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Active storage of captured CO_2 in net zero construction products

ASCCENT

D2.2. Booklet with training materials from the ASCCENT 2025 summer school

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Booklet with training materials from the ASCCENT 2025 summer school

Deliverable No.	D2.2.
Version date	13 October 2025
Subject	Public report presenting the training materials from the doctoral summer school on Carbon storage in net zero construction products. The summer school provided an overview of the latest advances in understanding and development of net zero construction products by active storage of captured CO_2, including both theoretical and practical parts and training on acquired knowledge and skills for understanding advanced analytical techniques.
Lead partner	KU Leuven
Main authors	Vanja Gilja, Marijana Serdar, Ruben Snellings, Massimo Pizzol, Jan Suchorzewski, Bruno Huet
Main reviewers	Ruben Snellings, Marijana Serdar
Status	
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Contents

1 Introduction

The first summer school on “Carbon storage in net zero construction products” was organised as a twinning initiative between the University of Zagreb (Croatia), KU Leuven (Belgium), Aalborg University (Denmark), RISE (Sweden), and Holcim (France). The doctoral summer school took place from 26-29 May 2025 on the island of Zlarin, Croatia.

The program was focused on mineral carbonation science, life cycle assessment (LCA), innovation management, and industry perspectives for net-zero construction products.

Over four days, participants engaged in a dynamic program of expert-led lectures, hands-on workshops, and interactive discussions. The sessions addressed cutting-edge approaches to carbon storage in cementitious products, sustainable construction, and the transition toward a low-carbon built environment, while fostering academic growth, interdisciplinary collaboration, and knowledge exchange.

The booklet with training materials from the ASCCENT 2025 summer school is published open-access on Zenodo (https://zenodo.org/records/17226579), with ISSN and DOI: 10.5281/zenodo.17226578 for easy citation and traceability.

