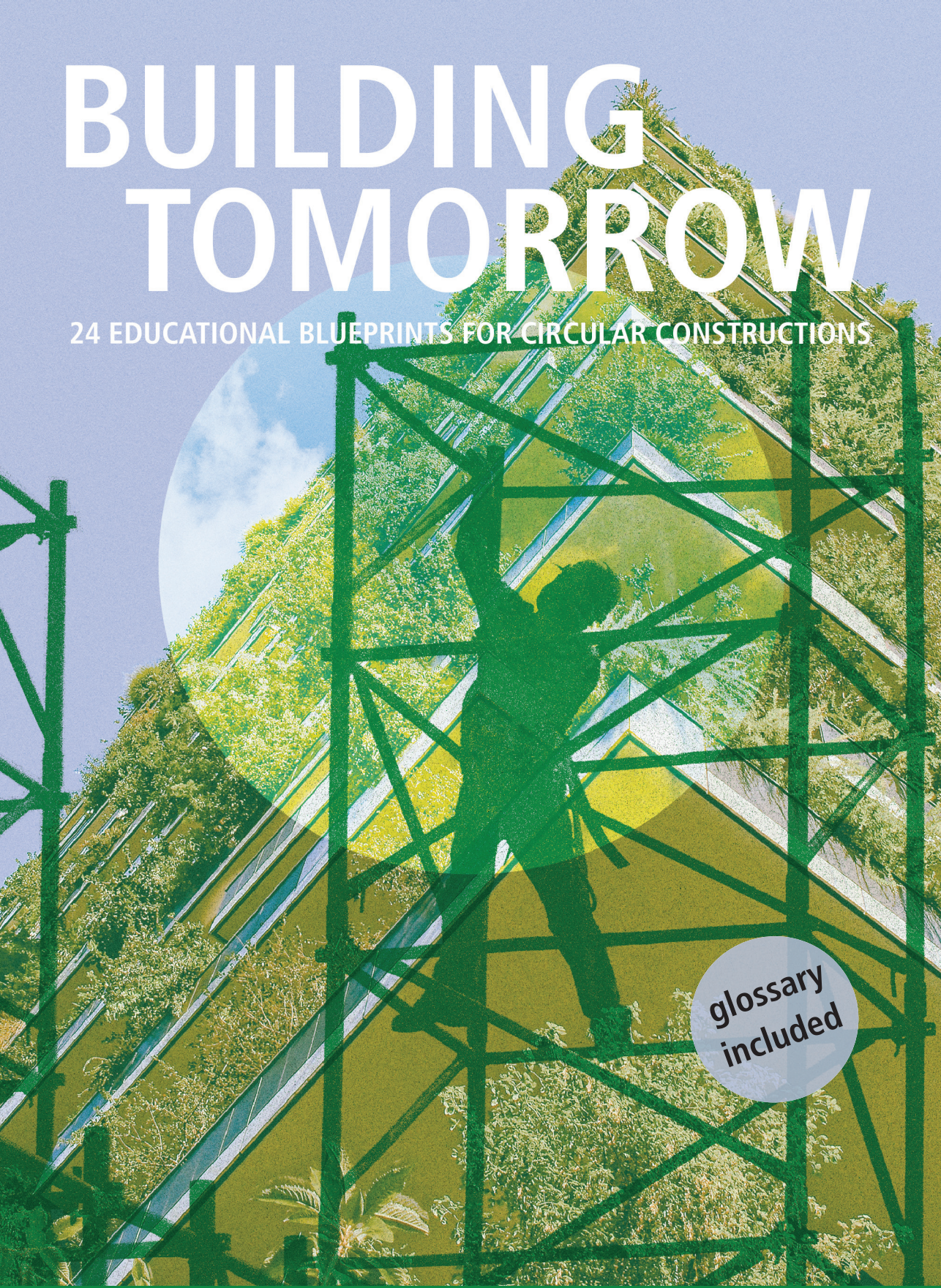
BUILDING TOMORROW

24 EDUCATIONAL BLUEPRINTS FOR CIRCULAR CONSTRUCTIONS



glossary included

Lidwien Jacobs Cihan Kayaçetin Lode Lefevre Frank Peeters Stijn Verdoodt Alexis Versele Monique Voet

Building tomorrow

24 educational blueprints for circular constructions

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24 educational blueprints for circular constructions

CBCI
Circular Bio-based Construction Industry

Interreg
2 Seas Mers Zeeën
EUROPEAN UNION
European Regional Development Fund

Other materials from CBCI:

- Kamp C CBCI Expositie 2022-2024, *Britselaan 20 - 2260, Westerlo;*
- Mobile exposition;
- Circular Built Tool, a tool for professionals.

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Contents

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For both structure and lay-out, we found great inspiration in Interdisciplinary Learning Activities *(Edelbroek, Mijnders, & Post, 2018)*. Therefore, we would like to acknowledge the authors of that book for their ideas on how to design a teacher's book with traditional lesson designs for higher education.

In terms of content, this book would never have come about without the research reports and tools developed by KU Leuven University researchers who built and ran the Living Lab in Ghent over the past three years. We are particularly grateful for their help in interpreting these materials in the light of lessons for higher education.

In addition, our sincere thanks go to the other authors of the three white papers published under the Interreg project: Fred van der Burgh, Kim Barentsen, Anja Beaujean-Kuijsters, Richard van Bremen, Barrie Dams, Barrie Izhar Van Eenennaam , Myron Koster, Jeras Projectmanagement, Evelyne Nguyen, Emile Quanjel, Petra Ronda, Martin Scherpenisse, Irene Schrotenboer, Sofie Torfs, Sissy Verspeek.

This book may not be delivered without an acknowledgment of appreciation for the writers of the book Interdisciplinary learning activities *(Edelbroek, Mijnders, & Post, 2018)*. They inspired us to make this teacher's book with classic lesson designs in higher education. Their concept is visible in this book, our sincere thanks.

Furthermore, our gratitude goes to the teachers and educational developers who helped us validate these blueprints, colleagues from Avans University of Applied Sciences, HZ University of Applied Sciences and KU Leuven University. Their feedback was indispensable in lifting the teaching modules to a higher level.

Last but not least, the concept of this book and especially the way teaching and research materials have been made digitally accessible to a wide audience required new processes and pioneering work. We thank all those who have worked on this: Antal Derene, Leon van Ekeren, Rudi Jilisen, Annelies Koomans van den Dries, Annelies Kuijten, Maurits Roos, Mariette Vissers, Marja van der Zanden.

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Preface

"For every tree is known by his own fruit" *(Luke 6:44)*

The project here presented, was still under way when we were getting this warm sensation that, slowly but surely, something out-of-the-way was coming alive. We knew – beyond doubt- that there was a lot to gain from the CBCI project (circular biobased construction industry) for governments and municipalities, for the financial sector, academics, and for civil society at large. In short, we were convinced there was something in it for all those whose daily lives takes place in the building and construction sector and especially for those who are constantly on the outlook for extra training.

CBCI did not emerge from a select group of academics living on their proverbial ivory towers. On the contrary, the CBCI approach was one embedded in applied scientific research, not one based on merely abstract and theoretical concepts, but an offer both practical and tangible.

We departed from one simple main idea: today, our current "construction economy" is fundamentally wrong. The ecological challenges are perhaps the most obvious, the social ones – even though the urgency is enormous – far less obvious. For unfortunately, more and more people are in danger of being left out in the cold when it comes to housing, assistance, etc. Most certainly so, when it comes to achieving ecological added values if we want to keep housing affordable. However, the ecological aspect and the social dimension are two sides of the same coin. They can reinforce each other rather than being opposed to each other. We are indeed faced with an increasing demand for buildings in all sectors: housing, care, education, etc. The housing shortage is considerable, the demand for adapted care and education infrastructure is on the increase. However, it cannot be the intention that we meet today's architectural needs while creating a whole series of new problems, both ecological and social. Building materials production often doesn't think beyond just how to recycle waste. Our concept of spacial design is often built in a linear, symptomatic way without taking into account short, medium and long term societal changes. Our neo-liberal economic model continues to increasingly ensure that we produce all the time more and at the same time continue to pollute more. There is a need for an absolute decoupling between growth and negative impact on people and the environment. How can we turn this vicious circle from the perverse "always more" paradigm into a virtuous "now it's enough" one of a circular economy? The methods and tools to intelligently develop building materials and components that stimulate reuse instead of preventing reuse are available. However, there is currently a most desperate lack of knowledge in the field. In fact, we could say, an ignorance along the entire construction chain. Time thus, to pass on the accumulated expertise from the CBCI project.

CBCI has been at the forefront of the "construction economy" system. The project involved system change. The complementarity between technical, financial and legal solutions as well as the relationships between stakeholders such as clients, designers, producers, developers, financiers,

etc. were examined. The connections between solutions and stakeholders were unravelled and analysed as a holistic system. The results are presented in the form of white papers on **(1)** essentials for successful circular biobased construction initiatives, **(2)** experiences of frontrunners and living labs for setting up the procurement and tendering process to realize circular biobased ambitions **(3)** rules and regulations. Researchers have not worked from the confined environment of a closed lab. CBCI is where labs have come to life. The white papers were tested in practice with two effectively built living labs: the construction of a healthcare institution in the Netherlands by Emergis and the development of a multi-applicable building concept on the Ghent Technology Campus (KU Leuven). Knowledge, attitude and practice were brought closely together. It is now time to pass on the theoretical and practical knowledge acquired to both students and professionals. Not just to the next generation of young people, but to generations thereafter. Construction professionals such as manufacturers, designers, real estate professionals, project developers, public and private real estate owners who are in practice today also benefit from the expertise acquired. The call is equally addressed to knowledge institutions, training centres, etc. to get started.

In the present book we have produced approaches for circularity from different angles. **(1)** Biobased and circular construction principles and design methods; **(2)** prototyping, testing of biobased and circular construction; **(3)** defining circular criteria and assessing them; **(4)** rules and regulations; **(5)** business models for more circularity and flexibility; **(6)** financial models for cost-value calculation of end-of-life and flexibility; **(7)** human based circular economy and cooperation models. The content of the courses in the book is presented under different teaching methods that we are familiar with, such as: workshops, course lectures, design studios, case studies and field trips. Furthermore, the lesser-known educational method, service learning, has been introduced to emphasize the societal relevance of the CBCI approach. Service learning is an approach that combines learning objectives with community service, volunteering or internships that provide practical experience for the student and combine it with a societal need that develops students' personal development and awareness of societal issues.

The results are there, but the work is not finished, and it most probably never will. We are only at the beginning of the transition and that is exactly why we wrote this book. The training modules will also continue to evolve as the society we live in evolves.

Alexis Versele | KU Leuven Ghent Technology Campus

3

Introduction

The construction industry is a large consumer of resources with 30-50% of total materials used in Europe going to construction. Between 2003 and 2011 approximately 1200-1800 Megaton of construction materials were used yearly in the EU, emitting annually 33% of total CO2 emissions. However, often the components and materials used are not adaptable during their use- and life-cycle, because most building projects are still designed in a linear way, making reuse hard and hence resource efficiency low.

