Educational Framework

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Table of Contents

Table of Graphics

1. Introduction

The WENUS project aims to enhance Vocational education and training (VET) in sustainable wood and timber construction by integrating circular economy (CE) principles and 3D printing technologies into the curriculum, addressing the industry's evolving needs for green and digital skills, and promoting innovation, sustainability, and efficiency.

To achieve this, the project focuses on creating a student-centered curriculum that integrates CE principles with practical training exercises in 3D printing. An e-learning platform will be launched to broaden access and enrich vocational training, equipping learners with essential green and digital competencies to drive greater sustainability and innovation within the sector. Additionally, a comprehensive guide for trainers will be developed, accompanied by widespread dissemination activities to maximize impact.

The WENUS project specifically addresses the priority of environmental sustainability and the fight against climate change by integrating CE principles and sustainable practices into the wood and timber construction curriculum. It emphasizes the use of green materials and technologies, efficient resource management, and sustainable design within the construction sector. By educating learners on the importance of minimizing waste, recycling, and reusing materials, WENUS directly contributes to reducing the environmental impact of construction activities. The inclusion of innovative technologies like 3D printing further supports the development of sustainable construction methods, aligning vocational training with the urgent need to address climate change and environmental degradation. The WENUS project significantly contributes to innovation in VET by introducing a curriculum that integrates CE principles with sustainable wood and timber construction practices, enhanced by digital technologies like 3D printing. This innovative approach modernizes VET by providing learners with relevant, future-oriented skills and knowledge, preparing them for the demands of the green and digital economy. Through its emphasis on practical, student-centered training content and the use of an e-Learning platform, WENUS not only enriches the learning experience but also ensures that VET remains at the forefront of educational and industry advancements. By doing so, WENUS directly supports the evolution and improvement of vocational education, aligning it with the needs of the construction sector and broader societal goals. The WENUS project addresses the digital transformation priority by developing digital readiness, resilience, and capacity among its participants. It achieves this through the integration of an e-Learning platform that facilitates access to cutting edge educational content and innovative training methodologies, including training materials about innovative technologies and processes such as 3D printing.

WENUS is designed to revolutionize VET in the wood and timber construction sector by embedding CE principles and cutting-edge technologies to foster sustainability, efficiency, and innovation. Objectives are meticulously designed to respond to the critical demands of the sector, contribute to environmental sustainability, and address the educational needs of the European workforce.

The purpose of this document is to develop a comprehensive framework of educational objectives and specific learning outcomes tailored to address the needs of the CE in the wood and timber construction sector. This effort seeks to identify and bridge critical gaps in current VET programs. This was achieved by analysing survey results with external experts in the wood and timber construction sector, conducting in-depth analyses of specific VET programs in four countries (Germany, Poland, Slovenia, Spain) and analysing reports – the GreenComp[1] and CEDEFOP[2].

2. Methodology

To develop a comprehensive educational framework tailored to the needs of the Circular Economy (CE) in the wood and timber construction sector, a multi-faceted methodological approach has been employed. This process aimed to identify gaps in current VET programs, align the curriculum with industry and sustainability goals, and define clear educational objectives and learning outcomes. The methodology included the following key steps:

2.1 Survey analysis with external experts

An online survey was designed and distributed to external experts in the wood and timber construction sector, including professionals from academia, industry, public institutions, and NGOs. The survey gathered valuable insights into current practices, perceived gaps in education, and priorities for CE-related skills and competencies. This input was crucial for shaping the framework to address real-world industry demands.

2.2 Analysis of VET programs

A detailed review was conducted on 35 specific VET programs across four European countries (Germany, Poland, Slovenia, and Spain). This analysis focused on curricular content, teaching methodologies, and the extent to which these programs integrate CE principles, sustainability, and Industry 4.0 technologies. Special attention was given to identifying strengths, weaknesses, and areas requiring enhancement, such as digital skills and practical training.

2.3 Review of relevant existing reports

To ensure alignment with broader EU educational and policy objectives, reports such as GreenComp and CEDEFOP were examined. These documents provided a solid foundation for understanding EU priorities in sustainability, digital transformation, and vocational education, offering benchmarks for integrating CE principles and Industry 4.0 tools into the curriculum.

[1] GreenComp: the European sustainability competence framework, https://publications.jrc.ec.europa.eu/repository/handle/JRC128040
[2] CEDEFOP: From linear thinking to green growth mindsets, https://www.cedefop.europa.eu/files/9184_en.pdf

3. Analysis of the survey

An online survey regarding VET programs in the timber construction and CE sectors was developed and shared in four countries (Germany, Poland, Spain and Slovenia) with relevant stakeholders. Identified relevant stakeholders were experts from academia, industry, public sector NGO's or self-employed who work in construction, architecture, CE or timber engineering sectors.

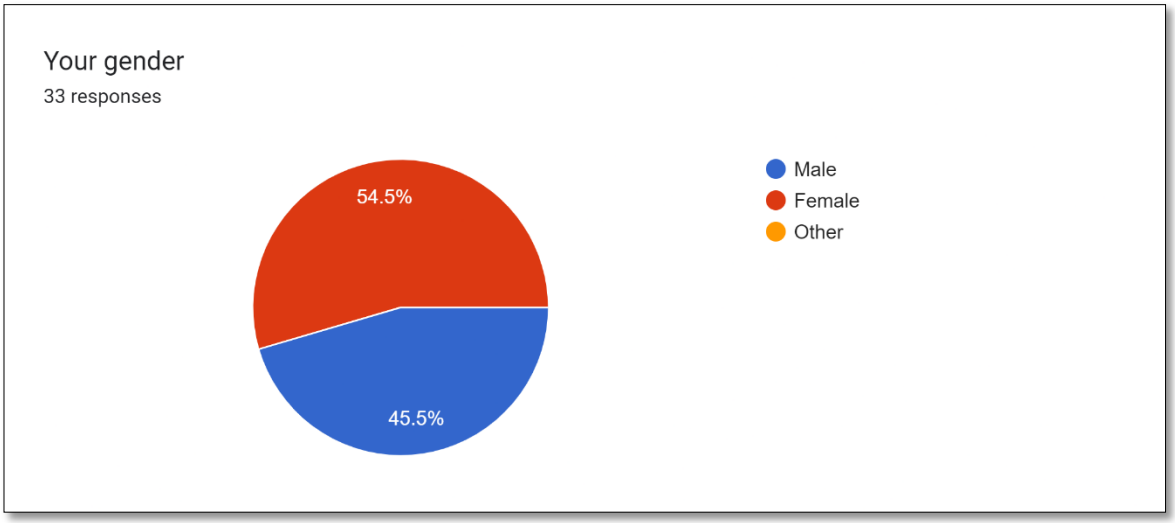
The aim of the survey was to gather valuable insights from experts in timber construction and CE sectors, which will help define specific learning outcomes and shape the "Educational Framework," ensuring that the curriculum supports sustainable practices and efficient resource management.

The survey was divided into six sections (professional background, perspectives about the current situation, evaluation of VET programmes, skills and competencies development, demographic and conclusion) and in total it included 16 questions.

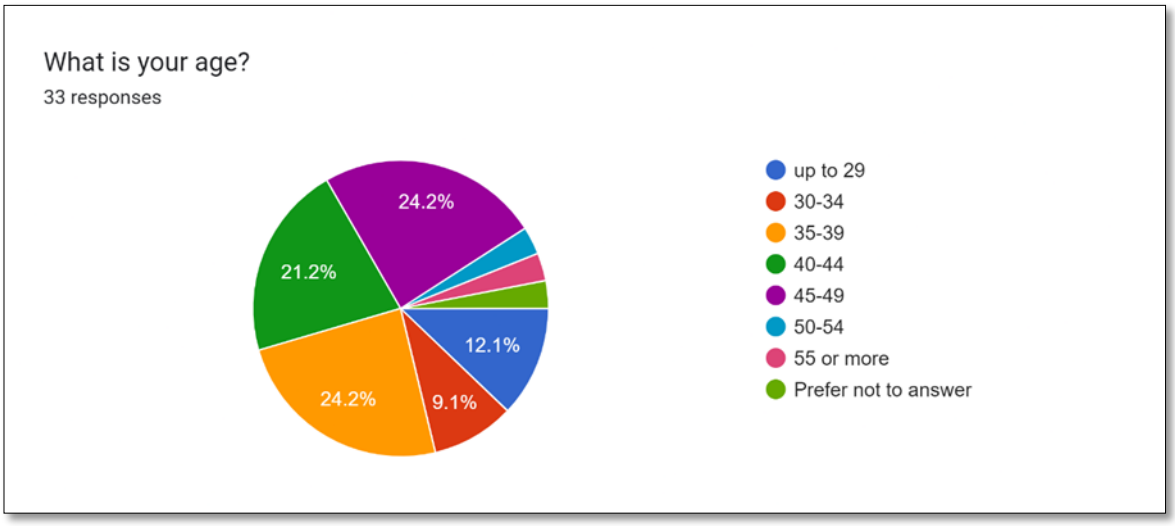
All graphs resulting from the analysis are provided in Annex 1 for consultation.

3.1 Demographic and professional background

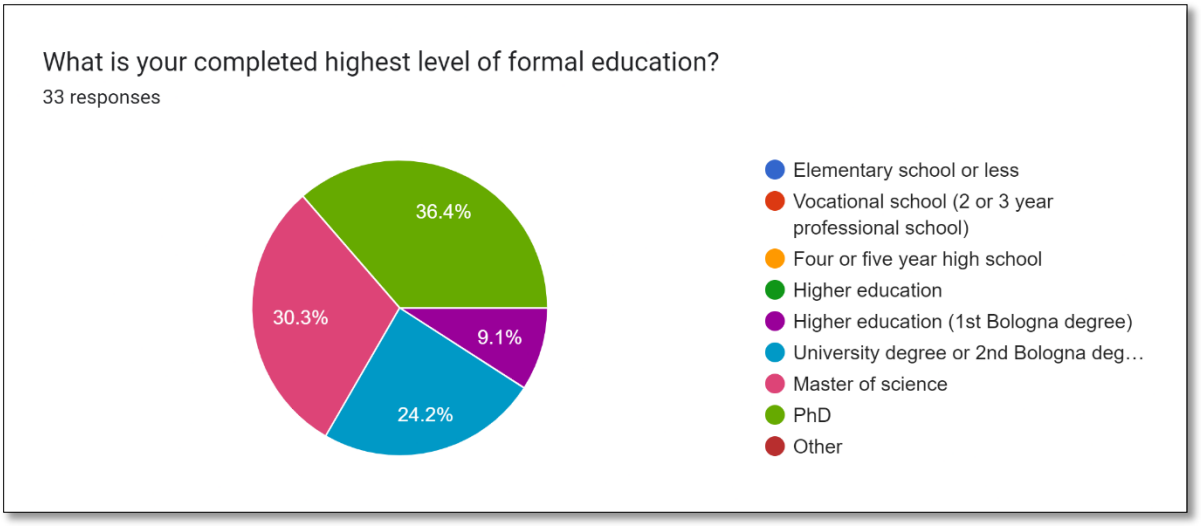
In total we received 33 responses, most of respondents were female (54.5%), from the age group 35-39 and 45-49 (24.2% respectively), with the PhD (36.4%).



Graphic 1: Gender of survey participants.

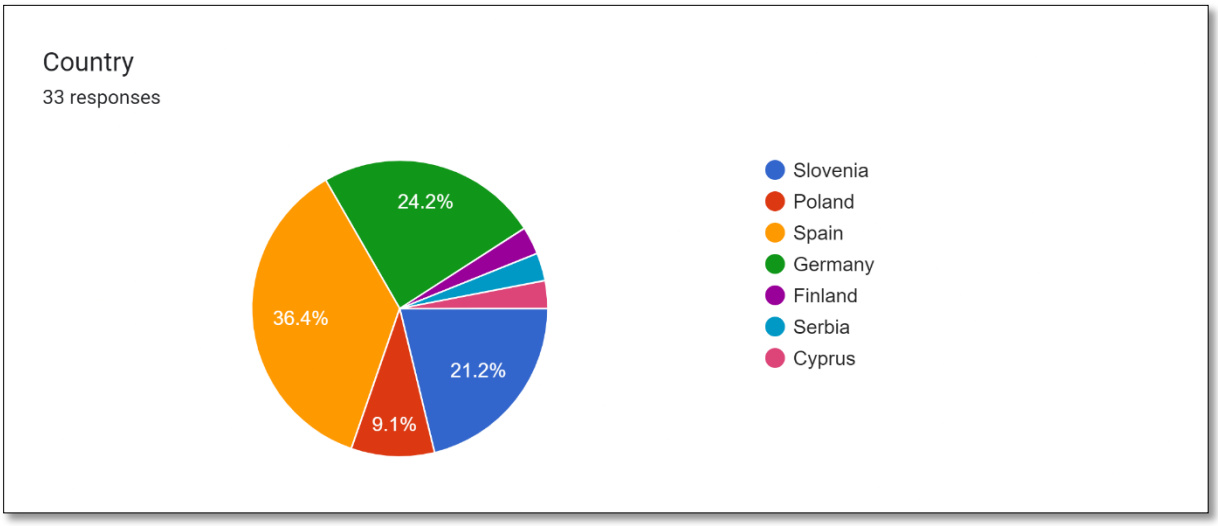


Graphic 2: Age range of survey participants.



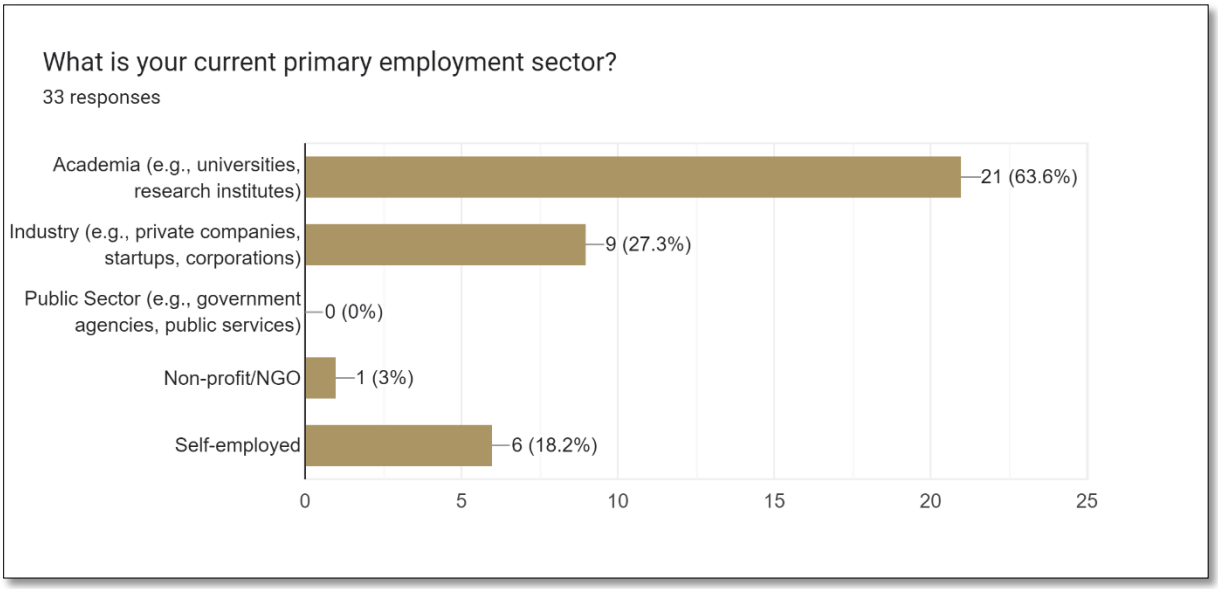
Graphic 3: Participants'level of education.

Among all respondents, the most (36.4%) were from Spain (24.2% from Germany, 21.2% from Slovenia, 9.1% from Poland, followed by Cyprus, Serbia and Finland).

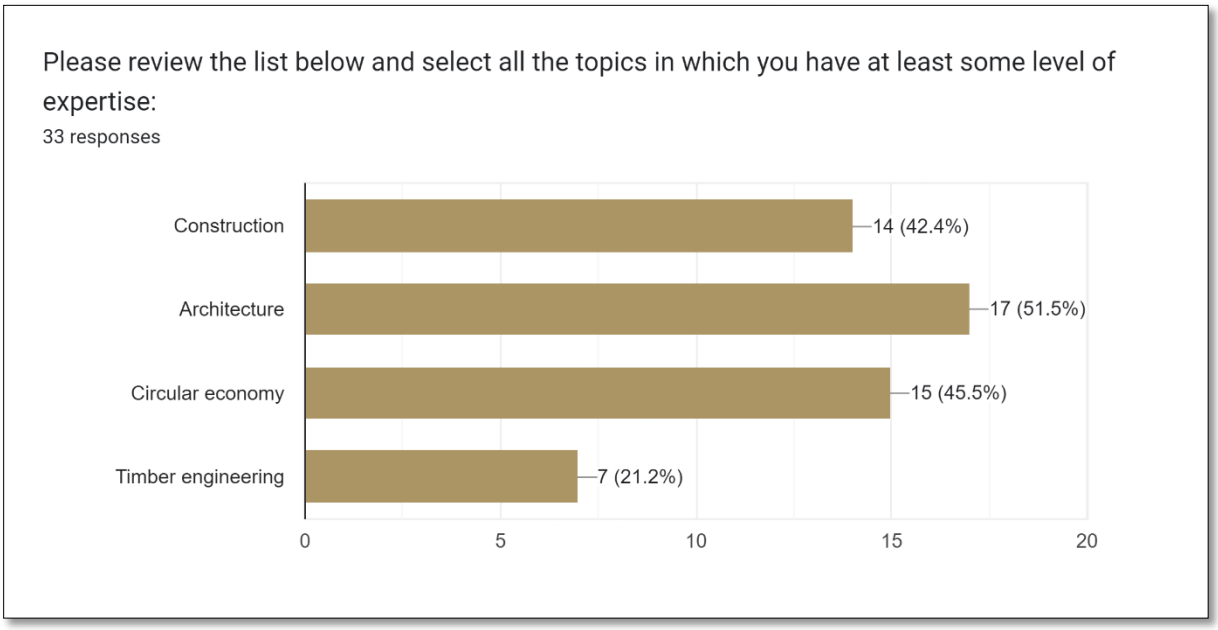


Graphic 4: Country of residence of participants.

The primary employment sector of most respondents was academia, including university and research institutes (63.6%), followed by private companies, startups or corporations (27.3%). Most respondents (51.7%) had at least some level of expertise from architecture, 45.5% from circular economy, 42.4% about construction and 21.2% regarding timber engineering.



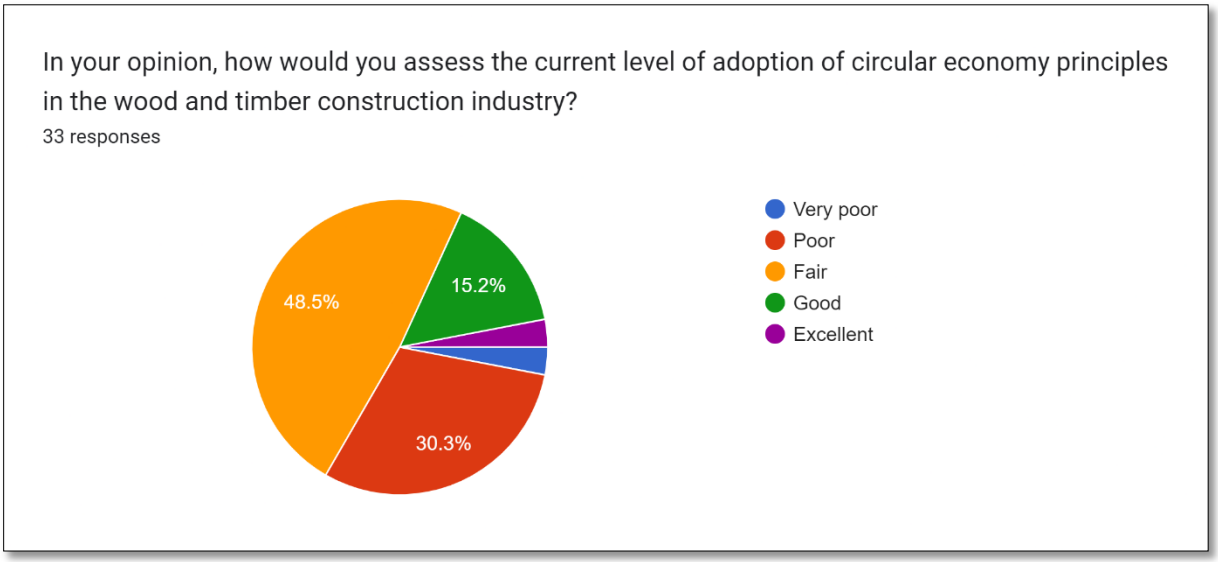
Graphic 5: Employment sector.