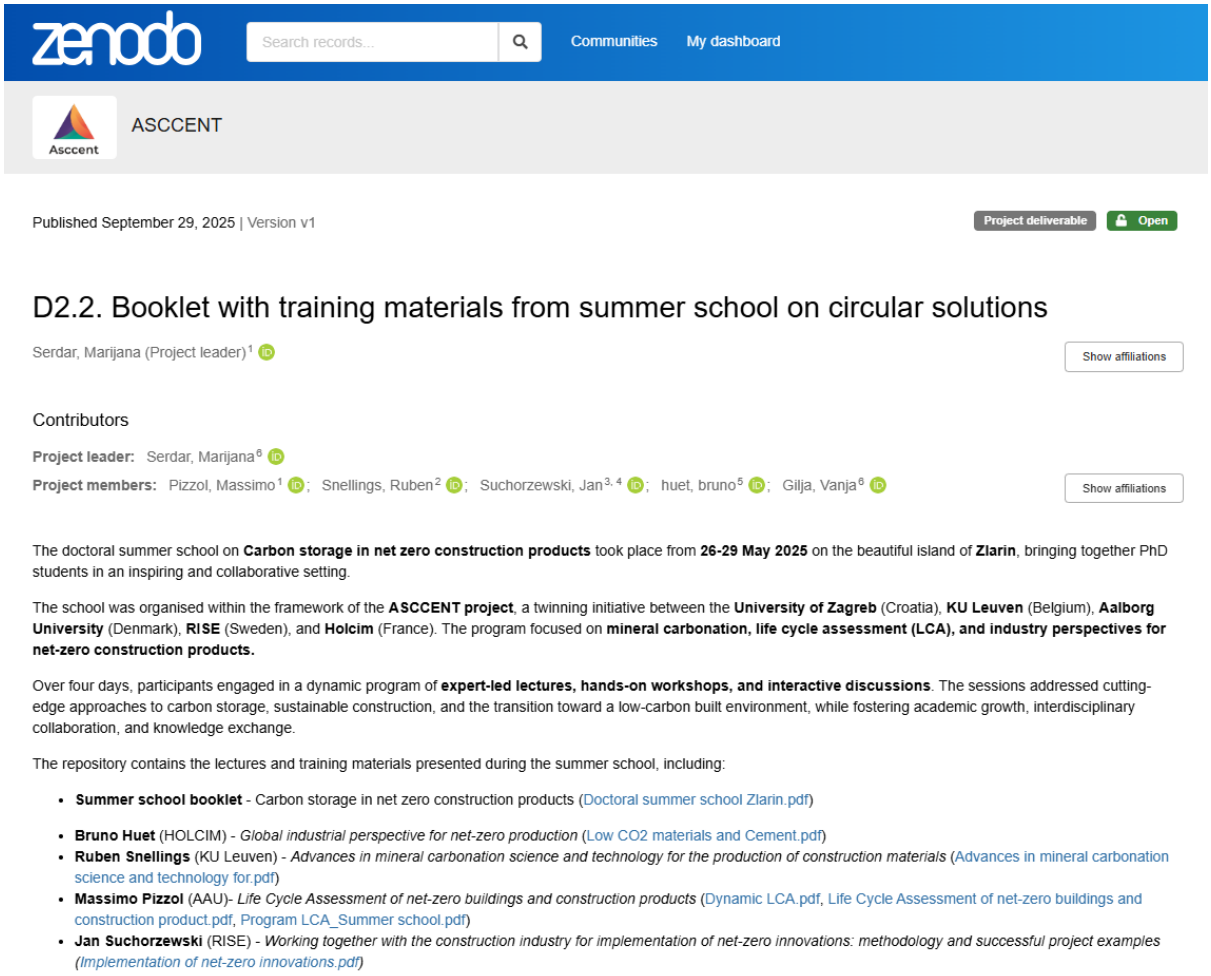

Figure 1. Booklet with training materials from summer school on circular solutions

The repository contains the lectures and training materials presented during the summer school, including:

1. Summer school booklet- Carbon storage in net zero construction products (Doctoral summer school Zlarin.pdf)
2. Bruno Huet (HOLCIM) - Global industrial perspective for net-zero production (Low CO_2 materials and Cement.pdf)
3. Ruben Snellings (KU Leuven) - Advances in mineral carbonation science and technology for the production of construction materials (Advances in mineral carbonation science and technology for.pdf)
4. Massimo Pizzol (AAU) - Life Cycle Assessment of net-zero buildings and construction products (Dynamic LCA.pdf, Life Cycle Assessment of net-zero buildings and construction product.pdf, Program LCA_Summer school.pdf)
5. Jan Suchorzewski (RISE) - Working together with the construction industry for implementation of net-zero innovations: methodology and successful project examples (Implementation of net-zero innovations.pdf)

2 Training materials

The doctoral school brought together 23 participants, 12 from Widening countries Serbia, Croatia, Slovenia, Hungary, and Estonia, along with 10 participants from Western European countries Belgium, Germany, Sweden, Italy, the Netherlands, and the United Kingdom and one participant from Brazil.

Participants of the summer school are PhD candidates and postdoctoral researchers working on diverse aspects of sustainable construction, circular economy, and the decarbonization of building materials. Their research covers topics such as carbonation of recycled concrete aggregates and fines, reactivity of supplementary cementitious materials (SCMs), and mechanochemical activation of recycled concrete fines (RCF). Several participants focus on the carbonation of alkali-activated materials and the development of lightweight construction materials based on alkaline industrial wastes through accelerated carbonation. Other research areas include carbon dioxide sequestration and mineralization in concrete, carbon mineralization in supplementary cementitious materials, and the use of recycled concrete and perlite for sustainable concrete mix design.

In addition to materials research, participants are engaged in life cycle assessment (LCA) of concrete and building materials, exploring material flow analyses, net-zero product assessments, and uncertainty modeling in LCA studies. Some are working on digitalizing building material stocks and developing material passports to enhance resource efficiency and material reuse in the built environment. Further research interests include valorization of industrial by-products through mineral carbonation, waste and nanomaterials for electromagnetic shielding, and broader themes in construction management and materials science.

