

GreenCompass - A self-assessment tool for fostering integration of green skills

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ABSTRACT

In today's ever-evolving landscape, fostering green skills emerges as a paramount endeavour, a beacon of progress towards a green(er) future. Within this transformative journey, this paper unveils a blueprint for organisations and institutions seeking to embrace a green future. The Self-Assessment Tool, GreenCompass, emerges as a pivotal cornerstone of this research, designed to quantitatively assess the green innovation capabilities of VET organisations. This tool offers a comprehensive view of an organisation's readiness and potential for fostering green skills for green innovation. The paper further unveils the insights garnered from the extensive pilot-testing of the GreenCompass across diverse geographical regions and within various types of vocational education and training institutions, validating its applicability for a broad spectrum of settings. In the last part, the paper emphasizes the creation of an environment, a nurturing environment wherein green skills can thrive. It's a conceptual framework dedicated to facilitating the growth of a sustainable and green mindset, in alignment with the evolving dynamics of the green transition. This journey underscores the significance of a comprehensive methodology, one that begins with self-assessment, evolves through empirical validation, and culminates in the establishment of an environment to nurture green innovation. Ultimately, this multi-faceted approach propels organisations towards a future characterized by innovation, sustainability, and an un-wavering commitment to a greener, more eco-conscious world.

Introduction

To address external environmental concerns and progress in sustainable development, green innovation for enterprises is an essential tool [1,2]. Global agendas and initiatives like the Paris Agreement and the United Nations Climate Action Summit have increased public awareness of business environmental performance [3]. To represent the universal principles of ecologically sustainable development, international corporations have begun to revise their long-term growth and innovation plans [4]. According to Hellström [5], a green innovation is environmentally conscious but also sustainable.

Fostering a variety of talents is essential for development and

implementation of green innovation. To start developing a green attitude, it is imperative to close the skills gaps. Educational institutions play a significant role in motivating and promoting green thinking by giving the appropriate courses and training. To enable educators to pass their environmentally conscious thinking to the next generation, it is imperative that they themselves receive comprehensive training. Moreover, to cultivate any form of green innovation, whether it pertains to product development, process refinement, or service enhancement, a collaborative effort between higher education institutions and businesses is essential.

This study provides a Centre of Vocational Excellence (CoVE) framework that enables the necessary interface between secondary and tertiary VET (Vocational Education and Training) providers, together with industry representatives and companies. It is now possible to support a creative, inclusive, and sustainable economy thanks to the CoVEs. The CoVEs focus on the expertise, resources, and infrastructures of the major players in developing innovation and skills environments, supporting regional development, and promoting social, economic, and environmental development through green and sustainable innovation processes.

Review of literature

Basics of green innovation

The terms “green innovation,” “ecological (or eco-) innovation,” “environmental innovation,” and “sustainable innovation” have all been used in the literature [1,6,7]. In the last few years, many countries have been exploring the introduction of corrective measures to decrease or mitigate environmental damages due to this innovation’s increased attention in academic and political circles [8,9]. Academic literature claims that green innovations, a subset of general innovations, share several characteristics with them [10]. Depending on the opportunities and challenges, innovations can represent something completely new and unknown, but also something existing and upgraded. Environmental management and green principles that enable the green transition are believed to be closely related to an organisation’s level of innovation [11].

In general, the dissemination of knowledge seems to be conceptually necessary for success in all types of innovation activities. How internal and external knowledge exchange affects green innovation, and an organisation’s effectiveness, is thought to be crucial [12]. However, how information sharing could encourage green innovation in organisations, nevertheless, is not yet obvious. The ability of an organisation to take on the necessary knowledge and skills reflects on its capacity to successfully implement green technologies. The high correlation between green innovation and company performance may be hindered by the important information transmission and skills [13].

At the Stockholm Conference in 1972, the significance of education in fostering environmental protection and conservation was recognised on a global level [14]. Since then, more higher education institutions (HEIs) have begun incorporating environmental education and education for sustainable development into various facets of their operations [15,16]. HEIs have a moral responsibility to promote the principles, sensibilities, and skills necessary to create a future that is both just and sustainable. Regardless of whether the goal is to acquire new competencies or enhance existing ones, there is a need for appropriate educational processes and collaboration. Development of the right skills and application of those skills in an effective manner, helps to foster

individual economic success and well-being, but also contributes to the overall improvement of society [17]. Higher education has a crucial role in establishing such a vision, yet this responsibility is usually overlooked. To promote green thinking and build a green attitude among students and employers, HEIs and diverse organisations must work closely together [18,19].