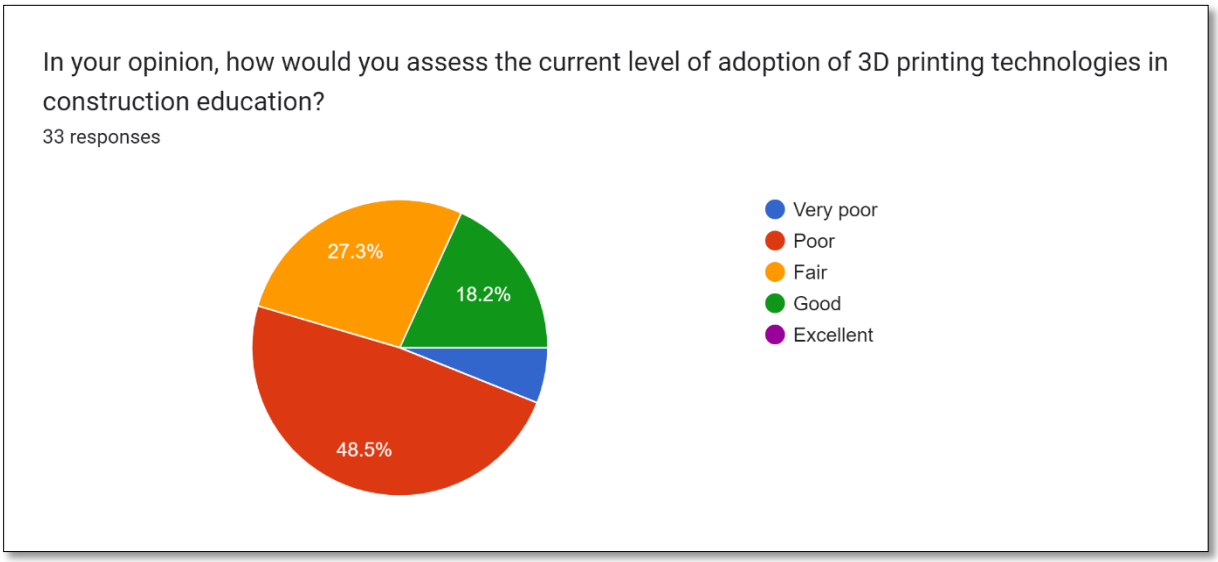
Graphic 6: Expertise of participants.

3.2 Perspectives about the current situation

Most respondents (48.5%) assessed the current level of adoption of CE principles in the wood and timber construction industry as fair, while current level of adoption of 3D printing technologies in construction education as poor (48.5%). They believe that that Industry 4.0 technologies that are currently being adopted in the timber construction industry are mostly Building Information Modeling (BIM), robotics and automation, IoT, data analytics, artificial intelligence, prefabricated and modular construction, digital twins, augmented and virtual reality, CNC machining, digital fabrication, optimization programs, 3D printing, scanning, blockchain, MES systems, smart factories, and simulation.



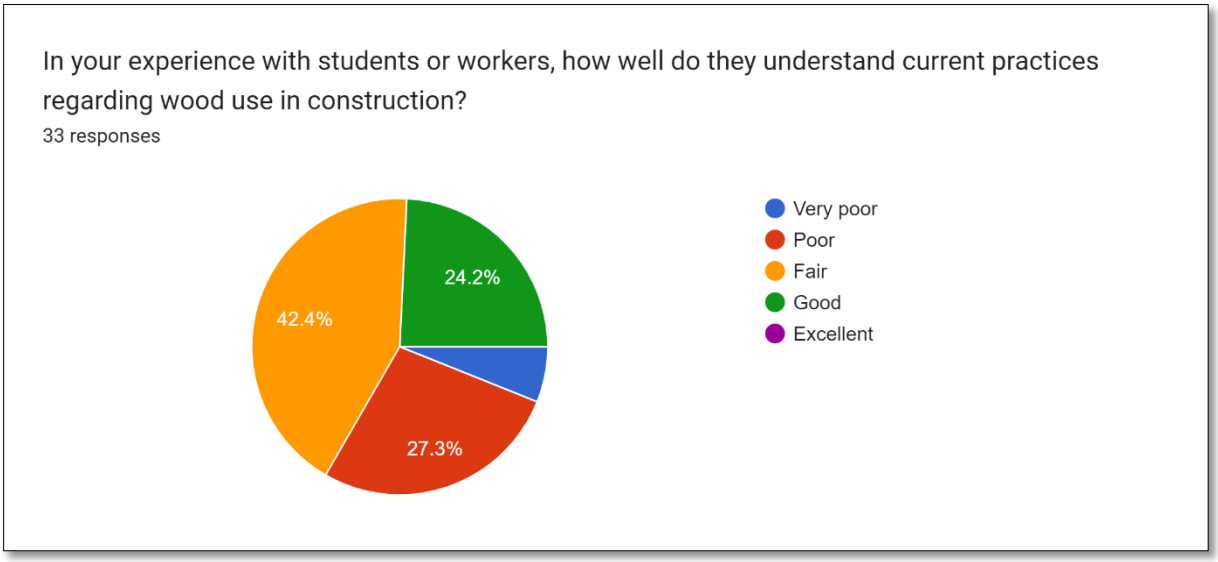
Graphic 7: Level of adoption of Circular Economy.



Graphic 8: Level of adoption of 3D Printing.

Respondents are in general familiar with the terms connected to CE and Industry 4.0. They mostly understand quite well, at least to some level, or could explain to others terms like resource and waste management, sustainable design, emerging technologies, recycled materials, BIM, cascading use of materials, certification of green buildings, circular thinking in planning, environmental footprint, environmental impact assessment, green public procurement of buildings, LCA, low-emission construction techniques. However, it's worth noticing that 12.1% of respondents do not understand what green public procurement of buildings is, and 18.2% never heard of the term cascading use of materials.

In experience with students or workers most of the respondents think they are fairly (42.4%) or good (24.2%) in understanding current practices regarding wood use in construction, while 27.3% think they are poor in this regard.



Graphic 9: Understanding current practices.

3.3 Evaluation of VET programmes

Most respondents think that current VET programs related to timber construction and engineering address principles of sustainable design fairly (48.5%), as opposed to 30.3% who think it addresses it poorly. The same goes for exploring Industry 4.0 technologies in sustainable construction as more than half (51.5%) assess it as fair, while 30.5% assess it as poor.

They assess as fair or good the relation to evaluating the advantages of wood construction, understanding the role and importance of forest certifications, comprehending the core principles of the circular economy, identifying the environmental advantages of wood as a building material, applying renewable energy solutions in timber construction, and promoting sustainable/circular wood construction practices.

However, most respondents (39.4%) think that current VET programmes address gaining in-depth knowledge of sustainable sourcing practices for wood, as well as analysing future trends in sustainable wood construction (42.4%) poorly.

Additionally, they assess all proposed terms as important (moderately, very, extremely) for fostering sustainability/circularity in wood construction. Only regarding the understanding the role and importance of forest certifications some (9.1%) think it is only slightly important.

Annex 2 includes all the VET programs analysed across the four consortium countries.

3.4 Skills and competencies development

Overall, respondents agree that all the proposed skills and competencies are essential for students to develop during their education. Green skills related to sustainable wood construction, such as reuse, recycling, and sustainable sourcing of materials, along with digital skills like 3D printing and automation, are seen as very important (54.5%). Additionally, evaluating and improving the environmental performance of wood-based construction to meet sustainability standards (e.g., FSC, PEFC) (63.6%), leading sustainable wood construction projects with a focus on environmental integration at every stage (57.6%), applying critical thinking to circular wood construction issues (60.6%), and implementing CE principles (e.g., reducing waste and improving material efficiency) (51.5%) are all considered very important.
At the end of the survey, we enabled an open question where respondents could share their comments/suggestions. We received 8 comments that mostly highlight the need to integrate digital skills and sustainability practices into timber construction education. Respondents emphasize the importance of practical training, to cover topics such as recycling, and to provide industry partnerships to prepare students for the future, particularly in Industry 4.0. They suggest updating curricula to include innovative materials like Cross-Laminated Timber (CLT) and focusing on timber's low carbon footprint. Hands-on experience, real-world case studies, and exposure to CE principles are also seen as essential for making learning more impactful and relevant.

4. Analysis of VET programs in the four countries

An analysis of specific vocational education and training (VET) programs was conducted across four European countries: Germany, Poland, Slovenia, and Spain. The primary objective was to examine the current curricular content, teaching approaches, and competencies covered, particularly in relation to the integration of circular economy (CE) principles, sustainability, and Industry 4.0 technologies.
In total, 35 programs were analyzed: 16 in Germany, 6 in Poland, 5 in Slovenia, and 8 in Spain. It is important to note that, due to the limited number of existing VET programs specifically focused on wood and timber construction, the analysis also included high school, bachelor's, and master's programs. This broader scope allowed for a more comprehensive understanding of how these topics are currently addressed in education.
The majority of the programs analyzed were 2 to 3 years in length, although some shorter programs (e.g., 22 months or 2 semesters) and longer ones (4 to 5 years) were also included. Programs were assessed at EQF/NQF levels 4 to 6, with some exceptions extending to levels 3, 7, and 8.
It is worth emphasizing that more than 50% of the analyzed programs correspond to higher education (bachelor's and master's levels) rather than VET. Consequently, the findings and results of this analysis must be adapted to align with the needs of vocational education and training, ensuring they address the specific characteristics and goals of VET learners.
This adaptation is critical to maintaining relevance and accessibility for VET students while leveraging insights from the broader analysis to inform curriculum development that integrates green skills, CE principles, and foundational digital competencies.

4.1 Program content

- **Commitment to CE principles and sustainability**

The analyzed VET programs demonstrate a commitment to CE principles and sustainability, which differs among countries and programs. In general, particularly in wood and timber construction programs, the commitment to CE is stronger. Key elements include the focus on material cycles, sustainable practices in construction, and eco-friendly technologies. Programs emphasize biodegradation, wood protection, and the efficient use of natural resources, with attention to environmental protection and waste management. Specialized modules on lifecycle analysis, recycling/upcycling, and biobased construction are prevalent, alongside training in energy-efficient building and innovative sustainable materials like bioplastics.

Programs align with CE by promoting resource-efficient timber construction, regional material sourcing, and eco-balance principles. Specific efforts include integrating sustainable building technologies and addressing durability and mechanics of material deterioration. Some curricula highlight ISO standards, ensuring quality and environmental management in furniture and wood manufacturing. These programs emphasize the typology, properties, and protection of wood as a structural material, its role in reinforced concrete, steel, and masonry systems, and the sustainable substitution of fossil materials. They highlight sustainable forest

management, carbon storage, biodiversity, and the circular bioeconomy through wood-based innovations.

Higher education programs show particularly robust alignment, progressing from foundational sustainability concepts to comprehensive CE management at advanced levels. Courses often include topics like cross-laminated timber (CLT) and sustainable design strategies.

Despite these, some vocational programs (e.g., Woodworker, Carpenter, and Carpenter Technician) lack explicit CE integration, instead focusing on basic material use. Additionally, some programs did not provide any information that would relate to CE topics which suggests that programs are likely to not include CE topics in its curricula.

- **Commitment to Industry 4.0 technologies**

There are significant improvements in certain areas and deficiencies in others when it comes to the incorporation of Industry 4.0 technologies in VET programs. In some programs, advanced equipment including CNC machines, CAD/CAM systems, and automated manufacturing technologies are frequently used to improve students' digital design, automation, and robotization skills. In order to prepare students for the demands of an industry that has undergone a digital transformation, programs also include data-driven production optimization, computer-integrated management systems, and contemporary manufacturing practices.

Some programs place a strong emphasis on computer tools for technical and technological documentation as well as cutting-edge techniques like digital project management and Building Information Modeling (BIM). Techniques like augmented and virtual reality to create digital twins, and digitalization is partly mentioned in some programs.

However, all programs do not successfully incorporate Industry 4.0. Some restrict their scope to basic machinery operation without deeper technological integration, but higher education offerings, such as master's degrees in wood science and technology, show robust compatibility. Digital tools are mentioned in passing in several programs, but there are no clear curricula to enable their full use.

Overall, Industry 4.0 technologies are found in some of VET programs, their integration into basic and vocational education is still unequal, offering room for improvement in future curriculum development. Additionally, in several programs we did not notice any information that would relate to topics of Industry 4.0 technologies, it is mentioned less frequently in comparison to CE principles.

4.2 Competencies covered by the program

In general, mostly the competencies covered in the examined VET programs, are woodworking methods and machine operation, including mastery of CAD/CAM systems and

CNC programming. With the help of practical instruction in workshops and apprenticeships that connect theoretical knowledge with practical applications, students gain technical drawing, project management, and problem-solving abilities.

Professional qualities like the capacity to manage projects, solve technical problems on your own, and maintain quality control are also emphasized in programs. Through cooperation and teamwork, social and communication skills are developed, and entrepreneurial abilities are incorporated to get students ready for leadership positions in the field.

Students can learn about the anatomy, characteristics, and sustainable processing techniques of wood through specialized programs that concentrate on wood science and technology. Structural design, sustainable construction techniques, and fire and sound protection are additional competencies. Multidisciplinary collaboration, creative material design, and leadership abilities are also highlighted. Additionally, they gain proficiency in interpreting and producing technical documentation, managing building projects, and preparing reports, budgets, and specifications using computer applications and BIM methodology. In some programs (mostly in Spain) competencies extend to 2D/3D modeling, 3D scanning, structural dimensioning, and analyzing lifecycle data for sustainable construction.

Certain sectors, like the furniture, emphasize eco-friendly production techniques, lifecycle analysis, and creative design. Other programs include specialized knowledge like damage identification, repair, and artistic woodworking.

Overall, although analysed VET programs cover some competences important for the wood and timber construction sector, possibilities for improvement exist. The limited CE integration, and the inconsistent Industry 4.0 coverage is a gap to be filled. While some programs include Industry 4.0 technologies like CNC machines, CAD/CAM systems, and automated manufacturing, their integration into basic VET programs is minimal. There is also limited coverage of digital tools such as 3D printing and scanning, data-driven sustainability practices like IoT, AI, and big data.

4.3 Teaching methodology and evaluation criteria

The teaching methodologies across analysed VET programs emphasize a project-based learning approach combined with practical training and theoretical lectures. Common methods include workshops, hands-on activities, fieldwork, and collaborations with companies, allowing students to apply knowledge in real-world contexts. Blended learning, which mixes theory classes and practical work, is also used, along with methods like seminars, case studies, group projects, and problem-solving exercises. Practical components often include on-site training, apprenticeships, and visits to construction sites and technology centers, fostering experiential learning. Innovative approaches, such as using digital tools, cross-laminated timber prototypes, and dialectical methods, also enrich the learning experience.

As for the evaluation criteria, it measures both theoretical knowledge and practical abilities through a combination of written exams, project-based evaluations, and practical

assessments. Practical projects, thesis presentations, module tests, and ongoing evaluations are important techniques. Real-world application is the emphasis of specialized tasks like the "Gesellenprüfung" and BIM modeling, while workshops and sustainability assessments provide thorough skill evaluation.

4.4 Learning outcomes

This section presents the learning outcomes identified through the analysis of existing VET programs in four countries (Germany, Poland, Slovenia, and Spain). These outcomes reflect the current integration of sustainability and circular economy principles into timber construction education, as well as the adoption of Industry 4.0 technologies. The findings provide a baseline for understanding the competencies already covered in existing curricula and highlight areas that require further enhancement to align with the evolving needs of the sector.

- Develop a deep understanding of sustainable materials, resource management, and sustainable forest practices, including lifecycle ecological footprint analysis.
- Apply sustainable materials and processes to reduce environmental impact while promoting wood durability, reuse, and cascading utilization.
- Design and implement sustainable building practices and timber structures with a focus on resource efficiency and circular construction principles.
- Model sustainability and energy efficiency parameters critical for CE practices, including eco-design and life cycle analysis.
- Master Industry 4.0 technologies, such as automation, CNC machinery, CAD/CAM systems, and data-driven tools for optimized production and lifecycle management.
- Integrate digital fabrication techniques, such as 3D printing and additive manufacturing, for innovative and sustainable wood construction.
- Apply data-driven tools and digital technologies to improve wood product manufacturing, quality, and lifecycle management.
- Foster expertise in Building Information Modeling (BIM) to enable sustainable and resource-efficient design and construction.
- Design smart, digitally optimized timber structures that prioritize innovation and sustainability.
- Gain proficiency in circular construction methods, eco-balance, and sustainable wood construction.
- Master principles of the circular economy, cascading wood utilization, and sustainable development.
- Understand pollution types in wood processing, their sources, and mitigation methods.
- Foster creativity and innovation in wood product design, restoration, and advanced composite development using cutting-edge technologies.
- Understand how Industry 4.0 technologies contribute to reducing environmental impacts in manufacturing and construction.
- Use Industry 4.0 tools for automated production, digital inspection, and quality improvement to ensure sustainability.

5. Existing reports

5.1 CEDEFOP

The CEDEFOP: From linear thinking to green growth mindsets report is a policy brief emphasizing how CE is essential to meet green deal targets.

It aligns strongly with the CE and sustainability by advocating a shift from a linear model to a regenerative approach centered on eco-design, recycling, and industrial symbiosis to reduce emissions and resource waste. It highlights the role of Vocational Educational Training (VET) in fostering circular skills, systems thinking, and lifelong learning to build a workforce aligned with CE practices. In the report the Industry 4.0 technologies are explicitly mentioned only once to ease the transition towards the circular economy. The technologies mentioned are artificial intelligence, augmented reality and blockchain that would help streamline CE management in production tracking, resource optimization and collaboration across sectors.

It identifies several key skill needs:

- Circular product design skills to promote eco-friendly manufacturing.
- Systems thinking for understanding and implementing circular principles.
- Transversal skills, including collaboration, communication, and problem-solving, to adapt to CE models.
- Technical skills, such as refurbishing IT equipment and assessing life-cycle impacts.
- Data analysis skills to support informed decision-making in circular practices.
- Upskilling for using Industry 4.0 technologies like blockchain, AR, and AI in CE processes.

The brief highlights the importance of VET curricula updates to integrate these skills, emphasizing short-term upskilling and long-term skill anticipation.

Circular economy-specific skills that are emphasized in the report are eco-design and reuse principles, repair and recycling processes, systems thinking, collaboration, and communication, digital skills for using AI, AR, and blockchain in CE processes, creativity and problem-solving for material innovation, and life-cycle assessment (LCA) expertise.

It also emphasized the need for skills for innovation in eco-design and data-driven technologies for circular production, promoting industrial symbiosis through digital platforms to enhance resource sharing, regulatory changes, including the Eco-design Directive, to encourage sustainable product design, and integrating sustainability principles into education, policies, and business models to create lasting change.

It highlights the importance of EU-level harmonization of VET courses for CE skills, and at the same time it acknowledges barriers like skill gaps, weak professional development for trainers, and poor working conditions in repair sectors, calling for targeted interventions. The report

presents a strong case for integrating CE and Industry 4.0 technologies while addressing the skills needed for a sustainable future.

5.2 GreenComp

GreenComp: The European sustainability competence framework is a JRC (Joint Research Centre) policy report to provide "evidence-based scientific support as input to the EU's policymaking process."

The GreenComp framework aligns strongly with the principles of the CE and sustainability by emphasizing competences that promote environmental awareness, equity, and responsible action. It integrates sustainability values such as promoting nature, systems thinking, and acting for sustainability which are essential for transitioning to a CE model. The report's focus on fostering a sustainability mindset supports long-term systemic change aligned with the goals of the European Green Deal and the Sustainable Development Goals (SDGs).

While it does not explicitly mention Industry 4.0 technologies, its emphasis on critical thinking, adaptability, and exploratory thinking indirectly supports the integration of advanced technologies in sustainability efforts.