Table 1 Summer school agenda

Monday, 26th May 2025

8:00 – 9:00	*Breakfast*
9:00 – 12:00	**BRUNO HUET** - Global industrial perspective for net zero production
12:00 – 13:00	*Lunch*
13:00 – 14:00	Cement basics, chemical reactions in concrete hydration, characterization techniques of concrete
14:00 – 17:00	Group work
19:30 - 21:00	Welcome session

Tuesday, 27th May 2025

8:00 – 9:00	*Breakfast*
9:00 – 12:00	**RUBEN SNELLINGS** - Advances in mineral carbonation science and technology for production of construction materials
12:00 – 13:00	*Lunch*
13:00 – 14:00	Principles, mechanisms, and analytical methods of mineral carbonation
14:00 – 17:00	Group work
17:00 – 17:30	Briefing with mentors

Wednesday, 28th May 2025

8:00 – 9:00	*Breakfast*
9:00 – 12:00	**MASSIMO PIZZOL** - Life Cycle Assessment of net-zero buildings and construction products
12:00 – 13:00	*Lunch*
13:00 – 13:45	Presentation on dynamic approaches to LCA
14:00 – 15:30	*Exercise: Calculating updated emission factors for construction products using dynamic tools*
15:45 – 17:00	Group work: applying the life cycle perspective to your case
17:00 – 17:30	Briefing with mentors

Thursday, 29th May 2025

8:00 – 9:00	*Breakfast*
9:00 – 12:00	**JAN SUCHORZEWSKI** - Working together with construction industry for implementation of net-zero innovations – methodology and projects examples
12:00 – 13:00	*Lunch*
13:00 – 14:00	*Regulatory aspects, innovative solutions and sales approaches*
14:00 – 17:00	*Group work*
17:00 – 17:30	*Briefing with mentors*
17:30 – 18:00	*Pitching*
18:00 – 18:30	KARMEN KOSTANIĆ JURIĆ - The Human Side of a PhD: Beyond the Lab, Papers and Deadlines

2.1 Industrial perspective

The first day of the PhD Summer School (26th May 2025), Bruno Huet from Holcim delivered an insightful lecture "Global industrial perspective for net zero production" covering the main decarbonisation challenges the cement and concrete industry is faced with, and the range of solutions the industry is researching and developing at the moment. The lecture "Cement basics, chemical reactions in concrete hydration, characterization techniques of concrete" provided participants with fundamentals of cement and concrete science. His presentation explored the basic principles of cement composition, the chemical reactions involved in cement hydration, and the key characterization techniques used to assess concrete properties and performance. This provided the participant a strong theoretical foundation and practical understanding of how material chemistry influences durability, strength development, and sustainability in modern construction. Through real-world examples and industrial perspectives, Dr. Huet highlighted the importance of innovation in cement manufacturing for achieving low-carbon and high-performance concrete solutions.

Figure 2. Dr. Bruno Huet (Holcim) during his presentation "Global industrial perspective for net zero production"

2.2 Fundamentals of mineral carbonation

Prof. Ruben Snellings from KU Leuven, delivered two in-depth lectures on advances in mineral carbonation science and technology for the production of sustainable construction materials. The first lecture "Advances in mineral carbonation science and technology for production of construction materials" focused on the latest developments and applications of mineral carbonation in the construction materials domain, while the second lecture on "Principles, mechanisms, and analytical methods of mineral carbonation" introduced the present state-of-the-art in scientific understanding underlying the process. Moreover, instruction and examples were provided on analytical techniques and approaches specific to mineral carbonation products. Together, these sessions provided participants with a comprehensive understanding of how mineral carbonation can contribute to CO_2 reduction, material innovation, and the decarbonisation of the construction industry.

Figure 3. Prof. Ruben Snellings (KU Leuven) during his presentation “Advances in mineral carbonation science and technology for production of construction materials”

2.3 Fundamentals of Life Cycle Assessment

On the third day of the Summer School (28th May, 2025), Prof. Massimo Pizzol delivered a presentation entitled “Life Cycle Assessment of Net-Zero Buildings and Construction Products,” which provided an in-depth introduction to the application of Life Cycle Assessment (LCA) in the context of net-zero buildings and construction materials. The presentation further explored advanced dynamic approaches to LCA, highlighting their relevance for assessing environmental performance over time. Participants then engaged in a practical exercise, calculating updated emission factors for construction products using dynamic LCA tools.

Figure 4. Prof. Massimo Pizzol provided an in-depth introduction to the application of Life Cycle Assessment (LCA)

The session concluded with hands-on group work, where participants applied the life-cycle perspective to individual case studies with LCA software SimaPro, reinforcing their understanding of environmental assessment in real-world contexts. After the hands-on group work students gained knowledge of the

theoretical and computational framework of LCA, relevant guidelines for the construction sector, and dynamic carbon accounting approaches. They developed skills in conducting LCA using commercial software SimaPro and databases, and in performing basic dynamic carbon calculations with research tools. They acquired the competence to assess the environmental impact of net-zero construction products from a life cycle perspective.

