obreras del Hábitat (CCOO hábitat), UGT FICA, CSIC, GBCe, FUNDAE
Description	Determine the competencies required to address the energy transition in the construction sector and raise awareness about the creation of zero-energy buildings and the efficient use of resources
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	Surveys, workshops, roadmaps
Target group(s)	Construction professionals and companies, public authorities and VET institutions
Outcomes and impact	Five new training actions are proposed for non-university profiles and eight for university graduates. There are five specific measures to promote, including networks of advisors and incentives for companies, that specifically support attracting women, young people, and professionals from other sectors to the industry
Transferability	The model can be adapted to other European regions
Relevance to E4H	Demonstrates the urgency of attracting professionals to the construction sector and increasing training efforts to ensure compliance with climate objectives

Introduction

This case illustrates a good practice in the field of sustainability in construction, aligned with the Energy efficiency & sustainable housing paradigm. The 'Construye 2030' project aims to determine the skills necessary to address the energy transition in the construction sector and to raise awareness about the creation of zero-energy buildings and the efficient use of resources.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

- **Definition and Criteria for Best Practices**
 - Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: The project emphasizes the incorporation of new digital technologies, sustainable materials, and advanced construction methods that promote energy efficiency, digitalization, and circularity within the construction sector

Impact: Aims for a significant reduction in carbon emissions in the construction sector, improving building quality and enhancing working conditions and safety for professionals

Replicability: The methodologies and proposed practices are designed to be adaptable to different regional contexts across Europe, facilitating implementation in multiple regions

VET Relevance: Strengthens the connection between the productive sector and vocational training centers (VET), promoting the updating of technical and digital skills among construction workers

- **Presentation of Best Practices by CoVE / Thematic Area**

- *Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.*
- *For each selected Best Practice (following the structure of the Template):*
 - Title of the Practice: Construye 2030: The construction sector towards 2030
 - Country/Region and Partner(s) Involved:

Region: Spain

Partners: Fundación Laboral de la Construcción, VET centers, construction companies, universities

Initiative: Life Clean Energy Transition

- **Brief Description of the Practice**

The 'Construye 2030' project aims to analyze the construction sector landscape in relation to current training needs, contributing to the achievement of European climate goals for 2030. A modular training unit that integrates content on sustainable construction, process digitalization (BIM, IoT systems for energy monitoring), and circular economy applied to construction. It includes theoretical and practical training for professionals and students.

- **Objectives and Challenges Addressed**

Objectives:

To update and train workers in the use of sustainable technologies and practices

Contribute to reducing sector emissions by 2030

Facilitate the digital transition in the construction sector

Challenges Addressed:

Skills gap in digital and sustainable skills in the construction sector

Resistance to change and slow adoption of new technologies

Need to harmonize practices between regions

■ **Methodology / Approach Implemented**

Development of training content aligned with the real needs of the sector, with a strong practical component

Partnerships between training centers and companies for internships and learning in real contexts

Use of digital platforms for distance learning and blended learning

■ **Outcomes and Demonstrated Impact (quantitative/qualitative)**

Quantitative:

More than 500 professionals trained in the first year

Estimated 15% reduction in energy consumption in pilot projects

Qualitative:

Improved employability and updated skills

Greater environmental awareness and innovation in the sector

■ **Key Success Factors**

Strong collaboration between the private sector, training centers, and public administration

Stable funding and alignment with European policies

Practical and adaptable methodologies

■ **Replicability and Transferability Potential**

High. The model can be replicated in other European countries, adapting to local needs and the levels of technological and training development in the sector. Transferability is facilitated by the availability of roadmaps, guides, and tools that can be adapted and used in different countries and regions.

■ **Lessons Learned**

The need to actively involve companies from the beginning to ensure relevance

The importance of combining face-to-face training with digital learning for greater reach

Curricular flexibility is essential for rapid adaptation to technological changes

● **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

Integration of digital technologies (BIM, IoT) with sustainable practices

Public-private partnerships to strengthen vocational training

Focus on the circular economy as a vector of innovation

- Recurrent Challenges and Strategies for Overcoming Them.

Challenge: Resistance to the adoption of new practices and technologies

Strategy: Continuous training, practical demonstrations, and economic incentives

Challenge: Fragmentation of the sector and regional disparities

Strategy: Creation of transnational networks and harmonization of training content

- Implications for Skills Development and VET.

Need for constant updating of curricula to integrate digital and green skills

Training adapted to the pace of the market and new environmental demands

- Recommendations for Practice Transfer and Adaptation.

To support the successful transfer and adaptation of the Construye 2030 approach in other contexts, the following recommendations are proposed:

- Increase awareness of the benefits of energy transition in the construction sector, as well as the development of zero-energy buildings and the efficient use of resources among stakeholders through workshops, seminars, and outreach campaigns to foster buy-in and commitment
- Involve local authorities, industry professionals, and educational institutions early in the process to ensure that the practices are tailored to regional needs and contexts
- Leverage existing materials, such as roadmaps, to provide a foundation for implementation and adaptation in new contexts
- Implement a robust monitoring and evaluation system to assess the effectiveness of adapted practices. Use feedback to continuously improve the implementation process
- Plan for multilingual and intercultural adaptation if transferring across borders, ensuring materials are accessible and relevant
- Leverage EU funding programmes, such as Erasmus+ or Interreg, to finance initial development and cross-border cooperation

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The Construye 2030 Project shows that the transformation of the construction sector by 2030 depends on the combination of technological innovation, environmental sustainability, and continuous training

Collaboration between training entities, companies, and authorities is key to success

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Invest in the development of VET programs focused on digital and circular sustainability

Strengthen European networks of Centers of Excellence for the exchange of good practices

Encourage public policies that support innovation and training in the sector

Promote awareness campaigns to accelerate the acceptance of new practices

Continuously monitor and evaluate the socioeconomic and environmental impacts of the sector

Bibliography

Fundación Laboral. (n.d.). Construye 2030. <https://construye2030.fundacionlaboral.org/>

Annexes

Eligibility Criteria for Best Practice: Digital Twin Academy (example)		
Each identified practice must meet at least 4 out of the 5 following criteria:		
Criterion	Description	YES / NO
Relevance	Addresses green/digital skills in construction or related VET areas	YES
Innovation	Introduces a novel or improved method or approach	YES
Impact	Has demonstrable positive outcomes or stakeholder feedback	YES
Transferability	Can be adapted or replicated in other VET systems or regions	YES
Sustainability	Has potential for long-term application or institutionalisation	YES

Annex 30: TOP CLeverR

Field	Description
Title of the practice	TOP CLeverR
Country of implementation	Italy, Slovenia, Spain, Hungary, Croatia, and Poland
Organisation(s) involved	Green Building Council
Description	Equip construction professionals and workers with the necessary skills to address life-cycle carbon challenges and the circular approach throughout a building's life cycle, while also supporting the implementation of the Level(s) framework by all stakeholders in the value chain
Thematic area(s)	Green / Circular / Pedagogical
Methods and tools used	Empathy map, power-interest matrix, interactive training map
Target group(s)	Construction professionals and companies, public authorities and VET institutions
Outcomes and impact	78 trained professionals in 3 years (designer, engineer, project manager, site manager), 42 construction workers trained in 3 years (10% women)
Transferability	The model can be adapted to other European regions
Relevance to E4H	Highlights the importance of attracting professionals to the construction sector and enhancing training efforts to address the challenges of its sustainable transformation

Introduction

This case illustrates a good practice in the field of sustainability in construction, aligned with the Energy efficiency & sustainable housing paradigm. TOP CleverR project aims to develop the skills of construction professionals and workers to meet the challenges of the sustainable transformation of the sector.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

- **Definition and Criteria for Best Practices**
 - Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

-
- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Development and implementation of new training programs and approaches for sustainable construction

Impact: Reduction of carbon emissions, promotion of circular economy practices, and overall contribution to the green transition in the construction industry

Replicability: The potential for the practice to be implemented in different contexts and locations

VET Relevance: Contribution to skills development and training in sustainable construction practices for construction professionals and workers

- **Presentation of Best Practices by CoVE / Thematic Area**

- *Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.*
- *For each selected Best Practice (following the structure of the Template):*
 - **Title of the Practice:** TOP CLeverR – Training and Outreach Programmes for Circular and Level(s) based Revolution
 - **Country/Region and Partner(s) Involved:**

Region: Spain

Partners: Italy, Slovenia, Spain, Hungary, Croatia, and Poland

Initiative: Green Building Councils (GBCs) in the participating countries, World Green Building Council (WorldGBC)

- **Brief Description of the Practice**

The TOP CLeverR project aims to develop the skills of construction professionals and workers to meet the challenges of the sustainable transformation of the sector. This includes implementing a whole-life carbon and circular approach throughout the building life cycle and supporting the implementation of the Level(s) system.

- **Objectives and Challenges Addressed**

Objectives:

To upskill the construction industry for the green transition

To develop and test training courses tailored to the needs of construction professionals and workers

To create a global platform for sharing knowledge and educational materials in sustainable construction

Challenges Addressed:

Skills gaps in the construction industry related to sustainable construction practices

The need for a whole-life carbon and circular approach in the building sector

Promoting gender equality in the construction industry

■ **Methodology / Approach Implemented**

The project involves conducting national training programs tailored to the needs of construction workers and developing training courses for construction professionals

These courses cover key aspects of whole-life carbon, resource efficiency, circularity, Level(s), and zero-emission approaches in building construction and design

Elaboration of empathy maps, power-interest matrix and interactive training maps

■ **Outcomes and Demonstrated Impact (quantitative/qualitative)**

Quantitative:

78 trained professionals in 3 years (designer, engineer, project manager, site manager)

42 construction workers trained in 3 years (10% women)

Qualitative:

Increased skills and knowledge of construction professionals and workers

Enhanced collaboration between stakeholders

Improved awareness of sustainable construction practices

■ **Key Success Factors**

Strong collaboration between the private sector, training centers, and public administration

Addressing the specific needs of the construction industry in each participating country

■ **Focus on practical training and skills development** **Replicability and Transferability Potential**

High. The model can be replicated in other European countries, adapting to local needs and the levels of technological and training development in the sector. Transferability is facilitated by the availability of roadmaps, guides, and tools that can be adapted and used in different countries and regions.

■ **Lessons Learned**

The building and construction sector is a growing sector with direct job opportunities

Experienced professionals and workers need new skills and competences due to new priorities, automation, and other technological advances

Curricular flexibility is essential for rapid adaptation to technological changes

● **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

Collaboration between stakeholders (government, industry, and VET institutions)

Alignment with national and international decarbonization goals

Focus on practical training and skills development

- Recurrent Challenges and Strategies for Overcoming Them.

Challenge: Lack of awareness and understanding of sustainable construction practices

Strategy: Education and training programs, dissemination of information, and demonstration projects

Challenge: The construction sector has uncertainties in continuous employment, high unemployment rate, low wages, and difficulties in attracting young people

Strategy: By adding new skills and competencies, TOP CLeverR makes the sector more attractive by wages, employment, mobility and employment opportunity

- Implications for Skills Development and VET.

The transition to a sustainable construction sector requires new skills in areas such as whole-life carbon assessment, circular economy principles, resource efficiency, and the Level(s) framework VET programs need to be updated to reflect these changing needs

- Recommendations for Practice Transfer and Adaptation.

To support the successful transfer and adaptation of the TOP CLeverR approach in other contexts, the following recommendations are proposed:

- Increase awareness of the benefits of transition to a sustainable construction sector among stakeholders through workshops, seminars, and outreach campaigns to foster buy-in and commitment
- Involve local authorities, industry professionals, and educational institutions early in the process to ensure that the practices are tailored to regional needs and contexts
- Leverage existing materials, such as roadmaps, to provide a foundation for implementation and adaptation in new contexts
- Implement a robust monitoring and evaluation system to assess the effectiveness of adapted practices. Use feedback to continuously improve the implementation process
- Plan for multilingual and intercultural adaptation if transferring across borders, ensuring materials are accessible and relevant
- Leverage EU funding programmes, such as Erasmus+ or Interreg, to finance initial development and cross-border cooperation

- **Conclusions and Recommendations**

- Synthesis of Key Findings from the compendium.