Green innovation and sustainability

There is an integrative relationship between green innovation and sustainability. Green innovation prioritises product design and production processes that lower emissions, conserve energy, cut down on garbage, and enhance the environment [20]. The basic goal of green innovation is to develop and orchestrate product innovation and manufacturing techniques that consume less energy, produce less waste and emissions, employ renewable energy sources, and are designed for closed-loop recycling and reuse environment [21,22]. A thorough understanding of processes, procedures, and assessments of resource efficiency is necessary for sustainable green innovation and green production processes. Because green innovation improves sustainability, it is highlighted as a major source of advantage in competition.

Globally, nations are incorporating green innovation into their ecological laws with greater clarity in the framework of sustainable growth. Enhancing green innovation could be a major task for the internet-based economy. Through increasing financial transparency, streamlining the framework of the industry, and developing market possibilities, among other indirect means, the growth of the internet-based economy may increase the amount of green innovation environment [23]. To drive green innovation inside organisations and improve the performance of sustainability, inventiveness has grown into a vital tool. A subject that is frequently disregarded is the essence of the connection between organisational innovation and sustainability environment [24].

Available tools to measure educational innovation level

To understand what else is required to encourage green skills and innovation, a detailed understanding of the organisations’ existing capacities is necessary. There are different tools available for measuring an organisation from various aspects, such as its level of innovation, digitalisation, entrepreneurship, and so on. Some of the available tools can be expanded upon within the scope of this study. For instance, the Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies (SELFIE) tool is used to recognise the integration of digital technology in an organisation; the Higher Education Innovation (HEInnovate), a self-assessment tool for higher education institutions developed through a long-term partnership between the OECD and the European Commission is used to assess the innovation capacity of a higher education organisation; while the Measurement Tool for Entrepreneurship Education (MTEE) offers self-assessment for teachers and principals who are engaged in entrepreneurial learning. Some quick explanations of the tools are provided below.

The SELFIE tool was created to assist educators in integrating digital technology into instruction, education, and student evaluation. It can draw attention to areas that require enhancement, what is already working effectively, as well as what must be prioritised [25]. The tool will eventually be available in additional languages in addition to the 24 recognised languages of the European Union. This tool collects, in confidentiality, the opinions

of educators, school administrators, and students, regarding the usage of technology in the classroom. A straightforward 1-5 agreement scale and brief statements and questions are used for this. The declarations address topics including student digital competency, teacher preparation, facilities, and management [26].

The HEInnovate is another innovation assessment tool for higher education institutions that aims to discover more about the capacity for innovation. In eight crucial areas, this tool leads higher education institutions through the authentication, prioritisation, and implementation processes of innovation. This tool is available in all EU languages for self-assessment [27]. This tool identifies an institution's strong and weak points, facilitates a conversation about how innovative and entrepreneurial an organisation is, and enables the organisation to evaluate and contrast changes over time. It ensures instant access to results, educational resources, and a network of professionals in an organisation. The HEInnovate tool can be used by any kind of higher education institution and is accessible to everyone, free of cost, and private [28].

The MTEE tool is designed and implemented by the LUT University in Finland, to assist educators in developing the skills that are required to teach entrepreneurship. It is structured in six areas, each containing several questions that teachers and educators should assess. As soon as the responses are submitted, the educators receive feedback aligned with the level of their skills, together with guidance for the future.

The Innovation Scoring by COTEC is a measurement tool used for measuring business innovation. It is used to rank the innovation level of an organisation consisting of 30 questions: nine about strategy, seven about the organisation, three about R&D and innovation practises, five about enablers, and six about impact [29].

The Determinants of Innovative Ability is a tool to identify the factors that encourage innovation in businesses [30]. This tool is used to identify several macro-determinants, as well as a subsequent collection of traits that affect an organisation's capacity for innovation. These traits include people features, strategies, cultural backgrounds, framework, accessibility to resources, connecting activity efficiency, and market features. The tool does not specifically highlight leadership as a factor that influences innovation.

