

ADDRESSING ENVIRONMENTAL CHALLENGES THROUGH INNOVATIVE AND ENGAGING EDUCATION APPROACHES: INSIGHTS FROM HORIZON EUROPE PROJECTS

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Abstract

In the current era, marked by complex environmental challenges that are becoming increasingly urgent, the need to reimagine our approach to education is more evident than ever. In this perspective, the recent EU **GreenComp** [1] study presents itself as a reference framework for sustainability competences and tries to meet the **European Green Deal** [2] objectives by suggesting the yet unexplored opportunity to transform education into a driver for both a social and an environmental transformation.

Through the years, APRE, the Italian Agency for the Promotion of the European Research, has gathered several experiences in innovative education methodologies and instruments, engaging hundreds of future changemakers of all ages, through the participation of its dedicated Projects Department in HORIZON EUROPE (HE) funded projects. This path is well illustrated by three running HE projects.

The GenB project has tested innovative formats and developed concrete products and toolkits to raise awareness and educate students, teachers and multipliers on the circular and sustainable bioeconomy. Those stakeholders have been engaged in the “Living Labs” format applied to classes of different age groups (from primary to secondary school). These laboratories are creating role-play, careers and board games inspired by bioeconomy, underlying the importance of an interactive education approach, particularly for STEM topics. Another format used in GenB is the Ambassador: selected through a European open call, more than 70 people from 6 to 30 years old are currently being trained in bioeconomy concepts and opportunities, as well as supported in taking over the role of agents of change.

The STE(A)M Learning Ecologies (SLEs) project aims at promoting science education as part of local community development, through “Open Schooling” and an interdisciplinary STE(A)M approach. The pilot project in Italy brought together students, teachers and external stakeholders (research centers, international organizations, and industries), involving them in a learning path on sustainable development, circular economy and active citizenship. Through a Living Lab format, students have then co-created three learning products, using arts-based, tinkering and project-based methodologies. In this perspective, the school is on the path of becoming the promoter of a concrete change for a more sustainable way of living.

The RuralBioUp project is developing a catalogue of innovative training, coaching and mentoring activities that can be provided to regional bioeconomy actors implementing small-scale bio-based solutions. At the same time, the project is facilitating both knowledge transfer and exchange of best practices among rural and bioeconomy actors. Targeting individuals who already possess a certain level of skills, these trainings aim at empowering the trainees with expertise, practical knowledge and tools to encourage the advance of bioeconomy in the European rural areas, as well as allowing them to become replicators of this wealth of knowledge among their respective communities.

All the aforementioned innovative education methodologies (i.e. Living Labs, Ambassador programs, Open Schooling and training activities), which are nourished with a creative and multi-stakeholders approach coming from APRE’s EU projects expertise, are proving effective in empowering people of all ages to become proactive agents of change for a more sustainable Green transition.

Keywords: Horizon Europe projects, green transition, changemakers, innovative education, bioeconomy.

1 INTRODUCTION

The recent EU GreenComp [1] study positions itself as a reference framework for sustainability competences, aiming to fulfill the objectives of the European Green Deal [2]. It explores the unexpressed potential to transform education into a driver for both social and environmental transformation. Indeed, integrating sustainability theories and practices into education can develop a heightened understanding of human-ecosystem interactions and environmental awareness, leading to a greater sense of

responsibility towards their natural surroundings [3]. This approach also aligns with the imperative to cultivate new skills and knowledge to address future challenges, particularly complex economic and employment-related ones linked to Europe's green and sustainable development.

The expectation of education for sustainability is catalyzing **behavioral change**. By educating individuals about the principles of sustainability and the importance of responsible consumption, we set the seeds for a more conscious society. As people become more aware of the environmental consequences of their actions, they are empowered to make choices that align with the goals of sustainability. This favorable attitude can spark behavioral and socio-economic changes with a twofold impact: a more sustainable consumption and lifestyle, and a future generation of decision-makers and workforce informed and interested in science-related topics.