The framework addresses green skills explicitly by defining sustainability competences and providing a reference for integrating them into educational programs. While digital skills are not a primary focus, the critical and systems thinking competences outlined are transferable to digital innovation and the use of technology in sustainable development.

6. Gaps to be addressed

Based on the performed analysis we identified several gaps that we need to address in the next steps of the project when we will be developing modules and curriculum in the field of sustainable wood and timber construction by integrating CE principles and 3D printing technologies.

- Limited coverage of CE principles in VET programs.
- Minor coverage of Industry 4.0 and digital skills, tools like 3D printing, digital twins, and IoT in the curriculum is not well integrated.
- Not enough practical training and real-world exposure, case studies, partnerships, and on-site training.
- Limited content about advanced materials like CLT, sustainable sourcing practices for wood, and analysing future trends in sustainable wood construction.
- Creative approaches about sustainable designs in timber construction are not covered sufficiently.
- Expand knowledge on LCA, carbon footprint of timber, green public procurement, and cascading use of materials.

- Green skills related to reuse, recycling, and sustainable sourcing of materials are not sufficiently covered.
- Digital skills related to 3D printing and automation, are not sufficiently covered.
- Integrating digital skills and sustainability practices into timber construction education not sufficiently performed.

7. Educational objectives

Based on the comprehensive analysis conducted as part of this document, we have identified and defined 10 educational objectives (EO) to address the gaps revealed in current training programs. These objectives are aligned with the demands of the circular economy (CE) in wood and timber construction and reflect the project's commitment to sustainability, innovation, and digitalization in the sector.

The objectives have been thoughtfully adapted to the context of Vocational Education and Training (VET), ensuring their practical relevance, accessibility, and alignment with the EQF framework. By focusing on foundational knowledge, green skills, and introductory digital competencies, these objectives provide a clear roadmap for equipping VET learners with the tools needed to thrive in a rapidly evolving industry.

These objectives are designed to bridge the gaps in integrating CE principles, sustainable practices, and Industry 4.0 technologies, while supporting the broader goals of the European Green Deal and the Sustainable Development Goals (SDGs). They will guide the development of a future-ready curriculum, forming the basis for impactful training modules that prepare learners for the challenges and opportunities in sustainable timber construction.

1. **Understand the principles of Circular Economy (CE):** Introduce learners to CE concepts such as material cascading, waste reduction, and sustainable sourcing practices, ensuring a foundational understanding of these principles in timber construction.
2. **Enhance knowledge of digital tools:** Provide theoretical insights into digital technologies like 3D printing, automation, and basic Industry 4.0 applications relevant to timber construction processes.
3. **Strengthen understanding of advanced materials:** Teach the benefits of innovative materials like cross-laminated timber (CLT) and their role in sustainability, focusing on environmental and structural advantages.
4. **Encourage sustainable design thinking:** Develop the ability to conceptualize simple, eco-friendly timber structures that integrate sustainability and CE principles.
5. **Build awareness of lifecycle assessments (LCA):** Teach how to evaluate the environmental impacts of timber products and processes, focusing on carbon footprint analysis and eco-design concepts.
6. **Promote green skills:** Emphasize the importance of reusing, recycling, and sourcing materials sustainably, aligning with CE principles.

7. **Foster understanding of Industry 4.0:** Explore the theoretical applications of Industry 4.0 technologies, such as automation and digital tools, in optimizing timber construction processes.
8. **Explore future trends in timber construction:** Identify and discuss emerging trends in sustainable timber construction, such as biobased materials and low-carbon technologies.
9. **Integrate green public procurement knowledge:** Teach learners to understand and apply basic principles of green procurement practices in the context of timber construction.
10. **Connect timber construction with global sustainability goals:** Highlight how timber construction contributes to achieving the Sustainable Development Goals (SDGs), particularly SDGs 9 (Industry, Innovation, and Infrastructure) and 13 (Climate Action).

8. Learning outcomes

This section presents the 20 learning outcomes (LOs) developed for the WENUS project's training modules. These outcomes are the result of an in-depth analysis conducted as part of this report, which examined 35 educational programs across four countries, stakeholder surveys, and key European frameworks such as GreenComp and CEDEFOP. The analysis revealed gaps in existing VET curricula, particularly in the integration of circular economy (CE) principles, sustainability practices, and Industry 4.0 technologies, which informed the definition of these learning outcomes.

The learning outcomes are specifically tailored to the context of Vocational Education and Training (VET), ensuring they are relevant, accessible, and aligned with the EQF framework. They emphasize theoretical knowledge, foundational green and digital skills, and the ability to connect these concepts to the timber construction industry. Designed for a self-directed, online learning approach, the outcomes aim to equip learners with competencies that address both industry demands and societal goals, including those of the European Green Deal and the Sustainable Development Goals (SDGs).

Grounded in the project's research methodology, these learning outcomes are intended to ensure that learners are prepared to meet the challenges of sustainable wood and timber construction in a rapidly evolving market. They form the basis for a future-oriented curriculum that bridges the gap between current VET programs and the skills required for a more sustainable and innovative construction industry.

The learning outcomes for the training modules that will be developed are as follows:

1. Explain the basic principles of Circular Economy (CE) and their application in timber construction.
2. Identify the cascading use of materials in timber construction to enhance sustainability.
3. Describe sustainable sourcing practices for timber and other construction materials.

4. Assess strategies for reducing waste and improving material efficiency in timber construction.
5. Recognize the environmental benefits of using advanced timber materials such as cross-laminated timber (CLT).
6. Explain the concept of carbon footprint and its relevance to timber products.
7. Recommend basic material choices aligned with sustainability goals in timber construction.
8. Outline the lifecycle of timber construction materials and identify key stages for reducing environmental impacts.
9. Describe how automation technologies can improve timber construction processes.
10. Explain the role of 3D printing and other advanced digital tools in timber construction.
11. Understand basic approaches to solving challenges related to sustainability in timber construction.
12. Describe key developments in sustainable timber construction, including the use of innovative materials and low-carbon techniques.
13. Analyze the advantages of timber construction for achieving environmental and economic sustainability.
14. Interpret basic green public procurement policies and their application in timber construction projects.
15. Describe the principles of green building practices and their integration into timber projects.
16. List the main challenges in the timber industry and propose basic strategies to address them using CE concepts.
17. Understand the role of Industry 4.0 technologies in modernizing timber construction processes.
18. Evaluate simple examples of lifecycle assessment (LCA) in timber construction to assess environmental impacts.
19. Recognize the importance of sustainable material sourcing strategies in the context of CE principles.
20. Explain the connection between timber construction and global sustainability goals, such as SDGs 9 and 13.

9. Conclusions and next activity

The Educational Framework outlined in this document represents a foundational step toward modernizing VET programs in sustainable timber construction. It provides the groundwork for addressing the gaps identified through the analysis of the survey, the 35 programs across four countries of the consortium, alongside insights from reports such as GreenComp and CEDEFOP. These gaps include limited integration of Circular Economy (CE) principles, insufficient focus on advanced digital tools like 3D printing, and inadequate emphasis on green skills and sustainable materials.

The framework introduces 10 educational objectives and 20 learning outcomes that are specifically adapted to VET needs, ensuring alignment with industry expectations while promoting sustainability and digitalization. These outcomes form the foundation for the

future training modules, which aim to equip learners with the essential skills and knowledge for sustainable timber construction.

This document establishes a clear direction for the next steps in the WENUS project. The framework will serve as a reference point for the development of a Joint Curriculum (JC) and teaching methodology, which will further refine and build upon the foundation provided here.

The subsequent activities include:

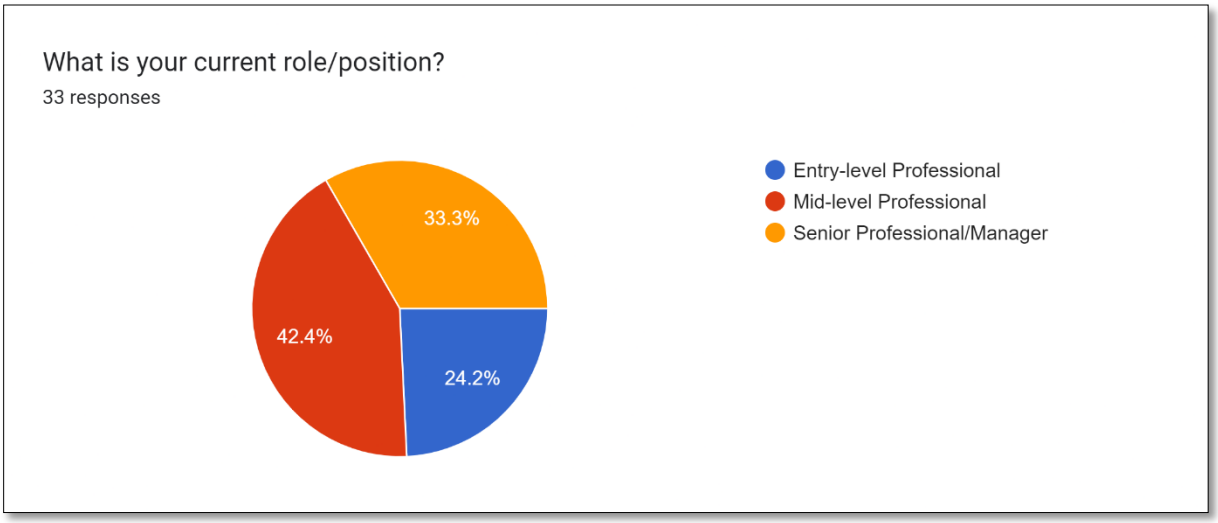
1. D2.2 Joint Curriculum and Methodology: Developing a structured curriculum and teaching methodology that incorporates advanced technologies, such as 3D printing, and integrates CE principles.
2. D2.3 Evaluation and Analysis of the Joint Curriculum: Conducting an external evaluation to assess the curriculum's effectiveness and ensure it meets industry standards and expectations.
3. D2.4 Comprehensive Educational Resource – WENUS Joint Curriculum: Finalizing the curriculum and accompanying methodological guide for teachers, which will also serve as the foundation for the trainers' guide in WP3. This resource will provide a holistic and practical tool for VET in sustainable wood and timber construction.

The Educational Framework developed in this document ensures that the WENUS project is well-positioned to address the educational and industry needs of sustainable timber construction. It supports the broader goals of equipping VET learners with the necessary skills to actively participate in a more sustainable and innovative construction sector. This framework also reflects the commitment of the WENUS project to align with European priorities, such as the Green Dealand Sustainable Development Goals (SDGs), while fostering innovation and relevance in vocational training.

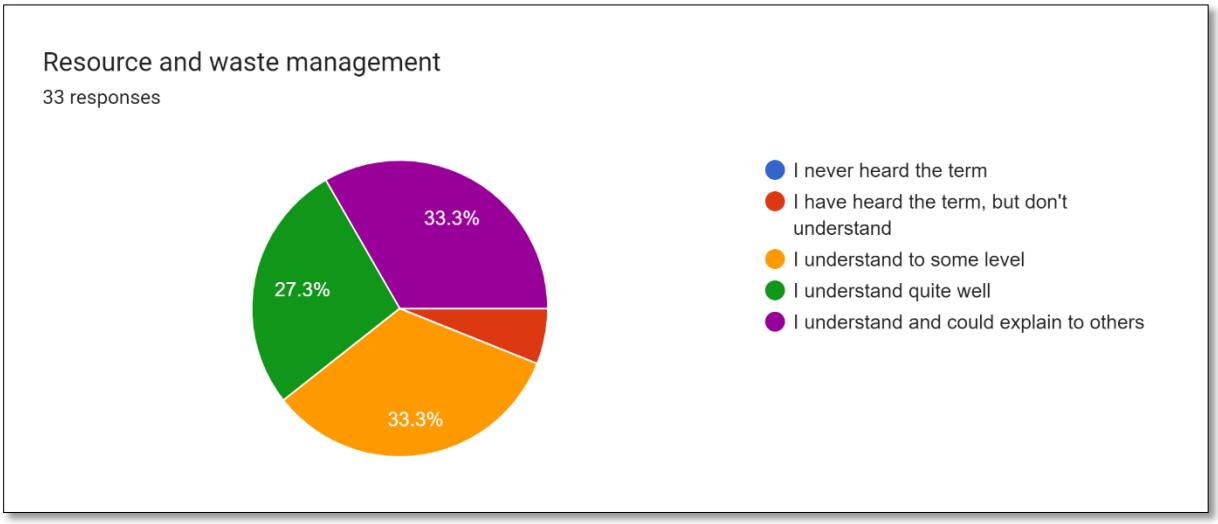
10. Annexes

10.1 Annex 1 – Graphs of survey with external experts

Section 1: Professional background

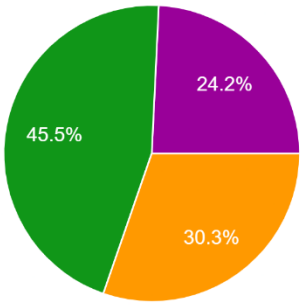


Section 2: Perspectives about the current situation
To what extent are you familiar with the following terms?



Sustainable design

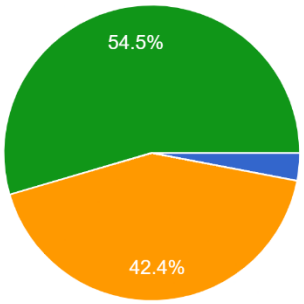
33 responses



- I never heard the term
- I have heard the term, but don't understand
- I understand to some level
- I understand quite well
- I understand and could explain to others

Emerging technologies

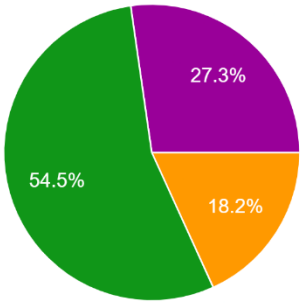
33 responses



- I never heard the term
- I have heard the term, but don't understand
- I understand to some level
- I understand quite well
- I understand and could explain to others

Recycled materials

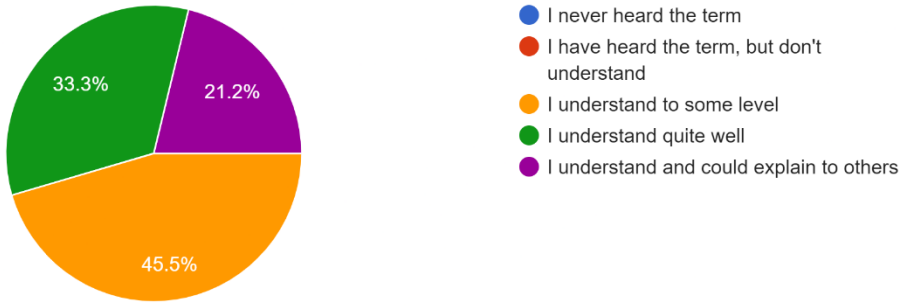
33 responses



- I never heard the term
- I have heard the term, but don't understand
- I understand to some level
- I understand quite well
- I understand and could explain to others