Despite the EU's wish to move from linear to circular systems, applicable circular approaches are scarce. Especially those coupling the technical and biological cycle with an integral approach of sectoral aspects: technique, economy & finance and framework & regulation. Enabling change towards integral circular biobased approach in the building sector requires new roles of stakeholders in the building sector (manufacturers, constructors, policy makers, investors, contractors & end-users).

The CBCI project contributed to the reduction of CO2 emissions and waste production by demonstrating how and to what extent the use of biobased materials within a context of circular building can provide an answer to this. This book aims to disseminate the acquired insights and experiences among the young professionals who will soon start working in the building sector. The lessons make future professionals aware of growing possibilities that biobased materials offer in the construction industry and the positive impact of circular building on our living environment in general and climate change in particular.

All lessons formulate clear learning objectives for both the future young professional and the teacher who guides them, like making well-founded choices for sustainable constructions, comparing different structural solutions, and consulting with partners in their building project. Mastering these skills will prepare students to making decisions that will enable the construction sector to finally achieve circularity.

This book is a start. Equally important are the accompanying and freely available study materials and professional tools, such as Excel workbooks and calculators. They enable the builder to do the math to support arguments and to underpin the choice for biobased materials and circular constructions. Furthermore, scholars will find plenty of references to prevailing standards, and legal rules and regulations.

If this book proves to be well-received, it is suitable to add study materials or even entire blueprints. Do not hesitate to contact the authors if you wish to contribute to this yourself.

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Learning by doing, the CBCI study 2019-2022

In 2019-2022 the study circular and biobased building industry (CBCI) united researchers of four universities and many partners in from the industry in revealing knowledge and practical instruments for the sustainable building industry.

The overall objective of CBCI is to set up the bases for the circular biobased construction sector to become an integral part of the construction market in the 2Seas area. This project has enabled the building sector not only to adopt an integral (process) approach for circular construction but also to use biobased materials in a circular context for buildings (coupling technical and biological cycle) for use and life-cycle (design, production, use, maintenance and reuse). CBCI also seeks to induce change in the funding & financing of circular projects, foster circular-friendly procurement, adapt the regulatory framework, and prepare (future) professionals to work circularly.

This integral approach will develop and strengthen a new branch of the construction sector and will reduce the use of unsustainable resources (materials, energy), reduce the amount of waste and CO2 emissions and increase the use and reuse of resources in the construction sector.

To cut a long story short, the future of the construction industry is circular and biobased. The CBCI project worked towards that, by developing practical solutions and tools in living labs. In three white papers, the CBCI study reveals important conditions for circular and biobased construction.

main principles

CBCI gathered practice-based insights
The project harvested experience and knowledge through living-labs, that will remain as proof of concept of circular biobased construction (CBC), and serve as cross-border educational models. In addition to these physical embodiments, this book with educational material is the outcome for impact on education. Additionally, there is an exposition in Kamp-C 2022-2024 for professionals and students. In this way, CBCI provided the necessary knowledge for (future) professionals to replace the linear construction approach for a circular one.

CBCI produced 3 white papers
These papers were published to inspire the stakeholders in charge of funding & financing, of the regulatory framework (policy makers) and of procurement, with the objective to facilitate the shift towards more circularity for professionals by an enabling environment. For professionals CBCI produced a practical guide and a feasibility study, as tools to accompany them in circular construction projects, at each stage of the process.

Titles of CBCI white papers

- *Five essentials for successful circular bio-based construction initiatives.*
  How real estate professionals, (public) property owners and developers put circular biobased principles into practice.
- *Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process.*
  Experiences of front-runners and living labs for the design of the procurement and tendering process to realise circular biobased ambitions.
- *How the legislative framework can stimulate circular, bio-based construction.*
  This white paper is about legislation and regulations, as producers, contractors, building owners and developers often see this as an obstacle to the wider adoption of circular, biobased construction.

cross border approach

Since circular building with biobased materials is still in its infancy, cross-border cooperation among the North Sea regions is a must.

The University of Bath in the UK stands out for its knowledge about the technical aspects of biobased materials and subsequent process management, while pilots in the UK, the Netherlands and Belgium need this.

Likewise, other North Sea regions can learn from the experience of working with biobased building materials and the insights in related business models that have been developed in Belgium and the Netherlands.

Furthermore, via observer Cd2e, all regional partners can benefit from the strong network of French small and medium sized enterprises when it comes to waste elimination.

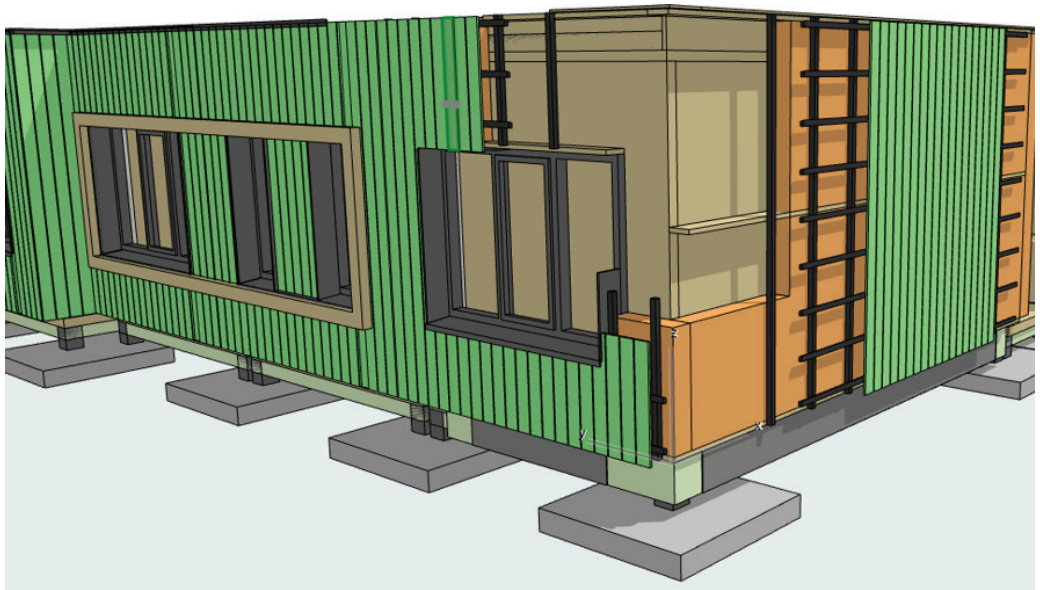
Moreover, cross-border cooperation is needed to reach a critical demand for renewable, biobased materials to accelerate the ongoing development of biobased elements.

The cross-border cooperation is also bearing fruit in the design and study of various living labs.

The different choices that were made for the construction of the living labs in the Netherlands, Belgium and the UK offer a wealth of comparison material. This applies to the project approach as well as to the choice of specific materials or technical installations, and to the analysis tools that were developed.

Emergis Living Lab

Kloetinge, The Netherlands



picture: CBCI

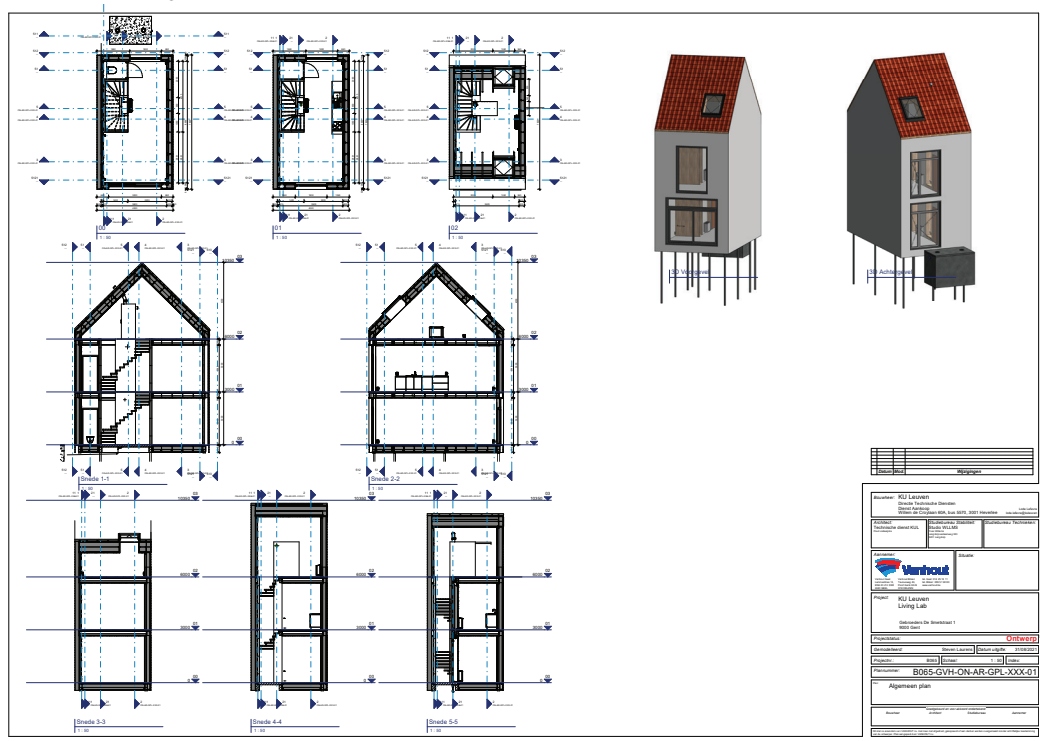
Emergis is an institution which provides mental health care in Zeeland, with it's main location in Kloetinge in the Province of Zeeland (the Netherlands). Building and maintaining real estate is an important tool of Emergis to provide safe environments for the care to their clients. One of which is their Ambulatory centre, previously consisting of about twenty so-called porto-cabins. Being 23-year-old and initially intended as a temporary solution, they were in high need of renewal. Moreover, the building and units were out of date, not energy sufficient/sustainable, noisy and lacking a dedicated entrance for the overall building. Based on the latest trends in mental health care, the centre required a more permanent solution that would also take into account future changes both in use and demand.

The replacement thus had to be circular and as such provide Emergis with a futureproof and safe building to establish the Ambulatory Centre for decades to come in the most material efficient way possible. The challenge was to develop an adaptable, demountable system that could be mounted on site in a very short time yet would withstand the test of time and most importantly meet the increased demands of an environment in which Emergis' clients normally reside.

The main targets were to let the building design support a healing environment to realize flexibility opportunities to replace and reconnect modules. The building expresses its nature with its characteristics inviting and natural-looking entrance.

Living lab KU Leuven

Ghent, Belgium



picture: CBCI

KU Leuven, Ghent, Belgium The Living Lab KU Leuven concerns a housing project in the city of Ghent (Belgium). One of the goals of this CBCI Living Lab is to realise a prototype for the renovation of terraced houses in urban innovation projects based on circular, biobased and industrial construction principles. The developed concept addresses three challenges.

1. The operational and demonstrable energy performance upgrade of the existing building stock. With the concept, specific existing homes are renovated to meet the EU's EPC-A objectives for 2050.
2. The concept handles the problem at the end of the lifespan of any solution by taking into account the availability of raw materials. The Living Lab is a materials database for future related projects but was also built with materials from existing materials databases, demonstrating that the ambitions for the end of the lifespan of the new concept are achievable today.
3. The concept entails 'design for adaptability' in addition to 'design for disassembly', by using a modular system that allows for modification throughout the lifespan of the concept. In addition to these project-transcending aspects, disassembly and flexibility are equally important from a project perspective.