Research efforts in science and environmental-related topics have also tangible **economic implications**, most notably in new job creation. As industries shift towards bio-based production methods and renewable energy sources, new opportunities emerge in sectors ranging from agriculture to manufacturing. This not only diversifies the job market but also fosters innovation and entrepreneurship, driving economic growth while simultaneously addressing pressing environmental concerns. The green sector offers enormous potential for job creation in the coming years, but all citizens should harvest its benefits in full, especially youth and women who are at risk of being excluded from the green economy [4].

However, a set of sustainability competences are needed to meet the challenges of our time, and a shift in young people's interest and aspirations in science-related subjects is needed to support the acquisition of skills and competences that are becoming essential in all areas of life. A green transition depends on the availability of skills that help learners to think, plan and act in a sustainable manner [1]. A good balance between hard and soft skills is needed, including problem solving, collaboration, entrepreneurship, holistic/systems thinking and critical thinking, and specific technical-scientific skills linked to the industry's needs. Moreover, the need to train teachers and educators is imperative to embed environmental sustainability topics into educational systems and school curricula.

To reach such expected outcomes, research and innovation (R&I) are crucial for overcoming the major environmental challenges our society faces today. Responsible Research and Innovation (RRI) enables to develop strategies that link education content to wider societal goals and engage learners to become responsible citizens.

To this end, APRE, the Italian Agency for the Promotion of the European Research, is actively involved in Horizon Europe projects related to bioeconomy, climate change and adaptation, and STEAM in Europe, aimed at bringing research results to the large public and developing new skills, values and policies, through education and engagement.

The GenB project (Informing and educating young people on more sustainable behaviours and choices to build a future Generation informed and interested in Bioeconomy) contributes to the implementation of the updated 2018 EU Bioeconomy Strategy and the European Green Deal priorities, the achievement of a climate-neutral Europe by 2050 and the Sustainable Development Goals. It aims to inform and educate young people on more sustainable behaviors and choices to build a future generation informed and interested in the Bioeconomy (Generation Bioeconomy).

The STE(A)M Learning Ecologies (SLEs) SLEs project aims to enhance scientific knowledge and skills and promote science at local, regional, and European levels develops by engaging open schooling-enabled science learning paths in learning continuums of formal and informal learning environments and enterprises. First, the project highlights the necessary conditions for bringing together all the actors: formal, non-formal and informal education providers, as well as enterprises and the civil society and giving all actors space and motivation to take initiative and central roles. Second, the project generates opportunities for the creation of comprehensive partnerships in the form of interconnected knowledge ecosystems, in local communities able to foster improved science education for all citizens.

The RuralBioUp project aims to promote sustainable development in rural areas through the adoption and implementation of bio-based solutions. It focuses on providing tailored support services to regional stakeholders, primarily agricultural entrepreneurs, to foster innovation, employment, and economic growth in rural areas. These services include training, coaching, mentoring, and facilitating knowledge exchange. The goal is to establish a network of regional hubs across Europe to boost collaboration and the exchange of best practices in the bioeconomy sector.

2 METHODOLOGY

APRE utilizes diverse engagement and innovative methodologies to achieve the goals described in the above-mentioned European-funded projects. The common thread of these methodologies relies on increasing and supporting a stronger stakeholder engagement, which facilitates collaboration and synergy among different actor categories. This approach is strongly supported and endorsed by the European Union, which advocates for "early and continuous engagement of stakeholders, (...) essential for sustainable, desirable, and acceptable innovation." [5]

In the following section, four different engagement methodologies are described, each contributing uniquely to the advancement of innovative approaches in education, skills development and awareness raising with respect to environmental sustainability topics.

2.1 Living Labs

Living lab is a practice that emphasizes the central role of the user and co-creation processes, involving students (users more in general) in problem-solving activities, in real-life situations. The European Commission [6] describes living labs as "user-driven open innovation ecosystem based on a partnership which enables users to take active part in the research, development and innovation process". The concept of living labs is a relatively new concept that emerged in the early 1990s [7] and is defined as 'a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts. In contrast to traditional labs, living labs are characterized by the fact that they take place in 'real-life' context and are 'user-centered' or 'user-driven'. Although the users are the forefront of living labs, they usually involve heterogenous actors in a public-private-people partnership [8].