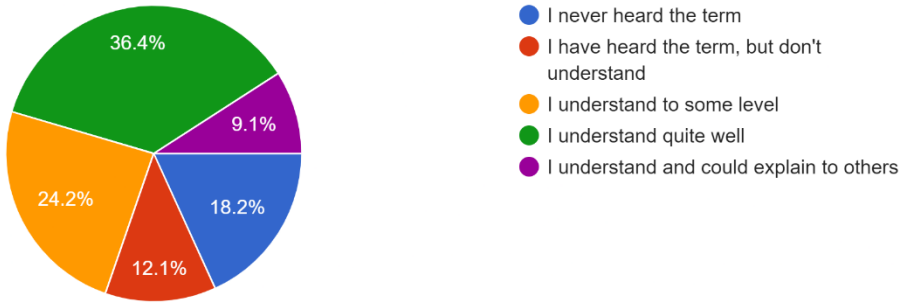
Building information modelling

33 responses



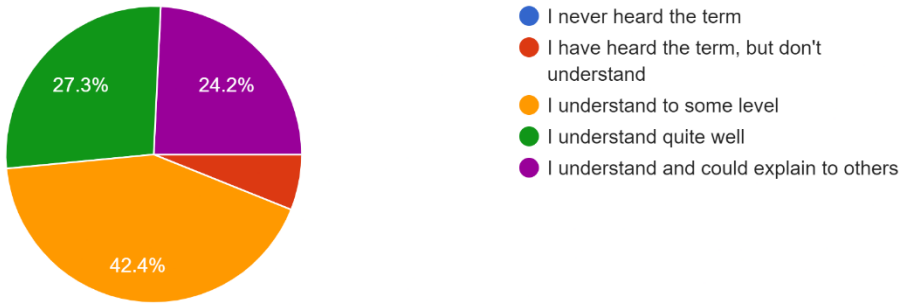
Cascading use of materials

33 responses



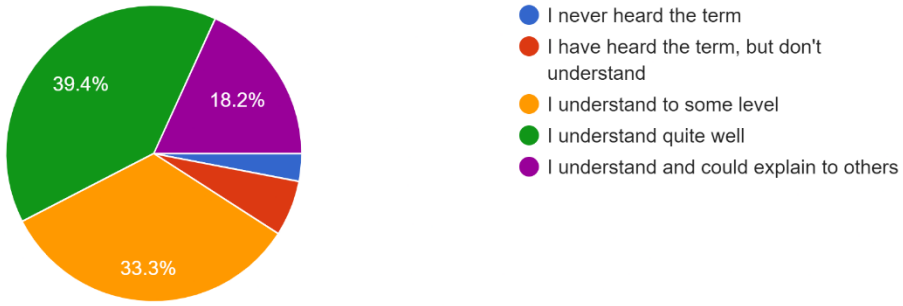
Certification of green buildings

33 responses



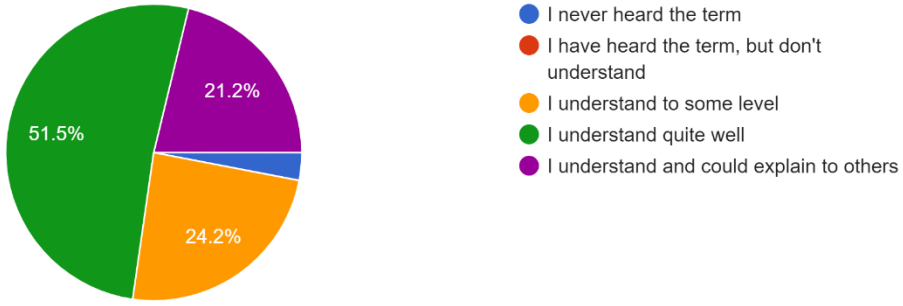
Circular thinking in planning

33 responses



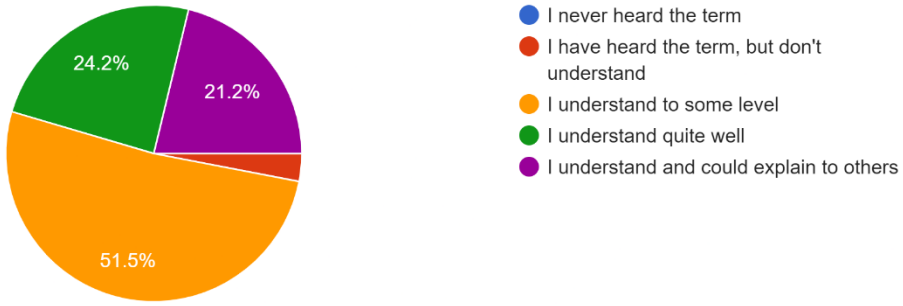
Environmental footprint

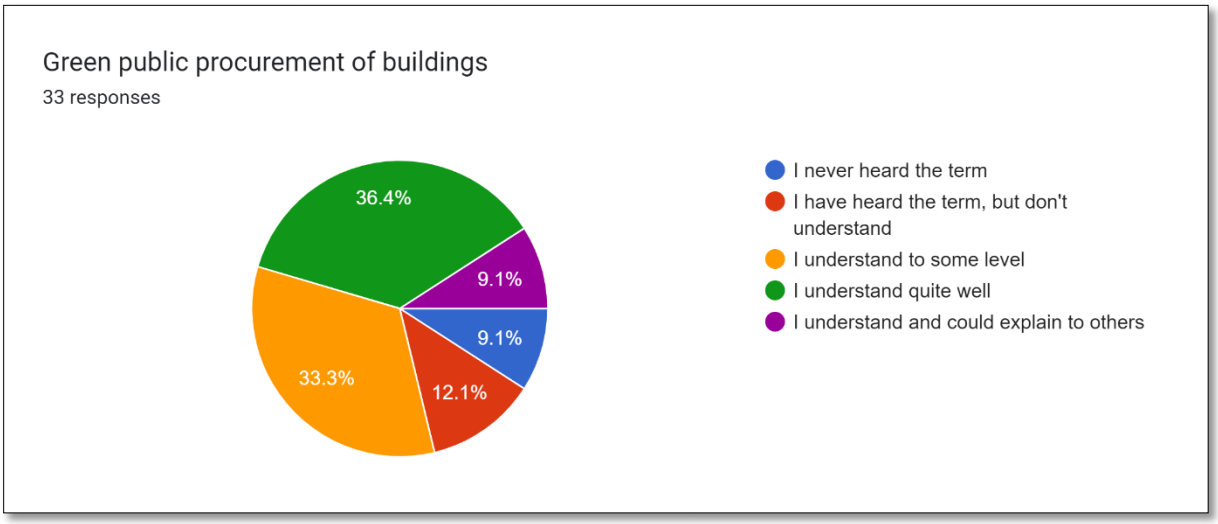
33 responses

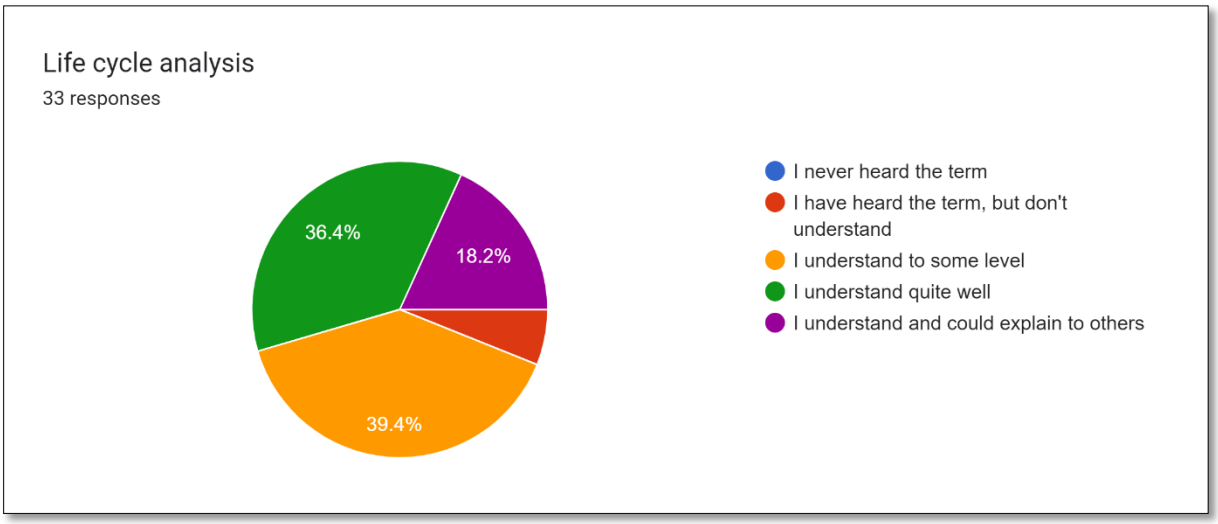


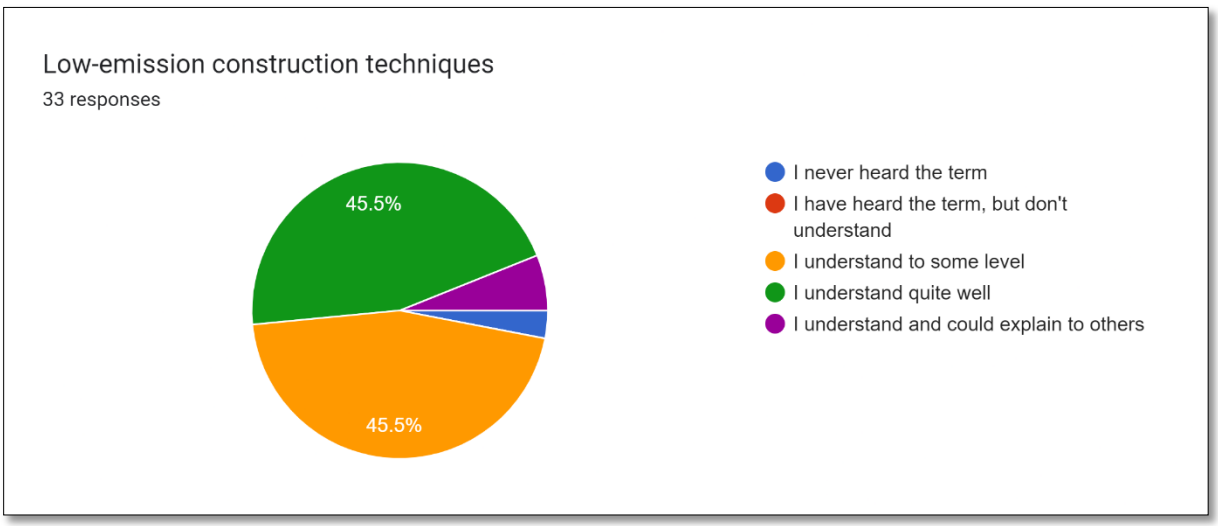
Environmental impact assessment

33 responses







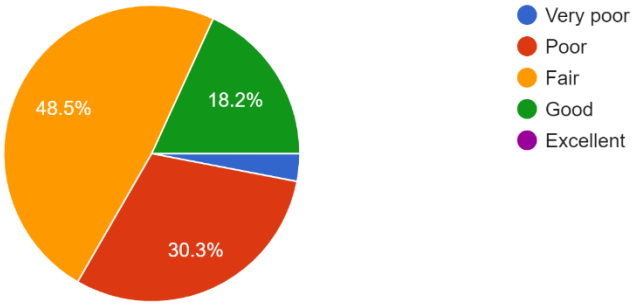


Section 3: Evaluation of Vocational Education and Training programmes

In your opinion how well do current VET programs related to timber construction and engineering address the following topics?

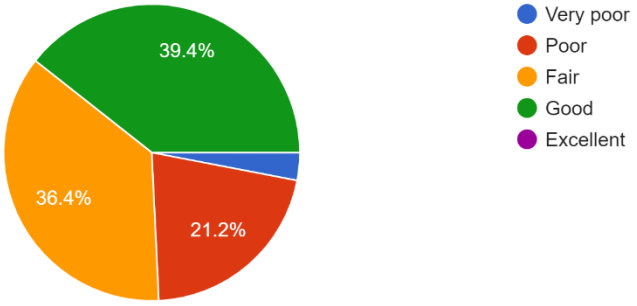
Mastering the principles of sustainable design

33 responses



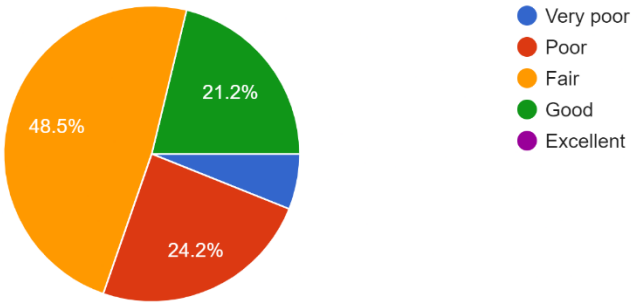
Evaluating the advantages of wood construction

33 responses



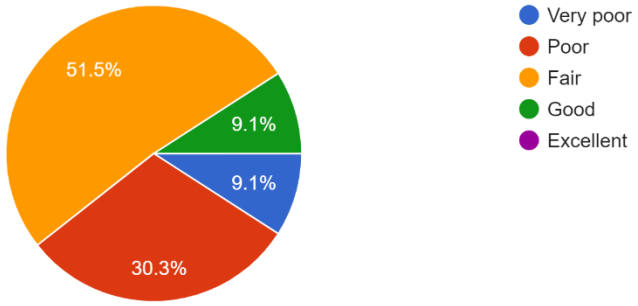
Understanding the role and importance of forest certifications

33 responses



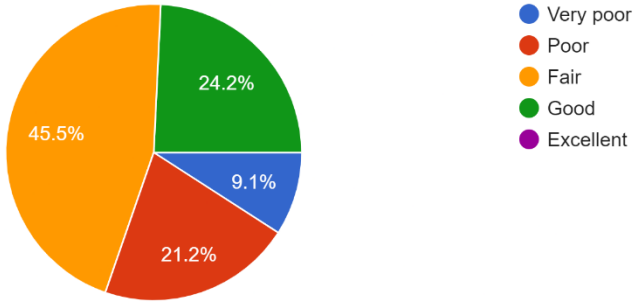
Exploring Industry 4.0 technologies in sustainable construction

33 responses



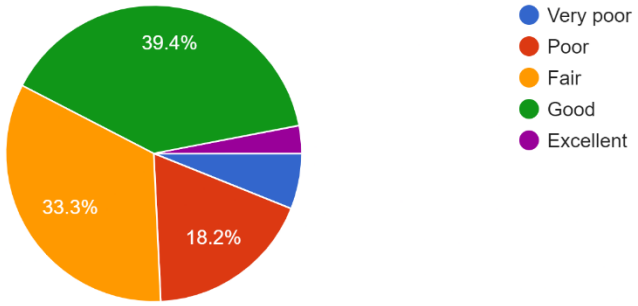
Comprehending the core principles of the circular economy

33 responses



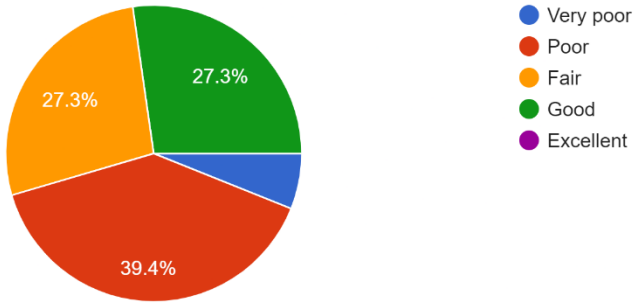
Identifying the environmental advantages of wood as a building material

33 responses



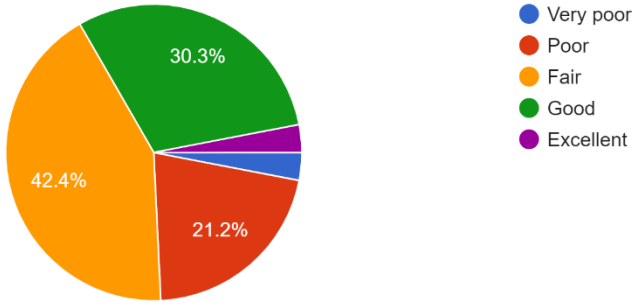
Gaining in-depth knowledge of sustainable sourcing practices for wood

33 responses



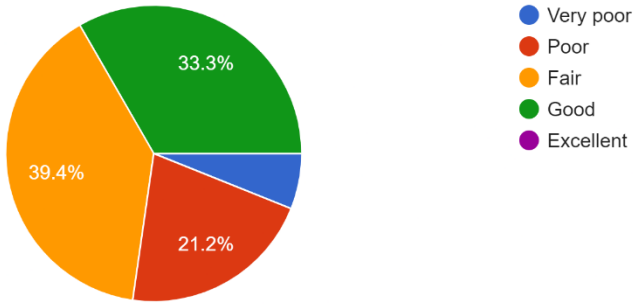
Applying renewable energy solutions in timber construction

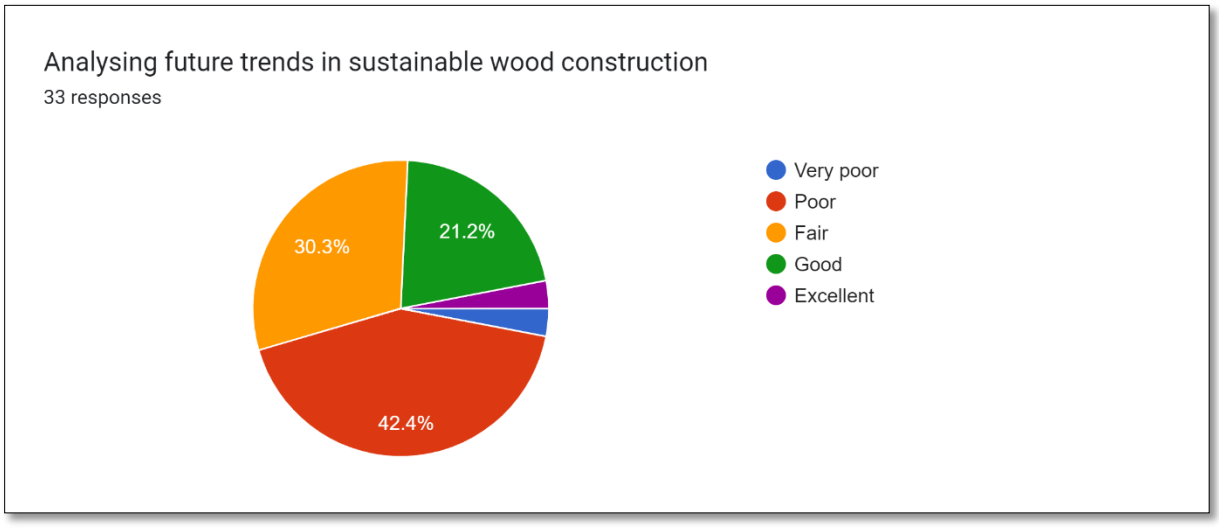
33 responses



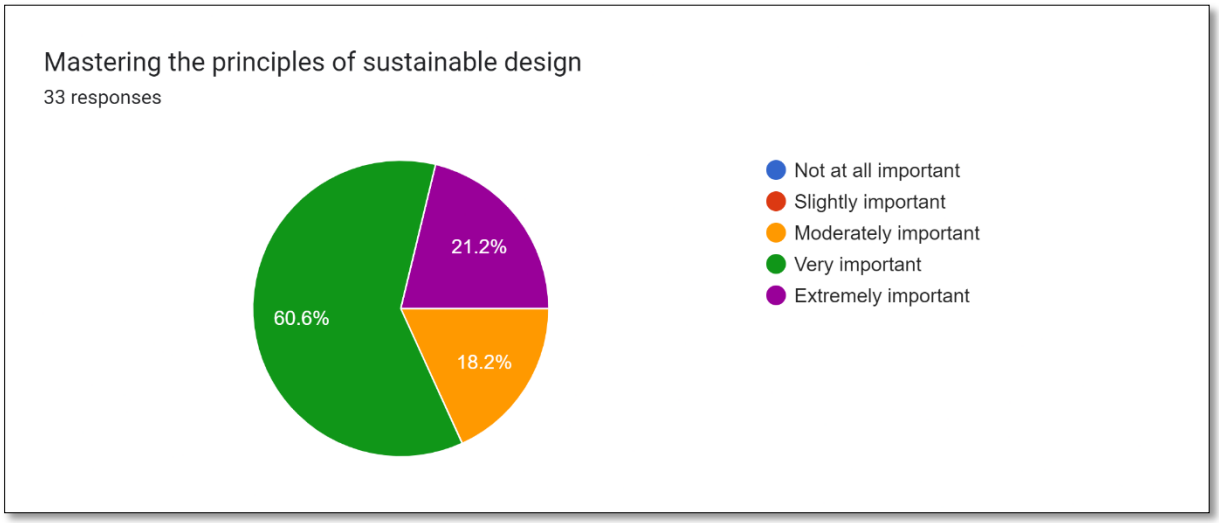
Promoting sustainable/circular wood construction practices

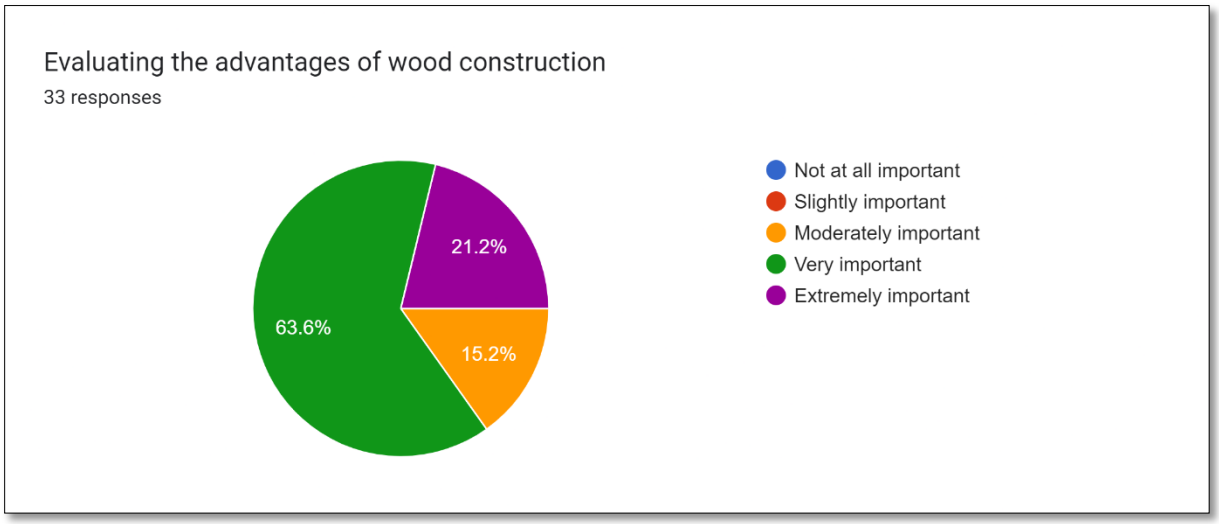
33 responses





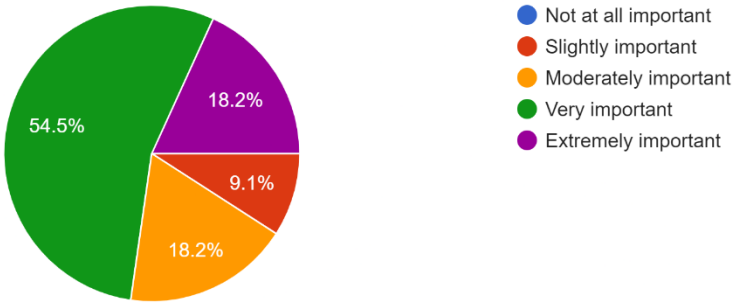
What do you consider most important for fostering sustainability/circularity in wood construction?