Methodology

This study undertakes an exhaustive review of both earlier and contemporary literature on the subject of green innovation. A variety of keywords, including "green innovation," "green transition," "green mindset," "sustainability," and others, were employed during the search process. Searches for pertinent literature related to green and sustainable innovation, educational capabilities, and industry requirements were conducted using well-established databases such as Scopus, Web of Science, EBSCO, Google Scholar, and more.

The research methodology is organized into three primary phases: i) development of a Self-Assessment tool for green innovation – GreenCompass; ii) pilot-testing of the Self-Assessment Tool involving key enablers; and iii) proposing a model for a green innovation environment.

In recognition of the critical need to comprehend how green innovation is currently integrated into various types of organisations, it is essential to ascertain their existing status. To address this, we conducted comprehensive research in the realm of green

skills and green innovation, a crucial component of the GREEN-OVET project (<https://greenovet.eu/>). This research culminated in the creation of a self-assessment tool. This study offers insights into the tool's development and the advantages it brings, particularly in terms of enhancing the transition to green practices and fostering innovation through collaborative endeavours.

The subsequent phase of the methodology focuses on evaluating the educational and innovation capacities of institutions and organisations that are pertinent to the advancement of green innovation. The tool was piloted in four regions across Europe to assess the capacities of key enablers in the field of green innovation. These enablers encompass Higher Education Institutions (HEIs), Vocational Education and Training (VET) providers, business representatives, and other educational providers.

The final stage of the methodology is dedicated to proposing a knowledge foundation that supports the development of an environment for green innovation. This environment incorporates elements such as the GREENOVET Academy, Smart Labs virtual laboratories, and networks designed to nurture green talents.

This structured research methodology enables a comprehensive investigation into the integration of green innovation within diverse organisations and the development of a sustainable environment for fostering green innovation.

Results

Self-Assessment tool to measure the green innovation – GreenCompass

It is crucial to gauge an organisation's level of innovation to promote green innovation capacity and aptitude. This study provides a self-assessment tool designed to measure the green innovation of a VET institution, named "GreenCompass". The name was chosen to symbolize its role in guiding organisations toward a green future. The tool was created in the frame of the GREEN-OVET project. Although there are several high-quality self-assessment tools for assessing the potential of educational institutions, they are still lacking the green dimension. The GreenCompass has been developed by following the direction of such recognised (self)assessment tools but colouring their dimensions in green.

The GreenCompass is primarily developed for organisations that deliver vocational education and training (VET) programmes, having in mind that "VET programmes prepare participants for direct entry into specific occupations without further training, whose successful completion leads to a vocational or technical qualification that is relevant to the labour market" [31]. This instrument measures the level of innovation using six dimensions: i) organisational capability (infrastructure, funding, and human resources); ii) methods of education (selection of critical teaching techniques for VET's green education); iii) assessment procedures; iv) impact measurement; v) research and development potential (related to green entrepreneurship and innovation); and vi) facilitating and impeding factors for the growth of green innovation. Each dimension contains five questions and/or statements which need to be assessed depending on the respondent's level of agreement. Taking into consideration the fact that the proposed factors might not be enough to identify the status quo of a particular institution, the GreenCompass offers an opportunity for reflecting on additional factors that support or hinder the green transition and the development of green innovation, through open questions.

Figure 1 shows the tool in a snapshot. As soon as all statements per area are assessed, appropriate feedback appears, which is aligned with the assigned grades and provides recommendations for enhancing performance in the respective area. For instance, Figure 1 only visualises two dimensions (Organisational capability of the VET institutions, Methods for education) out of six dimensions. Additionally, five statements of each of the dimensions are also visualised in column 1 (Areas) in Figure 1. Based on each statement, the respondent can insert his/her opinion following the Likert scale (1-6) as seen in column 2 in Figure 1. Column 3 (Assessment) in Figure 1 accumulates all the score and summed up the values out of total score of 30. Based on this score, GreenCompass essential feedback (column 4 in Figure 1) that guides the corresponding institution with necessary suggestions to foster

green innovation. Additionally, any comments from the respondents also can be inserted in column 5 in Figure 1.