The activities in living labs generally involve four stages [9] that can be done once or several times iteratively depending on the needs.

- **Co-creation/co-design:** This is the ideation stage. With the help of different co-creation tools and methodologies, the participants develop a portfolio of possible ideas to implement to reach the desired goals.
- **Exploration:** With the portfolio of ideas, the participants explore the ideas in more detail and together come to a consensus on which ideas they would like to produce and experiment on.
- **Experimentation:** At this stage, the participants test the developed prototypes or products with the target population. Like with the previous stages, co-creation tools and methodologies specifically for experimentation are used.
- **Evaluation:** At the last stage, the participants reflect on how their product or products were received by the target population, whether they managed to reach the goals they were intended for and whether any adaptation is required to make the product or products reach the goals better.

The GenB project tested innovative formats and developed concrete educational products and toolkits to raise awareness and educate students, parents, teachers and multipliers on the circular and sustainable bioeconomy. In GenB, living labs are implemented in schools to produce new educational formats together with students. The objectives of living labs in GenB are multiple: 1. Co-create with students and teachers' new formats for communicating the opportunities from the bioeconomy and the ecological and circular transition 2. Develop new ideas with solutions for sustainability and reduction of the environmental impact 3. Support children and teenagers as experts and ambassadors of change and promotion of these issues towards families and society.

From March to May 2023, APRE conducted a Living Lab process in 2 classes of a primary and lower secondary school (I.C. Guicciardini school, Rome), through 4 co-creation workshops following the four-phases of the methodology. In September 2023, a focus group with experts was also conducted as part of the evaluation phase.

In the SLEs project, living Labs are adopted to actively involve students in co-creating learning products, using arts-based, tinkering and project-based methodologies, in collaboration with external stakeholders. The methodology uses design cycles: 1) Starting from a real problem with the aim of studying, developing and proposing a solution; 2) Actively involve students and stakeholders in co-creation; 3) Conceptualize, design and propose solutions together with students and stakeholders; 4) Prototype initial versions of possible solutions; 5) Test and evaluate preliminary solutions and obtain feedback to improve them.

During the projects' implementation, stakeholders with expertise in bioeconomy/sustainability, social innovation and science communication have been engaged in living Labs formats applied to classes of different age groups (from primary to secondary education) across all Europe. Students explored and proposed solutions, developed possible ideas, interacted with stakeholders, created an action plan and create their project/prototype to co-create new educational materials and new learning products that matched the desired goals of educating on the green and circular transition.



Figure 1: Living lab workshop in Italy, GenB, 2023

2.2 Open Schooling

An open school is a more engaging environment for learning and makes a vital contribution to the community: student projects meet real needs in the community outside school and draw upon local expertise and experience [10].

The SLEs project promotes science education as part of local community development, by adopting an open schooling and interdisciplinary STE(A)M approach. To achieve these, the project introduces the powerful concept of “learning ecologies” as a vehicle for envisaging and realizing impactful local open schooling partnerships as science learning continuums.

Open schooling partnerships are based on a multi-actor approach (MAA) as leverage of the engagement of the local communities. MAA aims at a demand-driven innovation through the involvement of various actors (end users, associations, businesses, etc.) throughout the project: from participation in work planning to its execution and dissemination of results. This should generate innovative solutions that are more likely to be implemented through cross-fertilization of ideas among actors, co-creation, and generation of co-ownership for the final outcomes [11].

The pilot project implemented by APRE in Italy (2023/2024) brought together students, teachers and external stakeholders, actively involved in a learning path on sustainable development, circular economy and active citizenship.