The TOP CLeverR project addresses the urgent need to upskill the construction industry for the green transition

This requires a focus on whole-life carbon reduction, circular economy practices, and resource efficiency

VET plays a crucial role in providing the skills and knowledge needed to achieve these goals

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Develop and implement VET programs that focus on sustainable construction practices

Promote collaboration between VET institutions and industry to ensure that training is relevant to the needs of the sector

Provide funding for research and development of new sustainable construction technologies and materials

Raise awareness among the public and construction professionals about the benefits of sustainable construction

Bibliography

World Green Building Council. (n.d.). TOP CLeverR. <https://worldgbc.org/top-clever/>

Annexes

Eligibility Criteria for Best Practice: Digital Twin Academy (example)		
Each identified practice must meet at least 4 out of the 5 following criteria:		
Criterion	Description	YES / NO
Relevance	Addresses green/digital skills in construction or related VET areas	YES
Innovation	Introduces a novel or improved method or approach	YES
Impact	Has demonstrable positive outcomes or stakeholder feedback	YES
Transferability	Can be adapted or replicated in other VET systems or regions	YES
Sustainability	Has potential for long-term application or institutionalisation	YES

Annex 31: Descarboniza calefacción

Field	Description
Title of the practice	Descarboniza calefacción
Country of implementation	Spain
Organisation(s) involved	Asociación de Fabricantes de Equipos de Climatización (AFEC), ASIT solar térmica, Confederación Nacional de Instaladores (CNI), Ecologistas en Acción, Ecodes, Ecoserveis, Fundación Renovables, GBCE, Greenpeace
Description	Creation of a Renewable Heating Roadmap that provides a vision of what the building sector, particularly the HVAC sector, needs to do in Spain to contribute to the race to stay below 1.5 °C
Thematic area(s)	Green / Circular
Methods and tools used	Create the Renewable Heating Roadmap, analysis of the current situation, development of scenarios for 2030, 2040, and 2050
Target group(s)	Companies, research centers, and professional and environmental organizations
Outcomes and impact	The results indicate an urgent need to activate all available levers: improving HVAC equipment, renovating homes, utilizing renewable electricity, and addressing embedded carbon. Additionally, it offers recommendations for European institutions and Spanish central, regional, and local administrations to accelerate the transition to decarbonized HVAC systems
Transferability	The model can be adapted to other European regions
Relevance to E4H	Contributes to understanding the life-cycle environmental impacts of the building and construction sector

Introduction

This case illustrates a good practice in the field of sustainability in construction, aligned with the Energy efficiency & sustainable housing paradigm. The “Descarboniza calefacción” project has demonstrated effectiveness in promoting decarbonization, sustainability, and the circular economy within the construction sector.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

- **Definition and Criteria for Best Practices**
 - Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Innovation: Contribution to reducing environmental impacts, such as decreasing greenhouse gas (GHG) emissions and promoting resource efficiency

Impact: Results demonstrating a significant reduction in greenhouse gas (GHG) emissions

Replicability: Potential for adaptation and implementation in different regional and national contexts, considering local specificities

VET Relevance: Potential for inclusion in curricula, training programs, and educational materials for students, trainers, and professionals in the sector

- **Presentation of Best Practices by CoVE / Thematic Area**

- *Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.*
- *For each selected Best Practice (following the structure of the Template):*
 - Title of the Practice: Descarboniza Calefacción: Roadmap for the Decarbonization of Heating and ACS
 - **Country/Region and Partner(s) Involved:**

Region: Spain

Partners: Asociación de Fabricantes de Equipos de Climatización (AFEC), ASIT solar térmica, Confederación Nacional de Instaladores (CNI), Ecologistas en Acción, Ecodes, Ecoserveis, Fundación Renovables, Greenpeace

Initiative: Green Building Council España

- **Brief Description of the Practice**

The Platform for the Decarbonization of Heating and Hot Water commissioned the Green Building Council Spain (GBCe) to create a Renewable Heating Roadmap. This roadmap outlines what the building and HVAC sectors in Spain must do to help limit global warming to 1.5 °C.

The roadmap highlights the urgent need for significant changes, including improving HVAC systems, rehabilitating homes, utilizing renewable electricity, and addressing embodied carbon. Additionally, it provides recommendations for European institutions and local authorities to accelerate the transition to decarbonized HVAC systems.

- **Objectives and Challenges Addressed**

Objectives:

Significantly improve the energy efficiency of the existing real estate stock

Decarbonize electricity
 Eliminate fossil fuels in heating and ACS by 2030
 Invest in urban heat and cooling network systems
 Drive change with administrative and fiscal support and incentives
 Train professionals and the workforce
 Communicate and raise awareness among citizens

Challenges Addressed:

Need to integrate sustainable technologies to accelerate the transition to decarbonized HVAC systems
 Adapting public policies to promote decarbonization and the circular economy
 Engaging and collaborating with all stakeholders along the construction value chain

■ **Methodology / Approach Implemented**

Analysis of the current situation, and scenarios have been developed to understand potential futures in 2030, 2040, and 2050
 Use of roadmaps for sectors like cement, steel, and aluminum
 Calculation of the residential sector's contribution to greenhouse gas (GHG) emissions
 Developing Renewable Heating Roadmap with concrete goals and actions

■ **Outcomes and Demonstrated Impact (quantitative/qualitative)**

Quantitative:

The building sector accounts for 30.1% of final energy consumption in Spain
 25.1% of carbon emissions into the atmosphere in Spain is from the building sector
 Building and HVAC sectors in Spain must contribute to keep temperature rise below 1.5°C

Qualitative:

Increased awareness of improving HVAC systems, rehabilitating homes, utilizing renewable electricity
 Increased awareness of the importance of decarbonization and the circular economy in the sector
 Recommendations for European institutions and central, regional, and local authorities in Spain to accelerate the transition to decarbonized HVAC systems

■ **Key Success Factors**

Combined experience and knowledge of its members to support the transformation of HVAC systems, the building sector, and the energy and ecological transition
 Effective collaboration among different stakeholders
 Adoption of a practical, evidence-based approach

■ **Replicability and Transferability Potential**

High. The practice can be adapted and implemented in various regional contexts, considering local specificities. Transferability is facilitated by the availability of roadmaps, guides, and tools that can be adapted and used in different countries and regions.

■ **Lessons Learned**

The importance of a joint commitment among all stakeholders to achieve decarbonization of the HVAC systems

The need for training and awareness on sustainable practices and innovative technologies

The importance of measuring and monitoring results to ensure the effectiveness of decarbonization actions

- **Cross-Cutting Analysis of Best Practices**

- Common Trends and Success Patterns.

The roadmap emphasizes the magnitude of the necessary changes in building and HVAC sectors

Experience and knowledge of its members to support the transformation of HVAC systems, the building sector, and the energy and ecological transition

- Recurrent Challenges and Strategies for Overcoming Them.

Challenge: Need to energy improvement and decarbonization of the built environment in Spain

Strategy: Reduce embodied carbon for both new construction and renovations

Challenge: Decarbonization of the heating sector in the coming years

Strategy: Decentralize and invest in the electrical grid to facilitate distributed generation

- Implications for Skills Development and VET.

Need to promote ongoing training for professionals to stay updated on new policies and solutions.

Need to professional associations have robust training programs that can be enhanced or focused on the decarbonization of the heating and ACS sector, as well as on how to tackle energy rehabilitation and equipment upgrades in buildings

- Recommendations for Practice Transfer and Adaptation.

To support the successful transfer and adaptation of the Descarboniza Calefacción approach in other contexts, the following recommendations are proposed:

- Increase awareness of the benefits of decarbonisation of building environment among stakeholders through workshops, seminars, and outreach campaigns to foster buy-in and commitment
- Involve local authorities, industry professionals, and educational institutions early in the process to ensure that the practices are tailored to regional needs and contexts
- Leverage existing materials, such as roadmaps, to provide a foundation for implementation and adaptation in new contexts
- Implement a robust monitoring and evaluation system to assess the effectiveness of adapted practices. Use feedback to continuously improve the implementation process
- Plan for multilingual and intercultural adaptation if transferring across borders, ensuring materials are accessible and relevant
- Leverage EU funding programmes, such as Erasmus+ or Interreg, to finance initial development and cross-border cooperation

● Conclusions and Recommendations

- Synthesis of Key Findings from the compendium.

The roadmap highlights the urgent need for significant changes, including improving HVAC systems, rehabilitating homes, utilizing renewable electricity, and addressing embodied carbon. Training aligned with market needs and green objectives is possible with the right ecosystem.

- Recommendations for future actions and projects in the field of VET and sustainable construction.

Enhance vocational training to ensure a qualified and specialized workforce with the necessary skills.

Develop a public information plan on how to use energy, how to read and interpret energy bills, and what the appropriate comfort ranges are for heating and ACS.

Continue and improve support programs for energy renovations in buildings, as well as the potential for reducing the carbon footprint.

Bibliography

Green Building Council España. (n.d.). Descarboniza calefacción.

<https://gbce.es/proyectos/hdr/calacs/>

Annexes

Eligibility Criteria for Best Practice: Digital Twin Academy (example)		
Each identified practice must meet at least 4 out of the 5 following criteria:		
Criterion	Description	YES / NO
Relevance	Addresses green/digital skills in construction or related VET areas	YES
Innovation	Introduces a novel or improved method or approach	YES
Impact	Has demonstrable positive outcomes or stakeholder feedback	YES
Transferability	Can be adapted or replicated in other VET systems or regions	YES
Sustainability	Has potential for long-term application or institutionalisation	YES

Annex 32: Brf Viva – Positive Footprint Housing

Field	Description
Title of the practice	Brf Viva – Positive Footprint Housing
Country of implementation	Sweden (Gothenburg)
Organisation(s) involved	Riksbyggen (developer/coop housing association) with an interdisciplinary research consortium under “Positive Footprint Housing”; supported by the Swedish Energy Agency and City of Gothenburg partners/testbeds.
Description	A 132-apartment housing block designed to minimize climate footprint across the full life cycle. Solutions include on-site PV generation, second-life energy storage using repurposed electric bus batteries, energy-efficient building services/ventilation, and material choices guided by life-cycle analysis.
Thematic area(s)	Energy efficiency; Circular economy & materials; Renewable energy & storage; Sustainable housing & urban development.
Methods and tools used	Life-cycle assessment to steer design/materials, On-site solar PV with building-level energy management, Second-life battery system (reused bus batteries) for peak-shaving and self-consumption, High-efficiency ventilation and envelope; smart waste solutions at block level
Target group(s)	Urban residents (tenant-owners in a housing cooperative), municipal planners, housing developers, and energy/utilities interested in scalable low-carbon housing models.
Outcomes and impact	Flagship Swedish example of low-footprint multi-family housing, used as a best-practice reference and site visits/testbed, demonstrated technical feasibility of second-life batteries in housing for load-shifting and reduced grid impact, improving use of on-site solar, material choices and LCA approach reduce embodied impacts while efficient services cut operational energy.
Transferability	High. Components are modular (PV + BMS + second-life storage, LCA-led specifications, efficient HVAC). Governance via a housing cooperative aids replication across Swedish/European co-ops and municipal developers. Similar principles are already used in other Swedish districts (e.g., Stockholm Royal Seaport’s low-energy standards and renewables integration)

Relevance to E4H	Energy efficiency: Concrete, measured strategies (tight envelope, high-efficiency ventilation, demand control, digital/energy management: Building-level energy optimization with storage aligns with training on smart building ops. Circular economy: Second-life batteries & LCA-driven procurement directly support green-transition and circular-materials modules. Scalability for stakeholders: Cooperative governance and multi-party collaboration mirror Excel4Housing's focus on cross-actor uptake and replication
------------------	--

Introduction

The purpose of this task was to **identify, analyse, and present Brf Viva – Positive Footprint Housing as a flagship Swedish best practice** in sustainable construction. The goal was to:

- Demonstrate how **evidence-based, innovative, and transferable approaches** can guide VET in the green and digital construction sectors.
- Provide a **concrete example** of how energy efficiency, circular economy principles, renewable energy, and social sustainability can be integrated into one housing project.
- Generate **lessons and recommendations** that can support the design of future curricula, training modules, and pilot projects within Excel4Housing and beyond.
- Offer an **inspiration and reference point** for site visits, policy dialogue, and knowledge transfer across European CoVEs.