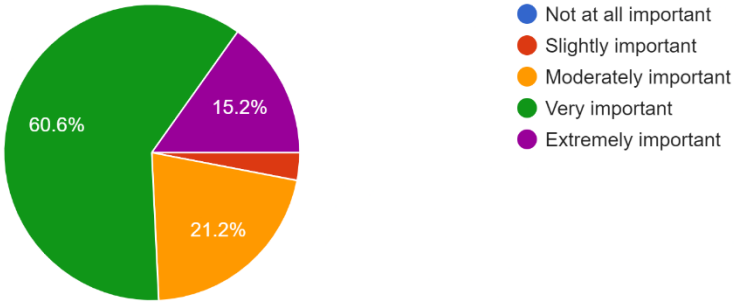
Understanding the role and importance of forest certifications

33 responses



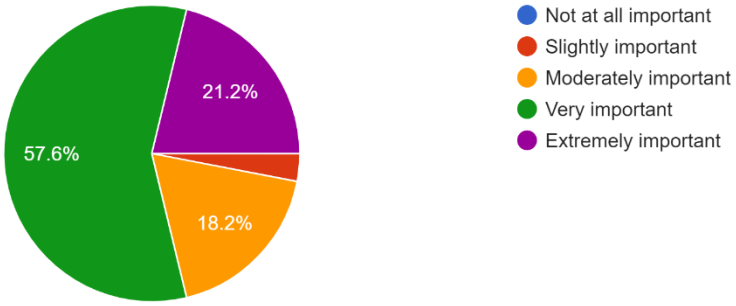
Exploring Industry 4.0 technologies in sustainable construction

33 responses



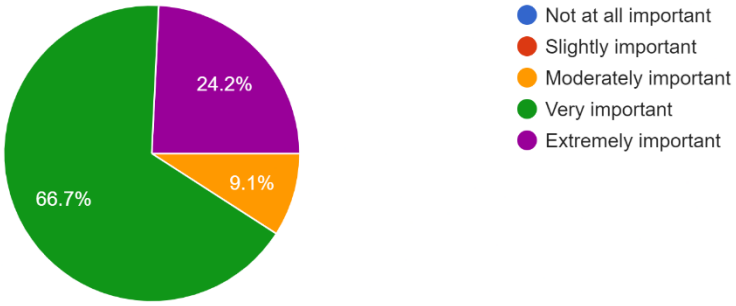
Comprehending the core principles of the circular economy

33 responses



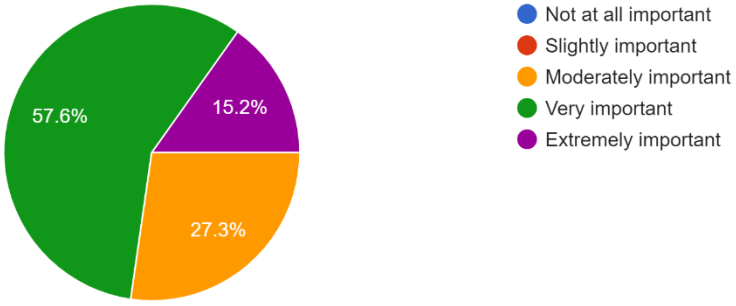
Identifying the environmental advantages of wood as a building material

33 responses



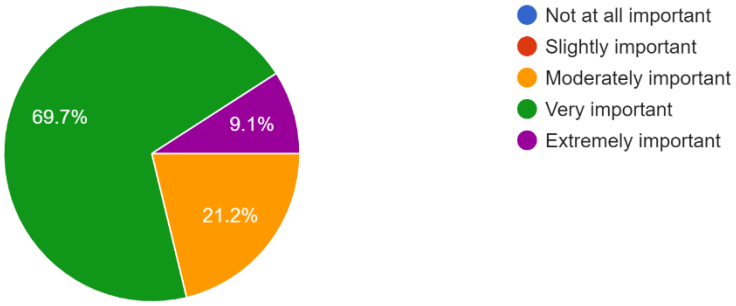
Gaining in-depth knowledge of sustainable sourcing practices for wood

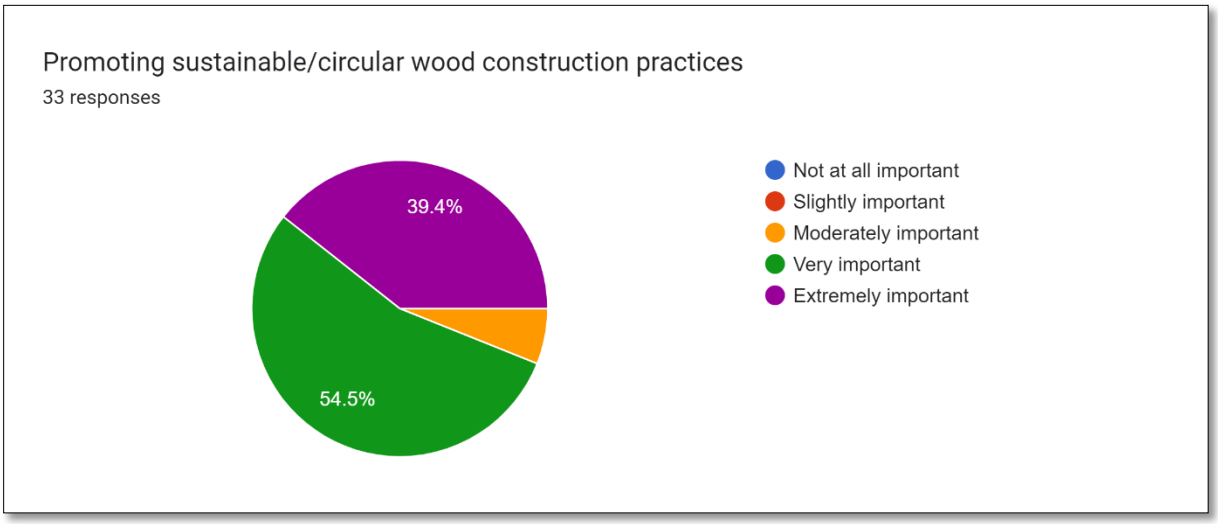
33 responses

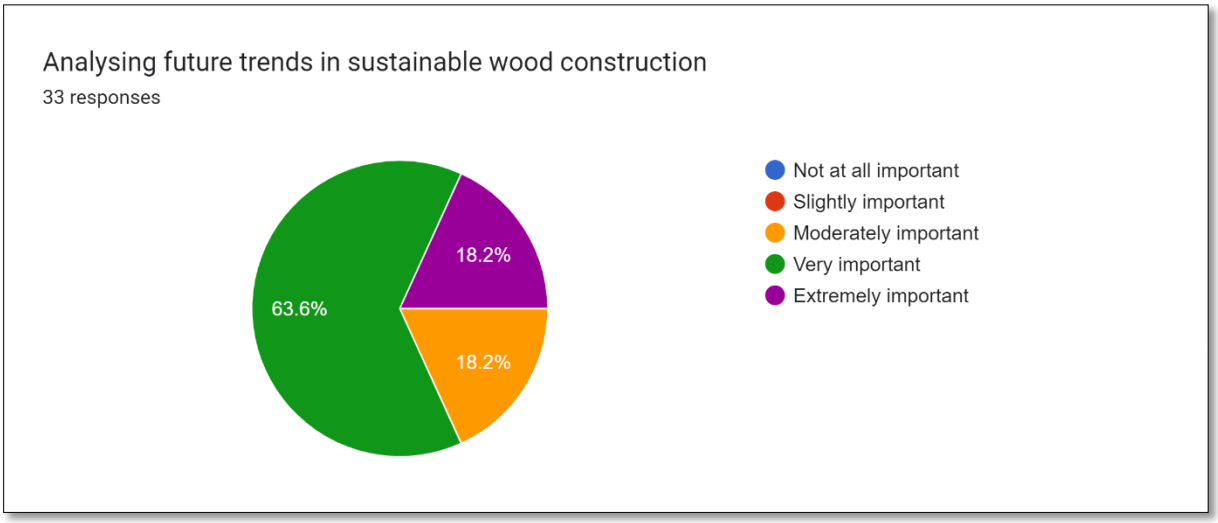


Applying renewable energy solutions in timber construction

33 responses





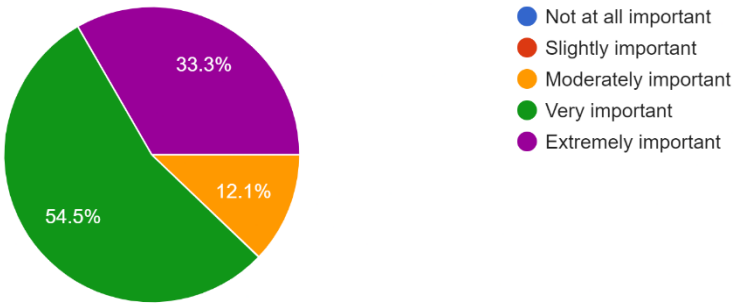


Section 4: Skills and competencies development

In your opinion/experience, how important are the following skills and competencies that students should develop?

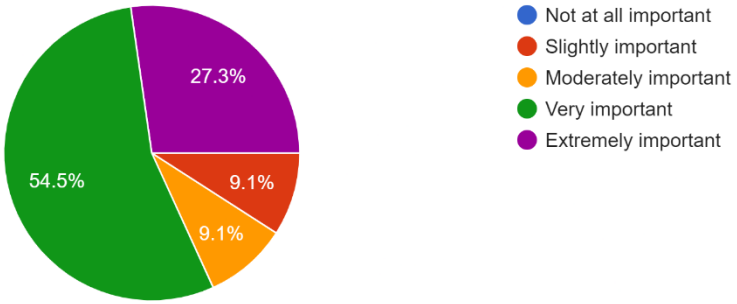
Green skills relevant to sustainable wood construction (e.g. reuse, recycling, and sustainable sourcing of materials).

33 responses



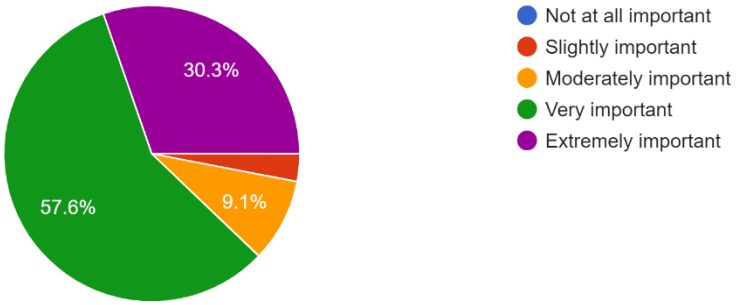
Digital skills relevant to sustainable wood construction (e.g. including technologies like 3D printing and automation).

33 responses



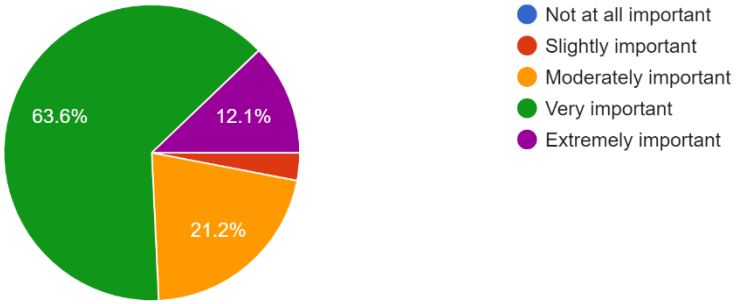
Lead sustainable wood construction projects, ensuring the integration of environmental considerations at every stage.

33 responses



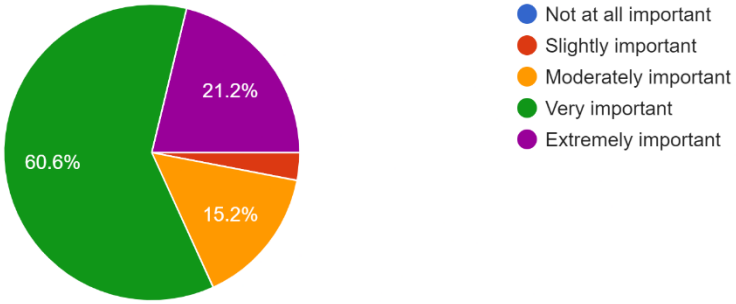
Evaluation and improvement of the environmental performance of wood-based construction, ensuring compliance with sustainability standards (e.g., FSC, PEFC).

33 responses



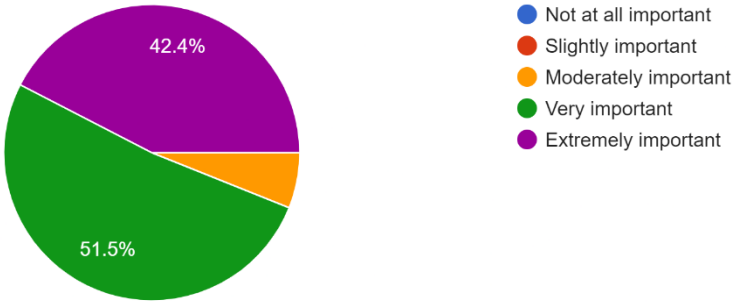
Applying critical thinking to issues related to circular wood construction.

33 responses



Applying circular economy principles in timber construction (e.g. reducing waste and increasing material efficiency).

33 responses



10.2 Annex 2 – Analysis of VET programs

10.2.1 VET programs in Germany

1. General information

Title: Vocational Training and Retraining as a Carpenter / Joiner		
Description: The program trains students in woodworking techniques, design, and production, with a focus on custom furniture and structures. It combines practical training with theoretical education.		
Duration: 3 years (dual system)	EQF/NQF Level:4	Country: Germany
Webpage: https://www.bs-holzfarbetextil.de/holz/berufsschule/tischler/unterricht/inhalte		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on material cycles, promoting sustainable practices in wood construction.

Alignment to Industry 4.0 technologies:

- Integrates modern tools like CNC machines and CAD software.

3. Competencies covered

List competencies covered by the program:

- Woodworking techniques and machinery use & CAD and CNC skills

The program focuses on the development of action competence across various dimensions:

- Professional competence: Ability to solve tasks using knowledge and skills.
- Human competence: Ability to reflect on personal development and life planning.
- Social competence: Ability to build and manage social relationships.
- Methods competence: Skills for planning and executing tasks.
- Communication competence: Communication skills for effective interactions.
- Learning competence: Ability to learn independently and continuously.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-based learning, workshops and theoretical lectures.

5. Evaluation criteria:

- Practical exams, written tests, and project evaluations.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Emphasis on responsible resource use and material recycling.

1. General information

Title: Wood mechanic		
Description: The program trains students to work with wood machinery and materials, focusing on production processes and the optimization of woodworking techniques.		
Duration: 3 years	EQF/NQF Level:4	Country: Germany
Webpage: https://www.bs-holzfarbetextil.de/holz/berufsschule/holzmechaniker/unterricht/inhalte		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- The program teaches the selection of appropriate wood types, considering not only technical properties but also aesthetic, economic, and ecological aspects, promoting sustainable material use.

Alignment to Industry 4.0 technologies:

- Integrates modern tools like CNC machines and CAD software to optimize design and production.

3. Competencies covered

List competencies covered by the program:

- Operating woodworking machinery, material processing, quality control, and troubleshooting in wood production processes.
- CAD and CNC skills
- The competencies covered in the "Vocational training to become a wood mechanic" program focus on the development of comprehensive action competence. This includes:
- Professional competence: Ability to solve tasks independently and methodically.
- Self-competence: Personal development, autonomy, responsibility, and critical thinking.
- Social competence: Collaboration and communication skills, understanding and resolving social dynamics.
- Methodological competence: Structured and goal-oriented problem-solving approaches.
- Communication and learning competence: Understanding and conveying ideas effectively, lifelong learning.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-based learning, hands-on workshops, and theoretical lectures.

5. Evaluation criteria:

- Practical exams, written tests, and project evaluations.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Focus on sustainable material use and efficient production methods.

1. General information

Title: Carpenter		
Description: This vocational training program teaches students the skills required to work as a carpenter, combining traditional craftsmanship with modern manufacturing techniques. It covers a wide range of activities, including design, construction, and installation of furniture, windows, doors, and interiors.		
Duration: 3 years (can be shortened in special cases)	EQF/NQF Level:4	Country: Germany
Webpage: https://www.bs-elmshorn.de/tischler.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- The training includes learning how to select appropriate wood types, considering ecological, economic, and aesthetic aspects, which aligns with sustainable practices in construction.

Alignment to Industry 4.0 technologies:

- The program offers additional training in CNC (Computer Numerical Control) skills.

3. Competencies covered

List competencies covered by the program:

- Professional Competence: Ability to design, construct, and install woodworking projects independently.
- Self-Competence: Development of personal and professional responsibility, critical thinking, and self-reliance.
- Social Competence: Effective communication and teamwork skills in professional environments.
- Methodological Competence: Goal-oriented problem-solving, project planning, and execution.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- The teaching includes lectures, project-based learning, and practical workshops.

5. Evaluation criteria:

- The training is assessed through exams, practical projects, and the final "Gesellenprüfung" (journeyman examination).

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- The program emphasizes sustainable material usage, efficient production techniques, and the ecological impact of woodworking, aligning with circular economy principles.

1. General information

Title: Wood Mechanic		
Description: in the field of furniture and interior construction work on mass production of tables, seating furniture, shelving systems, and store fittings. They also create custom pieces using wood-based materials, plastics, and metal parts. The work is performed with automated and computer-controlled machinery.		
Duration: 3 years	EQF/NQF Level:4	Country: Germany
Webpage: https://www.philipp-holzmann-schule.de/holzmechaniker-in.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- No information provided.

Alignment to Industry 4.0 technologies:

- The training involves working with automated and computer-controlled machinery for manufacturing processes.

3. Competencies covered

List competencies covered by the program:

- Proficiency in producing furniture, seating, shelving systems, and shop fittings in series production or custom items.
- Skilled use of wood, plastics, and metal materials, with automated and computer-controlled machinery.
- Precision in measurement and woodworking, with a strong foundation in mathematics, physics, chemistry, and technical drawing.
- Expertise in manufacturing techniques, machinery, and system technology, including handling production tasks and customer orders.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Practical training, while the theory is covered in the vocational school.

5. Evaluation criteria:

Intermediate Exam: At the end of the second year.

- Final Exam: The final Exam consists of a practical test, including a customer order, followed by a discussion, and a theoretical exam covering manufacturing techniques, machinery, and economics.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- No information provided.

1. General information

Title: State-certified Wood Technician		
Description: Wood technicians assist with planning and managing tasks in wood processing, focusing on areas like interior design, furniture manufacturing, and construction of prefabricated homes. They work in customer service, design, project planning, production control, quality assurance, and business management.		
Duration: 22 months	EQF/NQF Level:4	Country: Germany
Webpage: https://www.philipp-holzmann-schule.de/zweijaehrige-fachschule.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Involved in sustainable wood processing and construction techniques.

Alignment to Industry 4.0 technologies:

- Utilization of advanced machinery and digital tools in production planning.

3. Competencies covered

List competencies covered by the program:

- Wood processing and production planning
- Quality management
- Customer relationship management
- Project management and preparation
- Business and organizational management in the wood sector
- Knowledge of woodworking machinery and technology
- Industry-specific technical expertise in materials and design

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Primarily project-based learning. Lectures and practical exercises in wood technology and management.

5. Evaluation criteria:

- Written and oral exams covering practical and theoretical knowledge.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Deep understanding of sustainable materials and resource management.
- Ability to work with sustainable practices in construction and manufacturing, promoting circular economy principles.

1. General information

Title: Specialist Engineer in Timber Construction		
Description: Focus on ecological practices in timber construction, including energy efficiency and resource conservation.		
Duration: 2 Semesters	EQF/NQF Level: Continuing education, part-time	Country: Germany
Webpage: https://www.tha.de/Architektur-und-Bauwesen/ibi/Fachingenieur-Holzbau.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on “material cycles”, promoting sustainable practices in wood construction.

Alignment to Industry 4.0 technologies:

- No information provided.

3. Competencies covered

List competencies covered by the program:

- Structural design and construction
- Fire and sound protection
- Sustainable building practices
- Project coordination and planning processes
- and more

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Weekend seminars, block weeks, excursions, and interactive project-based learning.

5. Evaluation criteria:

- Exams and continuous assessments.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Ability to implement sustainable building practices and develop detailed construction solutions with an integrated, interdisciplinary approach.

1. General information

Title: Bachelor degree in Wood Engineering		
Description. The program focuses on sustainable and structural design in timber construction.		
Duration: 7 Semesters	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.fh-aachen.de/studium/studiengaenge/holzingenieurwesen-beng		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Includes sustainable timber construction, resource efficiency, and energy-efficient building.

Alignment to Industry 4.0 technologies:

- CAD

3. Competencies covered

List competencies covered by the program:

- Structural engineering, construction methods, CAD, materials science, business law, project management, innovative timber solutions and more.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Lectures and lab exercises, with a 10-week practical project followed by a final Bachelor's thesis.

5. Evaluation criteria:

- Exams, projects, and thesis presentations, with the option for oral re-exams if written attempts are insufficient.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Graduates can design sustainable timber structures, focusing on resource efficiency.

1. General information

Title: Bachelor of Engineering in Timber Construction and Interior Construction		
Description. The program focuses on engineering and design in timber construction, combining theoretical knowledge and practical application. Students gain expertise in construction, materials science, and industry technologies.		
Duration: 7 Semesters	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.th-rosenheim.de/studium-und-weiterbildung/studienangebot-der-th-rosenheim/bachelorstudiengaenge/holzbau-und-ausbau/holzbau-und-ausbau#c5955		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- The program integrates sustainable building technologies, focusing on eco-friendly materials like timber and sustainable construction practices, supporting circular economy principles.

Alignment to Industry 4.0 technologies:

- CAD/CAM and automation

3. Competencies covered

List competencies covered by the program:

- Construction and planning in timber buildings.
- Structural analysis and material science
- Sustainable building technologies
- Business management in the construction industry
- and more.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-based learning, practical workshops, and theoretical lectures.