The open schooling path was tested in a lower secondary school (I.C. Guicciardini Elementary school, Rome) from November 2023 to May 2024. The pilot project, implemented in different modules and learning contexts, aimed to develop knowledge, critical and creative thinking on environmental sustainability, promoting active citizenship, entrepreneurship, teamwork and resilience of young people. Curricular integration (science, technology, civic education, art and literature) and a strong experiential project-based approach was adopted through tinkering, action-based learning, group work, and interactive learning tools (quiz, rap, videos, games, cards).

Overall, 40 hours of activities were implemented in different phases and educational contexts, including hands-on workshops, informative seminars in classroom, outdoor on-field activities and dissemination to the community. Two teachers, twenty students and six external stakeholders of various national research centers and organizations based in Rome (e.g. ISPRA, ENEA, INAIL, FAO, Unitelma Sapienza) were involved in the learning path. The topics of the activities covered sustainable and circular economy, the ecological beach and Posidonia Oceanica, the SDGs, food waste, and bio-based plastics through interactive lessons and participatory co-creation workshops conducted by experts in collaboration with teachers. The on-field activities (natural reserve and to a bio-based company of the local territory) enabled students to deepen the content acquired, gain hands-on experience and generate a stronger connection with the ecosystem. Finally, two final dissemination events (Sustainability Day and Festival Riscarti - 2024, Rome) have been organized for the entire community to inspire other stakeholders and teachers to replicate the experience.



Figure 2: Exploring Ecological Beaches: On-Field Activity with ISPRA, SLEs project, Italy

2.3 Ambassadors

Another format used in GenB project is the “Ambassadors”: selected through a European open call, more than 70 people from 6 to 30 years old are being trained in bioeconomy concepts and opportunities, as well as supported in taking the role of agents of change. Through this format, the project aims to attract and engage young people as ambassadors of bioeconomy and support young generations to take an active role in the circular and sustainable transition.



Figure 3: Call for GenB Ambassadors, GenB 2023

GenB Ambassadors are young people (max 30 years old) who would like to contribute to the sustainable and circular transition in Europe and have an interest in the bioeconomy and its related sectors.

The format foresees a direct connection among peers. Youngsters are keener on learning from other young people because they are perceived as inspirational examples, who are close to their age, experiences and who share the same values. In addition, young people are the perfect multipliers of sustainability contents, greatly contributing to promoting behavioral changes also in their family and social circle.

The role of the Ambassadors is multiple: to make their voice heard in decisions and debates, engaging with communities, students and civil society, and politicians at national and European level; to raise awareness of the bioeconomy, especially among the youth communities of their country; becoming a young journalist and participating in specific social media campaigns as young influencers and green-sensitive activists.



Figure 4: GenB Ambassadors involved in public events such as the Researchers' Night (Sept. 2023).

Those who will be appointed "GenB Ambassadors" will participate in the project's activities and will be able to receive learning and training opportunities. The project offers a program dedicated to capacity building, a kit of tools and resources to promote the bioeconomy, and the involvement of GenB Ambassadors in national and European events to inform and inspire other peers as well as in career orientation days to share professional/study experiences.

2.4 Training and coaching to educators and multipliers

In the RuralBioUp project, a variety of practical training, coaching, and mentoring activities are being crafted, tailored to the needs of regional bioeconomy actors implementing small-scale bio-based solutions. These comprehensive training programs are vital for supporting the transition to a circular economy, as they equip the local actors with the interdisciplinary skills needed to address complex challenges across various sectors such as food, forestry, energy, and materials and their value chains.

These initiatives are designed to provide, online, participants with the hands-on knowledge and tools necessary to advance the bioeconomy in European rural areas. The training topics were proposed during the project's kick-off phase by all the partners. Then, existing training resources and external training opportunities were gathered and reviewed by the partners to create the most comprehensive and updated selection of training related to bioeconomy.

Through this project, a comprehensive and up-to-date collection of existing training courses on bioeconomy was developed. These trainings are then delivered by project partners (called regional facilitators) in each region in the local language to facilitate understanding and engagement among local stakeholders, including entrepreneurs and citizens.