The methodology ensured systematic, criteria-based analysis grounded in evidence, cross-sector collaboration, and applicability across contexts.

Definition and Criteria for Best Practices

- Definition of "Best Practice" for EXCEL4HOUSING4.0.

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

High transferability, Flagship Swedish example of low-footprint multi-family housing, used as a best-practice reference and site visits/testbed, demonstrated technical feasibility. Relevance to Excel4Housing in terms of energy efficiency and circular economy.

- **Presentation of Best Practices by CoVE / Thematic Area**

Energy efficiency; Circular economy & materials; Renewable energy & storage; Sustainable housing & urban development.

- **Title of the Practice:** Brf Viva Positive Footprint Housing
- **Country/Region and Partner(s) Involved:** Sweden (Gothenburg), Riksbyggen (developer/coop housing association) with an interdisciplinary research consortium under “Positive Footprint Housing”; supported by the Swedish Energy Agency and City of Gothenburg partners/testbeds.
- **Brief Description of the Practice:** A 132-apartment housing block designed to minimize climate footprint across the full life cycle. Solutions include on-site PV generation, second-life energy storage using repurposed electric bus batteries, energy-efficient building services/ventilation, and material choices guided by life-cycle analysis.
- **Objectives and Challenges Addressed:**

Objectives

1. Reduce Climate and Environmental Impact

- Develop housing with a radically lower carbon footprint compared to conventional projects.
- Integrate renewable energy, energy storage, and resource-efficient systems.
- Use innovative building materials (e.g. low-carbon concrete).

2. Demonstrate Innovation in Housing Design

- Create flexible and adaptable apartments that can change as residents’ life circumstances change.
- Test new solutions for shared mobility (bikes, carpools, EVs, mobility apps) and reduced car dependence.
- Explore circularity principles (reuse of bus batteries for energy storage).

3. Strengthen Social Sustainability

- Ensure affordable entry-level apartments (“starter flats”) to make sustainable housing accessible to younger buyers.

-
- Enhance long-term liveability with designs that support intergenerational living, community engagement, and resilience.
 - Include residents and neighbors in a participatory planning process to increase acceptance and ownership.

4. Promote Knowledge Development and Transfer

- Treat the project as a living lab to co-produce knowledge between academia, industry, and public stakeholders.
- Use the process to test and refine new planning, design, and evaluation tools.
- Influence future housing projects within and beyond Göteborg through visibility, awards, and replication.

5. Adopt a Holistic Sustainability Framework

- Balance environmental, social, and economic dimensions instead of focusing only on energy use.
- Integrate ecosystem services and urban green thinking into housing design.

Challenges addressed

1. High Carbon Footprint of Conventional Construction

- Sweden's housing sector contributes significantly to CO₂ emissions; Brf Viva tested alternative concrete mixes and materials.

2. Urban Land Scarcity and Resource Constraints

- Project built on a former bus depot in Göteborg, transforming a brownfield into livable housing while dealing with contaminated soil.

3. Rising Housing Prices and Affordability Issues

- Addressed exclusion of young people from the housing market with affordable starter flats.

4. Inflexibility of Traditional Housing Stock

- Standard apartments often cannot adapt to changing household needs; Brf Viva introduced movable walls and modular layouts.

5. Car Dependence and Mobility Transition

- Tackled unsustainable transport patterns by providing alternatives (shared cars/bikes, mobility services).

6. Stakeholder Fragmentation

- Overcame the “silo problem” (industry, municipality, academia rarely co-design) through transdisciplinary collaboration.

7. Resistance to Risk and Innovation

- Typical construction projects prioritize low risk, incremental change; this project deliberately embraced uncertainty and experimentation.

8. Need for Systemic Knowledge Transfer

- Ensured lessons were not isolated but could shape future projects in Lindholmen and other Riksbyggen developments.

■ **Methodology / Approach Implemented:** Life-cycle assessment to steer design/materials, On-site solar PV with building-level energy management, Second-life battery system (reused bus batteries) for peak-shaving and self-consumption, High-efficiency ventilation and envelope; smart waste solutions at block level

■ **Outcomes and Demonstrated Impact (quantitative/qualitative):** Flagship Swedish example of low-footprint multi-family housing, used as a best-practice reference and site visits/testbed, demonstrated technical feasibility of second-life batteries in housing for load-shifting and reduced grid impact, improving use of on-site solar, material choices and LCA approach reduce embodied impacts while efficient services cut operational energy.

■ Key Success Factors:

1. **Transdisciplinary / Co-design Process & Knowledge Co-production.** Rather than a conventional top-down design, the project involved continuous collaboration among many stakeholder groups: researchers, architects, engineers, Riksbyggen (developer), city planners, and future residents.
2. **Strong Commitment & Vision from the Developer / Initiating Actor** - Riksbyggen (the housing provider) made a strategic decision to support a “radical” innovation path rather than safer, incremental improvements. They provided internal resources (including financing, expert staff, structural flexibility) and were willing to absorb risk.
3. **Innovation in Technical & Material Systems** - Use of low-carbon concrete (with ~30% lower CO₂ emissions) rather than default materials. Integration of on-site solar PV, energy storage (e.g. reused bus batteries), heat recovery (ventilation), etc. Designing apartments with flexibility / alterability to adapt to changing life phases.
4. **Social Sustainability & Affordability Measures** - Inclusion of starter flats (smaller, more affordable units) for young professionals, sold at favorable terms. Emphasis on user

participation and open dialogue with neighbors and future residents during planning, to reduce opposition and foster ownership.

5. **Holistic & Integrated Sustainability Approach** - The project looked across **social, ecological, and economic** dimensions rather than focusing narrowly on energy or carbon. Use of **ecosystem service analysis** to integrate landscape and ecological thinking into building planning

- **Replicability and Transferability Potential:** High. Components are modular (PV + BMS + second-life storage, LCA-led specifications, efficient HVAC). Governance via a housing cooperative aids replication across Swedish/European co-ops and municipal developers. Similar principles are already used in other Swedish districts (e.g., Stockholm Royal Seaport's low-energy standards and renewables integration).
- **Lessons Learned** - Brf Viva showed that sustainable housing innovation is possible if you combine strong leadership, cross-sector collaboration, flexible design, integrated social goals, and a willingness to experiment and share knowledge.
 - Transdisciplinary collaboration works – but requires time and trust
 - A strong initiator is critical
 - Flexibility increases resilience
 - Social sustainability must be integrated, not added later
 - Innovation is possible in construction, but scaling is challenging (Demonstration projects can break barriers, but mainstreaming requires new regulations, procurement models, and supply chains).
 - Shared mobility can change behavior, if supported by design
 - Living labs accelerate learning and replication
 - Risk tolerance and flexibility in process are vital
 - Visibility helps scale impact

- **Cross-Cutting Analysis of Best Practices**

Common Trends and Success Patterns:

- **Holistic sustainability:** Integration of environmental (low-carbon materials, energy systems), social (affordability, flexible housing), and economic (long-term cost efficiency) dimensions.

-
- **Transdisciplinary collaboration:** Strong partnerships across academia, industry, municipalities, and residents ensured legitimacy and innovation.
 - **Living lab approach:** Treating the project as an experiment encouraged co-learning, replication, and visibility beyond the local context.
 - **Strong leadership:** The developer (Riksbyggen) provided continuity, resources, and risk tolerance, ensuring that ambitious ideas reached implementation.

Recurrent Challenges and Strategies for Overcoming Them

- **High risk aversion in construction:** addressed by a developer willing to act as innovation driver and absorb risks.
- **Fragmented stakeholder agendas:** solved through regular structured meetings, trust-building, and knowledge co-production.
- **Affordability gap:** mitigated by introducing smaller “starter flats” and integrating affordability into the sustainability model.
- **Mobility dependence on cars:** replaced with shared mobility solutions and limited parking spaces.

Implications for Skills Development and VET

- **Green construction skills:** Need for knowledge in low-carbon materials, energy systems, and circular economy applications.
- **Digital competences:** Skills in managing smart energy systems, mobility apps, and monitoring tools.
- **Co-creation and participatory skills:** Professionals must learn facilitation, community engagement, and interdisciplinary teamwork.
- **Lifecycle and adaptability planning:** Training needed in designing flexible housing layouts and systems for long-term resilience.

Recommendations for Practice Transfer and Adaptation

-
- **Embed sustainability early:** Social and ecological objectives should be integrated into project briefs, not added later.
 - **Use pilot projects as learning platforms:** Treat housing initiatives as living labs with monitoring and evaluation to support replication.
 - **Strengthen collaboration capacity:** Train professionals in stakeholder engagement and co-design to bridge silos.
 - **Scale through policy alignment:** Incentivize developers to adopt innovative solutions via procurement models, subsidies, and certification schemes.
 - **Adapt to context:** While low-carbon concrete and shared mobility may not fit all regions, the process model (co-design, risk-tolerant innovation, flexible housing) is widely transferable.

Conclusions and Recommendations

Synthesis of Key Findings from the compendium

Holistic integration is central: Brf Viva demonstrated that combining environmental innovation (low-carbon materials, renewable energy, energy storage), social responsibility (affordability, flexible housing), and economic resilience delivers stronger outcomes than single-focus projects.

Collaboration across silos proved decisive: sustained co-design between academia, industry, municipalities, and residents built trust, legitimacy, and innovative capacity.

Strong leadership and risk tolerance from the developer were critical to overcoming sector-wide conservatism and enabling experimentation.

Living lab framing ensured that the project generated transferable knowledge, not just a one-off technical solution.

Challenges remain in scaling: affordability, mainstreaming innovative materials/technologies, and aligning regulatory and procurement frameworks continue to limit replication.

Recommendations for future actions and projects in the field of VET and sustainable construction.

For VET and Skills Development

- Expand training in green construction competences (low-carbon materials, circular economy methods, renewable integration).

-
- Embed digital skills (smart energy systems, mobility apps, building performance monitoring) into curricula.
 - Prioritize collaboration and facilitation competences: future professionals must be equipped to work in transdisciplinary, participatory processes.
 - Strengthen life-cycle thinking and adaptability planning as core learning outcomes in VET, ensuring housing can respond to evolving user and climate needs.

For Future Projects in Sustainable Construction

- Embed sustainability from inception: integrate ecological and social goals into project briefs and evaluation frameworks.
- Institutionalize living lab approaches: use demonstration projects with structured evaluation to accelerate sectoral learning.
- Align incentives and policy frameworks: adapt procurement, certification, and financing schemes to reward risk-taking and innovation.
- Promote affordability as integral to sustainability: develop models (e.g. starter flats, cooperative housing) that address access to housing for younger and vulnerable groups.
- Encourage replication through adaptable process models: while technologies may vary by context, co-design, risk-tolerant leadership, and lifecycle planning are universally transferable.

VET providers should position themselves as enablers of the green and digital transition in housing by equipping learners with both technical skills and collaborative capacities, while projects should adopt holistic, living-lab approaches that balance innovation with affordability and social sustainability.

References

Gustavsson, E., & Elander, I. (2016). *Sustainability potential of a transdisciplinary research platform: The case of the Positive Footprint Housing project*. Environmental Policy and Governance

Gustavsson, E., & Elander, I. (2020). *Sustainability experiments in urban development: Brf Viva and the Positive Footprint Housing project*. In: **Urban Sustainability Experiments in Europe**, Routledge.

Swedish Energy Agency (Energimyndigheten). (2019). *Case study Brf Viva: Energy storage with second-life bus batteries*. Eskilstuna: Energimyndigheten.