5. Evaluation criteria:

- Written exams, practical assignments, project work, and a bachelor thesis

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Graduates will be prepared to lead sustainable, circular timber construction projects, using modern technologies.

1. General information

Title: Training Program: Wood and Building Preservation Specialist		
Description: This program prepares trainees for careers in building and wood preservation, including inspection, damage assessment, and preventative measures against fungi, insects, and moisture.		
Duration: 2 years	EQF/NQF Level: 4	Country: Germany
Webpage: https://www.hwk-reutlingen.de/ausbildung/ausbildungsberufe-a-z/bau-und-ausbaugewerbe/fachkraft-fuer-holz-und-bautenschutzarbeiten-mwd.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on damage prevention and environmental protection, including proper handling of hazardous materials.

Alignment to Industry 4.0 technologies:

- No information provided.

3. Competencies covered

List competencies covered by the program:

- Damage identification and treatment
- Wood preservation and moisture protection
- Use of tools and measurement devices
- Collaboration with architects and stakeholders.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-Based Learning, Practical Training, and Fieldwork.

5. Evaluation criteria:

- Exams, a mid-term and final exam.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Graduates will effectively assess, prevent, and remediate damage, ensuring long-term building protection and sustainability.

1. General information

Title: Dual Study Program: Wood Construction Engineering and Carpentry		
Description: This dual program combines a Bachelor's in Civil Engineering with an apprenticeship as a Carpenter, offered in partnership with the Technical University of Rosenheim. It covers both theoretical and practical aspects of timber construction and building preservation.		
Duration: 4.5 years	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.regnauer.de/karriere/ausbildung/ausbildung-verbundstudium.php		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on eco-friendly timber construction and sustainable building practices.

Alignment to Industry 4.0 technologies:
Training includes the latest industrial machinery and digital planning tools.

3. Competencies covered

List competencies covered by the program:

- Structural engineering fundamentals.
- Timber construction and preservation techniques.
- Use of modern industrial machinery.
- Project management and teamwork skills.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Lectures, project-based learning, on-site training, and apprenticeship.

5. Evaluation criteria:

Theoretical courses, practical assessments and Bachelor thesis.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- No information provided.

1. General information

Title: Dual Study Program with Intensive Practical Training in Construction		
Description: This program combines practical training at Regnauer and academic studies at the Technical University of Rosenheim. It offers degrees in Architecture, Civil Engineering, or Energy and Building Technology, adjusted to individual preferences.		
Duration: 4- 5 years	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.regnauer.de/karriere/ausbildung/ausbildung-studium-vertiefte-praxis.php		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on eco-friendly building design and energy-efficient solutions in wood construction.

Alignment to Industry 4.0 technologies:

- Training includes modern construction technique and digital planning tools.

3. Competencies covered

List competencies covered by the program:

- Project management.
- Architectural and engineering design.
- Sustainable construction techniques.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Lectures, project-based learning, practical training phases.

5. Evaluation criteria:

- Theoretical courses, practical assessments and Bachelor thesis.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- No information provided.

1. General information

Title: Certificate of Advanced Studies (CAS) in Timber Construction		
Description: The CAS program offers specialized knowledge in wood construction, covering material properties, construction processes, and project management. It combines theoretical learning with real-world applications.		
Duration: 1 year	EQF/NQF Level: 5/6	Country: Germany
Webpage: https://www.bfh.ch/ahb/de/weiterbildung/cas/bauen-holz/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on sustainable wood construction, regional material sourcing, and circular economy principles.

Alignment to Industry 4.0 technologies:

- Integration of prefabrication techniques and the Timber Structures 3.0 (TS3) technology for innovative wood joining.

3. Competencies covered

List competencies covered by the program:

- Wood construction techniques
- Project management
- Cost estimation and quality assurance
- Interdisciplinary teamwork.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Lectures, workshops, case studies and group projects.

5. Evaluation criteria:

- Written exams, project work, group presentations and practical assessment.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Ability to apply sustainable design principles. Proficiency in advanced wood construction techniques, including TS3 applications.

1. General information

Title: Minor in Circular and Sustainable Building / Minor in Digital Construction		
Description: Offers specialized qualifications within Bachelor's programs in architecture, wood engineering, or civil engineering, focusing on circular economy, sustainable construction, and digital building processes.		
Duration: 2 Semesters	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.bfh.ch/ahb/de/themen/minor/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on lifecycle analysis, reuse of materials, biobased construction, and recycling/upcycling approaches.

Alignment to Industry 4.0 technologies:

- Focus on Building Information Modeling (BIM), digital project management, data science, and simulation for enhanced efficiency and collaboration in the construction process.

3. Competencies covered

List competencies covered by the program:

- Mastery of BIM and digital tools.
- Knowledge in sustainable material usage.
- Ability to optimize construction processes through digitalization.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-based learning, case studies, group projects, interdisciplinary collaboration.

5. Evaluation criteria:

- Completion of projects, participation, case study presentations, and a final assessment.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Proficiency in implementing circular construction methods.
- Capability to manage projects using BIM and data-driven tools.
- Skills to guide sustainable and digital construction projects effectively.

1. General information

Title: Diploma in Wood Technology		
Description: A comprehensive program in wood technology focusing on structural wood construction, interior design, and wood industry/commerce.		
Duration: 3 years	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.bfh.ch/ahb/de/studium/hf-holz/holztechnik-hf/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on efficient use of wood, sustainable material sourcing, and innovative recycling/upcycling practices in construction and production.

Alignment to Industry 4.0 technologies:

- CNC machines, robotics, and digital production planning.

3. Competencies covered

List competencies covered by the program:

- Project management.
- Expertise in wood construction and materials.
- Business management and leadership skills.
- Digital and technical skills for modern production method.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Project-based learning, workshops, praxissemster, and applied projects.

5. Evaluation criteria:

- Semester projects, exams, practical assessments, workshops and Diploma.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Proficiency in sustainable wood practices.
- Competence in integrating Industry 4.0 tools for optimized production.
- Ability to lead projects and apply circular economy principles.

1. General information

Title: TUM.wood – Building with Wood Certificate Program		
Description: specialized program offering cutting-edge knowledge in ecological, economic, technical, and architectural aspects of modern wood construction. It equips participants with practical expertise to understand and implement sustainable wood building techniques, focusing on planning, eco-balance, and circular economy.		
Duration: 1 month	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.lll.tum.de/zertifikatsprogramme/tum-wood-mit-holz-bauen/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Focus on ecological aspects, eco-balance, and the integration of circular economy principles in wood construction.

Alignment to Industry 4.0 technologies:

- No information provided.

3. Competencies covered

List competencies covered by the program:

- Architectural and regulatory knowledge in wood construction.
- Expertise in planning and executing wood building projects.
- Understanding of wood-specific planning processes, eco-balance, and circular economy applications.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Modular program with a mix of web-based learning, project-based work, and field trips

5. Evaluation criteria:

- Completion of assigned tasks, exams, and practical projects.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Deep understanding of sustainable wood construction, eco-balance, and circular economy practices in the building sector.

1. General information

Title: Bachelor's Program in Civil Engineering		
Description: The program covers all aspects of civil engineering, from constructing buildings to environmental engineering, including material sciences, structural mechanics, and environmental technology. Focus is placed on ecological and economic challenges.		
Duration: 6 semesters	EQF/NQF Level: 6	Country: Germany
Webpage: https://www.cee.ed.tum.de/hbb/lehre/bauingenieurwesen-bsc-msc/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Environmental technology, material behavior, and sustainable construction practices.

Alignment to Industry 4.0 technologies:

- No information provided.

3. Competencies covered

List competencies covered by the program:

- Structural design and calculation, environmental technology, materials science, construction management, water and traffic infrastructure.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Lectures, integrated exercises, project-based learning.

5. Evaluation criteria:

- Module-based credits, project work, written exams.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Competence in developing and evaluating construction solutions. Understanding of sustainable building principles and eco-balance

10.2.2 VET programs in Poland

1. General information

Title: Wood technology
Description: A 3.5-year program of study for an engineering degree. Students have the rare opportunity to shape their study path according to their individual, professional or scientific interests by choosing one of two specializations: management and engineering of wood materials; conservation of historic wood.

Duration: 7 semesters (3.5 years)	EQF/NQF Level: 6th	Country: Poland
Webpage: https://sggw.edu.pl		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Forest propaedeutics
- Fundamentals of biodegradation of wood materials
- Environmental protection
- Protection and preservation of wood
- Refining of wood and wood materials
- Wood defects

Alignment to Industry 4.0 technologies:

- Engineering graphics in CAD systems
- Information technologies
- Mechanical engineering
- Ergonomics
- Fundamentals of electronics with elements of electrical engineering
- Automation
- Use of carpentry power tools
- CAD design
- Machine tools
- Fundamentals of wood plastic technology
- Wood construction
- Hydrothermal modification of wood
- Production optimization

3. Competencies covered

List competencies covered by the program:

- Specialization in wood processing and utilization of wood and wood-based materials.
- Knowledge of techniques, tools and technologies which enable optimization of wood production.
- Capability to evaluate and analyse existing technological solutions regarding wood production.
- Ability to conduct simple experiments in the wood industry.
- Good knowledge of practical usage of dedicated IT tools in wood production.
- Capability to select proper tools and methods to solve technical problems and ability to collect, evaluate, present and analyse relevant data.
- Basic knowledge in economics, law and ethics necessary for individual entrepreneurship.

4. Teaching methodology

Lectures, Auditory exercises, Laboratory exercises, Project based learning, Experimental learning, Apprenticeships, Problem-solving, learning by doing, Discussions.

5. Evaluation criteria:

Written Exams, Projects, Engineering Thesis, Apprenticeships, Essays, Oral Exams.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Understanding the complicated relations between human activities and forest environments, especially in terms of issues at the intersection of wood processing and forestry.
- Awareness of threats that human activities pose to environment and the importance of legal protection of the environment, especially regarding protection of forests in Poland.
- Understanding the multilayered connections between biodegradation processes and wood.
- Knowledge of tools, technologies and techniques to preserve wood from biodegradation processes.
- Ability to reduce biological cost of wood production to reduce ecological footprint.
- Awareness of pollution types typical in wood processing, their sources and methods for their recognition, minimization and disposal.
- Knowledge of natural environment protection, typical environmental pollutants and methods to reduce and manage them effectively.
- Ability to identify defects in raw wood and assess their impact on sustainable and rational wood use in the industry.
- Familiarity with analytical methods for evaluating chemical contaminants typical of wood materials.
- Knowledge of environmental protection legislation, regulations and legal requirements in terms of wood industry as well as awareness of the environmental organizations.
- Ability to use air, water, and soil quality assessment methods to recognize associated pollutants.
- Ability to independently design wood preservation methods and select appropriate materials for protection.
- Knowledge of preventive measures for wood protection against damaging factors.
- Ability to implement strategies to combat biological corrosion in wood and wood-based products.
- Familiarity with the specific needs for protecting and conserving historical wood, including applications in production processes and finished products.
- Ability to locate, understand, analyse and creatively use information from various sources in wood protection and conservation contexts.
- Knowledge on quality control optimization principles in the furniture and wood industries, including statistical and visual methods for assessing product quality through lean manufacturing techniques. This includes knowledge of basic quality management methods (FMEA, FTA, Ishikawa diagrams, Pareto method), statistical quality assessment methods, principles for determining product quality, as well as basic lean manufacturing methods and Six Sigma.

1. General information

<table>
<tr><td colspan="3">Title: Furniture industry</td></tr>
<tr><td colspan="3">Description: A 3.5-year program of study for an engineering degree. This program prepares students for careers in the rapidly evolving furniture industry and related fields, such as interior design, as well as in enterprises or companies that collaborate with the furniture sector.</td></tr>
<tr><td>Duration: 7 semesters (3.5 years)</td><td>EQF/NQF Level: 6th</td><td>Country: Poland</td></tr>
<tr><td colspan="3">Webpage: https://sggw.edu.pl</td></tr>
</table>

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Biodegradation of wood and non-wood materials
- Environmental protection in furniture making
- Biological testing in the furniture industry
- Mechanics of material deterioration
- Durability of materials
- Fundamentals of furniture design in the idea of upcycling
- ISO standardization in quality management
- Raw materials and technologies of the future
- Protection of wood materials in the furniture

Alignment to Industry 4.0 technologies:

- Computer automation of technological processes in furniture manufacturing
- Engineering graphics in CAD systems
- Fundamentals of design in CAD systems
- CAM systems in furniture manufacturing
- CAD systems in furniture manufacturing
- Information technologies
- Mechanical engineering
- Fundamentals of electronics with elements of electrical engineering
- Ergonomics in furniture making
- Automatics in furniture making
- Hydrothermal and plastic woodworking
- Cutting machining and tools
- Structures and technologies of box furniture
- Machine tools used in furniture making
- Operation of machine tools and tools in furniture manufacturing
- Technical preparation of production in furniture making
- Fundamentals of wood plastics technology
- Furniture design in CAD systems
- CNC machine tool programming
- Design of technological processes in furniture manufacturing
- Basic carpentry machine tools
- Design thinking and innovation management
- Management Systems. Lean Manufacturing
- Production and Transportation Machines
- Mechanical Engineering
- CAD in Practice
- Power tools for woodworking
- Dust collection system for wood industry
- APS systems
- Reverse engineering
- Innovative technology systems in the furniture industry

3. Competencies covered

List competencies covered by the program:

- Specialization in furniture industry and interior design.
- Ability to apply techniques and technologies that optimize furniture production and conduct preliminary economic evaluations of proposed solutions.
- Good knowledge of CAD/CAM tools and software used in the design and creation of furniture products.
- Understanding of both wood and non-wood materials used in furniture manufacturing, with skills to process and combine these materials to create functional and aesthetically pleasing products.
- Basic knowledge in economics, law and ethics in terms of furniture industry.
- Good organizational and managerial skills, enabling effective furniture production management and work coordination.

4. Teaching methodology

Lectures, Auditory exercises, Laboratory exercises, Project based learning, Experimental learning, Apprenticeships, Problem-solving, learning by doing, Discussions.

5. Evaluation criteria:

Written Exams, Projects, Engineering Thesis, Apprenticeships, Essays, Oral Exams.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Understanding the importance and complexity of sustainable forest development and ability to balance it with the needs of industry.
- Understanding the multilayered connections between biodegradation processes and wood.
- Knowledge of tools, technologies and techniques to preserve wood from biodegradation processes.
- Ability to reduce biological cost of wood production to reduce ecological footprint.
- Knowledge of environmental protection legislation, regulations and legal requirements in terms of wood industry as well as awareness of the environmental organizations.
- Ability to use air, water, and soil quality assessment methods to recognize associated pollutants.
- Ability to organize laboratory biological tests for wood protection methods, plastics, and textiles used in furniture making as well as to conduct and interpret test results on biodegradation of used materials.
- Knowledge how to evaluate quality and usability of materials for furniture construction.
- Awareness of the principles of eco-design, sustainable development, sustainable production, circular economy, cascading wood utilization, life cycle analysis, the New European Bauhaus, green transformation, and ability to integrate this knowledge into technical abilities.
- Ability to integrate design with the technologies and materials used in production, assess the furniture life cycle and analyse the potential for recycling post-production and end-of-life materials.
- Understanding the importance of the post-production use and end-of-life materials in manufacturing processes.
- Advanced knowledge on standardized quality management systems, including ISO 9000/9001, ISO 13485, ISO 14000/14001, ISO 14971, ISO 17025, ISO 22000 and HACCP.
- Understanding of basic concepts related to systems approaches in quality management, environmental management, and occupational health and safety.
- Familiarity with the theoretical framework and industrial applications of ERP (Enterprise Resource Planning) and MRP (Material Resource Planning) systems in the furniture industry.

- Being familiarised with the potential of new technologies in the wood and furniture industries within the context of sustainable development, green chemistry, and circular economy.
- Ability to assess the environmental impact of technologies and having a sense of responsibility for professional activities in terms of environmental impact.

1. General information

Title: Furniture Designing		
Description: Furniture Design students acquire extensive knowledge in the fields of designing, construction and manufacturing furniture as well as interior fittings. They are familiarised with each stage of the design process, from ideation, modeling, prototyping, visualization techniques, construction documentation, strength calculations, structural documentation, production technology within digital management systems, through to the simulation of the manufacturing process and the actual production of furniture.		
Duration: 7 semesters (3.5 years)	EQF/NQF Level: 6th	Country: Poland
Webpage: https://skylark.up.poznan.pl		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Materials Science
- Wood Science
- Wood-Based Materials

Alignment to Industry 4.0 technologies:

- Information technologies
- CAD studio - Autodesk AutoCAD
- CAD studio - Autodesk Inventor
- Bionics
- Tools and machine tools
- Ergonomics
- Woodwork technologies
- Case furniture technologies
- Computer techniques in furniture design
- Computer-integrated management

3. Competencies covered

List competencies covered by the program:

- Comprehensive knowledge in furniture and interior design.
- Familiarity with all stages of production process as well as production process management methods, including concept development, prototyping, modeling, visualization techniques, construction documentation, structural calculations and production technology within digital management systems, leading to the simulation of manufacturing processes and full-scale realization of furniture.
- Awareness of contemporary and historical styles and trends in furniture design and production.

- Awareness of the newest technologies and production methods along with the ability to transfer this technical and technological knowledge into real design applications.
- Ability to skilfully select optimal construction and technological solutions to achieve targeted outcomes.
- Necessary knowledge to make independent design and organizational decisions that contribute to achieving functional, ergonomic, structural, technological, and production goals.
- Ability to adapt to changing market demands and advances in techniques and technologies in the fields of furniture design, carpentry, and interior fittings.

4. Teaching methodology

Lectures, Auditory exercises, Laboratory exercises, Project based learning, Experimental learning, Apprenticeships, Problem-solving, learning by doing, Discussions.

5. Evaluation criteria:

Written Exams, Projects, Engineering Thesis, Apprenticeships, Essays, Oral Exams.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Knowledge of legal frameworks protecting different plants and animals.
- Awareness of current environmental issues and multilayered consequences of climate changes.
- Proactive approach of social responsibility for environment protection.
- Advanced knowledge in in assessing the quality and functional value of various materials, with a strong ability to evaluate wood materials and recognize certification standards.
- Ability to select materials based on technical, ecological and economic criteria, with a focus on sustainability.
- Proficiency in sustainable design principles, including knowledge of eco-friendly solutions for applying coatings that reduce resource, water and energy usage.

1. General information

Title: Wood Technology		
Description: Students enrolled in wood technology study programme are able to tailor their educational path according to their personal interests, they can choose modules focused on either mechanical wood technology (including furniture design) or chemical wood technology.		
Duration: 7 semesters (3.5 years)	EQF/NQF Level: 6th	Country: Poland
Webpage: https://skylark.up.poznan.pl		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Wood science
- Wood plastics
- Environmental protection
- Secondary wood processing

- Bioplastics
- Wood protection and conservation
- Protection of wood and wood-based materials
- Water and waste management in the wood industry
- Active natural substances
- Biomass processing

Alignment to Industry 4.0 technologies:

- Information systems engineering
- Electrical and electronic engineering
- Fundamentals of mechanical engineering
- Fundamentals of CAD
- Automation
- Basic tooling and machine tools
- CAD of wood products
- Multi-operation machine tools
- Manufacturing equipment
- Structures and technologies of woodwork products
- Transportation
- Information technologies
- CAD studio - Autodesk AutoCAD
- CAD studio - Autodesk Inventor
- Bionics
- Tools and machine tools
- Ergonomics
- Woodwork technologies
- Computer techniques in furniture design
- Computer-integrated management

3. Competencies covered

List competencies covered by the program:

- Proficient knowledge in the areas of wood science; mechanical processing of wood and wood-based materials; chemical processing of wood raw materials; design and technology of wooden furniture and wood products;
- Advanced skills in: operation of machinery, tools, and transport equipment; diagnostic and measuring equipment, design systems for wood and wood-based material processing.
- Ability to: participate in the design and implementation of technological processes for the mechanical processing of wood and wood-based materials; engage in chemical processing of wood raw materials as well as furniture and wood product design and technology; carry out tasks supporting the design of wood and wood-based material processing machines; supervise the operation of machinery; and select engineering materials used for tools in wood and wood-based material processing.

4. Teaching methodology

Lectures, Auditory exercises, Laboratory exercises, Project based learning, Experimental learning, Apprenticeships, Problem-solving, learning by doing, Discussions.