The prototype building will be present at the technology campus in Ghent for a limited time, around ten years. It will then be reconstructed elsewhere and used as a home. In order to design and build the CBCI Living Lab Ghent, a team was formed with KU Leuven as principal and expert in sustainable design. Support by CBCI experts and prototyping partners as well as a consortium of contractors has led to a unique result. First and foremost, the circular character and use of biobased materials are of importance when it comes to legislation and regulation. In addition, the temporary character, relocation and change of function are at least equally relevant.

5

Understanding the course designs

A blueprint in this book is a detailed design of an educational module. Much of the information within such a blueprint is already available, but at the same time there is conscious room to adapt the blueprint, to elaborate it in detail or tailor it to personal preferences and goals.

That is why this book is primarily intended for developers of education in circular building. It is also a textbook for teachers specialised in circular and biobased building, and it offers beginning professionals in building technology a questionnaire. All this is based on the latest insights gained from practical research.

Each blueprint outlines the teaching idea or concept for one or more lessons or workshops, the duration of which depends on the target group and the complexity of the subject.

learning outcomes

All blueprints mention learning outcomes, but these are not uniform. This is because authors relied on their own educational experiencein the creation of teaching modules for this book. For example, learning objectives may be described as targets, activities, or skills.

language mix

The study materials are in English. In a few cases Dutch language material has been added to the study materials, such as a knowledge clip or a second Dutch language version of a white paper.

study materials, meaning of the QR code

Study materials can be viewed and downloaded from a publicly accessible file server, grouped per blueprint. Teachers can provide the QR code or shortened URL to students so they can find all they need to prepare upcoming classes.

availability of video materials

Some materials come with knowledge clips. A guest lecture is incidentally available. Note that although some are subtitled, quite a few knowledge clips are only available in Dutch.

6

Navigating the book and study materials

The edicational blueprints are a source of teaching suggestions, exercises and lesson plans. The CBCI knowledge has been converted into the blueprints of chapter 8. For the quick overview, each educational blueprint is presented on 2 pages of basic information (see navigation example at next page). Then the blueprint is further explained in the following pages that speaks for themselves.

in general:

- The book is laid out on browsing though blueprints;
- From the overview it is possible to make a selection from the available educational blueprints.;
- The functional set-up of the book is explained here; for questions concerning content, please refer to the glossary;
- Many documents are in English, as is this book. Some accompanying documents and videos are in Dutch, due to the common language used by many contributors throughout the CBCI project;
- The order of the book is based on the order of construction.

descriptive components

Each blueprint is basically made up of the components listed below, except for small differences. A number of these components will be briefly explained. Please take a look at the overall overview to be able to compare blueprints and make choices.

skills

In the book Interdisciplinary Learning Activities *(Edelbroek, Mijnders, & Post, 2018)* are skills used and explained, that characterise modules. This book uses the same set of skills, supplemented with construction- and design-related skills.

- The sub-skills of Facione (2011), which include critical thinking: ordering & structuring, reasoning, analysing, evaluating, and sound decision making.
- Skills for collaboration: formulating a common goal, situation awareness, a questioning attitude.
- Skills for reflection: perspective taking and reflection.
- Added to this are: academic learning, serving, critical awareness, observing and designing.

Chapter

Navigating the book

How to use

overview keywords
keywords that define the main meaning of the blueprint

code:unique code for communication purpose

matching picture to the blueprint

overview

A short summary of the blueprint.

characteristics

possible options:
who: individual / group
what: course / workshop / design studio / service learning / case studies / excursion

duration

An indication in time, plus the number of items in the series.

skills

possible options:

- academic learning
- analysing
- a questioning attitude
- critical awareness
- dealing with cognitive biases
- designing
- evaluating
- formulating a common goal
- observing
- ordering and structuring
- perspective taking
- reasoning
- reflection
- serving
- shared leadership
- situation awareness
- sound decision making

target group

The education level of the student is indicated over here.

prerequisites

The substantive starting level of the student is indicated over here.

learning outcomes

A learning outcome indicates what is to be achieved by education.

Overview

		working form						
	target group: undergoing relevant bachelor/master	case studies	course	design studio	excursion	practical course	service learning	workshop
01	Five essentials for successful circular biobased construction initiatives		■					■
02	Cooperation models in circular economy	■	■					■
03	Role-play in initiation teams							■
04	CBCI - Back to the future							■
05	Basics biobased structural and facade materials & construction methods							■
06	Prototyping testing of biobased and circular construction		■					■
07	Circular and biobased ambitions in construction projects; an integrated approach to the tendering process		■					■
08	Circular and biobased ambitions in construction projects; Part 1: initiative and feasibility phase		■					■
09	Circular and biobased ambitions in construction projects; Part 2: project definition		■					■
10	Circular and biobased ambitions in construction projects; Part 3: procurement		■					■
11	Circular and biobased ambitions in construction projects; Part 4: implementation		■					■
12	Rules & regulations in the circular and biobased construction industry		■					■
13	Circular & biobased design approach, using an iterative design process			■				
14	Measuring circularity characteristics of circular and biobased construction		■					■
18	Measuring the social and societal impact of circular and biobased building		■					■
19	In situ testing of biobased and circular construction		■					■
22	Excursion Living Lab Leuven, Ghent - Belgium				■			
23	Excursion Living Lab Emergis, Kloetinge - The Netherlands		■		■			
24	Excursion Exhibition Kamp C, Westerlo - Belgium				■			
	target group: undergoing relevant master							
15	Cooperation models in circular construction projects	■						■
16	Social economy and corporate social responsibility		■				■	
17	Flexibility and end-of-life calculators					■		■
20	Life cycle assessment of circular and biobased construction		■					
21	Overview and application of circular assesment tools		■					■

	work size			skills														
	group	duo	individual	academic learning	analysing	a questioning attitude	critical awareness	designing	evaluating	formulating a common goal	observing	ordering and structuring	perspective taking	reasoning	reflection	serving	situation awareness	sound decision making
01		■											■		■		■	
02	■												■	■	■			
03	■									■			■				■	■
04		■	■		■	■									■			
05		■	■		■													
06	■		■		■	■			■			■			■			
07			■										■		■		■	
08	■				■	■							■				■	
09	■				■	■							■				■	
10	■				■	■							■				■	
11	■				■	■							■				■	
12	■		■		■	■			■			■		■				
13	■				■			■							■			
14	■		■		■	■			■			■			■			
18	■				■				■	■						■		
19	■				■				■									
22			■			■					■			■				
23			■			■					■			■				
24	■					■												
15	■					■				■		■			■			
16	■			■											■	■	■	
17	■				■	■			■						■			
20	■				■	■	■		■			■						
21	■								■	■								■

7

24 educational blueprints for circular constructions

01

Five essentials for successful circular biobased construction initiatives

How real estate professionals, (public) property owners and developers put circular biobased principles into practice.

keywords
biobased building circular building

code: CBCI3HZS013

credit: Léon van Woerkom

overview

Introduction to the concepts of circular buildings and the use of biobased materials in new constructions.

skills

- perspective taking
- situation awareness
- reflection

characteristics

- individual
- course / workshop

duration

2 x 60 minutes

target group

- Bachelor and master students
- Students from various fields of study for whom circular construction with biobased materials is unknown territory.

prerequisites

none

learning outcomes

- The student can list the five essentials from the white paper.
- The student can describe the five building blocks from the white paper.
- The student can illustrate for each of the five building blocks an example from the white paper.
- The student can explain why a building constructed from biobased materials and built according to the principles of circular building is more cost effective than traditional buildings.
- The student can explain how a well-considered choice of materials and construction methods increases the flexibility of a building.
- The student can explain the advantages of a passive building constructed with biobased materials in comparison to traditional buildings.
- The student can explain how an integral approach is necessary if one has the ambition to build in a circular way and with biobased materials.
- The student can explain why the choice for traditional ownership is the most appropriate choice in circular building projects with biobased materials.

setup - teacher preparation

Lesson 1:

- Watch the two minutes introductory video on the Circular Biobased Construction Industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**
- Read the white paper *"Five essentials for successful circular bio-based construction initiatives"*.
- Take a look at the corresponding slideshow.
- Collect the questions prepared by the students and use them to complete a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz.
- Optional: Watch the corresponding video lectures.

setup - student preparation

Lesson 1:

- Study the white paper *"Five essentials for successful circular bio-based construction initiatives"*.
- Design two multiple choice questions that can be integrated into a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz.
- Share the questions you prepared with the teacher.

Lesson 2:

The students prepare in teams of two an essay of maximum two pages wherein they explain the topics referred to in Learning Outcomes 4-8. Students from year two or above can be requested to explain the topics based on previously studies construction projects.

teaching setup

Lesson 1. Lecture

STEP 1: The teacher and the students together watch the introductory video on the Circular biobased construction industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**

STEP 2: The teacher provides a short lecture guided by the slideshow concerning the white paper *"Five essentials for successful circular bio-based construction initiatives"*.

STEP 3: The teacher organises a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz based on the questions he collected from students.

Lesson 2. Workshop

STEP 1: The teacher assigns some teams to share their findings in a five minutes presentation.

STEP 2: Students fire questions at the presenting peers.

STEP 3: Students provide feedback on the team that did the presentation.

STEP 4: The teacher offers feedback on presentation, questions, anwers and possible comments.

variations

The students study the subject independently based on the materials provided (white paper, presentation, video lecture) and share their work according to lesson 2 of the preparation student setup.

references

White paper:
White paper - Five essentials for successful circular bio-based construction initiatives.pdf
White paper - Vijf bouwstenen voor succesvolle circulaire biobased bouwinitiatieven.pdf

Avans_ETI. (2020, 14 december). Explanimation Circular Bio-based Construction Industry (CBCI) [Video]. YouTube. Geraadpleegd op 2 juni 2020, van https://www.youtube.com/watch?v=vtBeyPj4OZw

Koster, M., Schrotenboer, I., Van der Burgh, F., Dams, B., Jacobs, L., Versele, A. & Verdoodt, S. (2020). Five essentials for successful circular bio-based construction initiatives: How real estate professionals, (public) property owners and developers put circular bio-based principles into practice (White paper). CBCI.

Koster, M., Schrotenboer, I., Van der Burgh, F., Dams, B., Jacobs, L., Versele, A. & Verdoodt, S. (2020). Vijf bouwstenen voor succesvolle circulaire biobased bouwinitiatieven: Hoe vastgoedprofessionals, projectontwikkelaars, en publieke- en private vastgoedeigenaren circulaire biobased principes in praktijk brengen (White paper). CBCI.