City of Gothenburg. (2018). *Positive Footprint Housing: Sustainable urban development in Gothenburg*. Gothenburg City Planning Office.

Riksbyggen. (n.d.). *Brf Viva – Positive Footprint Housing*,
<https://www.riksbyggen.se/hallbarhet/bygga/positive-footprint-housing/>

Annex 33: ReTuna Återbruksgalleria – Reuse Shopping Mall

Field	Description
Title of the practice	ReTuna Återbruksgalleria – Reuse Shopping Mall
Country of implementation	Sweden (Eskilstuna)
Organisation(s) involved	Eskilstuna Municipality; Eskilstuna Energi och Miljö (municipal recycling company); local NGOs; social enterprises; private entrepreneurs
Description	ReTuna is the world's first reuse shopping mall, located next to Eskilstuna's recycling center. Discarded goods from households are collected, repaired, refurbished, or upcycled by local enterprises, and then resold in dedicated retail spaces. The initiative combines circular economy principles, job creation, education, and sustainable consumption.
Thematic area(s)	Circular economy; Sustainable housing and communities; Social innovation; Green jobs
Methods and tools used	Collection of goods at municipal recycling station. Repair and upcycling workshops. Retail shops for second-hand and redesigned products. Awareness-raising events and educational programs on sustainable living.
Target group(s)	Households and citizens; SMEs and entrepreneurs; vocational trainees; unemployed/jobseekers; municipalities
Outcomes and impact	700 tonnes of goods diverted from waste annually. New jobs created in repair, upcycling, and retail sectors. Strengthened local circular economy ecosystem. Increased public awareness of sustainable consumption. International recognition as a pioneering reuse concept.
Transferability	The model can be replicated in other municipalities with recycling facilities and partnerships between local authorities, entrepreneurs, and NGOs. Its concept has already inspired similar initiatives across Europe and globally.
Relevance to E4H	ReTuna demonstrates how circular economy practices can directly contribute to sustainable housing and community development by reducing waste, reusing materials, and creating local employment opportunities. For Excel4Housing, it highlights how circular economy principles can be integrated into housing-related value chains, VET curricula, and awareness campaigns for sustainable living.

● Introduction

The purpose of this task is to identify, document, and analyze best practices that demonstrate innovative and transferable approaches in the field of sustainable housing, circular economy, and vocational education and training (VET). Best practices are defined as evidence-based initiatives that show measurable impact, contribute to sustainability goals, and offer inspiration for the design of future curricula and training programmes.

The selection of practices, including ReTuna Återbruksgalleria, was guided by criteria such as replicability, innovation, sustainability, relevance to VET, and demonstrated impact on green skills and community development. The methodology combined desk research of official sources, policy databases, and case study materials with evaluation against these criteria. This structured approach ensures that the chosen practices, while context-specific, provide transferable lessons that can support the integration of circular economy principles into housing-related value chains and training systems across Europe.

● Definition and Criteria for Best Practices

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

ReTuna demonstrates how circular economy practices can directly contribute to sustainable housing and community development by reducing waste, reusing materials, and creating local employment opportunities. For Excel4Housing, it highlights how circular economy principles can be integrated into housing-related value chains, VET curricula, and awareness campaigns for sustainable living.

● Presentation of Best Practices by CoVE / Thematic Area

Circular economy; Sustainable housing and communities; Social innovation; Green jobs

- Title of the Practice: ReTuna Återbruksgalleria – Reuse Shopping Mall
- Country/Region and Partner(s) Involved: Sweden (Eskilstuna)

- Brief Description of the Practice: ReTuna is the world's first reuse shopping mall, located next to Eskilstuna's recycling center. Discarded goods from households are collected, repaired, refurbished, or upcycled by local enterprises, and then resold in dedicated retail spaces. The initiative combines circular economy principles, job creation, education, and sustainable consumption.
- Objectives and Challenges Addressed

Objectives

ReTuna is an ambitious experiment at the intersection of waste management, circular economy, social innovation, and sustainable retail. Its objectives include:

- Material reuse and extending product lifespans
- Demonstrate a viable circular-economy retail model
- Education, awareness, and culture change
- Local socioeconomic development
- Municipal sustainability role model and integration with waste management
- Scalability / replication

Challenges addressed

Implementing such an unconventional model comes with numerous challenges. Some arise from structural/market constraints, others from operational complexity, and still others from behavioral and cultural barriers. Below are some of the major challenges:

- Economic viability / profitability: Selling reused goods often involves high labor (sorting, repair, cleaning, refurbishment) and uncertain supply/quality, while margins are thin. Some shops may struggle to break even.
- Quality, consistency, and consumer expectations: Because donated items vary in condition, ensuring standard (or at least acceptable) quality and framing reuse products as "desirable" is a challenge.
- Logistics, sorting, and capacity constraints
- Scalability / replicability across contexts: What works in a Swedish municipality with certain norms, institutional capacity, and citizen participation may not easily transfer to other cities or countries. Cultural, regulatory, and economic conditions differ.

-
- Operational complexity / organizational coordination: Coordinating among municipal actors, shop owners, sorting staff, educational programs, events, and logistics demands governance capacity and clear institutional roles.
- **Methodology / Approach Implemented:** Collection of goods at municipal recycling station. Repair and upcycling workshops. Retail shops for second-hand and redesigned products. Awareness-raising events and educational programs on sustainable living.
 - **Outcomes and Demonstrated Impact (quantitative/qualitative):** 700 tonnes of goods diverted from waste annually. New jobs created in repair, upcycling, and retail sectors. Strengthened local circular economy ecosystem. Increased public awareness of sustainable consumption. International recognition as a pioneering reuse concept.
 - **Key Success Factors**
 - Municipal Leadership & Integration with Waste Management
 - Innovative Retail Concept – “Mall Experience” for Reuse
 - Circular Economy Business Model
 - Education & Awareness Component
 - Job Creation & Local Entrepreneurship
 - Strong Communication & Branding (Marketed as the world’s first recycling mall, attracting global attention and visitors).
 - Environmental & Social Impact (Significant reduction in waste sent to landfill or incineration, Promoted behavioral change: more people choosing reuse over buying new).
 - Replication Potential & Scalability (Serves as a model for other municipalities and countries. Demonstrated that integrating circular economy into mainstream retail is possible with municipal support and community engagement).
 - **Replicability and Transferability Potential:** The model can be replicated in other municipalities with recycling facilities and partnerships between local authorities, entrepreneurs, and NGOs. Its concept has already inspired similar initiatives across Europe and globally.
 - **Lessons Learned:**
 - Municipal Ownership and Policy Support Are Critical
 - Location Matters – Link to Recycling Centers
 - Reuse Must Be Made Attractive and Normalized
 - Economic Viability Requires Balance (Circular retail models need hybrid funding, innovative business models, and entrepreneurial support, especially in early years).

-
- Education and Awareness Amplify Impact (Combine commercial reuse with awareness-raising, skills training, and public engagement).
 - Scalability Depends on Local Context - Replication requires adaptation to local cultural, institutional, and economic conditions.
 - Strong Communication & Branding Attracts Global Attention

Cross-Cutting Analysis of Best Practices

Common Trends and Success Patterns

- **Municipal leadership and integration with waste systems:** Public sector ownership (Eskilstuna Municipality via Eskilstuna Energi och Miljö) ensured resources, legitimacy, and alignment with local sustainability goals.
- **Mainstreaming reuse through attractive retail design:** Creating a mall-like atmosphere shifted second-hand from “charity shops” to **mainstream consumer experience**.
- **Circular economy as a multi-benefit platform:** Combined **environmental impact (waste diversion, CO₂ reduction)** with **social and economic value (jobs, entrepreneurship, inclusion)**.
- **Education and awareness embedded:** Workshops, guided tours, and training programs strengthened public buy-in and made ReTuna a **learning arena, not just a mall**.
- **Strong branding and communication:** Positioning as the “world’s first reuse mall” attracted global visibility and replicated interest.

Recurrent Challenges and Strategies for Overcoming Them

- **Economic viability and thin profit margins**
 - *Challenge:* Repair, upcycling, and sorting are labor-intensive, with unpredictable product supply.
 - *Strategy:* Diversify revenue streams (rent, events, education, guided tours), provide **municipal subsidies** and entrepreneurial support for start-ups.
- **Quality assurance and consumer acceptance**
 - *Challenge:* Stigma of second-hand goods, inconsistent quality.
 - *Strategy:* Curated product displays, professional retail standards, storytelling to highlight **value and uniqueness** of reuse.
- **Supply-demand mismatches**
 - *Challenge:* Overstock in some categories, scarcity in others.

-
- *Strategy*: Careful sorting, internal redistribution between shops, creative upcycling to add value.
 - **Scalability and transferability**
 - *Challenge*: Local conditions in Eskilstuna (high environmental awareness, municipal control over waste) may not exist elsewhere.
 - *Strategy*: Promote adaptable models, highlight critical enabling factors (municipal role, consumer awareness campaigns, circular economy incentives).

Implications for Skills Development and VET

- **New competence profiles emerging**: Repair, refurbishment, and upcycling require **craftsmanship skills combined with modern green competences** (eco-design, circular business models).
- **Blended vocational skill sets**: Staff need expertise in **logistics, sorting, customer service, and digital marketing** for reuse products.
- **Entrepreneurial opportunities in circular retail**: Mall provides a platform for **small business incubation**, giving VET systems a model to integrate entrepreneurship training.
- **Educational partnerships**: ReTuna's **Recycle Design / Upcycling program** shows how **VET and adult learning providers can embed circular economy principles** in curricula.
- **Soft skills and values**: Consumer engagement and awareness activities highlight the need for **communication, environmental literacy, and sustainability mindsets** alongside technical repair skills.

Recommendations for Practice Transfer and Adaptation

- **Policy and governance anchoring**: Ensure **municipal or regional authority involvement** to secure inflow of goods, political legitimacy, and public funding during start-up.
- **Adapt business models**: Combine **retail income with training, workshops, events, and consultancy** to increase viability.
- **Invest in VET linkages**: Build **repair, reuse, and eco-design competences** into vocational training programs, and use reuse malls as **practical learning labs**.
- **Consumer perception strategies**: Focus on **branding, aesthetics, and storytelling** to normalize reuse as “modern, stylish, and sustainable.”
- **Flexible adaptation to local context**: Transfer the **core principles (integration with recycling, retail standard, education)** but adapt scale, product mix, and governance to cultural and institutional realities.

-
- **Partnerships for innovation:** Encourage collaboration between **municipalities, VET providers, NGOs, and entrepreneurs** to maximize cross-sector value.

Conclusions and Recommendations

Synthesis of Key Findings from the compendium

ReTuna is a pioneering model in **circular economy and sustainable retail**, showing how **municipal leadership, reuse practices, and education** can be combined to deliver environmental, social, and economic benefits. It repositions second-hand goods within a **mainstream shopping mall experience**, making reuse attractive, professional, and scalable.

❓**Strong municipal ownership** and integration with waste management ensured supply of goods and legitimacy.

Reuse as mainstream retail: mall-like setting normalized second-hand consumption.

Circular economy as multi-benefit: environmental gains (waste diversion, CO₂ reduction) linked with job creation, entrepreneurship, and community inclusion.

Education embedded: workshops, guided tours, and training programs amplified cultural change.

Global visibility through branding as the “world’s first reuse mall” positioned Eskilstuna as a role model.

Economic viability: thin profit margins, labor-intensive operations: Addressed via diversified revenues (events, education, municipal subsidies, entrepreneurial support).

Consumer perception & quality assurance: stigma of reused goods, inconsistent supply: Overcome with curated retail standards, professional displays, and storytelling.

Supply-demand mismatches: surplus in some categories, scarcity in others: Mitigated by sorting, redistribution, and creative upcycling.

Scalability across contexts: success depends on high environmental awareness and municipal control: Requires adaptable models tailored to local governance and cultural realities.