Figure 2 shows a sample result of the innovation levels of six distinct organisations based on the single dimension of “research and development.” The research and development dimension for each of the six organisations are shown as (A), (B), (C), (D), (E), and (F). According to Figure 2, Organisation ‘A’ has the highest level of research and development, and Organisation ‘E’ has the lowest level.

It should be noted that each of the six dimensions used to measure innovation level has its individual defining parameters. For instance, Figure 3 visualises the five different sentences in Y-axis that are considered the parameters used to measure “research and development” dimension for innovation level. The X-axis in

GREENOVET tool

Institution:

Date:



Areas	Likert scale [1-strongly disagree, 6-strongly agree]	Assessment	Feedback	Comment section (explain why you chose your response)
Organisational capacity of the VET institution (Infrastructure, Funding and HR)				
<i>The organisational capacity of an institution drives its ability to deliver on its strategy and influences the ability to sustain change. Strategic thinking and planning will lead to a successful mobilisation and allocation of resources.</i>				
1 Our institution has set common goals for green innovation and entrepreneurial education.	1 2 3 4 5 6	3	Your institution is on the right track! Strong leadership and ability to manage key resources could sustain and grow the entrepreneurial capacity. Your assessment puts you on a good level. It is great that your institution has a clear vision, as well as key resources for sustaining the innovation and entrepreneurial capacity. To reach the next level, your institution should think of ways to strengthen the existing resources and to work continuously on the action plan. Check out the statements that you've marked with lower marks and work more intensively on them. Suggestions that may improve the organisational capacities in your institution: continuously engage with funders and investors, continuously invest in modern and functional equipment, boost collaboration among all staff, support interdisciplinary teaching and researching, set individual objectives and performance indicators for all staff, measure the performance of innovation activities	
2 In our institution, we have the resources needed to implement entrepreneurial education and support green innovation among learners, and we allocate them respectively.	1 2 3 4 5 6	4		
3 Our institution has the capacity and culture to build new relationships and synergies across the institution.	1 2 3 4 5 6	5		
4 Our institution invests in staff development to support its green innovation and entrepreneurial agenda.	1 2 3 4 5 6	4		
5 Our institution is supported by a wide range of sustainable funding and investment resources to fulfill entrepreneurial objectives	1 2 3 4 5 6	6		
		22		
Methods for education (selection of teaching methods that are key for green education in VET)				
<i>A teaching method comprises the principles and methods used by teachers/educators to enable student learning. In order to foster innovative thinking and green awareness, traditional teaching methods should be replaced/upgraded with more interactive ones.</i>				
1 In our institution teachers/educators are encouraged to link the subject being taught with green learning methods, green innovation and green technologies.	1 2 3 4 5 6		Your feedback will show here after you have entered your assessment into the gray fields.	
2 In our institution, we foster mentoring and other forms of personal development offered by experienced individuals from academia or green industry.	1 2 3 4 5 6			
3 In our institution we apply inquiry-based learning, active learning promoting engagement, curiosity and experimentation in regard to green innovation and technologies.	1 2 3 4 5 6			
4 In our institution we apply project-based learning to promote green innovation and green technologies.	1 2 3 4 5 6			
5 In our institution we practice work-based learning, such as: internship, apprenticeship, workplace tours, on-the-job-training, practice-based learning, virtual learning environments.	1 2 3 4 5 6			

Figure 1. A snapshot of the GreenCompass.

Research and development potential in respect to green innovation and entrepreneurship