The widespread distribution of video courses, toolkits, and educational materials, coupled with the presence of a regional facilitator who serves as a mentor for those involved, enables continuous and targeted training. The objective is to raise awareness of the economic opportunities presented by the bioeconomy sector, thereby fostering a network of local entrepreneurs who can serve as catalysts for replicating and expanding the bioeconomy business model.

In GenB project, APRE implemented intensive capacity building for primary school teachers called "Teaching the circular bioeconomy to kids": the 6-hour online training course was repeated in Nov-Dec 2022, March 2023 and in Jan-Feb 2024. The training aimed at empowering teachers at the primary

schools with insightful contents, educational materials, and inspirational case studies on the bioeconomy and bio-based products. The trainings performed in 2022 and in 2024 were delivered via the “S.O.F.I.A.” platform of the Italian Ministry of Education, providing teachers with professional credits. The teachers that successfully completed the trainings were also provided with 30 hardcopies of the book for kids “What’s Bioeconomy?” [12] to be distributed to their students.



Figure 5: GenB webinars for teachers on bioeconomy on Italian Ministry of Education platform.

Within the SLEs open schooling partnerships, mentoring occurs across the different actors involved to take full advantage of the learning. Moreover, personal and professional development opportunities are generated in the context of the evolving synergies of education, research, innovation, and industry in the local partnerships. The implementation and facilitation of the project includes planning, support, reflection meetings and training activities between APRE (as national coordinator) and the local stakeholders involved in the pilot phases.



Figure 6: Mentoring between researcher of a national research center (ENEA) and a Secondary school teacher, SLES, Italy

3 RESULTS

3.1 Learning products and games on circular bioeconomy and sustainability

In the GenB project, living labs have produced different games (role-play, escape game and board games) on bioeconomy, underlying the importance of an interactive approach in education, particularly for STEM topics. These games are intended to be used by students, teachers, multipliers and non-

formal educators (museums, festivals, NGO) parents and other R&I projects that deal with young people to learn the bioeconomy through an educational tool.

In the context of the living lab with the Elementary school I.C. Guicciardini (Rome, Italy), APRE has developed an educational **board game** which aims to increase youngsters' awareness on the sustainable and circular bioeconomy and bio-based products. The objective of the game is to complete a recipe to produce bio-products (e.g. cosmetics, paper materials, etc.) derived from biological resources (e.g. tomato peel, apple peel). The recipients are elementary school students (9 -13 years old) and their parents, teachers and other adults who will play together with them.



Figure 7: Bioeconomy board game co-produced with students as results of the living lab in Italy

In the SLEs living lab in Italy, students co-designed and co-created four different **learning products** in collaboration with external experts by answering «What actions can you adopt for a greater environmental sustainability? ». Thus, the school is becoming promoter of a change addressing solutions for local challenges related to environmental sustainability. The first product, related to the circular economy, is a house for book-crossing made with reused materials. Secondly, on the theme of sustainable development an annual calendar, made with drawings and multimedia content on the most important sustainability-related dates. The third product, on the topic of the ecological beach and Posidonia Oceanica, is a thematic and creative diary made with recycled materials found during the field trip to the natural reserve. Finally, a collaborative video produced by students to communicate the activity results to other classrooms. The project ideas produced by students represent new practical models for more sustainable schools and can be replicated and used also in other contexts.