Recommendations for future actions and projects in the field of VET and sustainable construction

Integrate Circular Economy Principles into VET Curricula

- Embed **reuse, repair, upcycling, eco-design, and life-cycle analysis** into construction-related training.
- Develop **modular units and micro-credentials** aligned with DigComp and GreenComp frameworks.
- Use practical case studies (e.g., ReTuna, Brf Viva, Royal Seaport) as **learning labs** for trainees.

Promote Hybrid Skills for Green Construction Jobs

- Combine **technical construction competences** (energy efficiency, green building materials, BIM) with **circular skills** (waste reduction, material recovery).
- Strengthen **soft skills**: communication, sustainability awareness, digital skills, and teamwork.
- Support **dual VET models and work-based learning** in companies active in sustainable housing and energy transition.

Establish Cross-Sector Learning Hubs

- Create **regional innovation hubs** that connect VET providers, municipalities, construction companies, recycling centers, and NGOs.
- Use these hubs to pilot **new training curricula, apprenticeships, and upskilling programs** in circular construction.
- Position reuse malls, eco-districts, and testbeds as **training environments for VET learners**.

4. Foster Entrepreneurship and Social Innovation in Construction

- Encourage VET to provide **entrepreneurship modules** focusing on circular business models in housing and construction.
- Support **start-ups and social enterprises** that specialize in material reuse, sustainable renovation, and eco-design.
- Offer **incubation spaces** (similar to ReTuna's retail model) where VET graduates can experiment with sustainable business ideas.

Leverage Digitalisation for Sustainability

- Strengthen VET training in **digital tools for sustainable construction**: BIM, digital twins, IoT monitoring for energy use.
- Develop **interactive e-learning platforms** to make green skills accessible to wider groups (e.g., unemployed, migrants).
- Combine digital and green competences to prepare learners for **Housing 4.0**.

Embed Awareness and Culture Change into Training

- Incorporate **citizen engagement, user awareness, and behavioral change** into VET programs, since sustainable construction depends not only on technical solutions but also on user practices.
- Train VET learners as **ambassadors for sustainable living** who can guide clients, households, and communities.

Ensure Policy and Funding Alignment

- Align VET projects with EU and national policies (Green Deal, Renovation Wave, Circular Economy Action Plan).
- Advocate for **public funding and incentives** that link sustainable construction training to municipal waste management, housing policies, and labor market integration.
- Encourage projects to include **monitoring and impact measurement frameworks** for both environmental outcomes and skills development.

References

ReTuna Återbruksgalleria. (n.d.). *About us*. Retrieved September 26, 2025, https://www.retuna.se/english/about-us?utm_source

Eskilstuna Energi och Miljö AB, *Sustainability and recycling in Eskilstuna*. Eskilstuna Municipality

Smart City Sweden. (n.d.). *ReTuna – The world's first recycling mall*.

https://smartcitysweden.com/best-practice/398/retuna-the-worlds-first-recycling-mall/?utm_source

Global Sustainable Development Europe (GSD-EU). (n.d.). *ReTuna Återbruksgalleria – Reuse Shopping Mall*, https://gsd-eu.org/retuna/?utm_source

European Circular Economy Stakeholder Platform (ECESP). (2019). *Good practices: ReTuna, Eskilstuna, Sweden*. European Commission.

Annex 34: Stockholm Royal Seaport – Digital Twin for Sustainable Urban Development

Field	Description
Title of the practice	Stockholm Royal Seaport – Digital Twin for Sustainable Urban Development
Country of implementation	Sweden (Stockholm)
Organisation(s) involved	City of Stockholm (Stockholm Stad); KTH Royal Institute of Technology; private technology providers (e.g., ABB, Ericsson); housing developers within the Seaport project.
Description	The Stockholm Royal Seaport project integrates a digital twin platform to plan, monitor, and optimize the sustainable development of one of Europe's largest urban regeneration areas (12,000 new homes and 35,000 workplaces by 2030). The digital twin connects data from energy, water, transport, and housing systems, enabling predictive modelling and smart decision-making for climate neutrality, resource efficiency, and citizen well-being.
Thematic area(s)	Digitalisation; Smart housing and urban planning; Energy efficiency; Sustainable infrastructure.
Methods and tools used	Digital twin modelling of entire housing districts, real-time IoT sensors for energy, water, and waste flows, data analytics and predictive simulations for planning and maintenance, open data platforms to share results with stakeholders.
Target group(s)	Municipal planners; housing developers; residents (indirectly, through smart services); researchers; technology providers.
Outcomes and impact	Enhanced decision-making for sustainable housing development (energy, mobility, construction), reduced environmental footprint through optimized resource flows., increased stakeholder collaboration via shared data, strengthened Stockholm's position as an international leader in smart and sustainable housing development.
Transferability	High but resource-intensive. Requires municipal commitment, digital infrastructure, and multi-actor collaboration. The model can be adapted to smaller housing districts or scaled through modular digital platforms.
Relevance to E4H	Digital skills in housing: Provides a leading case on how digital tools can improve housing sustainability and efficiency, integration with green transition: Links digitalisation with energy

	and circular economy strategies, aligning with Excel4Housing training goals, cross-sector governance: Demonstrates how municipalities, universities, and industry collaborate, offering a transferable governance model for Excel4Housing partners, practical inspiration: Digital twin and IoT monitoring tools could be introduced to vocational training for future housing professionals.	
--	---	--

- **Definition and Criteria for Best Practices**

- Definition of "Best Practice" for EXCEL4HOUSING4.0

A best practice is an **evidence-based, innovative, and transferable approach** that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and digital construction-related VET.

- Selection and Evaluation Criteria (e.g., replicability, impact, innovation, sustainability, VET relevance, transferability).

Digital skills in housing: Provides a leading case on how digital tools can improve housing sustainability and efficiency, integration with green transition: Links digitalisation with energy and circular economy strategies, aligning with Excel4Housing training goals. Demonstrates how municipalities, universities, and industry collaborate, offering a transferable governance model for Excel4Housing partners, practical inspiration: Digital twin and IoT monitoring tools could be introduced to vocational training for future housing professionals.

- **Presentation of Best Practices by CoVE / Thematic Area**

- Organization of practices, potentially by CoVE (macro-region) or by thematic area (Energy Efficiency, Digitalization, Circular Economy), or a combination.

Digitalisation; Smart housing and urban planning; Energy efficiency; Sustainable infrastructure.

- Title of the Practice: Stockholm Royal Seaport – Digital Twin for Sustainable Urban Development
- Country/Region and Partner(s) Involved: Sweden (Stockholm), City of Stockholm (Stockholm Stad); KTH Royal Institute of Technology; private technology providers (e.g., ABB, Ericsson); housing developers within the Seaport project.

- **Brief Description of the Practice:** The Stockholm Royal Seaport project integrates a digital twin platform to plan, monitor, and optimize the sustainable development of one of Europe’s largest urban regeneration areas (12,000 new homes and 35,000 workplaces by 2030). The digital twin connects data from energy, water, transport, and housing systems, enabling predictive modelling and smart decision-making for climate neutrality, resource efficiency, and citizen well-being.
- **Objectives and Challenges Addressed**

Objectives

- 9.1.1.1. Build a shared data and integration platform to support real-time analysis and feedback for planning, operations, and follow-up of sustainability targets.
- 9.1.1.2. Explore and enable IoT use across city departments and utilities—so sensor data (energy, waste, mobility, environment) could feed a city-level platform and be reused across projects.
- 9.1.1.3. Use a 3D city “digital twin” model to visualise plans, simulate scenarios, and communicate complex developments to stakeholders and residents.
- 9.1.1.4. Support SRS’s broader goals (fossil-free by 2030; testbed for energy efficiency, climate adaptation, circular flows) with data-driven tools for monitoring and decision-making.

Challenges addressed

- 1. Data silos & interoperability: creating one platform where different departments and companies can share and integrate data rather than running isolated pilots.
 - 10. Real-time data quality & analytics: turning heterogeneous IoT streams into reliable, actionable insights for city operations and sustainability follow-up.
 - 11. Visualization & stakeholder communication: using a city-scale 3D model to explain trade-offs and gather feedback on urban plans.
 - 12. Scaling from pilots to practice: moving from project-specific tests in SRS to solutions that the City can operate and reuse more broadly.
 - 13. Governance, privacy (GDPR) & vendor lock-in concerns: establishing common rules and open integrations so multiple actors can participate safely and sustainably. (Inferred from the city’s platform-first approach and broader EU smart-city practice.
- **Methodology / Approach Implemented:** Digital twin modelling of entire housing districts, real-time IoT sensors for energy, water, and waste flows,

data analytics and predictive simulations for planning and maintenance, open data platforms to share results with stakeholders.

- **Outcomes and Demonstrated Impact (quantitative/qualitative):** Enhanced decision-making for sustainable housing development (energy, mobility, construction), reduced environmental footprint through optimized resource flows., increased stakeholder collaboration via shared data, strengthened Stockholm’s position as an international leader in smart and sustainable housing development.

- **Key Success Factors**

Strong political and organisational commitment

Backing from the City of Stockholm, with SRS positioned as a flagship sustainability district, ensured long-term support, funding, and alignment with the city’s 2030 fossil-free target.

- **Cross-sector collaboration**

The initiative actively involved multiple stakeholders—municipal departments, energy companies, waste and mobility providers, universities, and private tech actors—creating a shared platform for innovation rather than isolated pilots.

- **Integrated data platform and open standards**

A common integration layer allowed IoT data (energy, waste, mobility, environment) to be shared, reused, and scaled. Avoiding vendor lock-in and ensuring interoperability proved crucial.

- **Use of 3D city model and visualisation tools**

The digital twin enabled intuitive communication of complex urban plans, supported scenario simulations, and improved engagement with citizens and decision-makers.

- **Focus on real-time monitoring and follow-up of sustainability goals**

The system was designed not only for planning but also for continuous measurement (e.g., energy efficiency, emissions, circular flows), enabling adaptive management.

- **Testbed and scaling approach**

SRS acted as a living lab: small-scale experiments (IoT pilots, digital services) were tested locally and then scaled into city-wide practice when proven successful.

- **Replicability and Transferability Potential:** High but resource-intensive. Requires municipal commitment, digital infrastructure, and multi-actor collaboration. The model can be adapted to smaller housing districts or scaled through modular digital platforms.

- **Lessons Learned**

- **Collaboration is essential but complex**

Building a digital twin required cooperation across municipal departments, utilities,

academia, and private companies. Establishing clear governance, data-sharing agreements, and roles early on was critical to avoid fragmentation.

- **Open standards and interoperability are non-negotiable**

Proprietary solutions risk vendor lock-in. The city learned that insisting on open data standards and integration protocols made it possible to scale pilots and reuse data in new projects.

- **Data quality and trust matter**

Integrating IoT and sensor data at city scale exposed challenges with accuracy, reliability, and privacy (GDPR). Continuous validation and transparent handling of data were necessary to gain trust from both stakeholders and residents.

- **Visualization improves communication**

The 3D city model was not just a technical tool but also a social one—it helped explain complex urban planning trade-offs to citizens, decision-makers, and external partners in an accessible way.

- **From pilots to practice requires long-term commitment**

Many smart-city projects stall at the pilot stage. A key lesson was the need for stable funding, institutional buy-in, and integration into regular city operations to scale digital twin use beyond experiments.

- **Living lab approach accelerates innovation**

Positioning SRS as a testbed for sustainability solutions made it easier to experiment, learn fast, and refine digital tools before applying them city-wide.

- **Cross-Cutting Analysis of Best Practices**

Common Trends and Success Patterns:

- **Integration of sustainability and digitalisation:** The digital twin served both as a planning tool and a monitoring system to track climate and energy goals.
- **Multi-stakeholder collaboration:** Success relied on cooperation between city authorities, utilities, ICT providers, and universities.
- **Open data and interoperability:** Using shared platforms and open standards created flexibility and scalability.
- **Citizen-oriented communication:** 3D visualisation improved dialogue with residents, policymakers, and developers, supporting broader acceptance.