Figure 5. Hands-on group work with the LCA software SimaPro

2.4 Integration of research and innovation into practice

Dr. Jan Suchorzewski (RISE) held a lecture titled “Working Together with the Construction Industry for the Implementation of Net-Zero Innovations - Methodology and Project Examples.” He discussed the regulatory aspects, innovative solutions, and market and sales approaches that support the adoption of net-zero technologies in the construction sector. Through practical examples, he illustrated how effective collaboration between research institutions and industry accelerates the implementation of sustainable and low-carbon innovations.

Figure 6. Dr. Jan Suchorzewski (RISE) during a lecture titled “Working Together with the Construction Industry for the Implementation of Net-Zero Innovations - Methodology and Project Examples”

2.5 Inspirational talk

Dr. Karmen Kostanić Jurić delivered an inspiring talk entitled “The Human Side of a PhD: Beyond the Lab, Papers and Deadlines”. In her lecture, she addressed the personal and emotional challenges often faced by PhD students, including stress, uncertainty, and the pressure to achieve academic excellence. Through her motivational message, she encouraged students to remain patient, resilient, and

confident throughout their doctoral journey, emphasizing the importance of balance, perseverance, and self-belief in overcoming obstacles and achieving long-term success.

Figure 7. Dr. Karmen Kostanić Jurić inspiring talk entitled "The Human Side of a PhD: Beyond the Lab, Papers and Deadlines."

2.6 Group work on proposed Challenge

During the summer school, participants engaged in group work addressing a practical sustainability challenge. Each team was tasked with designing an innovative product, concept, or technology aimed at reducing CO_2 emissions and contributing to net-zero goals, while ensuring technological and economic feasibility and delivering a measurable environmental impact.

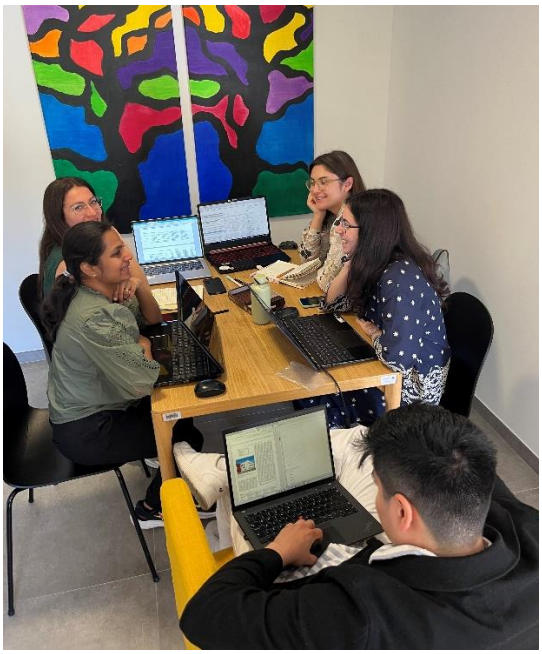

Figure 8. Students during the work group preparation of the Challenge

Working in teams of five, students collaborated to develop creative and feasible solutions, defining their target market, functionality, and implementation strategies. The outcomes of their work were presented through concise three-minute pitch presentations, where teams showcased their concepts and explained how their ideas could effectively reduce emissions or address specific environmental challenges.