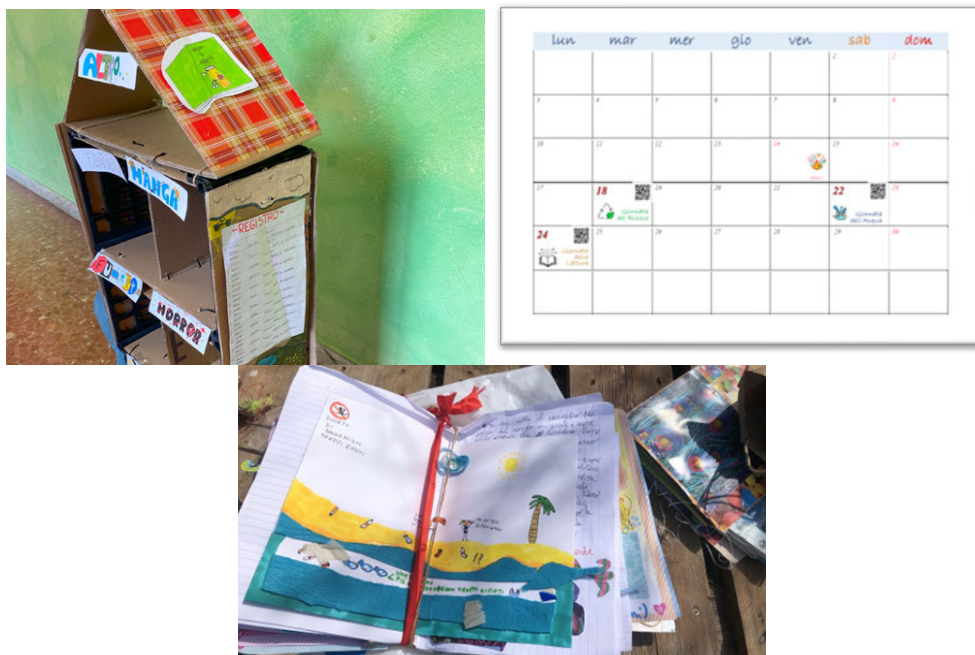


Figure 8: Learning products by students on environmental sustainability, SLEs project, Italy

3.2 Online training products for teachers, youth and communities

GenB project produced online recorded webinars and MOOCs for teachers and educators, as well as capacity building trainings for Ambassadors.

The GenB format "Educating teachers in teaching the bioeconomy" smartly combines and integrates three elements: the GenB toolkits, a massive open online course (MOOC) and the bioeconomy job profiles.

The GenB **Toolkits** represent a compilation of materials and resources aimed at promoting knowledge and teaching methods for including Bioeconomy in school curricula and enabling the acquisition of significant learning on the subject. The educational activities within the toolkit aim to take advantage of the didactic potential of different materials and develop learning experiences that allow educating students in Bioeconomy by giving them a leading role in the ecological transition, in accordance with the goal of GenB. These activities will constitute practical cases of knowledge generation on Bioeconomy in real environments.

The massive open online course (**MOOC**) or an open online course is an online course aimed at unlimited participation and open access via the Web. It is a high-quality free training course curated for teachers and educators from various educational settings and levels, that in addition to traditional course materials, such as filmed lectures, readings, and problem sets, provide interactive user forums or social media discussions. The MOOC is intended for all target ages' teachers, based on the GenB toolkits and other available materials. The GenB MOOC is aimed at training teachers on how to introduce the topic of bioeconomy in their classrooms and how to utilize the teaching materials developed within the GenB Project.

Bioeconomy job profiles are sets of teaching materials consisting of bioeconomy factsheets and interviews with bioeconomy experts, intended for high school (14-19 years old) and their teachers. These materials contain information and explanations of career and educational possibilities in the field of bioeconomy, featuring professionals that provide insights from the field to spread awareness, inspire and motivate high school learners to pursue a profession in bioeconomy. These formats would allow teachers to raise students' interest towards bioeconomy from the perspective of different science, technology, engineering and mathematics STEM and non-STEM fields that play an important role in the transition to circular and more sustainable lifestyles.

In GenB, more than 70 young European GenB Ambassadors have been provided with knowledge, capacities (including transversal skills) and opportunities to become frontrunners in driving change, attracting and influencing other young people. The **capacity building package for the GenB Ambassadors** is composed of different modules:

- Basic level 1: Awareness and knowledge of bioeconomy (applications of the bioeconomy, skills and jobs in the field, controversial aspects and challenges, contribution to sustainability challenges, communication and raising awareness on bioeconomy)
- Basic level 2: Contents of the GenB educational toolkits;
- Advanced level: Hard, soft and transversal skills (copywriting, videomaking, planning a communication campaign, design and visual thinking or public speaking).