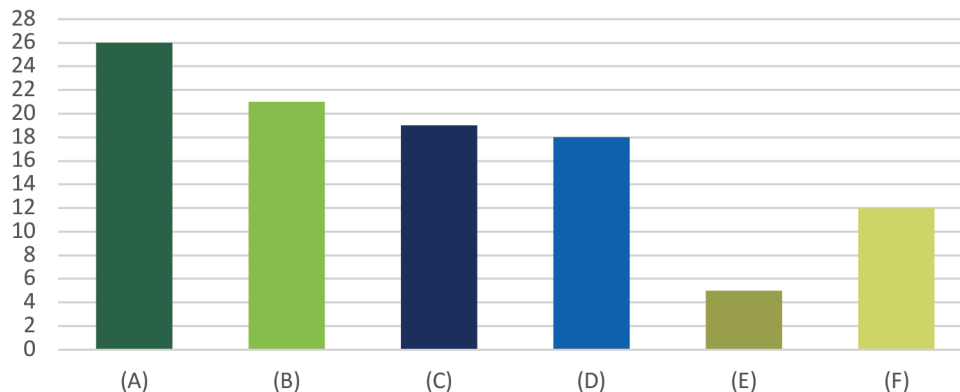


Figure 2. Case example to compare research and development level at six organisations.

Figure 3 represents the level of potential of research and development dimension for each of the studied organisations (A, B, C, D, E, F) with a scale of from 1-6 (1 is lowest while 6 is the highest score). As an example taken from Figure 3, it is seen that the first parameter “Results of green innovation and entrepreneurship research are integrated into all educational programmes in our institution”, organisation ‘A’ scored 5 as the highest while organisation ‘E’ scored 1 as the lowest.

Pilot-testing of the GreenCompass

The self-assessment tool GreenCompass was piloted in four regions across Europe: Styria in Austria, Vaasa in Finland, Leiria in Portugal and Skopje in North Macedonia. This activity was enabled through the collaborative work of the GREENOVET project team members and a broader group of key stakeholders who are part of the Regional Committees in Green Innovation. The establishment of these committees has played a pivotal role in acquainting key quadruple helix actors to achieve excellence in green innovation. The pilot-testing of the self-assessment tool GreenCompass was realised in 24 different types of institutions in total, considering 6 institutions per region as seen in Table 1. Table 1 provides a breakdown of the participating institutions by type and

region, which shows that the GreenCompass is suitable for various institutions that provide some kind of educational activities. Such institutions range from formal and informal educational institutions, including higher education institution, secondary VET school, company, as well as training centres/another VET provider as seen in Table 1. Table 1 shows that all types of institutions from four regions, with the exception of Leiria, participated in the pilot testing of the GreenCompass tool. Due to the lack of other types of institutions, only secondary VET schools participated in the pilot test.

In general, the findings emphasise the need for collaboration at both national and international levels to facilitate a smooth transition toward sustainable practices. The results of the pilot self-assessment showed that some institutions seem to be better prepared than others when it comes to addressing the challenges of the green (and digital) transition. Generally, Styrian organisations are willing to be involved in green innovations and are largely prepared to allocate some of their resources for more extensive involvement. However, certain institutions lack support and impact measurement procedures. According to the participants in Vaasa, some factors that are useful for capacity building and development of green innovation include international collaboration, the level of cooperation between educational insti-

Table 1. Type of organisation per region participating in the pilot testing of the GreenCompass.

Type of organisation per region	Styria	Vaasa	Leiria	Skopje
Higher education institution	2	3		2
Secondary VET school	2	2	6	2
Company	1	1		1
Training centre/another VET provider	1			1
Total	6	6	6	6

VET, vocational education and training centre.