White paper - presentation:
White paper - Five essentials for successful circular bio-based construction initiatives - Presentation.pptx

White paper - Video Lecture:
White paper - Five essentials for successful circular bio-based construction initiatives - Video Lecture (general).mp4

White paper - Video Lecture:
White paper - Five essentials for successful circular bio-based construction initiatives - Video Lecture (case studies).mp4

For more information:
scan the QR-code, or
go to the url: **edu.nl/m6dxn**

02

Cooperation models in circular economy

How and why working together positively influences the circular ambitions in construction projects.

keywords
Circular construction Cooperation models

code: CBCI3ULR023

credit: freepik.com

overview

What is cooperation? Why should/do stakeholders engage in cooperations and what barriers/pitfalls do exist? What cooperation models in construction do exist and in what way can they contribute to the change towards a CBCI? In what phases of the life cycle of buildings and how do cooperation find application?

skills

- perspective taking
- reasoning
- reflection

characteristics

- group
- case studies / course / workshop

duration

4 hours of lecture + 20 hours of service

target group

Master students

prerequisites

Basic knowledge on construction project processes and management.

learning outcomes

The students have a good understanding of the concept of cooperation, what types and models are applicable in the construction industry, how they can contribute to the circular economy and why they are significant at all.

setup - teacher preparation

Read the D1.1.5 report and relevant literature that was used for the report for additional background knowledge on cooperation models.

Lesson 1:

- The teacher needs to prepare his/her set up for collecting the input from the students during the group sessions. This could be analogue or digital. In addition some content to share the summary material of steps 1-4 needs to be prepared.
- At the end of lesson 2, the students need to be divided into groups for and are appointed a case study to analyse by the next lesson.

Lesson 2:
For step 1, prepare content to explain the Kaats & Opheij cooperation model. Study and analyse the case studies in preparation of step 2.

setup - student preparation

Lesson 1:
No preparation needed.
Lesson 2:
Study and analysis of the case study based on the content learned in lesson 1.

teaching setup

Lesson 1. What? Who and Why?
STEP 1: What is cooperation?
In a group session using sticky notes or an app or an online platform like Miro, the characteristics of cooperation are gathered to come to a good definition (common goal, retaining autonomy, sharing abilities, responsibilities, limited duration etc.). In a concluding step an overview of relevant characteristics and a available definitions are presented.
STEP 2: Which stakeholders should be considered when cooperating in the construction sector?
Similarly to step 1, the students document stakeholders using sticky notes or an app or an online platform like Miro. A case study from the CBCI project can be used to make it more concrete for the participants (like the temporary court house of Amsterdam). The teacher/lecturer organises the different stakeholders in groups while the discussion is going on. Afterwards the quadruple helix system is presented as an overall conclusion on stakeholders in cooperations.
STEP 3: Why cooperation?
Similar to the first two steps the students think of reasons and added benefits of cooperation. In addition Barriers and Pittfalls can be discussed.
STEP 4: Cooperational models - intersectoral cooperation
Several case studies can be presented to the students to demonstrate the gathered theory in practise. For example: industrial ecosystems, CESOCO's, SME Clusters, Community Currencies and local supply chains.

Lesson 2. Cooperational models - inter-organisational cooperation
The cooperation model of Kaats & Opheij is used to give the students more insight in how cooperation works on project level.
STEP 1: The model of Kaats & Opheij is presented and demonstrated using the cases giving in the relevant literature (Kaats, Opheij, 2014).

STEP 2: The students were divided into groups in lesson one and in preparation of lesson 2 studied a case study from WP1 that was appointed to them. The students work in their individual groups and apply the cooperation model to their case. Afterwards they give a small presentation of their findings to the whole group.

example

Lesson 2: The youth wing for the Emergis clinic (with the donor building at Terneuzen) can be used as case to apply the cooperation model of Kaats and Opheij. The case lies between an explorative and enterpreneurial cooperation. The stakeholders did not know what they would end up with at the end of the project and the risk is shared over the most important stakeholders (including the client, which is rare).

variations

- Lesson 1, step 4, can be changed into a group work form or an additional lesson where the students need to study the cases themselves and present their findings.
- Additional information can be given on the different types of cooperation and their legal aspects (Integrated contracts, construction teams, alliancing etc.)

remarks

- This is cooperation from a general perspective. This is not so much about project management or the deontological triangle in the constructions. It is about more global concepts that deal with the sector level.
- Teachers who teach in the Dutch language can expand the lesson with the knowledge clip "Cooperation models in the initiation stage". In it, researcher Lode Lefevre explains the design of such a process illustrates with a real-life example. Make this part of the student's preparation, or choose to watch and discuss the video together. Duration 35 minutes. The video is available on the website.

references

CBCI White Paper of WP1
CBCI D1.1.5 report on cooperation models

A View of SME Clusters and Networks in Europe:
Potinecke, T., Rogowski, T., Boucher, X., Dolgui, A., Agoti, S., Stylios, C., Groumpos, P. P., Heavey, C., Liston, P., Byrne, P. J., Salvador S., & Salvador, M. (2009). A view of SME clusters and networks in Europe. In A. Villa & D. Antonelli (Eds.), *A road map to the development of European SME networks: Towards collaborative innovation* (pp. 23-60). Springer. https://doi.org/10.1007/978-1-84800-342-2_2

Kaats, E., & Opheij, W. (2014). *Creating conditions for promising collaboration: Alliances, networks, chains, strategic partnerships*. Springer.

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Taurino, T. (2015). Evaluating Collaboration and Governance in SME Clusters. In L. M. Camarinha-Matos, F. Bénaben, & W. Picard (Eds.), *Risks and resilience of collaborative networks* (pp. 388–397). https://doi.org/10.1007/978-3-319-24141-8_35

For more information:
scan the QR-code, or
go to the url: **edu.nl/vgygn**

03

Role-play in initiation teams

Role-play to master the dynamics in a building initiate team.

keywords
initiation circular ambition building trust giving culture

code: CBCI4AHS024

credit: shutterstock, Martin Bergsma

overview

Role-play is a strong learning tool to experience how the various stakeholders in a large construction project can contribute to enable ambitious circular construction solutions. Find the case study and approach here.

skills

- formulating a common goal
- perspective taking
- situation awareness
- sound decision making

characteristics

- group
- workshop

duration

135 minutes

target group

Bachelor and master students

prerequisites

Students should have an understanding of the role of a client, the use of construction teams and the relevance of working with the environment.

learning outcomes

- Have students discover the power and expertise of stakeholders in the view of collective new building solutions.
- Reveal bottom-up solutions that respect the background.
- Create a “giving culture” and culture of mutual understanding for professionals.
- Recognizing what it takes to build trust in a multidisciplinary context.
- Share actionable ideas and help one another.

setup - teacher preparation

- Read the Whitepaper
- Check the roles in the set-up of this roleplay and consider their relevance
- Create a logistical design for the roleplaying game appropriate to the group size

setup - student preparation

- Read the Whitepaper
- Focus on items that illustrate the need for knowledge from different perspectives.
- Think ahead about which parties should ideally be involved at the start of a construction project that must excel on circularity and material use. Bring a short list to the class room.

teaching setup

Invite all participants to come together in as many small groups as you provide roles. Have them delegate a role player.

- Client
- Contractor
- Future occupant (required up to and including here)
- Architect
- Logistics partner (transport and storage)
- Municipality
- Producer
- The climate
- The neighbour

A detailed teacher guide with a timeline is online available

Design of the role-play meeting.
STEP 1: Introduce the LivingWins case. Present a motivational invitation to participants, divide roles, and appoint a chairperson with an advisor/writer.
STEP 2: Students prepare their roles, and identify with an imaginary person in the role.
STEP 3: Go through the five rounds of the meeting. Each round of this group discussion opens with a question. Allow participants to think about it for a moment. Next, participants bring their information forward. The chair identifies common points and deepens the issues with the role-players. The chair rewards a problem-solving attitude and a giving culture.
STEP 4: Now find the commonalities between the contribuants in the group. Conclude what sustainable ambitions the participants already have in common. Check what ambitions are valuable but challenging.
STEP 5: Debrief and capitalize on learning experiences for the students.
STEP 6: Check out. Pay particular attention to those who have played a role that has been in the spotlight.

variations

This workshop can also be done well online using a digital whiteboard such as Mural or Miro. In that case, the questions are prepared online and the participants make their contributions on the sticky notes. This requires the teacher to be experienced in facilitation.

The debrief can also be given to individual students as an assignment. In a subsequent lesson, the teacher can add their own points of interest and elaborate on points that were left too much in the excitement of the role-play.

remarks

Roleplaying is a useful form of work that can also meet initial resistance. Which contributes to success and fun:

- Give students time to settle into the role, and end that phase by making a name tag so that role players have a good idea of who they are at the table with.
- then, as chair, proceed to address people in their roles.
- If things get awkward, it is a good idea to take a three-minute time-out. Roleplayers use this time to improve the interpretation of the role with a partner.
- Apply a thorough schedule. The briefing in the teaching materials provides general instructions for role players.

references

Koster, M., Schrotenboer, I., Van der Burgh, F., Dams, B., Jacobs, L., Versele, A. & Verdoodt, S. (2020). Five essentials for successful circular bio-based construction initiatives: How real estate professionals, (public) property owners and developers put circular bio-based principles into practice (White paper). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/wphd7**

04

CBCI - Back to the future

Longterm succes and failure factors for upscaling of the circular and bio-based construction industry with a focus on flexibility.

keywords
flexibility circularity R-value succes and failure factors

code: CBCI1AHR012

credit: Istock, LuckyStep48

overview

In this module, the thinking is reversed in time. Circularity and flexibility only come to value in the utilization phase of the building. What elements in the design, process, the information provision and commitment of people lead to that success?

skills

- analysing
- a questioning attitude
- reflection

characteristics

- individual / duo
- workshop

duration

1 lesson including workshop-element of 1,5 hour

target group

Bachelor and masters students

prerequisites

General knowledge of the concept of building and rebuilding

learning outcomes

- The student takes a reflective stance on the long-term effects of circular building.
- The student understands where responsibilities are taken, what actions by whom, and what roles are required for exploiting the flexibility and adaptability of a building concept.
- The student knows the meaning of the period between the first delivery and the realization of the variants for which flexibility is specifically used.

setup - teacher preparation

STEP 1: Read the CBCI Whitepaper 1.
STEP 2: Study the flexibilty calculators and materials related to flexibility available in the CBCI database.
STEP 3: Study the CBCI case of your choice or study an alternative case that incorporates flexbility design principles which were used during the use phase (a building that was adapted or moved location for example).
STEP 4: List all possible succes and failure factors of flexibility and CBCI in preparation of the plenary session with the students.

setup - student preparation

- For Case Emergis: Watch the teaser: **https://www.youtube.com/watch?v=L1cuH_iKlIg**
- For Variety Living Lab KU Leuven: Watch the teaser **https://www.youtube.com/watch?v=aRyHqChgEJU&t=1s**
- Read the CBCI Whitepaper 1 *"Five essentials for successful circular bio-based construction initiatives"* the general introduction and the section about the following essential: *Flexible Ownership. Pay particular attention to the cases: Emergis (p.12), Tijdelijke Rechtbank (p.14), Science Museum Group (p.18) and Adnams Brewery (p.21).*
- Check the glossary on the terms 'Bio-based', 'Circular', 'Flexible', 'Adaptible', 'Building components', Demountability, Disassembly, Durabiility' and 'End of Life'.

teaching setup

It's February 8, 2025. You are part of the group that built the wonderful living lab Emergis. Emergis even added wings and moved some modules. And it has been successful. So: the process that your building team set in motion in 2022 has been a tremendous success. Your organization has won the National Award for the biobased and circular construction industry. A reporter from the BBC is here to interview you.