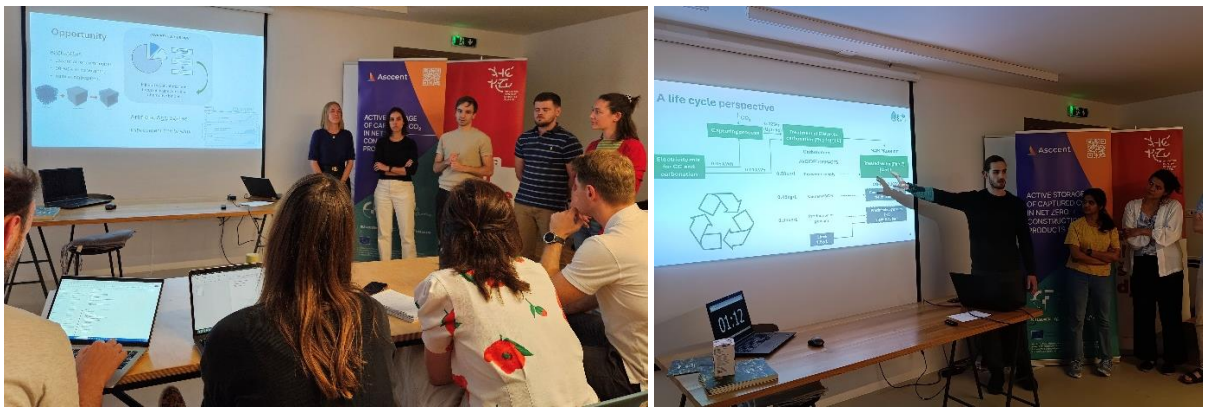

Figure 9. Student teams pitch presenting their Challenge solutions

A commission composed of experts and lecturers participating in the summer school, i.e., Prof. Snellings, Dr. Suchorzewski, Prof. Serdar, and Dr. Kostanić Jurić evaluated the presentations. The commission engaged in a discussion with the students, evaluated the proposed innovations while providing constructive feedback, with possible improvements for further development of their concepts. The session fostered critical discussion, creativity, and applied understanding of sustainable innovation in the context of net-zero construction.

3 Feedback from participants

After the completion of the summer school, participants were invited to fill out a feedback survey where they shared their overall impressions and opinions about the program. The responses reflected a highly positive experience, emphasizing the value of both academic and collaborative components of the school. Many participants highlighted the opportunity to interact with fellow researchers and lecturers as one of the most rewarding aspects. The atmosphere encouraged open exchange of ideas, international collaboration, and cross-disciplinary discussions, which fostered both professional and personal growth. The team-based challenge and pitching exercise were particularly appreciated. Participants emphasized how the activity encouraged them to think differently, step outside their usual research frameworks, and learn to communicate complex technical ideas clearly and concisely. The pitching sessions helped them develop effective communication and presentation skills, simulating a more business-oriented context where scientific ideas need to be translated into practical, engaging narratives. While the feedback was overwhelmingly positive, some suggestions for improvement included providing more time for group preparation, introducing the main challenge earlier, and assigning dedicated mentors to each group to improve communication and guidance. Overall, participants described the summer school as a wonderful and inspiring experience that successfully combined academic depth, teamwork, and creativity. It offered a great platform for learning, networking, and developing essential professional skills in a collaborative and supportive environment.

4 Conclusion

The summer school successfully fulfilled its aim of advancing knowledge and skills related to sustainable construction and the transition towards net-zero buildings. By combining theoretical lectures, practical exercises, and collaborative group work, participants gained a comprehensive understanding of Life Cycle Assessment (LCA), dynamic carbon accounting, and innovative approaches for reducing CO_2 emissions in the construction sector.

The initiative demonstrated significant educational, scientific, and professional impact. Participants developed practical competencies in conducting LCA, applying dynamic methods for carbon assessment, and designing environmentally responsible construction products. The group innovation challenge encouraged teamwork, creativity, and interdisciplinary problem-solving, fostering the ability to apply scientific principles to real-world sustainability challenges. The impact of the summer school is reflected in the participants' strengthened analytical and practical skills to assess and design environmentally responsible solutions.

After the completion of the summer school, participants were invited to fill out a feedback survey where they shared their overall impressions and opinions about the program. Overall, participants described the summer school as a wonderful and inspiring experience that successfully combined academic depth, teamwork, and creativity. It offered a great platform for learning, networking, and developing essential professional skills in a collaborative and supportive environment.

The ASCCENT 2025 Summer school provided significant educational and professional benefits by bridging scientific knowledge with real-world application, encouraging cross-disciplinary collaboration, and inspiring future professionals to contribute to the development of net-zero construction technologies and policies. Knowledge initially transferred from Belgium (KU Leuven), Sweden (RISE), Denmark (AAU) and France (Holcim) to Croatia (UNIZG-FCE) will be disseminated further across the region, multiplying the project's benefits and enhancing UNIZG-FCE's research profile, reputation, and attractiveness.

The summer school not only provided up-to-date insights into net-zero construction technologies but also facilitated networking and collaboration opportunities through dedicated social activities. These interactions are expected to foster long-term partnerships, promote innovation, and support the ongoing development of sustainable solutions for carbon-neutral construction.