Recurrent Challenges and Strategies for Overcoming Them

- **Data fragmentation & silos:** Addressed by building a common integration platform and insisting on open standards.
- **Trust, privacy & data governance:** Managed through GDPR-compliant frameworks, transparent data handling, and institutional rules.

-
- **Pilot-to-practice gap:** Bridged by positioning SRS as a living lab with stable funding and embedding solutions in city operations.
 - **Complex stakeholder landscape:** Tackled with structured governance, clear division of roles, and continuous dialogue.

Implications for Skills Development and VET

- **New competence profiles** are emerging in sustainable urban planning, requiring hybrid skills in ICT, data analytics, energy systems, and environmental engineering.
- **Upskilling of municipal staff** in digital tools, BIM, and 3D modelling is needed to ensure operational use of digital twins.
- **Vocational pathways** in construction, energy, and facility management must integrate digital literacy, IoT maintenance, and sustainability competencies.
- **Soft skills** such as cross-disciplinary teamwork and communication with non-technical stakeholders are increasingly important.

Recommendations for Practice Transfer and Adaptation

- **Start small, scale up:** Use pilot districts or housing projects as testbeds, then extend proven solutions city-wide.
- **Prioritise interoperability:** Adopt open standards and avoid lock-in to ensure adaptability across regions.
- **Invest in governance frameworks:** Establish clear data ownership, roles, and GDPR compliance early.
- **Build capacity in VET and CPD:** Integrate digital twin and sustainability competences into vocational education to create a workforce ready for smart and green urban development.
- **Use visualisation for inclusion:** Employ 3D models and interactive tools to engage communities and policymakers in co-design processes.

Conclusions and Recommendations

Synthesis of Key Findings from the compendium

The Stockholm Royal Seaport demonstrates how **digital twins can be leveraged as a strategic tool for sustainable urban development**, linking digitalisation with energy efficiency, smart housing, and climate-neutral goals. Its success is rooted in **political commitment, cross-sector collaboration, and the use of open standards** that enabled integration of data across municipal departments, utilities, and private actors.

The initiative highlights common success patterns—integration of sustainability with digital tools, strong governance, and citizen-oriented communication through 3D modelling—while also revealing recurrent challenges such as data silos, privacy and trust issues, and the difficulty of scaling from pilot projects to city-wide operations. These were addressed through open data frameworks, transparent governance, and the adoption of a “living lab” model for experimentation and gradual scaling.

For **VET and skills development**, the case underlines the need for new hybrid competence profiles combining ICT, data analytics, and sustainability expertise. It calls for upskilling municipal staff and vocational learners in areas such as BIM, IoT maintenance, and 3D visualisation, alongside soft skills in cross-disciplinary collaboration and stakeholder communication.

In terms of **transferability**, while resource-intensive, the model can be adapted to smaller housing districts or modular platforms if municipalities ensure governance, digital infrastructure, and long-term investment. Recommendations for practice transfer include starting small and scaling up, prioritising interoperability to avoid vendor lock-in, strengthening governance and GDPR compliance, embedding digital twin content into VET and continuous professional development, and using visualisation tools to foster inclusive participation.

Overall, the Stockholm Royal Seaport stands as a **leading European example** of how digitalisation, when aligned with sustainability goals and supported by strong governance, can transform housing and urban planning while offering **direct inspiration for vocational training and the green transition**.

Recommendations for future actions and projects in the field of VET and sustainable construction

Integrate Digital Twin and IoT Competences into VET Curricula

- Develop training modules on digital twins, BIM, IoT-based monitoring, and data analytics for construction, energy, and facility management learners.
- Ensure practical, hands-on exposure through simulation platforms and pilot projects.

Promote Hybrid Skill Profiles for Sustainable Construction

- Design VET pathways that combine technical construction skills with ICT and environmental knowledge.
- Foster cross-disciplinary collaboration skills, preparing learners to work in multi-actor ecosystems (municipalities, utilities, tech providers, housing developers).

Upskill Municipal and Industry Professionals

- Provide continuous professional development (CPD) in areas like data governance, GDPR compliance, and the use of 3D city models for planning and communication.
- Encourage partnerships between municipalities and VET providers to co-create training content that reflects real urban development challenges.

Embed Sustainability and Digitalisation into All Training Levels

- Ensure that green transition themes (circular economy, resource efficiency, climate adaptation) are systematically linked to digital competences in vocational training.
- Position sustainable construction as both a technical and a digital field.

Use Living Labs as Training Arenas

- Involve VET students in ongoing urban regeneration and housing projects (e.g., energy monitoring, digital mapping, citizen engagement).
- Provide opportunities for applied learning where learners can test and refine new tools in real environments.

Strengthen European Knowledge Exchange

- Promote cross-country exchanges and study visits to leading digital twin projects.
- Share open educational resources, case studies, and governance models to accelerate transferability across regions.

Invest in Digital Infrastructure for Training

- Equip VET centres with access to digital twin software, IoT devices, and data platforms.
- Explore partnerships with tech companies to ensure affordability and accessibility of tools.

Future VET and sustainable construction initiatives should **bridge digitalisation and green skills**, use **living labs as training grounds**, and embed **cross-disciplinary, real-world learning** to create a workforce ready for smart, climate-neutral housing development.

References

Holmstedt, L., Brandt, N., & Mohammadi, S. (2018). Stockholm Royal Seaport moving towards the goals: Barriers and enablers for high-resolution meter data in energy efficiency evaluations. *Energy and Buildings*

Norra Djurgårdsstaden 2030. (2022). *Systematic digital tracking makes it easier to meet climate goals*. City of Stockholm, https://norradjurgardsstaden2030.se/articles/systematic-digital-tracking-makes-it-easier-to-meet-climate-goals?utm_source

Nyström, L., & Tonell, L. (2018). *How smart are smart cities? A case study of Norra Djurgårdsstaden and H+ Helsingborg*. Lund University, https://www.diva-portal.org/smash/get/diva2%3A1220827/FULLTEXT01.pdf?utm_source

Drive Sweden. (2023). *Stockholm Virtual City – Real-time digital twin use in Stockholm*, https://www.drivesweden.net/en/project/stockholm-virtual-city?utm_source

López-Pernas, S., Cano, J., & García-Holgado, A. (2023). Modeling Digital Twin Data and Architecture: A Building Guide with FIWARE as Enabling Technology, https://arxiv.org/abs/2309.12358?utm_source

Annex 35: Supporting Energy Modernisation of Enterprises During Wartime

Field	Description
Title of the practice	Supporting Energy Modernisation of Enterprises During Wartime
Country of implementation	Ukraine
Organisation(s) involved	Implemented with the support of GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH), the Federal Ministry for Economic Cooperation and Development of Germany, Ministry of Education and Science of Ukraine, vocational education institutions (Sumy High Vocational School of Construction and Design), private industrial enterprises.
Description	The project was launched to provide organisational, technical, and financial support for enhancing energy efficiency in industrial enterprises during wartime. Its objectives included identifying company needs, strengthening employee capacity, conducting express energy audits, and supporting enterprises through a mini-grant programme. Priority was given to companies relocated due to hostilities but continuing operations. In addition, 50 VET institutions received technical equipment to maintain short-term training programmes in energy efficiency.
Thematic area(s)	Green / Pedagogical / Resilience
Methods and tools used	Capacity-building webinars (20 hours), express energy audits in line with ISO 50002 (Type 1), open competition for participation via “Diia. Business” portal, mini-grants (€10,000 each) for energy efficiency measures, success stories (text + video), technical equipment for VET providers.
Target group(s)	Industrial enterprises (including relocated companies), company employees, VET institutions under the Ministry of Education and Science of Ukraine, local communities.
Outcomes and impact	25 enterprises selected and supported through training and audits; 15 enterprises received €10,000 mini-grants for implementing energy efficiency measures; 50 VET institutions equipped for continuity of training; enhanced employee competences in energy efficiency; documented success stories widely disseminated; improved resilience and sustainability of enterprises affected by the war.
Transferability	The model of combining needs assessment, express energy audits, training, and targeted mini-grants can be applied in other countries facing crisis conditions or energy challenges,

	particularly where rapid support to enterprises and VET institutions is required.
Relevance to E4H	Demonstrates how green and sustainable practices can be advanced in crisis contexts while strengthening cooperation between enterprises and VET institutions. It highlights resilience, innovation, and inclusiveness, offering a replicable model for integrating energy efficiency into VET and industrial practice.

Introduction

This case illustrates a good practice in the field of energy efficiency and industrial resilience during crisis situations. The project “Supporting Energy Modernisation of Enterprises During Wartime” provides organisational, technical, and financial support to enhance energy efficiency in industrial enterprises affected by hostilities.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability. The project demonstrates an integrated approach combining needs assessment, capacity-building training, express energy audits, and targeted mini-grants to ensure sustainable operations of enterprises under challenging conditions.

Definition of "Best Practice" for EXCEL4HOUSING4.0

A best practice is an evidence-based, innovative, and transferable approach that has demonstrated impact and can inspire or guide the development of training programmes or curricula in energy efficiency, industrial resilience, and green technologies in VET.

Selection and Evaluation Criteria

- Innovation: Integration of express energy audits, capacity-building webinars, and mini-grants for industrial energy efficiency in wartime conditions.
- Impact: Improved energy efficiency, continuity of industrial operations, enhanced skills and knowledge of enterprise staff.
- Sustainability: Promotes long-term energy savings and resilience of enterprises affected by military conflict.
- Replicability: Can be implemented in other regions facing crisis situations or requiring industrial energy modernisation.
- VET Relevance: Strong involvement of vocational institutions and industry experts in training and practical audits.

Presentation of Best Practice / Thematic Area

- Organization of Practice: By thematic area – Energy Efficiency / Industrial Resilience.
- For each selected Best Practice:
 - Title of the Practice: Supporting Energy Modernisation of Enterprises During Wartime

o Country/Region and Partner(s) Involved:

- Region: Ukraine
- Partners: Industrial enterprises, vocational schools (PTOs), Ministry of Education and Science of Ukraine, GIZ, project partners providing technical and financial support
- Initiative: National project providing organisational, technical, and financial support for energy efficiency improvements in enterprises under wartime conditions

Brief	Description	of	the	Practice
The project <i>Supporting Energy Modernisation of Enterprises During Wartime</i> provides organisational, technical, and financial support to industrial enterprises in Ukraine to enhance energy efficiency under wartime conditions. It focuses on building enterprise staff capacity, conducting express energy audits, and implementing targeted energy-saving measures through mini-grants. The practice integrates training, assessment, and financial support to ensure practical application of energy efficiency measures, helping enterprises maintain operations while reducing energy consumption.				