STEP 1: Introduction film CBCI 2020 (shows the overall context for the workshop).
A short summary of CBCI White Paper 1 is given and/or the experience film of the CBCI Living Lab is shown.
An introduction on White Paper essential 2 (Flexibility) is given. Look into long term window on reusability (PP sheet 8).
STEP 2: As a personal reflection the in plenary form a padlet with learnings is filled in.
STEP 3: Prepare for future functions: explain the levels of flexibility (PP sheet 11- 13).
STEP 4: Take a case students are familiair with, go back in time and analyse flexibility via these perspectives.
STEP 5: Interview preparation. Discuss the success of your case. What has happened since 2022? How will that success be accomplished? Discuss in your subgroup what you will tell the reporter. In each subgroup, someone is taking notes. At the end of this conversation, what is your most important insight? Nominate someone who will share your most important insight to the large group. The presentation should last no more than 1 minute.
STEP 6: Plenary presentations of lessons learned from the cases. What are the most important success factors and added benefits of design-for-adaptability and flexbility?

variations

Use the presentation with an adjustment, adapt it to Living Lab KU Leuven in Ghent. It is interesting to pay attention to the topic of construction waste in the discussion.

The spin-off of the CBCI Living Lab KULeuven has managed to realize 250 houses like the Living Lab in 3 years time. Some homes were expanded or already relocated. The whole concept appears to be a success. The flexibility of the houses allows us to respond to changing needs with a minimum of waste and a second-hand market of Living Lab components (floors, walls, windows,...) is created.

remarks

Thinking from a future perspective requires some preparation of a situation outline that allows students to move their thoughts to the future, and storytelling, e.g., saying something about what stage of life they are in then, helps with that.

references

Koster, M., Schrotenboer, I., Van der Burgh, F., Dams, B., Jacobs, L., Versele, A. & Verdoodt, S. (2020). *Five essentials for successful circular bio-based construction initiatives: How real estate professionals, (public) property owners and developers put circular bio-based principles into practice* (White paper). CBCI.

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CBCI Calculators:
CBCI Calculator - End-of-life.xlsx (+ download URL for future updates)
CBCI Calculator - Flexibility.xlsx (+ download URL for future updates)

Calculator workshop presentations:
Learning Session 1 - Presentation - Essential 5 - Ownership & end of life scenario's.pptx (slide 6-8, 10)
Learning Session 2 - Presentation - Essential 2 - Flexibility.pptx (slides 7-18, 22)

CBCI. (2020). *Design and simulation for CBCI LL Ghent: Introduction* (v.1 Internal). CBCI.
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For more information:
scan the QR-code, or
go to the url: **edu.nl/mw9jw**

05

Basic biobased structural and facade materials & construction methods

Circular construction, basic concepts, and recognizing levels of circularity.

keywords

materials
biobased materials
circular
R-value
levels of circularity

code: CBCI3AHR005

credit: Matthew Barnett Howland, Dido Milne, Oliver Wilton

overview

This class introduces students to relevant characteristics, applicability and functional performance of biobased insulation materials. Students will study an example of a comparative study of insulation options for different parts of a building.

skills

- analysing

characteristics

- individual / duo
- workshop

duration

2 x 90 minutes

target group

Bachelor and master students

prerequisites

Knowledge of the concept biobased materials.

learning outcomes

- Students know at least 5 biobased insulation materials and additionally 3 non-biobased materials, if not yet known before.
- Students know the indicators of quality and durability, from present insights and norms, main indicators for architects and builders from the application perspective.
- Student are able to compare materials, make trade-offs and from a sustainability and feasibility perspective, and defend the outcome from a sustainability perspective.
- Student can bring up simple research questions from their reflections on insulation materials.

setup - teacher preparation

- Study paper D2.1.1: Technical specifications - bouwmaterialenbieb: insulation and facade materials. Add your own favorite materials. Prepare an explanation the concept R-value.
- Prepare the definition of biobased materials. Collect pictures of the mentioned materials, or better, bring samples of the materials.
- Go though the materials of *Workshop WP3 Technical specifications of biobased insulation materials*.
- Check CBCI Materials List v1.0 and the CBCI Standard list.
- Be prepared regarding the 8, 9 or 10R model on circularity, as you know it.

setup - student preparation

Lesson 1:

- Lesson 1: Study datasheet D2.1.1: Technical specifications - bouwmaterialenbieb. Prepare a presentation of materials for roof insulation and Facade insulation. Study the additional presented materials.
- Our preparation for workshop 1: Visit an advanced construction site in your neighbourhood and, through brief interviews and inquiries, find out the insulation material used and the motivation for that material. Find out what the characteristics of the insulation material are.
- Make a 4 sheet presentation, start with a picture of the construction site, discuss the material and end with questions reflecting on the use of that insulation material.Bring focus to this assignment by highlighting three criteria from the top row of materials. For example, thermal conductivity, specific heat capacity and compostability.

Lesson 2:

- Lesson 2: Study data sheet D2.1.1: Prepare a presentation on the specifications listed in the top row and argue which ones you want to be prioritized for decision making.
- Write a paper of 3000 words as a preparation for workshop 2. Do you prefer to make a visual? Running text may be replaced by a graphic figure, provided you explain how to read that figure.

teaching setup

Individual preparation: A short introduction on film, 10 minutes with the learning outcomes and the first assignment, make your own recording.

Workshop 1
STEP 1: Organize the desks in your lesson room to 5 stations, one station for each insulation material.
STEP 2: Invite the students to go to the insulation material they prepared the best, reallocate if necessary. End this part with short presentations, one for each material.
STEP 3: Make groups of a maximum of 5 students and give two samples to choose from. Invite to discuss the chosen material: list specifications and applicability. Assign each group a classic insulation material, require an in-depth comparison, ready for presentation.
STEP 4: Discuss the materials in depth in front of the group. Refer to the preparation. Ask randomly for participants to bring in the information from their preliminary study. Organize for every material a presentation group and a group of critical friends.

Workshop 2
STEP 1: show circular/recycled and biobased and common non-biobased insulation materials in a display, possibly with a picture of the application.
STEP 2: Study discussion, all students bring in a question of their interest in response to their preliminary study. Group questions accordingly to the number of groups of 3á4 participants. Invite a chairperson and helper. The latter will keep notes of the group results.
Have each student join a table of conversation. The task for the groups is to use the knowledge gained for the papers to explore answering the question. Each group has to bring at least 3 insights.

STEP 3: Plenary discussion of the results. End up with filling in together online a matrix of materials against circularity, applicability or feasibility. An activation tactic here is the use of a Miro or Mural template.

remarks

The method requires sessions of at least 1.5 hours.

references

CBCI team workpackage2. (2022). Material list. CBCI.
D2.1.4 Report on testing protocols
D3.2.1 Report on Rules&Regulations
Standards List (@Annelies de opsteller is CBCI team workpackage3)
Regulations list (@Annelies de opsteller is CBCI team workpackage3)

Dams, B., Cascione, V., Verdoodt, S., Lefevre, L., Kayacetin, C., Kretschmann, T., Quanjel, E., Nguyen, E., Shea, A., Maskell, D., Van der Burgh, F., Verspeek, S., & Sluis, J. (2022). *Test protocols on real-life settings testing: Analysis of performance: Parts 1-4* (Research Report D2.1.4). CBCI.

Vrijders, J., Nguyen, E., Van Bremen, R., Ronda, P., Van der Burgh, F., Verspeek, S., Versele, A., Beaujean-Kuijsters, A., & Walker, P. (2020). *Exploration of the current and future framework of product standards, policy and legislation in circular bio-based construction in the 2Seas-region* (Research Report D3.2.1, v.3 pre-final). CBCI.

For more information:
scan the QR-code, or
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06

Prototyping testing of biobased and circular construction

How to organise, perform and report tests of CBC prototypes.

keywords
prototype testing
indoor air quality
structural testing
fire safety testing
hygrothermal testing

code: CBCI2ULR003

credit: CBCI

overview

In this module it is described what (inter) national standards of the two-seas region and what rules of good practice should be taken into account when testing prototypes and how to report on findings. This can be hygrothermal, accoustic or structural testing. This module considers the component scale.

skills

- analysing
- a questioning attitude
- evaluating
- ordening & structuring
- reflection

characteristics

- individual / group
- course / workshop

duration

2 x 60 - 90 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on biobased and circular construction principles.
Basic knowledge on building characteristics.

learning outcomes

- The students have basic knowledge on where to find and to some extend the content of existing standards on construction related testing of testing set-ups/samples (hygroscopic, thermal, structural or acoustic) and in addition how to interpret these documents.
- The students learn how to organise and perform a testing procedure and how to report on the foundings.

setup - teacher preparation

- Study the general content on prototype testing of the CBCI research project. Firstly, this contains a list of testing protocols for testing of the different characteristics (thermal, hygroscopic, acoustic and structural aspects) in the different reports of the CBCI research project. Secondly a list of deconstruction (specific circularity characteristic) is provided. Lastly the testing reports of the performed test is available. Document where the specific standards for testing can be found and how to interpret them. Study the specific test cases of the CBCI project, including the test standards, test set-ups and test reports.
- Document what specific prototyping testing can be performed at your teaching organisations' facilities and that are suitable for the curriculum of the students. Look into what tests and results of the CBCI research project can be used as a case for exemplary purposes.

- Specifically for a testing workshop; make all preparations necessary for the students to organise themself, preparations for the test can be a specific part reserved for the students and have an educational purpose.

setup - student preparation

- The students need to have an advanced level of construction and a good understanding of either one of the following topics structural engineering, building physics, indoor air quality or acoustics. Preparatory courses that educate on these specific topics and/or a refreshing of these topics by the students on an independent basis before the course starts can be relevant preparations.

- Specifically for a testing workshop; make all preparations necessary to have a successful test, read the instructions in advance, bring necessary equipement and prepare reporting files.

teaching setup

Lesson 1. Theory (by means of course presentation by the teacher)
STEP 1: Recap of testing dimensions (thermal, structural) and purpose of testing.
STEP 2: Overview of existing standards and where to find them.
STEP 3: How to organise, perform and report tests of CBC prototypes.
STEP 4: The CBCI research project testing as case study.

Lesson 2. Workshop (by students, teacher gives guidance)
STEP 1: Testing preparations.
STEP 2: Test performing and logging.
STEP 3: Test reporting, evaluation and conclusion.

example

Lesson 1. Theory
STEP 1: The hygrothermal properties of biobased medium stiff insulation materials are discussed in the theory, including basic theory and strenghts and weaknesses of the specific considered material.
STEP 2: The relevant standards for testing are documented in preparation of the test.