5. Evaluation criteria:

Exams, Projects, Engineering Thesis, Apprenticeships, Essays.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Good knowledge of the natural environment and industrial threats, with a special focus on the wood industry and methods for rational environment protection and conservation of natural resources.
- Familiarity with the principles of sustainable development and the key legal and regulatory frameworks related to ecology and environmental protection.
- Proficiency in terminology related to environmental science and ecology, supporting clear and accurate communication on topics concerning the natural environment.
- Proactive approach of social responsibility for environment protection.
- Awareness of current environmental issues and multilayered consequences of climate changes.
- Knowledge of legal framework in Poland regarding wood waste utilization and methods of reduction/recycling of wood-waste in the industry.
- Familiarity with bioplastics, biomaterials, bioplastics and nanomaterials, and their application in sustainable industries.
- Understanding of wood and wood-based material preservation techniques.

1. General information

Title: Furniture Engineering		
Description: Furniture Engineering equips students with key competencies in planning, preparing and maintaining furniture production systems. Students have an opportunity to gain knowledge in such fields as furniture manufacturing techniques, wood material properties, computer-aided furniture design, design principles, logistics, and production management with a special focus on environmental considerations.		
Duration: 7 semesters (3.5 years)	EQF/NQF Level: 6th	Country: Poland
Webpage: https://pb.edu.pl		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Materials Science
- Wood science
- Wood-based materials
- Wood protection
- Ecology and waste management in the furniture industry

Alignment to Industry 4.0 technologies:

- Ergonomics of furniture
- Fundamentals of mechanics
- Information technology

- Fundamentals of design notation in CAD environment
- Computer aided design of furniture
- Computers and manufacturing equipment in the furniture industry
- Methods of computer data analysis
- Modern manufacturing techniques in furniture making
- Innovation in furniture making
- Automation and robotization in furniture engineering
- Computerized systems to support business management

3. Competencies covered

List competencies covered by the program:

- Knowledge and skills in planning, preparing and maintaining furniture production systems.
- Ability to design furniture using computer-aided design (CAD) methods.
- Understanding the logistics processes within furniture companies.
- Capability to manage furniture production with consideration for its environmental impact, aligning production practices with sustainability principles.
- Understanding of both wood and non-wood materials used in furniture manufacturing, with skills to process and combine these materials to create functional and visually-appealing products.

4. Teaching methodology

Lectures, Auditory exercises, Laboratory exercises, Project based learning, Experimental learning, Apprenticeships, Problem-solving, learning by doing, Discussions.

5. Evaluation criteria:

Exams, Projects, Engineering Thesis, Apprenticeships, Essays.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Understanding of product life cycle, from design to disposal.
- Expertise in tools, materials, technological/technical systems for furniture engineering.
- Awareness of the significance of sustainable furniture production for natural environment.
- Proficiency in identifying and analyzing phenomena, with the ability to make decisions and take actions using appropriate methods, techniques, technologies, tools and materials which influence design, production, product quality, human health and the condition of natural resources and the environment.
- A strong sense of responsibility for producing high-quality furniture with minimal environmental impact, and an understanding of the social, ethical, and non-technical implications and consequences of engineering activities.

1. General information

Title: Carpentry
Description: After this programme, student is qualified to produce various types of furniture, building joinery and small wooden items with the use of manual woodworking tools and woodworking machines. Students are equipped with knowledge necessary to work efficiently with different types of wood and wood-like materials.

Duration: 6 semesters (3 years)	EQF/NQF Level: 3	Country: Poland
Webpage: https://www.gce.gliwice.pl/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Introduction to machine design

Alignment to Industry 4.0 technologies:

- Introduction to machine design
- Technologies used for repairing machine parts, devices and tools
- Manufacturing of machine parts, devices, and tools
- Assembly, repair and maintenance of machine parts, devices and tools

3. Competencies covered

List competencies covered by the program:

- MEC. 08 – Manufacturing and repair of machine parts, devices, and tools, using manual and machine processing methods.
- Ability to prepare technical documentation.
- Capability to calculate manufacturing costs.
- Proficiency in selecting appropriate means and methods for transporting and storing materials.
- Knowledge of new manufacturing technologies, new tools and methods for operating machines and equipment.
- Proficiency in a foreign language and the ability to use foreign-language information sources.
- Knowledge of and ability to comply with health and safety regulations, fire protection, environmental protection, and ergonomic requirements.
- Ability to provide first aid in case of emergency.

4. Teaching methodology

Mini-lecture, presentation, demonstration with instructions, exercises, observations, didactic discussion, guided text method, project method.

5. Evaluation criteria:

Exercises, research, practical tasks, projects, oral response, written response, vocational exam, professional internship, observation of student's work and behaviour.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Performing professional tasks (cutting, sawing, drilling, threading, riveting, bending, straightening of elements, etc.) in accordance with environmental protection regulations.
- Knowledge of these regulations and the ability to interpret them in the context of environmental protection.
- Ability to identify and point out institutions dealing with environmental protection in Poland and the tasks they perform.

- Proper selection of methods for protecting wood against corrosion and other damage, which affects its durability, as well as choosing operational methods to minimize the risk of damage.
- Knowledge of the durability of specific materials.

10.2.3 VET programs in Spain

1. General information

Title: Higher Technician in Building Projects		
Description: The general competence of this qualification consists of preparing the technical documentation for building projects, carrying out site layout (staking out) work, and managing the document control for their execution, while complying with current regulations and the established conditions of quality, safety, and environmental standards.		
Duration: 2000 hours / 2 years	EQF/NQF Level: 5	Country: Spain
Webpage: https://www.todofp.es/que-estudiar/familias-profesionales/edificacion-obra-civil/proyectos-edificacion.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Identify the typology of structural elements made of reinforced concrete, steel, wood, and masonry, and their fundamental characteristics.
- Proposes construction solutions for building structures, relating their typology to the properties of the material used and its on-site implementation process, including wood.
- Dimensions simple structural elements and systems made of reinforced concrete, steel, wood, or masonry, applying regulations and using calculation procedures.
- Includes wood as a structural material. Typology, properties, and protection.
- The subject Construction Planning includes the development of plans regarding safety and the environment protection.

Alignment to Industry 4.0 technologies:

- The subject Building Project includes the identification of potential new production or service technologies
- Among its objectives, it stands out to analyse and utilize learning resources and opportunities related to the scientific, technological, and organizational evolution of the sector and information and communication technologies

3. Competencies covered

List competencies covered by the program:

- Intervene in the development of building projects by obtaining and analyzing the necessary information and proposing different solutions.
- Intervene in the preparation of written documentation for building projects by creating reports, specifications, measurements, budgets, and other required studies using computer applications.

- Prepare graphic documentation for building projects by representing the necessary plans to define them, using computer-aided design software.
- Pre-dimension and, if necessary, dimension the elements of plumbing, sanitation, air conditioning, ventilation, electricity, telecommunications, and special installations in buildings, following the instructions of the responsible technical manager, applying established calculation procedures, and interpreting the results.
- Pre-dimension elements of building structures and, if necessary, assist in their definition, working with computer applications under the instructions of the responsible technical manager.
- Create 2D and 3D models, plans, and presentations to facilitate the visualization and understanding of building projects.
- Manage the documentation of building projects and works, reproducing and organizing it according to established quality criteria.
- Request and compare offers, obtaining information for suppliers, contractors, or subcontractors, evaluating and standardizing the received ones.
- Evaluate projects and works by generating budgets based on information from sections and items and/or received offers.
- Create plans/programs, performing basic performance calculations to control the drafting phase of the project, the contracting process, and the execution phase of building works.
- Adapt the plan/program and costs to the actual progress of the work, based on periodic monitoring or arising needs from changes or unforeseen events.
- Create work certifications, adjusting valued reports to approved measurements for issuance and billing.
- Intervene in the energy qualification of buildings under design or already built, collaborating in the certification process using approved tools and software programs.
- Create safety and health plans, as well as construction and demolition waste management plans, using project documentation and ensuring compliance with regulations.
- Obtain required permits by completing the necessary administrative procedures related to the project and/or execution of building works.
- Carry out the layout of points, alignments, and elevations, properly stationing and operating with topographic measuring instruments and tools.
- Adapt to new work situations, keeping up-to-date with scientific, technical, and technological knowledge relevant to their professional environment, managing their training and using existing resources for lifelong learning, and employing information and communication technologies.
- Solve situations, problems, or contingencies with initiative and autonomy within their area of competence, showing creativity, innovation, and a spirit of improvement in personal work and team performance.
- Organize and coordinate work teams, supervising their development responsibly, maintaining smooth relationships, taking on leadership, and offering solutions to group conflicts that arise.
- Communicate effectively with peers, superiors, clients, and subordinates, using effective communication channels, transmitting the appropriate information or knowledge, while respecting the autonomy and competence of those involved in their work.
- Create safe environments in the development of their work and their team's work by supervising and applying occupational and environmental risk prevention procedures according to regulations and company objectives.

- Supervise and apply quality management, universal accessibility, and "design for all" procedures in professional activities included in production or service provision processes.
- Perform basic management for creating and operating a small business and show initiative in their professional activity with a sense of social responsibility.
- Exercise their rights and fulfill the obligations arising from their professional activity, in accordance with current legislation, actively participating in economic, social, and cultural life.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Blended learning combining theory classes and practical work.
- Classroom-based: Workshops and site visits to reinforce practical experience.

5. Evaluation criteria:

Module exams: final exam and practical works in the different subjects

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Verifies the characteristics of the building envelope and the performance of its installations, comparing them with the established bioclimatic parameters and the defined 'sustainable' behavior.

1. General information

Title: Technician in Interior Works, Decoration, and Rehabilitation		
Description: The general competence of this qualification consists of organizing and executing construction finishes in new builds, renovations, and rehabilitations, carrying out flooring, partitions, and ceilings through the installation of panels or prefabricated pieces, the placement of plates or sheets, the application of continuous coatings, and the painting of surfaces, all while meeting the established conditions and deadlines, as well as the quality, safety, and environmental regulations.		
Duration: 2000 hours / 2 years	EQF/NQF Level:	Country: Spain
Webpage: https://www.todofp.es/que-estudiar/familias-profesionales/edificacion-obra-civil/obras-interior-decoracion-rehabilitacion.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Identification of the main materials used in construction, including wood.
- Applies enamels and varnishes on surfaces and construction elements.
- Analyze the environmental and occupational risks associated with the professional activity.

Alignment to Industry 4.0 technologies:

- Adapt to new work situations arising from technological and organizational changes in production processes, updating knowledge, using existing resources for lifelong learning, and information and communication technologies.
- Information and communication technologies (ICT) will be incorporated into all phases of the construction processes, including execution.

3. Competencies covered

List competencies covered by the program:

- Carry out partitions and dry lining by assembling prefabricated panels, checking their position, fixation, flatness, and final finish.
- Install suspended ceilings with prefabricated pieces, laying out and assembling support elements, ties, profiles, and panels.
- Install technical floors and partitions, laying out the position of elements and assembling supports, profiles, flooring pieces, and service access panels.
- Carry out finishing works on construction coatings with pastes and mortars, performing plastering, skimming, rendering, and coating tasks.
- Apply surface coatings on vertical and horizontal elements with lightweight materials (such as paper, textiles, wood, plastic, and metal, among others), preparing supports, fixing sheets and/or pieces, and solving joints and seams.
- Apply finishes with paints, enamels, and varnishes on construction elements, preparing supports, mixing materials, and applying specified layers using both manual and mechanical methods.
- Apply coatings on horizontal and vertical surfaces by laying rigid flooring pieces, cladding, and tiling, ensuring flatness and correct joint positioning.
- Organize the execution of interior work, decoration, and rehabilitation tasks, planning activities, allocating and adapting materials, human resources, tools, and equipment.
- Budget interior work, decoration, and rehabilitation tasks by measuring and evaluating work units.
- Interpret construction blueprints, identifying their elements and obtaining dimensions.
- Analyse and adopt quality, occupational risk prevention, and environmental procedures, specifying the necessary actions to comply with regulations.
- Adapt to new work situations caused by technological and organizational changes in production processes, updating knowledge, using existing resources for lifelong learning, and information and communication technologies.
- Act responsibly and autonomously within their area of competence, organizing and developing assigned tasks, cooperating or working as part of a team with other professionals in the workplace.
- Responsibly resolve issues related to their activity, identifying the causes within their area of competence and autonomy.
- Communicate effectively, respecting the autonomy and competence of the different individuals involved in the work environment.
- Apply workplace safety protocols and environmental protection measures during the production process to prevent harm to people and the work and environmental setting.
- Apply quality procedures, universal accessibility standards, and “design for all” principles in professional activities within production or service provision processes.
- Perform basic management tasks for the creation and operation of a small business and show initiative in their professional activity.

- Exercise their rights and fulfil the obligations arising from their professional activity, in accordance with current legislation, actively participating in the economic, social, and cultural life.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Blended learning combining theory classes and practical work.
- Classroom-based: Workshops and site visits to reinforce practical experience.

5. Evaluation criteria:

Module exams: final exam and practical works in the different subjects

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Applies ethical and work habits in the development of their professional activity, according to the characteristics of the job position and the procedures established by the company.

1. General information

Title: Timber Structures, Construction and Design		
Description: The aim of this master's degree is to train highly qualified technicians who can respond to the growing demand; from knowledge of the characteristics of the material to the design and execution of new structures, as well as intervention in existing structures. This master's degree is positioned in an emerging market where wood, as a self-regenerating material, is key, and its promotion in sustainable construction is considered crucial.		
Duration: 15 months	EQF/NQF Level: 7	Country: Spain
Webpage: https://www.ehu.eus/es/web/graduondokoak/master-estructuras-construccion-diseno-madera		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- The master's degree promotes the use of wood as a self-regenerating and key material in sustainable construction.
- Aligned with the Basque Government's commitment to the promotion of wood, a local and sustainable resource.
- It includes the design and execution of new structures and intervention in existing structures, aiming towards a more sustainable future in architecture.
- It promotes construction systems that combine traditional and new technologies for a more environmentally responsible construction.

Alignment to Industry 4.0 technologies:

- Use of advanced design and calculation tools.
- Specific subject on Geometric Control and Generative Design, which may include advanced computational techniques.

- Training in Calculation Software, relevant to the automation and digitalisation of structural design processes.

3. Competencies covered

List competencies covered by the program:

- In-depth knowledge of the properties and characteristics of wood as a structural material.
- Design, calculation and construction of timber structures.
- Intervention and rehabilitation of existing structures.
- Application of advanced techniques in generative design and structural calculation.
- Understanding of wood production and transformation processes.
- Use of specialised software for the design and calculation of structures.
- Development of team projects through practical workshops and site visits.
- Direct relationship with professionals and leading companies in the sector.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Blended learning combining theory classes and practical work.
- Classroom-based: Workshops and site visits to reinforce practical experience.
- Blended: Flexibility to facilitate autonomous and face-to-face learning in theoretical subjects.
- Follow-up workshops: These encourage the guided development of academic work.
- Visits to technology centres and real construction sites: Focus on contextualised learning.

5. Evaluation criteria:

Module exams: 25% of the final mark.

Partial assignments and Final Master's Thesis (TFM): 65% of the final mark.

Participation in workshops, visits and other practical activities.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Ability to design sustainable structures with wood, respecting the principles of sustainability.

Knowledge of wood production and transformation processes to promote sustainable practices in the sector.

1. General information

Title: Specialisation Course in Building Information Modelling (BIM) (Access GS)		
Description: Course that accredits the specialisation to be able to work in public and private companies in the architecture, engineering and construction sector that develop projects under the BIM methodology, whose activities have a clear tendency towards the digitalisation of the development processes of project and asset information models.		
Duration: 600 hours	EQF/NQF Level: 5	Country: Spain

Webpage:	https://todofp.es/que-estudiar/familias-profesionales/instalacion-mantenimiento/ce-modelado-informacion-construccion.html

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Obtain sustainability and energy efficiency magnitudes and indicators from BIM models.
- Recognised sustainability or energy certification certificates.

Alignment to Industry 4.0 technologies:

- Augmented, mixed and virtual reality techniques to BIM models to obtain digital twins.
- 3D scanning and digitalisation techniques of the environment.

3. Competencies covered

List competencies covered by the program:

The general competence of this specialisation course consists of developing and modelling the graphic and non-graphic information of Architecture, Engineering and Construction projects under the BIM methodology in its different dimensions, as well as collaborating in the project processes, respecting the client's requirements (EIR, Employer's Information Requirements) and the prescriptions established in the BIM Execution Plan (BEP, Building Execution Plan), among others. Some specific competences are:

- Prepare the technical documentation of the project under the BIM methodology, its dimensions, level of detail and definition, workflows, BIM uses, collaboration processes, among others.
- Determine and represent the work processes between the different specialities of the project according to the established requirements.
- Develop BIM objects of different specialities by introducing the necessary parameters.
- Identify the modelling processes of graphic and non-graphic information to obtain information and data from the virtual model.
- Develop virtual models with graphic and non-graphic information of the different specialities present in the project.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.): Project-Based Learning

5. Evaluation criteria:

BIM Methodology

- Establish the content of the BIM execution plan, objectives, dimensions and BIM uses.
- Identification and characterisation of interoperable workflows.
- Operation and management of BIM and IFC files with various platforms, ensuring interoperability and traceability in the cloud.
- Architectural and structural modelling

Development of templates and modelling of architectural objects and structures.

- Creation of architectural projects with different BIM objects (walls, floors, roofs).
- Documentation of model information by means of tables and drawings.
- Modelling of Mechanical Installations and Sustainability

Creation of templates for mechanical installations and modelling of plumbing, HVAC and sustainability systems.

- Assessment of sustainability and energy efficiency (6D) through energy simulations and use of BIM tools.
- Electrical Installation and Communications Modelling

Development of templates for electrical, lighting and communications installations.

- Configuration and modelling of electrical, CCTV and alarm systems, generating diagrams and technical documentation.
- Documentation of the model by means of tables, plans and visualisations.
- Control, Management and Budgeting

Organisation of workspace for project control (4D) and budgeting (5D).

- Modelling of planning and control processes, integration of budgets with BIM models.
- Documentation of model information, generation of control reports and thematic visualisations.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Sustainability analysis (6D) of the BIM project.
- Modelling of sustainability and energy efficiency parameters, crucial for the circular economy.
- Assessment of energy efficiency and compliance with environmental regulations.

1. General information

Title: Structural timber engineering		
Description: The subject is aimed at providing students with the necessary training to design, calculate, plan and manage the most common infrastructures and constructions in the field of their competence. This involves the study of the construction elements in timber construction, the acquisition of knowledge that enables the dimensioning and calculation of timber structures in construction.		
Duration: 6 months	EQF/NQF Level: 7	Country: Spain
Webpage: https://www.usc.gal/es/estudios/masteres/ingenieria-arquitectura/master-universitario-ingenieria-agronomica/20202021/ingenieria-madera-estructural-15087-14564-3-89337		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

The programme focuses on the design and calculation of wooden infrastructures and buildings, including practices on dimensioning, structural calculation and specific connections.

Alignment to Industry 4.0 technologies:

The use of specific software such as Estrumad for structural calculations is introduced.

3. Competencies covered

List competencies covered by the program:

- Ability to design, plan and execute infrastructure works, buildings, installations and equipment necessary in the agri-food sector.

- Knowledge and skills to develop and apply technology in structural wood engineering.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

- Theoretical classes with an expository method interspersed with questions to stimulate participation and verify understanding.
- Seminars and group practices
- Use of infrastructure such as construction halls and software for real practices.
- Dialectical methods encourage critical and participatory reasoning.
- Personal work and tutorials

5. Evaluation criteria:

Theoretical-practical examination

Assessment of the ability to integrate knowledge and information, to form criteria and to deal with the complexity of making judgements in the field of content.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Learning outcomes related to sustainability and CE are not explicitly specified.

1. General information

Title: Certificate of Professional Competence ASSEMBLY AND INSTALLATION OF WOODEN CONSTRUCTIONS		
Description: This course is aimed at the accreditation of professional competences acquired through work experience and non-formal training that will enable students to acquire the professional skills necessary to carry out the operations of installation, assembly, adjustment and finishing of light, heavy, large-square frame constructions, logs, laminated wood and panelled systems, in conditions of occupational health and safety.		
Duration: 510 hours	EQF/NQF Level: 3	Country: Spain
Webpage: https://www.academiaintegral.com.es/cursos-gratis/certificados-de-profesionalidad/madera-mueble-y-corcho/mamb0210-montaje-e-instalacion-de-construcciones-de-madera-11915.html		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- The course focuses on the use of wood as a main building material, promoting its use in a safe, technical and efficient way.
- Environmental regulations applicable to the application of finishing products.