All the materials will be soon publicly available on the GenB project website.

3.3 RuralBioUp portfolio of trainings for empowering communities

By carefully collecting and analyzing data, a wide range of learning resources have been produced in the RuralBioUP project, including 165 training materials and a detailed portfolio of financial opportunities related to bioeconomy sector. The complete catalogue of training is public and accessible through an online platform called [RuralSpot](#).

The training topics are the following: The EU bioeconomy ecosystem, Better nutrient recycling in the circular bioeconomy, Bioeconomy in the agriculture & forestry sector, Best practices in different value chains, Technological trends in bioeconomy, Innovation in Bioeconomy & "Do no significant harm" principle, How to increase awareness on bioeconomy, Communicate the bioeconomy: tools & methodologies, Education in bioeconomy, Funding opportunities in Bioeconomy, Business Angels, Venture Capitalists & private finance cycle in bioeconomy, How to pitch, Innovation support & technology transfer, Methodologies to increase collaboration in the bioeconomy sector, RuralBioUp One-Stop Shop, RuralBioUp Impact assessment, What is the bioeconomy?, Bioeconomy and key principles of sustainability, Relevant policies in bioeconomy.

The RuralBioUp training programme will be implemented in 2024 and 2025 within 9 Regional Hubs, empowering participants, mainly agricultural entrepreneurs, with practical skills and knowledge. The trainings will enable them to effectively contribute to the bioeconomy's advancement within their respective communities. Furthermore, ongoing updates and additions to training resources ensure that RuralBioUp remains responsive to evolving needs and priorities, maximizing its impact on sustainable rural development.

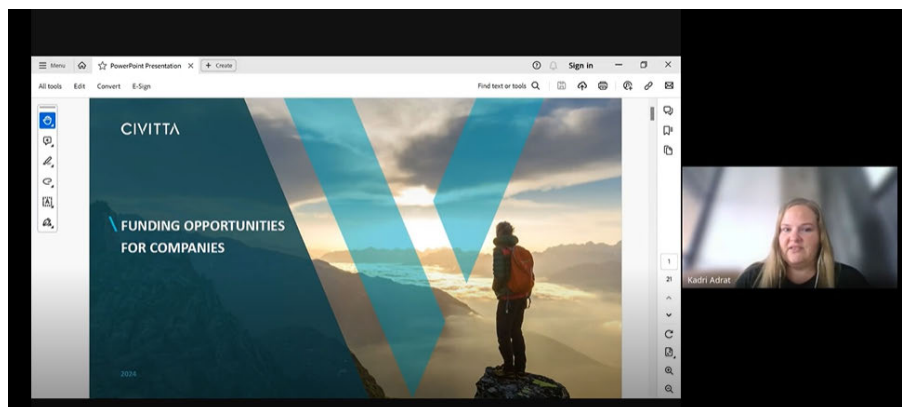


Figure 9. Training opportunity for regional stakeholders.

4 CONCLUSIONS

The innovative educational approaches adopted in the running GenB, SLEs and RuralBioUp Horizon Europe projects where APRE is involved in play a significant role in fostering societal change and driving economic growth. Living Labs, Ambassador programs, open schooling, training and mentoring methodologies, supported by a multi-stakeholder approach and by APRE's expertise, are proving effective in empowering people to become proactive agents of change for a sustainable green transition. They are particularly effective in engaging and informing citizens, especially youngsters, on science-related subjects. Such approaches can provide environmental, climate-neutral and socio-economic benefits through education, training and awareness raising on sustainable production, consumption and lifestyles by engaging children, young adults, teachers and society at large.

The innovative educational approaches can be successfully used in other themes beyond bioeconomy such as food systems (sustainable consumption and waste management), renewable energies, climate adaptation. These themes are central in the policy agenda of the European Commission and there is the need for profound transformation of society to overcome the non-technological barriers for the application of innovations and could be produced thanks to education to the young generations.

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