Lesson 2. Workshop
STEP 1: A test set-up is made using the chosen material togheter with a benchmark set-up.
STEP 2: Tests are performed.
STEP 3: Evaluation.

remarks

This could be a perfect basic course in preparation of a master thesis which involves some kind of lab testing.

references

D2.1.4 Analysis of performance
D2.2.2 Test protocols on construction methods
D2.2.3 Deconstruction Analysis

or alternatively, directly from the ISO norms:
-> Outdoor & indoor climate (T, RH, black bulb T, indoor comfort, CO2, VOC, PM)
Measurement protocol Flanders, NBN ISO 16798, NBN ISO 7243, NBI ISO 7726, NBN ISO 7730, NBN ISO 15251, NBN ISO 13779, BS ISO 16000-31:2019, EN 12341,
-> Building envelope (air permeability, draught rate, whole space heat loss, infrared scan)
Bauwens and Roel (2014), NBN ISO 6781, Katrien Maroy (2015)
-> Light quality (light intensity)
NBN ISO 12464-1
-> Energy (Energy use monitoring)
NBN ISO 6946
-> Water (Water use monitoring, rainwater collection or water purification if applicable)
BS 8542:2011, BS EN 16941, BS ISO 20468 (part 1, part 2, part 5)

British Standards Institution. (2011). *Calculating domestic water consumption in non-domestic buildings: Code of practice* (BS 8542:2011). BSI Group.
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International Organization for Standardization. (2018). *Guidelines for performance evaluation of treatment technologies for water reuse systems: Part 1: General* (ISO 20468-1:2018). ISO.
International Organization for Standardization. (2019). *Guidelines for performance evaluation of treatment technologies for water reuse systems: Part 2: Methodology to evaluate performance of treatment systems on the basis of greenhouse gas emissions* (ISO 20468-2:2019). ISO.
International Organization for Standardization. (2021). *Guidelines for performance evaluation of treatment technologies for water reuse systems: Part 5: Membrane filtration* (ISO20468-5:2021). ISO.

For more information:
scan the QR-code, or
go to the url: **edu.nl/e49gg**

07

Circular and biobased ambitions in construction projects; an integrated approach to the tendering process

Experiences of front-runners and living labs for the design of the procurement and tendering process to realise circular biobased ambitions.

keywords
biobased building circular building

code: CBCI3HZR021

credit: CBCI

overview

Introduction to the procurement framework for circular biobased buildings.

skills

- perspective taking
- situation awareness
- reflection

characteristics

- individual
- course / workshop

duration

2 x 60 minutes

target group

Bachelor and master students from various fields of study for whom circular construction with biobased materials is unknown territory.

prerequisites

none

learning outcomes

- The student can summarise the most important message that everyone should heed when starting a tendering procedure for circular biobased buildings.
- The student can describe the four steps of the tendering process from the white paper.
- The student can illustrate for each of the four steps an example from the white paper.
- The student can explain why starting the tendering process with the end in mind is quintessential in a tendering process for circular biobased buildings.
- The student can comment each of the focus areas in the initiation procedure for circular biobased buildings.
- The student can comment each of the focus areas in the definition procedure for circular biobased buildings.
- The student can comment each of the focus areas in the tendering procedure for circular biobased buildings.
- The student can comment each of the focus areas in the realisation procedure for circular biobased buildings.

setup - teacher preparation

Lesson 1:

- Watch the two minutes introductory video on the Circular biobased construction industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**
- Read the white paper *"Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process"*.
- Take a look at the corresponding slideshow.
- Collect the questions prepared by the students and use them to complete a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz.
- Optional: Watch the corresponding video lecture.

setup - student preparation

Lesson 1:

- Study the white paper *"Circular and biobased ambitions in construction projects; an integrated approach to the tendering process"*.
- Design two multiple choice questions that can be integrated into a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz.
- Share the questions you prepared with the teacher.

Lesson 2:

The students prepare in teams of two an essay of maximum two pages wherein they explain the topics referred to in Learning Outcomes 4-8. Students from year two or above can be requested to explain the topics based on previously studies construction projects.

teaching setup

Lesson 1. Lecture

STEP 1: The teacher and the students together watch the introductory video on the Circular biobased construction industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**

STEP 2: The teacher provides a short lecture guided by the slideshow concerning the white paper *"Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process"*.

STEP 3: The teacher organises a Kahoot! **(kahoot.com)** or Whooclap **(whooclap.com)** quiz based on the questions he collected from students.

Lesson 2. Workshop

STEP 1: The teacher assigns some teams to share their findings in a five minutes presentation.

STEP 2: Students fire questions at the presenting peers.

STEP 3: Students provide feedback on the team that did the presentation.

STEP 4: The teacher offers feedback on presentation, questions, anwers and possible comments.

variations

The students study the material independently based on the materials provided (white paper, presentation, video lecture) and share their work according to Lesson 2 of the preparation student setup.

references

White paper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process.pdf
White paper - Circulaire en biobased ambities in bouwprojecten; een integrale aanpak van het aanbestedingsproces.pdf

Avans_ETI. (2020, 14 december). Explanimation Circular Bio-based Construction Industry (CBCI) [Video]. YouTube. Geraadpleegd op 2 juni 2020, van https://www.youtube.com/watch?v=vtBeyPj4OZw

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Van Eenennaam I., & Quanjel E. (2021). *Circulaire en biobased ambities in bouwprojecten: Een integrale aanpak van het aanbestedingsproces: Ervaringen van koplopers en living labs voor het inrichten van het inkoop- en aanbestedingsproces om circulaire biobased ambities waar te kunnen maken* (White paper 2). CBCI.

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Van Eenennaam I., & Quanjel E. (2021). *Circular and bio-based ambitions in construction projects: An integrated approach to the tendering process* (White paper 2). CBCI.

White paper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process - Video Animation.mp4

For more information:
scan the QR-code, or
go to the url: **edu.nl/jrgcq**

08

Circular and biobased ambitions in construction projects. Part 1: initiative and feasibility phase

Acquiring insights to make circular biobased ambitions come to life in the procurement and contracting process, with two living labs as examples.

keywords
living labs | circular procurement | biobased procurement
initiative phase | feasibility phase

code: CBCI3AHS007

credit: stock.adobe.com | infographic: CBCI

overview

Based on two implemented practical cases (Living Lab KU Leuven and Living Lab Emergis) you will be taken through the past experiences within the CBCI project with circular and biobased ambitions in the procurement process. This blueprint consists of a series of four lessons, which can be followed separately as well sequentially.

skills

- analysing
- a questioning attitude
- perspective taking
- situation awareness

characteristics

- group
- course / workshop

duration

90 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on stakeholders involved and regular process of a procurement procedure.

learning outcomes

- The student will gain insight into how to procure circular and biobased manner in the initiation and feasibility phases. This is described in the white paper in such a way that this knowledge can be used and applied in the field.
- The student uses a lateral thinking and working process, which generates new ideas and insights to apply in the field.
- The student recognizes the tools used, as described in the white paper, in such a way to fulfil an advisory role in the field of circular and biobased procurement.
- The student becomes an ambassador for circular and biobased procurement.

setup - teacher preparation

Study the two Living Labs (Living Lab KU Leuven and Living Lab Emergis). The following material is available:

- General information about both projects
- Information video about the CBCI research project and two experience videos about the processes and faces behind the two Living Labs
- CBCI white paper on procurement
- Description of the project objectives and the building designs
- Tender dossiers of both Living Labs
- Evaluation documents on the procurement and implementation processes
- A white paper presenting practical experiences of both projects
- Process evaluation (KU Leuven Living Lab)

Prepare a presentation to share both Living Labs with the target audience in the meeting.
Make your own analyses in advance to guide the students.

setup - student preparation

- Read the white paper and study chapter 4 and 5.
- Study both CBCI Living Lab cases (Living Lab KU Leuven and/or Living Lab Emergis). Watch the experience videos and study the project definition(s) and building design(s).

teaching setup

STEP 1: Presentation on the project objectives and design of two Living Labs (can also be video)

STEP 2: Students choose one of the two Living Labs and analyze them in the following, using the white paper as a start.

Procurement framework
Part 1: Initiative and feasibility

- Own organization; map the stakeholders and make a project organization scheme.
- Market orientation; which market orientation is necessary to prepare for the procurement announcement?
- Type of cooperation; which type of cooperation seems appropriate for the specific project? What are the advantages and disadvantages of the various options?
- Market consultation; which parties should be consulted beforehand and how do you organize this?

STEP 3: Inverted assignment
Come up with and write down deteriorations for the chosen Living Lab based on the analysis already made. How do you make sure that the project fails on circularity/biobased in the tender? This is intended to help discover what so specifically does NOT help (and what we do wrong in the daily tenders).

STEP 4: Inventorise deteriorations and discuss.

STEP 5: Collect and discuss lessons learned related to circular and biobased procurement in terms of initiation and feasibility.

variations

- The lesson can be based on another project that is provided by the teacher. For example, take the most boring or least circular building you know of. It is key that this substitute project has similar characteristics in terms of circularity and biobased ambitions. The necessary documents for the case analysis should be provided.
- See STEP 3 of the teaching setup of blueprints 9, 10 or 11 for other educational methods, they are compatible with this blueprint.

remarks

The two CBCI cases differ a lot in procurement strategy. The lessons learnt for the students will depend on the case they chose. It is important to share lessons learned from both cases with the entire group.

references

2021 CBCI Whitepaper - Circulaire en biobased ambities in bouwprojecten; een integrale aanpak van het aanbestedingsproces
2021 CBCI Whitepaper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process
D4.3.1 Description of the Emergies Living Lab design
A4.4 Introduction - project goals of the KU Leuven Living Lab
D4.4.1 Description of the KU Leuven Living Lab design
D4.3.2 Tender of the Emergis Living Lab
D4.5.1 Tender of the KU Leuven Living Lab
D4.6.1 Process evaluation of the KU Leuven Living Lab (including relevant annexes)

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circulaire en biobased ambities in bouwprojecten: Een integrale aanpak van het aanbestedingsproces* (Whitepaper). CBCI.

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circular and bio-based ambitions in construction projects: An integrated approach to the tendering process* (Whitepaper). CBCI.

Brugman, R., Helmendach, C., Scherpenisse, M., Roovers, P., Van Bremen, R., Van der Burgh, F., & Verspeek, S. (2019). *Tendering method Emergis.* CBCI.

KU Leuven, Technische Diensten. (2020). *Ontwerp en leasing van de technische uitrustingen als plug-in module voor een rijwoning: Living lab.* KU Leuven.

CBCI. (2020). Aanbestedingsstrategie (PowerPoint). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/ydqk8**

09

Circular and biobased ambitions in construction projects. Part 2: project definition

Acquiring insights to make circular biobased ambitions come to life in the procurement and contracting process, with two living labs as examples.

keywords
living labs
project definition
circular procurement
biobased procurement

code: CBCI3AHS014

credit: stock.adobe.com | infographic: CBCI

overview

Based on two implemented practical cases (Living Lab KU Leuven and Living Lab Emergis) you will be taken through the past experiences within the CBCI project with circular and biobased ambitions in the procurement process. This blueprint consists of a series of four lessons, which can be followed separately as well sequentially.

skills

- analysing
- a questioning attitude
- perspective taking
- situation awareness

characteristics

- group
- course / workshop

duration

90 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on stakeholders involved and regular process of a procurement procedure.

learning outcomes

- The student will gain insight into how to procure circular and biobased manner in the initiation and feasibility phases. This is described in the white paper in such a way that this knowledge can be used and applied in the field.
- The student uses a lateral thinking and working process, which generates new ideas and insights to apply in the field.
- The student recognizes the tools used, as described in the white paper, in such a way to fulfil an advisory role in the field of circular and biobased procurement.
- The student becomes an ambassador for circular and biobased procurement.

setup - teacher preparation

Study the two Living Labs (Living Lab KU Leuven and Living Lab Emergis). The following material is available:

- General information about both projects
- Information video about the CBCI research project and two experience videos about the processes and faces behind the two Living Labs
- CBCI white paper on procurement
- Description of the project objectives and the building designs
- Tender dossiers of both Living Labs
- Evaluation documents on the procurement and implementation processes
- A white paper presenting practical experiences of both projects
- Process evaluation (KU Leuven Living Lab)

Prepare a presentation to share on both Living Labs with the target audience in the meeting.

setup - student preparation

- Read the white paper and study chapter 6.
- Study the two CBCI Living Lab cases. Watch the two experience videos and study the project definitions and building designs.

teaching setup

STEP 1: Presentation on the project objectives and design of two Living Labs (can also be video)

STEP 2: Students choose one of the two Living Labs and analyze them in the following, using the white paper as a start.