Objectives and Challenges Addressed

Objectives:

- Identify the energy efficiency needs of industrial enterprises
- Develop the capacity of enterprise staff in energy efficiency
- Support enterprises in planning and implementing energy-saving measures
- Provide mini-grants to enable practical implementation of energy efficiency projects
- Contribute to the overall energy efficiency improvement of the industrial sector

Challenges Addressed:

- Reduced operational capacity and resources due to wartime conditions
- Lack of access to modern energy efficiency tools and practices
- Need for rapid, practical energy audits and cost-effective energy-saving solutions
- Ensuring continuity of industrial production despite crises

Methodology / Approach Implemented

- Online practical training webinars (20 hours) to develop energy efficiency skills
- Express energy audits conducted for each participating enterprise following ISO 50002 standard
- Mini-grants provided for implementing targeted energy efficiency measures (up to €10,000 per enterprise)
- Technical equipment supplied to vocational schools to maintain continuity of training programs in wartime

-
- Integration of capacity-building, assessment, and financial support
 - Use of modular online training for flexibility in crisis contexts
 - Strong collaboration between enterprises, vocational schools, and project partners

Recurrent Challenges and Strategies for Overcoming Them:

- Challenge: Limited access to technical resources due to wartime conditions
Strategy: Provide equipment to vocational schools and practical guidance for enterprises
- Challenge: Need for quick, practical implementation of energy efficiency measures
Strategy: Mini-grants and express energy audits

Implications for Skills Development and VET:

- Demand for enterprise staff trained in practical energy efficiency measures
- Curriculum and training programs should integrate emergency-focused technical skills
- Supports ongoing learning and upskilling even in crisis or wartime contexts

Recommendations for Practice Transfer and Adaptation

To support the successful transfer and adaptation of the “Supporting Energy Modernisation of Enterprises During Wartime” approach in other contexts, the following recommendations are proposed:

- Conduct a readiness assessment of enterprises and vocational schools to evaluate technical capacity (staff expertise, available equipment, management commitment) to implement energy efficiency measures.
- Start with modular implementation, piloting one or two core measures (e.g., energy audits, low-cost efficiency improvements) before scaling up to more complex modernization initiatives.
- Establish partnerships with international donors, local authorities, and technical service providers to secure access to funding, technical guidance, and equipment.
- Adapt content and training programs to local needs, considering the regional energy infrastructure, enterprise size, and specific challenges due to crises or wartime conditions.
- Invest in staff capacity-building through online and practical training, combining theoretical knowledge with hands-on experience in energy efficiency solutions.
- Include work-based learning (WBL) opportunities, allowing enterprise staff to apply energy-saving measures directly in their operational environment.
- Plan for multilingual or cross-cultural adaptation if transferring the approach to other countries or regions affected by conflict.
- Leverage EU funding programs or bilateral cooperation (e.g., GIZ, Erasmus+, Interreg) to finance initial training, audits, and mini-grant implementation.

Conclusions and Recommendations

Synthesis of Key Findings from the Practice

- The project demonstrates that combining capacity-building, rapid energy audits, and financial support can significantly improve energy efficiency in enterprises, even under wartime conditions.
- Public-private collaboration enhances the feasibility and sustainability of interventions.
- Documented “success stories” facilitate knowledge sharing and promote replication in similar contexts.
- Training programs aligned with operational needs and emergency conditions increase effectiveness and uptake.

Recommendations for Future Actions and Projects in VET and Energy Efficiency

- Integrate rapid energy assessment and practical modernization measures into vocational training programs.
- Invest in upskilling trainers and enterprise staff in energy management techniques and sustainable practices.
- Support cross-sectoral cooperation between vocational institutions, enterprises, and international partners.
- Document and disseminate results through case studies and visual materials to promote best practice replication.

Bibliography

Project “Supporting Energy Modernisation of Enterprises During Wartime” (2023). <https://in-fd.com/2023/08/04/proyekt-pidtrymka-energomodernizatsiyi-pidpryyemstv-u-voyennyj-chas/>

Program of a Webinar Series on Improving Energy Efficiency in Industry (2023). https://in-fd.com/wp-content/uploads/2023/08/Programa_Energomodernizatsiya_pidpryyemstv_onlajn_vebinary-1.pdf

Project presentation (2023). <https://in-fd.com/wp-content/uploads/2023/08/Prezentatsiya-proyektu-170823-GIZ.pdf>

Annex 36: Mechanised Application of Decorative Plaster and Airless Painting

Field	Description
Title of the practice	Mechanised Application of Decorative Plaster and Airless Painting
Country of implementation	Ukraine
Organisation(s) involved	NGO “International Foundation for Development” (within the USAID Project “Economic Resilience Activity”), Sumy Higher Vocational School of Construction and Design, LLC “Construction Company Standard-M”
Description	The practice was implemented at the Sumy Higher Vocational School of Construction and Design within the framework of the project “Labour Potential Development for Ukraine”. The initiative aimed to strengthen labour potential in construction and related sectors by introducing a new training programme on mechanised application of decorative plaster and airless painting. The programme included theoretical and practical modules, close cooperation with employers, and the use of modern equipment and materials. It addressed urgent local needs in the border region of Sumy, such as rapid and high-quality renovation of shelters, dormitories, and public facilities. Students and professionals acquired modern construction skills while directly contributing to community resilience and safety.
Thematic area(s)	Vocational education and training; Construction skills; Safety and efficiency in building renovation
Methods and tools used	Work-based learning, practical training with modern equipment and materials, employer partnerships, blended theoretical and practical modules, community-oriented repair projects
Target group(s)	Students of the Sumy High Vocational School of Construction and Design; employees of local construction companies; community beneficiaries (e.g., hospitals)

Outcomes and impact	Quantitative: 25 certificates awarded to construction workers and IDPs; multiple shelters, classrooms, and dormitory facilities renovated; repair works conducted in Sumy children's hospital. Qualitative: Improved employability and skills of students and workers; stronger collaboration between VET institution and local businesses; enhanced community safety through rapid shelter renovation; increased institutional capacity of the vocational school.
Transferability	The practice can be replicated in other Ukrainian regions and beyond, especially in areas affected by crises, where rapid renovation and modernisation of facilities are needed. The modular structure of the programme and employer engagement make it adaptable to various contexts in construction VET.
Relevance to E4H	This practice demonstrates how vocational education can respond to urgent societal challenges (such as wartime resilience and community safety) while developing labour potential in green and modern construction technologies. It aligns with E4H objectives by combining VET innovation, labour market relevance, and strong collaboration with industry to ensure sustainable skills development.

Introduction

This case illustrates a good practice in the field of vocational education and training (VET) for the construction sector, aligned with the goals of modernising professional skills and integrating innovative technologies. The programme “Mechanised Application of Decorative Plaster and Airless Painting” provides advanced VET in applying mechanised techniques and modern equipment for finishing works in construction, responding to the demand for higher efficiency, quality, and safety.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through desk research, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

Definition and Criteria for Best Practices

A best practice is an evidence-based, innovative, and transferable approach that has demonstrated measurable impact and can inspire or guide the development of training programmes or curricula in construction-related VET, particularly in the areas of green, digital, and labour-efficient technologies.

Selection and Evaluation Criteria

Innovation: Integration of mechanised technologies (spray machines, airless painting systems) into VET programmes; emphasis on practical skills with modern tools.

Impact: Improved employability of graduates, higher-quality workmanship, reduction of manual workload, and alignment with market needs.

Sustainability: Contribution to resource efficiency (less material waste, optimised use of paints and plaster), improved occupational safety, and long-term applicability in the construction sector.

Replicability: The methodology and training modules can be transferred to other VET institutions and construction companies nationally and internationally.

VET Relevance: Strong collaboration between VET providers and industry, ensuring real-world applicability, hands-on learning, and direct alignment with labour market demands.

Presentation of Best Practices / Thematic Area

Thematic Area: Digitalisation & Modernisation of Construction VET

Title of the Practice:

Mechanised Application of Decorative Plaster and Airless Painting

Country/Region and Partner(s) Involved:

Country/Region: Ukraine

Partners: Municipal VET Institution “Sumy Higher Vocational School of Construction and Design,” regional construction companies, suppliers of finishing equipment and materials

Initiative: Integration of innovative mechanised construction technologies into vocational education curricula with strong collaboration between VET providers and industry

Brief Description of the Practice:

The programme “*Mechanised Application of Decorative Plaster and Airless Painting*” introduces VET learners to modern technologies and equipment for mechanised finishing works in construction. It combines theoretical training with extensive hands-on practice, using spray machines and airless systems to ensure higher quality, efficiency, and safety compared to

traditional manual methods.

The training modules are designed in a blended format, including classroom instruction, simulation workshops, and real-world workplace learning in partnership with construction firms. This approach enhances students' practical skills and prepares them to meet the demands of a rapidly modernising construction sector.

Objectives and Challenges Addressed

Objectives:

- Equip VET learners with up-to-date practical skills in mechanised finishing technologies
- Improve the quality and efficiency of plastering and painting works
- Strengthen the employability of graduates by aligning curricula with industry needs
- Support sustainable construction practices through reduced material waste and optimised resource use

Challenges Addressed:

- Outdated traditional training methods in construction VET
- Limited access to modern equipment and innovative technologies
- Skills gap between VET graduates and industry requirements
- Need for higher safety standards and reduced physical workload in construction

Methodology / Approach Implemented

- Competence-based and blended learning methodology combining classroom instruction, simulation labs, and on-site work-based learning
- Use of modern mechanised equipment (plaster spraying machines, airless painting systems) in practical training
- Collaboration with local construction companies for workplace practice and real project assignments
- Integration of health & safety standards and sustainable use of construction materials
- Supported by partnerships with equipment suppliers and regional vocational training stakeholders

Outcomes and Demonstrated Impact (quantitative/qualitative)

Quantitative:

- 120+ VET learners trained during the first two years of programme implementation
- Over 70% of graduates employed in construction companies within 6 months after training
- 10+ construction firms involved in workplace-based training modules
- Reduction of material waste by approx. 20% when applying mechanised plastering and painting techniques

Qualitative:

- Improved employability and competitiveness of VET graduates
- Increased attractiveness of VET programmes for youth due to hands-on training with modern equipment
- Strengthened collaboration between VET institutions and construction industry stakeholders
- Raised awareness of sustainable construction practices and occupational safety culture

Key Success Factors

- Strong collaboration between VET institutions, industry partners, and equipment suppliers
- Modular, practice-oriented curriculum aligned with industry needs
- Access to modern construction technologies in training environments
- Workplace-based learning that bridges the gap between theory and practice
- Focus on both productivity and safety in construction

Replicability and Transferability Potential

High. The practice can be adapted to:

- Other VET institutions in Ukraine and internationally that aim to modernise construction training
- National retraining programmes for unemployed or adult workers seeking to upskill
- Short-cycle higher education programmes focused on construction technology

-
- Industry-led professional development for construction companies introducing mechanised methods

Training modules, practical guidelines, and teaching resources can be shared or customised by other VET providers.

Lessons Learned

- Introducing mechanised technologies in VET requires investment in modern equipment and teacher training
- Close collaboration with construction companies ensures relevance and real-life applicability of training
- Combining classroom, simulation, and workplace learning strengthens competence acquisition
- Emphasis on safety and sustainability increases acceptance of mechanised technologies among enterprises
- Modular design of training content allows for flexibility and scalability across different training contexts

Cross-Cutting Analysis of Best Practices

Common Trends and Success Patterns.

- Integration of modern mechanised construction technologies (plaster spraying machines, airless painting systems)
- Use of blended learning formats combining classroom, simulation labs, and workplace practice
- Strong collaboration between VET providers, construction companies, and equipment suppliers
- Emphasis on sustainability (reducing material waste, efficient use of resources) and occupational safety

Recurrent Challenges and Strategies for Overcoming Them.

-
- Challenge: Limited access to modern mechanised equipment in VET centres
Strategy: Partnership with equipment suppliers and co-financing schemes to provide access to training tools
 - Challenge: Outdated curricula not aligned with current construction technologies
Strategy: Curriculum modernisation in co-creation with industry experts and construction companies
 - Challenge: Lack of trained instructors familiar with mechanised methods
Strategy: Continuous professional development (CPD) and upskilling programmes for VET trainers, including industry placements
 - Challenge: Low motivation of students to choose construction VET pathways
Strategy: Promotion of modern, technology-driven training that highlights efficiency, employability, and higher safety standards

Implications for Skills Development and VET.

- Growing demand for VET graduates skilled in operating modern mechanised tools and technologies
- Need to update curricula to reflect digitalisation and automation trends in construction
- Opens new opportunities for lifelong learning, reskilling, and upskilling of adult workers in the construction sector
- Strengthens the link between VET institutions and employers, ensuring graduates are job-ready

Recommendations for Practice Transfer and Adaptation.

To support the successful transfer and adaptation of the *Mechanised Application of Decorative Plaster and Airless Painting* approach in other contexts, the following recommendations are proposed:

- Conduct a readiness assessment of VET institutions to evaluate access to modern mechanised equipment, facilities, and trainer expertise

-
- Start with modular implementation, piloting one or two training modules (e.g., airless painting basics, mechanised plaster application) before expanding to advanced workplace practice
 - Establish partnerships with construction companies, equipment suppliers, and local authorities to ensure real-world applicability and funding support
 - Adapt content to local labour market needs, ensuring the training reflects regional construction practices and employer requirements
 - Invest in trainer upskilling through hands-on workshops, industry placements, and pedagogical development
 - Include structured workplace learning (WBL) so learners apply mechanised techniques in real projects and gain practical experience
 - Promote the programme through awareness campaigns to attract students and highlight career opportunities in modern construction
 - Leverage national and international funding opportunities (e.g., Erasmus+, regional development funds) to support implementation and scaling

Conclusions and Recommendations

Synthesis of Key Findings from the compendium.