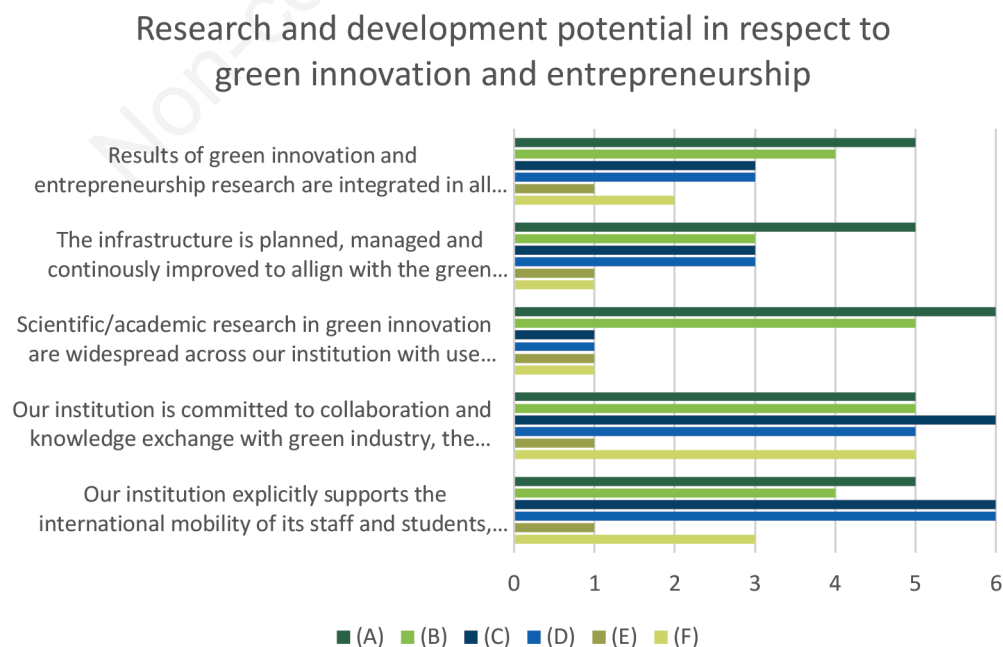


Figure 3. Case example to measure research and development level.

tutions and companies, and networking for education and working life with other schools on a regional, national, and international level. Considering the self-assessment in Leiria, the results show that there is a need for higher investments in modern technologies and equipment, as well as teacher training, to enable a green and sustainable transition. Finally, VET providers in the Skopje Region believe that there should be a stronger collaboration between local government, companies, and universities, to develop green innovation.

Environment for green innovation

The architecture shown in Figure 4 emphasises the need for a country or region to foster a green innovation environment. The green skills network, GREENOVET Academy, smart labs, and virtual labs are the three pillars of the framework, as shown in Figure 4. The Green Talents network has gathered all the fundamental abilities required to support green innovation. These competencies are gathered via questionnaire surveys from businesses. Different academic courses and training programmes are created for present and future students, as well as for employees of businesses, based on the technical skills, entrepreneurship, and digital skills gaps in green innovation. The GREENOVET Academy, which is also interfaced with the smart laboratories and virtual labs as depicted in Figure 4, plans and develops the curriculum of various courses and training materials.

All practical work that students need is available in the smart labs and virtual laboratories for them to do. Modern technologies and tools are available in the labs to ensure that prospective students receive top-notch instruction in green technologies and tools. A group of academic institutions can create these labs both physically and virtually. The labs will be furnished with a variety of tools and technology that the consortium members will employ to their mutual advantage. With virtual labs, the facilities are accessed online by consortium members via tools like digital twins (such as virtual reality, augmented reality, *etc.*).

The green innovation environment must include the option to host skill contests and propose collaboration projects in addition to GREENOVET Academy, smart labs and virtual labs, and the green skills network if it is to remain sustainable. The competition's main goals are to support the development of innovative and sustainable skills. This skills competition helps to polish the fundamental abilities needed for green innovation. The initiatives could be corporate solutions, green technology-based research projects, or innovative projects. These initiatives promote learning by doing and developing by allowing for quick experimentation and testing.

Model of CoVE in green innovation

As shown in Figure 5, the CoVE model for green innovation consists of three components: diversity management, teacher training, and living labs. In the case of teacher preparation, the objective is to build effective educators who can give students the essential learning strategies, instruction, practice, and guidance to develop a trained workforce for the green transition. To stimulate green innovation, it is crucial for diversity management to advocate for increased inclusion of workers from many backgrounds, including racial, religious, national, and demographic groups. To motivate organisations to implement different programmes and policies, diversity management incentives are required. The management of diversity can take the form of racial, religious, age, sex/gender, and sexual orientation diversity, among other forms.