Procurement framework.
Part 2: definition

- New purpose; summarize the project objective.
- Procurement strategy
- Functional specification or specifications; how will you describe the project result? Give a number of examples for the chosen approach.
- Management, maintenance and revision; how will these project phases be included in the tender?

STEP 3: Perspectives
Determine with the group which roles/ function groups are active in this phase of a construction project. Who are involved? What interests are involved? Divide the roles in the group. Ask the participants to put themselves in their role and look again at the analysis of part 2. All ideas and improvements are welcome.

STEP 4: Inventorise perspectives and discuss.

STEP 5: Collect and discuss lessons learned related to circular and biobased procurement in terms of project definition.

variations

- The lesson can be based on another project that is provided by the teacher. For example, take the most boring or least circular building you know of. It is key that this substitute project has similar characteristics in terms of circularity and biobased ambitions. The necessary documents for the case analysis should be provided.
- See STEP 3 of the teaching setup of blueprints 8, 10 or 11 for other educational methods, they are compatible with this blueprint.

remarks

The two CBCI cases differ a lot in procurement strategy. The lessons learnt for the students will depend on the case they chose. It is important to share lessons learned from both cases with the entire group.

references

2021 CBCI Whitepaper - Circulaire en biobased ambities in bouwprojecten; een integrale aanpak van het aanbestedingsproces
2021 CBCI Whitepaper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process
- nieuwe bestemming (aanbestedingsdossier Emergis en projectdefinitie KUL A4.4)
- aanbestedingsstrategie (powerpoint aanbestedingsstrategie KUL)
- functioneel specificeren of bestek? (Bestek Emergis & outputspecificaties structuur&schil KUL LL)
- beheer, onderhoud en revisie (outputspecificaties Plug-in KUL LL + contract)

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circulaire en biobased ambities in bouwprojecten: Een integrale aanpak van het aanbestedingsproces* (Whitepaper). CBCI.

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circular and bio-based ambitions in construction projects: An integrated approach to the tendering process* (Whitepaper). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/xbc3g**

10

Circular and biobased ambitions in construction projects. Part 3: procurement

Acquiring insights to make circular biobased ambitions come to life in the procurement and contracting process, with two living labs as examples.

keywords
living labs circular procurement biobased procurement

code: CBCI3AHS015

credit: stock.adobe.com | infographic: CBCI

overview

Based on two implemented practical cases (Living Lab KU Leuven and Living Lab Emergis) you will be taken through the past experiences within the CBCI project with circular and biobased ambitions in the procurement process. This blueprint consists of a series of four lessons, which can be followed separately as well sequentially.

skills

- analysing
- a questioning attitude
- perspective taking
- situation awareness

characteristics

- group
- course / workshop

duration

90 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on stakeholders involved and regular process of a procurement procedure.

learning outcomes

- The student will gain insight into how to procure circular and biobased manner in the initiation and feasibility phases. This is described in the white paper in such a way that this knowledge can be used and applied in the field.
- The student uses a lateral thinking and working process, which generates new ideas and insights to apply in the field.
- The student recognizes the tools used, as described in the white paper, in such a way to fulfil an advisory role in the field of circular and biobased procurement.
- The student becomes an ambassador for circular and biobased procurement.

setup - teacher preparation

Study the two Living Labs (Living Lab KU Leuven and Living Lab Emergis). The following material is available:

- General information about both projects
- Information video about the CBCI research project and two experience videos about the processes and faces behind the two Living Labs
- CBCI white paper on procurement
- Description of the project objectives and the building designs
- Tender dossiers of both Living Labs
- Evaluation documents on the procurement and implementation processes
- A white paper presenting practical experiences of both projects
- Process evaluation (KU Leuven Living Lab)

Prepare a presentation to share on both Living Labs with the target audience in the meeting.

setup - student preparation

- Read the white paper and study chapter 7.
- Study the two CBCI Living Lab cases. Watch the two experience videos and study the project definitions and building designs.

teaching setup

STEP 1: Presentation on the project objectives and design of two Living Labs (can also be video)

STEP 2: Students choose one of the two Living Labs and analyze them in the following, using the white paper as a start.

Procurement framework
Part 3: Procurement

- Procedure; what types of procurement procedure are legally possible? What are the advantages and disadvantages in relation to the project's objectives?
- Selection criteria; what are the selection criteria used?
- Award criteria; what are the award criteria used?
- Contract; what type of collaboration has been chosen and what steps are included in the contract?

STEP 3: To choose is to lose?
Divide the group into two parts: one half focuses only on circular construction, the other half focuses only on biobased construction. Review with at least two people the analysis as described in step 2 and come up with tips/ ideas/ changes/ innovations etc, now that you are suddenly focused on one of the two terms. Does this give you new insights?

STEP 4: Inventorise insights and discuss.

STEP 5: Collect and discuss lessons learned related to circular and biobased procurement.

variations

- The lesson can be based on another project that is provided by the teacher. For example, take the most boring or least circular building you know of. It is key that this substitute project has similar characteristics in terms of circularity and biobased ambitions. The necessary documents for the case analysis should be provided.
- See STEP 3 of the teaching setup of blueprints 8, 9, or 11 for other educational methods, they are compatible with this blueprint.

remarks

- The two CBCI cases differ a lot in procurement strategy. The lessons learnt for the students will depend on the case they chose. It is important to share lessons learnt from both cases with the entire group.
- Teachers who teach in the Dutch language can expand the lesson with a guest lecture by Lode Lefevre, one of the authors. *"Het aanbesteden van een circulair gebouw, verhaal uit de praktijk"*. Duration 25 minutes. The video is available on the website.

references

2021 CBCI Whitepaper - Circulaire en biobased ambities in bouwprojecten; een integrale aanpak van het aanbestedingsproces
2021 CBCI Whitepaper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process
- procedure (powerpoint aanbestedingsstrategie KUL)
- selectiecriteria (aanbestedingsleidraad Structuur&Schil KUL LL)
- gunningcriteria (aanbestedingsleidraad Structuur&Schil KUL LL)
- contract (aanbestedingsleidraad Structuur&Schil KUL LL)

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circulaire en biobased ambities in bouwprojecten: Een integrale aanpak van het aanbestedingsproces* (Whitepaper). CBCI.

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circular and bio-based ambitions in construction projects: An integrated approach to the tendering process* (Whitepaper). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/467cf**

11

Circular and biobased ambitions in construction projects. Part 4: implementation

Acquiring insights to make circular biobased ambitions come to life in the procurement and contracting process, with two living labs as examples.

keywords
living labs
implementation
circular procurement
biobased procurement

code: CBCI3AHS016

credit: stock.adobe.com | infographic: CBCI

overview

Based on two implemented practical cases (Living Lab KU Leuven and Living Lab Emergis) you will be taken through the past experiences within the CBCI project with circular and biobased ambitions in the procurement process. A series of four lessons, which can be followed separately as well sequentially.

skills

- analysing
- a questioning attitude
- perspective taking
- situation awareness

characteristics

- group
- course / workshop

duration

90 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on stakeholders involved and regular process of a procurement procedure.

learning outcomes

- The student will gain insight into how to procure circular and biobased manner in the initiation and feasibility phases. This is described in the white paper in such a way that this knowledge can be used and applied in the field.
- The student uses a lateral thinking and working process, which generates new ideas and insights to apply in the field.
- The student recognizes the tools used, as described in the white paper, in such a way to fulfil an advisory role in the field of circular and biobased procurement.
- The student becomes an ambassador for circular and biobased procurement.

setup - teacher preparation

Study the two Living Labs (Living Lab KU Leuven & Living Lab Emergis). The following material is available:

- General information about both projects
- Information video about the CBCI research project and two experience videos about the processes and faces behind the two Living Labs
- CBCI white paper on procurement
- Description of the project objectives and the building designs
- Tender dossiers of both Living Labs
- Evaluation documents on the procurement and implementation processes
- A white paper presenting practical experiences of both projects
- Process evaluation (KU Leuven Living Lab)

Prepare a presentation to share on both Living Labs with the target audience in the meeting.

setup - student preparation

- Read the white paper and study chapter 8.
- Study the two CBCI Living Lab cases. Watch the two experience videos and study the project definitions and building designs.

teaching setup

STEP 1: Presentation on the project objectives and design of two Living Labs (can also be video)

STEP 2: Students choose one of the two Living Labs and analyze them in the following, using the white paper as a start.

Procurement framework
Part 4: Implementation

- Monitoring; what tools were used to monitor the process? What were the main lessons learned?
- Collaboration and innovation; how was collaboration managed?
- Management, maintenance and revision

STEP 3: Give marks
Make smaller groups of about 4 to 5 students. Review the analysis of STEP 2 and give marks, how do you think the analysed project, in the corresponding construction phase, scores on circular and biobased procurement? Score from 0 (worst) to 10 (best). Then discuss with the smaller group: Why did you choose this grade? What do you need to make it a higher score?

STEP 4: Inventorise findings and discuss with the entire group

STEP 5: Collect and discuss lessons learned related to circular and biobased procurement in terms of implementation.

variations

- The lesson can be based on another project that is provided by the teacher. For example, take the most boring or least circular building you know of. It is key that this substitute project has similar characteristics in terms of circularity and biobased ambitions. The necessary documents for the case analysis should be provided.
- See STEP 3 of the teaching setup of blueprints 8, 9 or 10 for other educational methods, they are compatible with this blueprint.

remarks

- The two CBCI cases differ a lot in procurement strategy. The lessons learnt for the students will depend on the case they chose. It is important to share lessons learnt from both cases with the entire group.
- Teachers who teach in the Dutch language can expand the lesson with two knowledge clips. Firstly *"Introductie Wat en waarom van de zogenaamde morphological chart"*. Researcher Lode Lefevre explains in 4 minutes the main lines. His second clip is *"Process map, de template voor een goed bouwproces"*. Duration 35 minutes. Make this part of the student's preparation, or choose to watch and discuss the video together. The videos are available on the website.

references

2021 CBCI Whitepaper - Circulaire en biobased ambities in bouwprojecten; een integrale aanpak van het aanbestedingsproces
2021 CBCI Whitepaper - Circular and bio-based ambitions in construction projects; an integrated approach to the tendering process
- monitoren (Kick-off sessie, brainstorm sessie, process monitoring D4.6.1, morphological chart)
- samenwerken en innoveren (Kick-off sessie, brainstorm sessie, process monitoring D4.6.1, morphological chart)
- beheer, onderhoud en revisie"

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circulaire en biobased ambities in bouwprojecten: Een integrale aanpak van het aanbestedingsproces* (Whitepaper). CBCI.