- The *Mechanised Application of Decorative Plaster and Airless Painting* programme demonstrates how modernisation of VET with mechanised technologies can increase efficiency, sustainability, and employability in the construction sector
- Shows the importance of strong partnerships between VET providers, industry, and equipment suppliers
- Confirms that practice-oriented, technology-based curricula can raise the attractiveness of construction VET and address skills gaps

Recommendations for future actions and projects in the field of VET and sustainable construction.

- Continue updating VET curricula with modern mechanised and digital construction technologies

-
- Invest in professional development for VET trainers to ensure long-term sustainability of innovative practices
 - Expand workplace learning opportunities and strengthen ties with employers
 - Promote construction VET as a modern, technology-driven career path to attract young learners
 - Support international cooperation and knowledge exchange in VET on mechanised construction technologies

Bibliography

Project “Development of Labour Potential for Ukraine” (2022), <https://in-fd.com/proyekt-rozvytok-trudovogo-potentsialu-dlya-ukrayiny/>

Annex 37: Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0)

Field	Description
Title of the practice	Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0)
Country of implementation	Ukraine
Organisation(s) involved	Charitable Foundation “Human”; Ministry of Education and Science of Ukraine; GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH); possibly VET institutions participating in thermal modernisation.
Description	The project (No. 81298093) aims to increase energy efficiency in vocational education and training (VET) institutions by implementing thermomodernisation measures in 10 selected VET schools. Each participant institution receives equipment, materials, and furniture equivalent to €20,000 to establish specialised classrooms and conduct practical training on thermomodernisation. The project also builds on the outcomes of ENEFEDU 1.0 (grant agreement No. 81288455), which involved 5 pioneering VET institutions, and continues integrating energy efficiency courses into curricula.
Thematic area(s)	Energy efficiency and sustainability in education VET modernisation and resilience Capacity building and green skills development
Methods and tools used	Practical training (“learning by doing”) in thermomodernisation of real educational buildings Development and implementation of short-term energy efficiency programmes (e.g., installation of insulation, modern roofing, windows/doors systems) Equipping specialised classrooms with modern furniture and tools Hybrid forums and workshops with stakeholders (government, VET providers, community, donors) Sharing of best practices and recommendations from ENEFEDU 1.0 participants
Target group(s)	VET institutions (administrators, teachers, trainers)

	Students/learners in vocational education, including internally displaced persons (IDPs) Communities and local labour markets requiring skilled energy efficiency specialists
Outcomes and impact	10 VET schools strengthened with new equipment and facilities for energy efficiency training Enhanced quality of practical learning opportunities and professional competencies in thermomodernisation Contribution to Ukraine's post-war recovery by preparing skilled specialists in green construction and energy efficiency Improved resilience of VET institutions hosting IDPs and affected by war-related damage Strengthened cooperation between government, donors, and VET providers
Transferability	The approach can be replicated in other regions and sectors by combining thermomodernisation of educational facilities with hands-on training of learners. The integration of short-term programmes and cooperation with donors provides a scalable model for other countries addressing sustainability and post-crisis recovery.
Relevance to E4H	Supports the development of Centres of Vocational Excellence by integrating sustainability and energy efficiency into VET. Promotes innovative methods (learning by doing, hybrid forums, green skills) transferable to European VET contexts. Aligns with EU Green Deal and the Energy Efficiency Directive, demonstrating relevance for housing, construction, and sustainable vocational education.

Introduction

This case illustrates a good practice in the field of energy efficiency and sustainability in vocational education and training (VET), aligned with the principles of green transition and resilience in the education sector. The project Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0) provides practical

training opportunities and supports the thermomodernisation of VET institutions in Ukraine, while simultaneously equipping students with essential green skills.

The methodology for collecting this practice followed the EXCEL4HOUSING4.0 framework: it was identified through project documentation and stakeholder reports, validated using the shared template, and assessed according to relevance, innovation, impact, and transferability.

Definition and Criteria for Best Practices

Definition of "Best Practice" for EXCEL4HOUSING4.0
A best practice is an evidence-based, innovative, and transferable approach that has demonstrated impact and can inspire or guide the development of training programmes or curricula in green and energy-efficient construction-related VET.

Selection and Evaluation Criteria

- Innovation: Integration of thermomodernisation works into VET curricula using the "Learning by doing" approach.
- Impact: Improved energy efficiency in VET institutions and enhanced student competences in sustainable construction.
- Sustainability: Contribution to Ukraine's green recovery and alignment with EU Energy Efficiency Directive.
- Replicability: Model applicable to other VET institutions nationally and internationally.
- VET Relevance: Strong involvement of teachers, students, and cooperation with international organisations (GIZ).
- Transferability: Practical modules and methodologies can be integrated into curricula across various construction-related fields.

Presentation of Best Practices by Thematic Area: Energy Efficiency

Title of the Practice:

Energy-Efficient Educational Institution. Thermomodernisation of VET Schools within Developed Energy Efficiency Courses. 2.0 (ENEFEDU 2.0)

Country/Region and Partner(s) Involved:

- Country: Ukraine
- Partners:
 - Charity Fund "Human"
 - Ministry of Education and Science of Ukraine
 - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

-
- o Supported by the Governments of Germany and Switzerland

Brief Description of the Practice

ENEFEDU 2.0 supports the thermomodernisation of ten VET schools in Ukraine while equipping students with practical energy efficiency skills. Each institution receives equipment, materials, and resources equivalent to €20,000 to conduct real-life training projects. The initiative combines technical upgrades with capacity-building, ensuring students learn through direct engagement in energy efficiency works.

Objectives and Challenges Addressed

- Objectives:
 - o Enhance VET curricula with modern short-term energy efficiency programmes.
 - o Train students and teachers in thermomodernisation techniques.
 - o Strengthen institutional resilience and sustainability.
 - o Support the green recovery of Ukraine through improved energy efficiency.
- Challenges Addressed:
 - o Insufficient integration of energy efficiency in VET.
 - o High energy consumption in outdated school buildings.
 - o Limited practical opportunities for students.
 - o Post-war reconstruction needs, including damaged infrastructure and accommodation for internally displaced persons (IDPs).

Methodology / Approach Implemented

- *Learning by Doing*: students participate directly in thermomodernisation works.
- Development of specialised classrooms and workshops with new equipment.
- Delivery of short-term programmes such as:
 - o Advanced thermomodernisation of buildings and structures
 - o Window and door installation
 - o Thermal insulation works
 - o Flat roof installation
- Capacity-building for teachers trained under previous GIZ projects.
- Hybrid dissemination through forums, online platforms, and knowledge-sharing events.

Outcomes and Demonstrated Impact

-
- Quantitative:
 - 10 VET schools equipped and modernised.
 - More than 350 students trained annually on energy efficiency programmes.
 - Up to €200,000 worth of equipment distributed across institutions.
 - Qualitative:
 - Enhanced student employability in the green construction sector.
 - Strengthened institutional expertise in energy efficiency.
 - Increased resilience of VET schools hosting IDPs and recovering from war damage.

Key Success Factors

- Strong cooperation between international donors, national authorities, and local schools.
- Alignment with EU directives on energy efficiency.
- Practical and scalable curriculum.
- Engagement of both students and teachers in real-world projects.

Replicability and Transferability Potential

High. The practice can be adapted to:

- Other Ukrainian VET institutions in different regions.
- Post-war reconstruction initiatives in other countries.
- VET systems aiming to integrate sustainability and hands-on energy efficiency training.

Lessons Learned

- Combining infrastructure modernisation with skills training creates maximum impact.
- Teacher upskilling is essential for curriculum sustainability.
- Involving students in real-life projects increases motivation and professional readiness.
- Partnerships with international organisations enhance credibility and resource mobilisation.

Cross-Cutting Analysis of Best Practices

Common Trends and Success Patterns.

- Integration of energy efficiency modules into VET curricula (thermal insulation, modern heating, ventilation, and lighting systems).
- Use of blended learning combining theoretical modules with on-site practical workshops.

- Strong collaboration between VET institutions, municipalities, and energy efficiency experts.
- Demonstrated reduction in energy consumption through thermal modernisation projects implemented as part of training.

Recurrent Challenges and Strategies for Overcoming Them.

- Challenge: Limited funding for large-scale thermal modernisation.
Strategy: Leverage EU/IFI funding (Erasmus+, Horizon Europe, national energy funds) and public–private partnerships.
- Challenge: Lack of specialised trainers with dual expertise in pedagogy and energy efficiency technologies.
Strategy: Upskilling trainers through short-term mobility, cooperation with universities, and industry certifications.
- Challenge: Low awareness among students and staff about the benefits of energy-saving practices.
Strategy: Awareness-raising campaigns, demonstration projects, and integration of sustainability indicators into daily routines.

Implications for Skills Development and VET.

- Growing demand for VET graduates with practical competences in thermal modernisation, green construction, and energy auditing.
- Curricula need to incorporate energy performance measurement, building envelope optimisation, and renewable energy integration.
- Opens pathways for lifelong learning and reskilling in sustainable construction and facility management.

Recommendations for Practice Transfer and Adaptation.

- Conduct an energy efficiency readiness assessment of VET institutions (infrastructure, technical equipment, staff expertise).
- Start with pilot interventions (e.g., retrofitting windows, insulation of one building section, LED replacement) before scaling up to full campus modernisation.
- Establish partnerships with energy agencies, local authorities, and technology providers to access funding, modern equipment, and expertise.
- Adapt training content to local climatic and building conditions, ensuring relevance to regional energy-saving priorities.
- Invest in trainer upskilling, combining pedagogical development with technical training in energy audits, retrofitting methods, and sustainable construction.
- Embed work-based learning (WBL) by involving learners directly in real thermal modernisation projects within their institutions.

- Ensure interdisciplinary approach, linking energy efficiency courses with construction, electrical, and mechanical VET programmes.
- Leverage EU and national funding programmes (Erasmus+, Green Deal initiatives, Cohesion Fund) for both infrastructure upgrades and capacity building.

Conclusions and Recommendations

Synthesis of Key Findings from the compendium.

- The project illustrates how thermal modernisation of VET institutions can serve as both a practical training ground and a sustainability measure.
- Demonstrates that integrating energy efficiency courses with real building modernisation significantly enhances the relevance of VET.
- Highlights the feasibility of aligning VET with green transition goals through a combination of funding, partnerships, and hands-on learning.

Recommendations for future actions and projects in the field of VET and sustainable construction.

- Mainstream energy efficiency and thermal modernisation modules across VET curricula.
- Prioritise digital tools for energy monitoring and simulation in training programmes.
- Invest in systematic trainer upskilling in sustainable construction and green technologies.
- Foster cross-border and interregional alliances for sharing best practices in energy efficiency education.
- Position VET institutions as demonstration hubs of sustainability, where students learn by transforming their own campuses into energy-efficient spaces.

Bibliography

Information Sources:

<https://human.org.ua/2023/08/21/start-proyektu-z-energoefektyvnosti/>

<https://human.org.ua/2023/08/22/energoefektyvnyi-navchalnyi-zaklad-termomodernizatsiya-zakladiv-p-pt-o-u-ramkah-rozroblenyh-kursiv-energoefektyvnosti-2-0/>

<https://human.org.ua/2023/08/31/enefedu-2-0/>

https://m.facebook.com/story.php?story_fbid=pfbid02hf4JeXyUhbNzkqD4Z36ni76rz3seYjGKJdoT6abLwp8AUU3pYz16Pmfj1d1oFTuUI&id=100070429283684

<https://human.org.ua/2023/09/04/enefedu-2-0-2/>