Alignment to Industry 4.0 technologies:

- Use of semi-automatic machinery and portable tools for cutting, drilling, sanding and assembly, key elements of partial automation.
- Involves the operation of paint booths and robots for varnishing applications, aligning with advanced technologies.

- Use of quality control systems for finishing and sanding, integrating mechanised processes with technical inspection.

3. Competencies covered

List competencies covered by the program:

- Installation, assembly, fitting and finishing of wooden constructions in light, heavy and panelled trusses.
- Interpretation of technical documentation associated with construction systems.
- Use and maintenance of hand tools and portable machinery for working with wood.
- Application of construction, labour safety and risk prevention regulations.
- Wood Treatment for Durability and Fire Resistance.
- Execution of complementary installations (electricity, water, heating, solar energy, etc.).
- Quality control and application of finishes in carpentry.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Theoretical and practical, workshops and simulated environments.

5. Evaluation criteria:

Assessment of the mastery of practical and theoretical competences according to the training modules.

- Application of practical tests in workshops to measure technical skills (e.g., tool handling, assembly and finishing).
- Analysis of the correct interpretation of technical documentation and applicable regulations.
- Quality control in wood assembly and finishing processes.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Application of sustainable materials such as treated wood and wood-based products with a focus on energy efficiency.
- Implementation of processes that reduce environmental impact.
- Promotion of durability and reuse of wood elements through specialised treatments.
- Acquisition of skills to meet sustainability standards in construction.

1. General information

Title: CLT construction classroom workshop		
Description: This course is aimed at construction professionals who want to incorporate new timber construction technologies, including cross-laminated timber, into their offer.		
Duration: 21 hours	EQF/NQF Level: 3	Country: Spain
Webpage: https://www.clubmadera.com/courses/curso-practico-presencial-de-construccion-con-clt-barcelona-26-al-28-de-noviembre-2024/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

The course deals with construction technologies based on cross-laminated timber (CLT)

Alignment to Industry 4.0 technologies:

The use of wood cutting and machining tools for prototyping involves automation and machining technologies

3. Competencies covered

List competencies covered by the program:

- Prefabrication of two-dimensional CLT elements with integration of insulation and other technical finishes.
- Assembly procedures, control of overhangs, tolerances and positioning of elements.
- Application of connection systems and control of acoustic insulation, airtightness, fire sealing and air tightness.
- Manufacture and modification of construction modules on site.
- Resolution of construction details following the technical documentation of the project.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Theoretical and practical exercise based on a cross-laminated timber prototype.

5. Evaluation criteria:

The evaluation criteria for the course are not explicitly specified.

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Learning outcomes related to sustainability and CE are not explicitly specified.

1. General information

Title: Sustainable wood construction		
Description: Identify, plan and develop processes/projects aimed at promoting the use of wood as a sustainable material in the construction sector.		
Duration: 80 hours	EQF/NQF Level: 3	Country: Spain
Webpage: https://sede.sepe.gob.es/es/portaltrabaja/resources/pdf/especialidades/EOCJ01.pdf		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

- Sustainable forest management, including forest certification, carbon storage, biodiversity and sustainable production.
- Substitution of fossil materials (plastics, concrete, steel) with green wood.
- Life cycle analysis of materials and strategies for sustainable buildings.
- Promotion of the circular bioeconomy through new wood-based building products and processes.

Alignment to Industry 4.0 technologies:

No explicit mention of Industry 4.0

3. Competencies covered

List competencies covered by the program:

- Handling of concepts of sustainability and construction with wood.
- Analysis of the life cycle of materials and the Technical Building Code.
- Design and evaluation of construction projects with a greater presence of wood.
- Development of positive attitudes towards sustainability and innovation.
- Informed decision-making based on life cycle data.
- Initiative, flexibility and interest in practical cases of sustainable construction.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.): Project-Based Learning

5. Evaluation criteria:

Theoretical-practical, systematic and continuous assessment

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

- Understanding of sustainable forest management and its importance.
- Ability to analyse and reduce the ecological footprint in the life cycle of materials.
- Application of new construction processes with sustainable materials (engineered wood).
- Design of projects that increase sustainability and the integration of wood in construction.

10.2.4 VET programs in Slovenia

1. General information

Title: Biotechnical Faculty, Department of Wood Science and Technology
Description: Higher education First Cycle Study Programmes (Professional Study Programmes) - Wood Engineering First Cycle Study Programmes (Academic Study Programmes) - Wood Science and Technology Second Cycle Study Programmes (Master's Study Programmes) - Wood Science and Technology Third Cycle Study Programmes (Doctoral Study Programme in Biosciences) - Biosciences

Duration:3 y (Bachelor and Engineer), 2 y (Masters), 3 y Doctoral	EQF/NQF Level: 6, 6, 7, 8	Country: Slovenia
Webpage: https://www.bf.uni-lj.si/en/ ; https://www.bioznanosti.si/en/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

Wood Engineering: Very good alignment to sustainability on the level of material, CE covered on the processing and treatment levels

Wood science and technology: Very good alignment to sustainability (particularly in wood construction), CE not explicitly covered, but implied

Wood science and technology – Master's level: Excellent alignment to sustainability (particularly in wood construction), CE covered also on the management level

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Alignment to Industry 4.0 technologies:

Wood Engineering: Industry 4.0 technologies very rarely mentioned

Wood science and technology: Industry 4.0 technologies rarely mentioned

Wood science and technology – Master's level: Industry 4.0 technologies satisfactorily covered

3. Competencies covered

List competencies covered by the program:

Wood Engineering: Basic knowledge on wood anatomy, basic understanding relation between wood structure and properties, theoretical and practical knowledge of wood processing (solid wood and composites), basic knowledge of product construction and wood building construction, knowledge of small wood processing enterprise management

Wood science and technology: Knowledge on wood anatomy, understanding relation between wood structure and properties, basic knowledge of wood processing (solid wood and composites), basic knowledge of product construction and wood building construction, basic knowledge of wood processing chain management

Wood science and technology – Master's level: In-depth understanding relation between wood structure and properties, knowledge of wood processing (solid wood and composites), knowledge of product construction and wood building construction, knowledge of wood processing chain management. The graduate is trained independently to provide overall solutions to complex professional problems, especially by seeking new sources of knowledge, to work interdisciplinarity and to use scientific methods. They are trained in the creative use of modern information technologies and the organisation and management of groups and/or companies.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Wood Engineering: Lectures / Seminars / Seminar tutorials / Laboratory tutorials / Practical training

Wood science and technology: Lectures / Seminars / Seminar tutorials / Laboratory tutorials / Field work

Wood science and technology – Master's level: Lectures / Seminars / Laboratory tutorials

5. Evaluation criteria:

Wood Engineering: Exams (written and oral) for theoretical and Colloquia for practical work, thesis defence

Wood science and technology: Exams (written and oral) for theoretical and Colloquia for practical work, thesis defence

Wood science and technology – Master's level: Exams (written and oral) for theoretical and Colloquia for practical work, thesis defence

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Wood Engineering: The basic aim of the study programme is to educate an expert in the field of woodworking with excellent applied knowledge in the field of technologies for processing and treatment of wood and fibrous composites. The knowledge of the graduate is based on knowledge of the structure and properties of wood as a renewable engineering material, development and use of technologies and technological processes in woodworking, product development, legality of business operations and product marketing. Sustainability is addressed more on the material (wood as renewable resource from sustainably managed forests) level, an CE at processing and treatment levels.

Wood science and technology: The basic aim of the study programme is to provide basics for continuing studies in master studies in wood science and technology and other fields of study. The interdisciplinary knowledge of the graduate provides employment opportunities in fields ranging from solving demanding technological problems in the production and processing of wood and other ligno-cellulose materials, to cooperation in interdisciplinary research and development teams in designing and developing wood products and performing strategic leadership and development tasks in the local and/or international interdisciplinary professional environment. In the courses connected to design and construction of wooden products (especially buildings) sustainability and communication thereof are interwoven into the subject matter, while CE is mentioned in courses connected to wood processing.

Wood science and technology – Master's level: The basic aim of the study programme is to educate an expert who can cover the ever greater demand for a developmental approach by companies, which is increasing the need for top professionals from the field of wood science and technology. In-depth knowledge of the specific properties of wood and wood based materials, processing technologies and the organisational and economic characteristics of the operation of a company are crucial for the overall development of the branch and/or individual wood companies.

1. General information

Title: School Center Škofja Loka (SC Škofja Loka) - Secondary vocational and technical school of mechanical engineering		
Description: Vocational and technical education in fields like mechanical and wood engineering. It features secondary schools, vocational colleges, and adult education with programs integrating modern technology and sustainability concept. - Woodworker - Carpenter - Carpenter Technician (after Carpenter program) - Carpenter Technician - Wood engineer		
Duration: 2 or 3 years, depending on the program	EQF/NQF Level: 3, 4, 5	Country: Slovenia
Webpage: https://scsl.si/about-center-eng/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable): Mentioned that students are aware of sustainable development and the importance of waste management.

Alignment to Industry 4.0 technologies: Knowing computer tools used to prepare technical and technological documentation, programming for machines.

3. Competencies covered

List competencies covered by the program:

- technical drawing
- proficient in the various computer tools used to prepare technical and technological documentation
- materials,
- technological processes and surface treatments
- programming CNC machines
- production management
- information systems and computing
- business economics, managerial and organisational skills
- foreign languages

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Lectures / Seminar tutorials / Laboratory tutorials / Practical training / Web classrooms

5. Evaluation criteria:

Exam, 80% presence at lectures, thesis defence

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Wood engineers are employed in all industries, trades, commerce and non-commercial activities in a wide variety of jobs. They are versatile professional who can combine different skills to identify, analyse and solve a variety of technical challenges, independently or as part of a team.

1. General information

Title: Wood technology school Maribor		
Description: Study program Wood technology and Design of materials – wood		
Duration: 2 years	EQF/NQF Level: 3, 4, 5	Country: Slovenia
Webpage: https://www.lsmb.si/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

Wood technology – not mentioned

Design of materials – wood - not mentioned

Alignment to Industry 4.0 technologies:

Wood technology – Mentioning CNC technologies.

Design of materials – wood - Mentioning Computer Design software

3. Competencies covered

List competencies covered by the program:

Wood technology

- wood processing and treatment,
- saw-mills, production of boards and laminated wood,
- manufacture of furniture, carpentry and joinery,
- surface treatment, seasoning and kiln-drying of wood,
- wooden and pre-manufactured constructions and building,
- production management and quality control,
- CNC technology,
- Entrepreneurship

Design of materials – wood

- designing furniture and carpentry,
- creative design in wood,
- design and creation of art & craft, useful products,
- the basics of restoration of art & craft wooden products,
- wood carving,
- manufacture of models, prototypes,
- Computer-Added Design software use,

- alternative techniques of expression

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Wood technology and Design of materials – wood

- participation in projects, collaborations with companies, testing product ideas and producing in our school workshops
- lectures, seminary tutorials and laboratory work and 10 weeks of practical training in companies

5. Evaluation criteria:

Exams, thesis defence

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Wood technology: To develop expertise in creating modern wood products and wood composites, leveraging advanced technologies and hands-on experiences in workshops. The program aims to foster innovation, competitiveness, and motivation, leading to successful career opportunities in the wood industry.

Design of materials – wood: Foster creativity, innovation, and independent thinking through hands-on experiences, advanced facilities, and programs designed to support professional growth and prepare students for independent careers.

1. General information

Title: Secondary school of Construction, Wood Technology and pre-school Education		
Description: Construction Technician Wood Technician Cabinetmaker Woodworker		
Duration: 2, 3 or 4 years	EQF/NQF Level: 3, 4, 5	Country: Slovenia
Webpage: https://www.sc-nm.si/sglvs/en		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

no explicit focus on CE

Alignment to Industry 4.0 technologies:

some alignment - the use of modern interactive classrooms equipped with computers, projectors, and internet connectivity supports digital transformation in education. Additionally, practical lessons in specialized workshops, combined with on-the-job training in real-world environments, provide exposure to

advanced tools and methods relevant to Industry 4.0. However, the explicit integration of technologies into the curriculum is not detailed.

3. Competencies covered

List competencies covered by the program:

- Technical and professional skills in specialized areas like technical drawing and ACAD
- Practical, hands-on experience in workshops
- Problem-solving, critical thinking, and creative design.
- Real-world work experience through on-the-job training and apprenticeship.

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Lectures, workshops, internships

5. Evaluation criteria:

Matura examination, final exam, apprenticeship model of education

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

Focus on hands-on training in real-world conditions, including apprenticeships and practical lessons, can encourage environmentally responsible practices. Participation in extracurricular activities, like technical competitions, could further promote awareness of sustainable practices and innovation.

1. General information

Title: Secondary School of Transport and Woodwork		
Description: - Woodworker - Carpenter - Carpenter Technician		
Duration: 2 or 3 years	EQF/NQF Level: 3, 4	Country: Slovenia
Webpage: http://spls.scng.si/		

2. Program content

Alignment to CE and sustainability (specifically in construction or wood construction if applicable):

Woodworker – not mentioned, just that they work with natural materials

Carpenter - not mentioned, just that they work with natural materials

Carpenter Technician - not mentioned

Alignment to Industry 4.0 technologies:

Woodworker – limited to using tools for drawing

Carpenter – not mentioned

Carpenter Technician – mentioned just needed equipment (machines)

3. Competencies covered

List competencies covered by the program:

Woodworker

- basic skills of woodworking
- manual and mechanical woodworking
- use drawing and writing instruments
- select the correct materials and prepare technical documentation
- skills to maintain an orderly and safe working environment

Carpenter

- working tools such as drilling, grinding and cutting machines, hand saws, etc
- how to draw
- how to organise to work safely
- skills about assembling furniture, ordering materials, etc.
- entrepreneurial thinking skills.

Carpenter Technician

- how to use technical literature and design and technology documentation
- to define technological procedures and organise the production of wood products
- knowledge of the structure, operation, control and use of machinery, equipment and tools for wood processing
- entrepreneurial thinking skills

4. Teaching methodology

What teaching methods are primarily used in the program? (Web-Based Learning, Project-Based Learning, Lectures, etc.):

Woodworker – lectures, workshops, excursions

Carpenter – lectures, workshops, at least 50% of time at a company

Carpenter Technician – lectures, workshops, excursions

5. Evaluation criteria:

Woodworker – final exam (product or service and defence)

Carpenter – written and oral exam and product or service and defence

Carpenter Technician - written and oral exam and product or service and defence

6. Learning outcomes

Please describe any learning outcomes related to sustainability and circular economy:

You can continue studying or work in a wood workshop or other fields.

10.3 Annex 3 – Review of relevant existing reports

10.3.1 Analysis of GreenComp: The European sustainability competence framework

1. General information

Title: GreenComp: The European sustainability competence framework
Description: JRC (Joint Research Centre) policy report to provide "evidence-based scientific support as input to the EU's policymaking process."
Webpage or any link if applicable: https://publications.jrc.ec.europa.eu/repository/handle/JRC128040

2. Report content

Alignment to CE and sustainability:

The GreenComp framework aligns strongly with the principles of the Circular Economy (CE) and sustainability by emphasizing competences that promote environmental awareness, equity, and responsible action. It integrates sustainability values such as promoting nature, systems thinking, and acting for sustainability which are essential for transitioning to a CE model. The report's focus on fostering a sustainability mindset supports long-term systemic change aligned with the goals of the European Green Deal and the Sustainable Development Goals (SDGs).

Alignment to Industry 4.0 technologies:

While GreenComp does not explicitly mention Industry 4.0 technologies, its emphasis on critical thinking, adaptability, and exploratory thinking indirectly supports the integration of advanced technologies in sustainability efforts.

Addressing the industry's needs for green and digital skills:

The framework addresses green skills explicitly by defining sustainability competences and providing a reference for integrating them into educational programs. While digital skills are not a primary focus, the critical and systems thinking competences outlined are transferable to digital innovation and the use of technology in sustainable development.

Addressing innovation, and sustainability:

The GreenComp framework uses systems thinking and futures literacy to help learners imagine and create sustainable solutions. It supports the goals of the European Green Deal by encouraging informed actions that consider environmental, social, and economic factors, driving meaningful change.

3. Competencies covered

Are they mentioning any competences needed? If yes, which ones?

- **Embodying Sustainability Values:**
  Valuing sustainability
  Supporting fairness
  Promoting nature
- **Embracing Complexity in Sustainability:**
  Systems thinking
  Critical thinking
  Problem framing
- **Envisioning Sustainable Futures:**
  Futures literacy
  Adaptability
  Exploratory thinking
- **Acting for Sustainability:**
  Political agency
  Collective action
  Individual initiative

4. Other notes

The report emphasizes the importance of lifelong learning and transformative education to achieve a sustainability mindset. The framework is designed to be adjustable and adaptable, suitable for formal, non-formal, and informal education settings. Note: (non-formal education happens outside institutional setting but still with structure, like workshops, informal happens trough everyday experiences, self-learning or interaction with other people). GreenComp is intended as a living document, to be refined through practical applications and feedback from stakeholders. This analysis highlights how GreenComp provides a comprehensive foundation for integrating sustainability competences into education and training systems, with implications for policy, innovation, and societal transformation.

10.3.2 Analysis of CEDEFOP: From linear thinking to green growth mindsets

1. General information

Title: CEDEFOP: From linear thinking to green growth mindsets
Description: Policy brief emphasizing how circular economy is essential to meet green deal targets
Webpage or any link if applicable: https://www.cedefop.europa.eu/en/publications/9184

2. Report content

Alignment to CE and sustainability:

The policy brief aligns strongly with the Circular Economy (CE) and sustainability by advocating a shift from a linear "take, make, waste" model to a regenerative approach centered on eco-design, recycling, and

industrial symbiosis to reduce emissions and resource waste. It highlights the role of vocational education and training (VET) in fostering circular skills, systems thinking, and lifelong learning to build a workforce aligned with CE practices, driving job creation in repair, recycling, and renewable energy sectors while promoting social cohesion.

Alignment to Industry 4.0 technologies:

Industry 4.0 technologies were explicitly mentioned only once to ease the transition towards the circular economy. The technologies mentioned were artificial intelligence, augmented reality and blockchain and would help streamline CE management in production tracking, resource optimization and collaboration across sectors.

Addressing the industry's needs for green and digital skills:

The brief identifies several key skill needs:

- Circular product design skills to promote eco-friendly manufacturing.
- Systems thinking for understanding and implementing circular principles.
- Transversal skills, including collaboration, communication, and problem-solving, to adapt to circular economy models.
- Technical skills, such as refurbishing IT equipment and assessing life-cycle impacts.
- Data analysis skills to support informed decision-making in circular practices.
- Upskilling for using Industry 4.0 technologies like blockchain, AR, and AI in CE processes.

The brief highlights the importance of VET curricula updates to integrate these skills, emphasizing short-term upskilling and long-term skill anticipation.

Addressing innovation, and sustainability:

The brief emphasizes:

- Innovation in eco-design and data-driven technologies for circular production.
- Promoting industrial symbiosis through digital platforms to enhance resource sharing.
- Regulatory changes, including the Eco-design Directive, to encourage sustainable product design.
- Integrating sustainability principles into education, policies, and business models to create lasting change.

3. Competencies covered

Are they mentioning any competences needed? If yes, which ones?

Circular economy-specific skills:

- Eco-design and reuse principles.
- Repair and recycling processes.

Transversal skills: Systems thinking, collaboration, and communication.

Technical skills: Digital skills for using AI, AR, and blockchain in CE processes.

Soft skills: Creativity and problem-solving for material innovation.

Green-specific skills: Life-cycle assessment (LCA) expertise.

4. Other notes

The brief links CE principles to broader societal benefits, including environmental preservation and economic resilience. Highlights the importance of EU-level harmonization of VET courses for circular economy skills. Acknowledges barriers like skill gaps, weak professional development for trainers, and poor working conditions in repair sectors, calling for targeted interventions. This document presents a strong case for integrating CE and Industry 4.0 technologies while addressing the skills needed for a sustainable future.

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