The living lab scenario is regarded as an open innovation environment that uses an iterative feedback process to produce a lasting influence in a real-world setting. Co-creation, active user interaction, multi-stakeholder participation, orchestration, real-life setting, and testing of innovations and enterprises are generally its main focal points. The living lab acts as a liaison or coordinator between the general public, students, educators, staff members, research institutions, businesses (big organisations, SMEs, start-ups), and various levels of the government. The living lab provides an online platform to promote green innovation in the context of the environment for green innovation by building a portfolio of tools and services, setting up virtual classrooms for teaching and learning, preparing teachers to promote technical, entrepreneurial, and digital skills, *etc.*

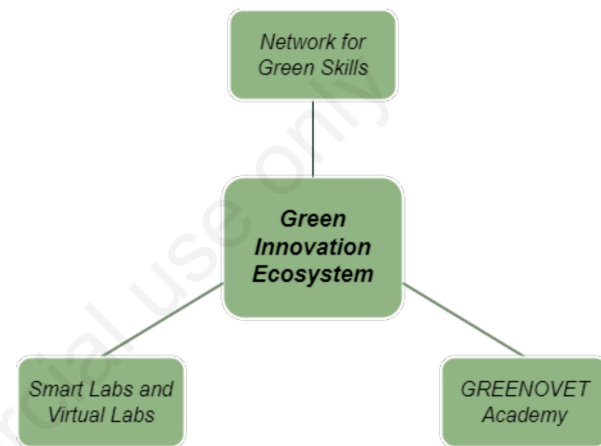


Figure 4. Green innovation environment.

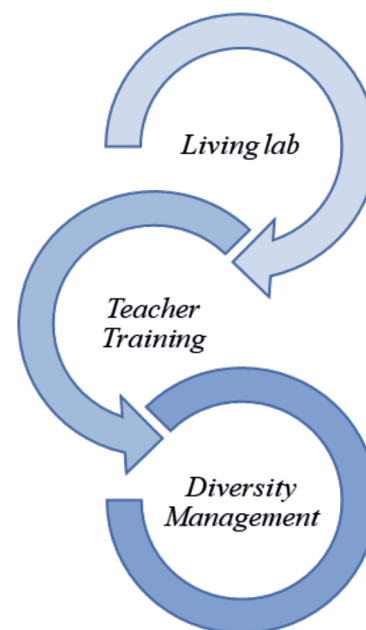


Figure 5. Model of centre of vocational excellence in green innovation.

Conclusions

Fostering green innovation on a global scale necessitates the provision of essential services and tools to businesses, students, and educators. These services and tools serve as catalysts for the development of living laboratories, environment orchestration, diversity management initiatives, and teacher training programs. It's imperative to consider a region's or nation's smart specialization strategy (S3) before embarking on green innovation initiatives. A region- or country-specific portfolio should be formulated in alignment with the S3 strategy, incorporating an analysis of regional status quo, addressing skills shortages, and embracing design thinking principles. The establishment of a motivating learning environment in the form of a CoVE is critical, tailored to address the specific skills gaps in green innovation within a given area or country. CoVEs offer a diverse learning environment that cultivates knowledge and expertise in sustainability, fosters creative thinking, and provides access to a skilled labour force. Furthermore, they play a pivotal role in nurturing innovative and entrepreneurial mindsets, facilitating the green and digital transformation, and enhancing the appeal of organisations to students, skilled professionals, and investors.

Within this framework, the key stakeholders within the regional green skills environment have a paramount position. They are integrated in the process through bodies named Regional Committees of Vocational Excellence in Green Innovation. These committees serve as advisory bodies, focus groups for testing of ideas and co-development, main dissemination groups, and act as early adopters for piloting innovative initiatives. Their role in guiding, evaluating, and supporting green innovation projects is instrumental in ensuring the overall success of the initiatives for development of skills for green innovation.

The implementation of the GreenCompass tool across different regions of Europe and within various types of VET institutions, including secondary and tertiary, formal and non-formal, as well as initial and continuous education, has demonstrated its robustness and adaptability to different settings and geographical regions. The results generated by this tool empower management with comprehensive insights into strengths and weaknesses within each category and sub-category, offering a dependable quantitative foundation for strategy development and progress assessment.

Crucially, the collaborative efforts of a wide range of stakeholders are pivotal for advancing towards a sustainable, green future. The diversity of the team brings objectivity to the identification of skills gaps and potential solutions. Moreover, each stakeholder's deep understanding of their own capacities, limitations, and potential contributes to a more effective collaborative environment. The establishment of Regional Committees in Green Innovation within the GREENOVET project exemplifies how experts are willing to contribute more when they have a heightened sense of belonging and impact in decision-making activities. This collective commitment and collaboration are central to the realization of our shared green vision.

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