Scherpenisse, M., Ronda, P., Barentsen, K., Beaujean-Kuijsters, A., Torfs, S., Koster, M., Lefevre, L., Versele, A., Van Eenennaam, I., & E. Quanjel, E. (2021). *Circular and bio-based ambitions in construction projects: An integrated approach to the tendering process* (Whitepaper). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/buqve**

12

Rules & regulations in the circular and biobased construction industry

An overview of policies & governmental initiatives subjected to a reality check by legislation and regulations from the perspective of the two CBCI Living Labs.

keywords
rules and regulations EU Circular Policies

code: CBCI3AHS017

credit: stock.adobe.com

overview

The 3.2 activity in CBCI focusses on rules & regulations. D3.2.1 is a desk research report that collected info on rules & regulations, circular labels, certifications. In the white paper on rules & regulations, the lessons learned from a series of interviews, as well as the findings of the two living labs will be implemented with the desk research material.

skills

- analysing
- a questioning attitude
- evaluating
- ordening & structuring
- reasoning

characteristics

- individual / group
- course / workshop

duration

2 x 90 min + 1 x 60 min preparation

target group

Bachelor and master students
Students dealing with construction related topics (architects, engineers, contractorsfinanciers, project managers, client representatives, policy makers,...)

prerequisites

Basic knowledge on construction principles and project proces.

learning outcomes

- Insights into the hierarchical structure of concepts of laws and regulations, building standards, European regulations, certification etc.
- Insights into the impact of regulations on innovation in construction, and the space that circular and biobased building needs.
- Insights into the ambitions at the European and national level regarding circular and biobased building and how these relate to the existing regulations. Analyses of a situation in which circular building and regulation are pitted against each other.

setup - teacher preparation

In general, the teacher should have a general knowledge of the regular legislative frameworks applicable in construction. In addition, reading the desk research report and the white paper can provide a good insight into the effectiveness of circular and biobased policies and their relationship to mainstream legislative frameworks.

Lesson 1:
Provide advance info on "What is a 'policy'?, What is a 'tool'? and 'What is a 'properties chart'?. Students are divided into groups and assigned a policy or draw blind from a batch. Students are given the 'properties chart' to analyze their tool in advance. Those analyses are submitted before the lesson and the teacher makes a summary of this for step 3 the group interview.

Lesson 2:
The interviews/info from the living labs lessons learned are studied in advance. A framework (e.g. in Miro or flip board) is prepared to properly document the insights from step 3.

setup - student preparation

Lesson 1:
The student analyzes in his/her group the assigned policy using the 'properties chart'. For the lesson, the analysis is submitted. A pitch of the key properties and effectiveness on circularity and biobased material use is prepared.

Lesson 2:
Watch the CBCI videos of the two Living Labs in preparation. Also read the final report of both Living Labs.

teaching setup

Lesson 1. Ambitions
STEP 1: Student groups give a short presentation on the policy 'pulled' from them (e.g. EU Green Deal, Circular Economy Action Plan, updated Bioeconomy Strategy or on country level Circular Accelerator Centre, Green Deals, Flanders Circular). Each group has 5 minutes to pitch their policy. No more than 6 groups.

STEP 2: The groups will 'duel' in pairs and engage in discussion to find which of the two policies is most effective in achieving circularity and biobased material use in the building sector. The students throw in the properties of the formatted 'properties chart' into the fray.

STEP 3: All 'properties charts' are shared with the entire group in a summary overview by the teacher. In a group discussion, students share their insights on a general level and collaborate on learning and focus points in dealing with the policies.

Lesson 2. Reality Check
STEP 1: Lessons learned from the two living labs are shared with the group, through interviews recorded beforehand.

STEP 2: Students will discuss in their groups from last time if it is possible to adjusttheir policy from last lesson or improve the revealed obstacles.

STEP 3: The insights are shared with the group. In a group discussion, strategies to deal with the demonstrated difficulties are collected.

example

Different labels that exist on the market are collected and analysed by the students. In a discussion, the students compare their labels with others and see how effective and/or severe they are for realising circular and biobased ambitions. The labels are categories according to ISO 14020 standard, Environmental labels and declarations – General. In the discussion part it will become evident that not all labels are created equally and that caution is to be made for green washing.
In the second lesson it will become evident how to actually use and acquire such labels in a real life test case and how effectively they are used in such environments.

variations

The format of collecting data by the students that is analysed, then compared to similar data and finally held against the existing regulations as a means to define hurdles and coping strategies, can equally be applied to certification, standards and labels.

remarks

- Students dealing with construction related topics (architects, engineers, contractorsfinanciers, project managers, client representatives, policy makers,...).
- Teachers who teach in the Dutch language can expand the lesson with this intereresting casu that shows a practical dilemma. *"Circulariteit door hergebruik, Casus Dakvenster"*. Watch and discuss the video together. Duration 15 minutes. The video is available on the website.

references

D3.2.1. DeskresearchReport Rules and Regulations Circulair Biobased 2seas 28 april https://ap.lc/4j8Zi rapport rules and regulations White paper on rules and regulations

Vrijders, J., Nguyen, E., Van Bremen, R., Ronda, P., Van der Burgh, F., Verspeek, S., Versele, A., Beaujean-Kuijsters, A., & Walker, P. (2020). *Assessment of the current and future framework of product standards, policy and legislation in circular bio-based construction in the 2Seas-region* (V.3 pre-final) . CBCI.

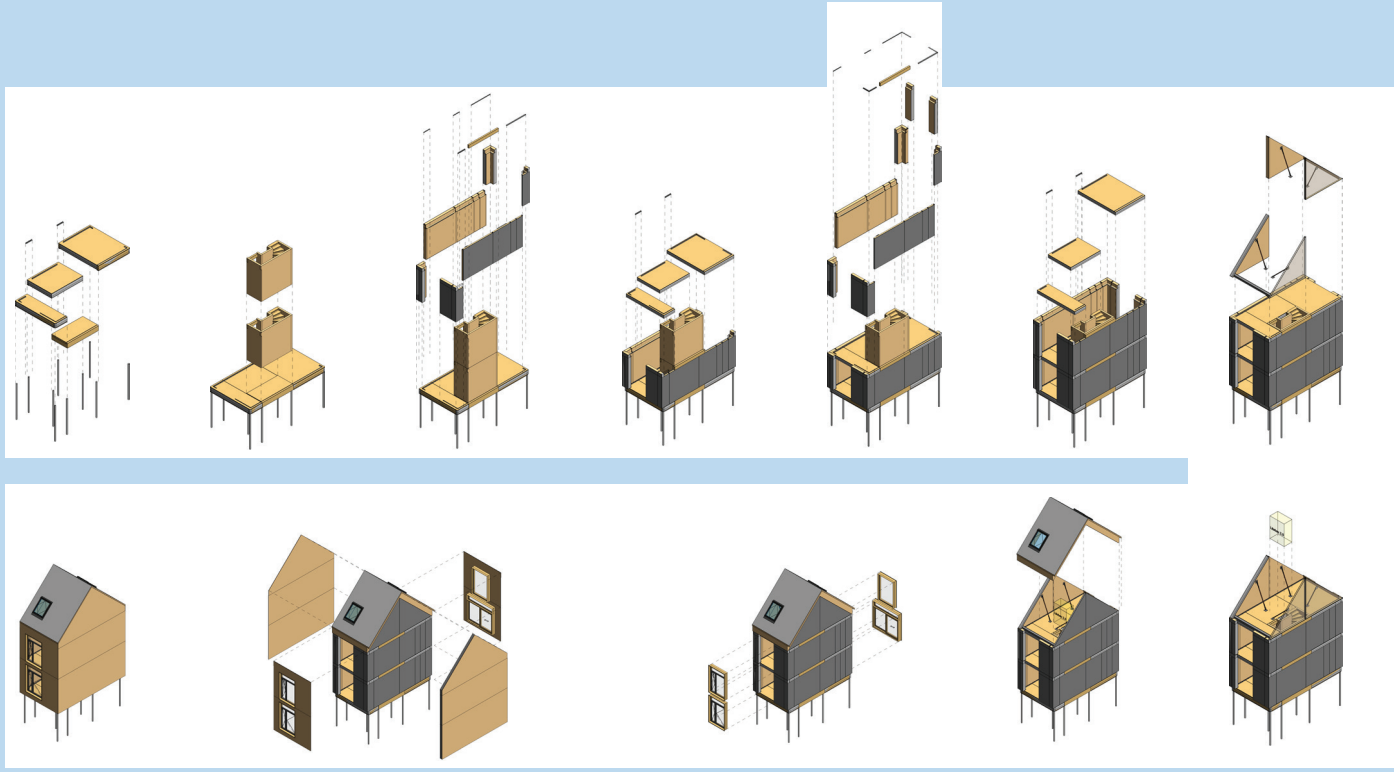
Van der Burgh, F., Van Bremen, R., Quanjel E., Ronda P., Verspeek S., & Nguyen E. (2022). *Hoe het wetgevend kader circulair, biobased bouwen kan stimuleren* (White paper 3). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/47tux**

13

Circular & biobased design approach, using an iterative design process

Based on the method of Chakrabarti.



credit: CBCI

keywords
biobased circularity iterative approach

code: CBCI3AHR008

overview

A spatial design is made on the basis of prior knowledge, prior study in the field of circular and biobased building methods plus a prep course and an example project. Here, advancing insight is continuously tested and applied in the next designing phase (research-based designing with an iterative approach). Then the three tools are applied to the design, using once again an iterative approach.

skills

- analysing
- designing
- reflection

characteristics

- group
- design studio

duration

5 x 90 minutes possible prep courses (14, 18, 20), 7 x 90 minutes design studio, 7 x 90 minutes design tools.

target group

Bachelor and master students, third year architecture/design specialisation.

prerequisites

Basic knowledge on biobased and circular construction principles + three courses (18: 'Measuring the social and societal impact of circular and biobased building', '20: Life cycle assessment of circular and biobased construction' and '14: Measuring circularity characteristics of circular and biobased construction').

learning outcomes

- The student analyzes his own design based on predefined criteria, in such a way that these advancing insights can be used in the redesign.
- The student demonstrates ability to deal with conflicting criteria, in such a way that a convincing explanation can be given for the decisions made.
- The student applies the principles of circular and biobased design in a design, in such a way that the input of the three mentioned lessons are reflected in the final result.
- The student applies an iterative design approach, such that advancing insight is visibly implemented in the redesign at least three times.
- The student understands interdependence between requirements, by using the tools: not all conditions can be met perfectly, each influence the other.

setup - teacher preparation

STEP 1: Study three CBCI lessons: 'Measuring the social and societal impact of circular and biobased building', 'Life cycle assessment of circular and biobased construction' and 'Measuring circularity characteristics of circular and biobased construction'.
STEP 2: Study the iterative design process, among others described in D4.4.1 Design and Simulation (adapted from Blessing and Chakrabati 2009).
STEP 3: Study CBCI Living Lab Ghent, which was created iteratively and is biobased, circular, demountable, adaptable, modular and flexible.
STEP 4: Formulate a circular and biobased design approach, with specific frameworks and criteria.
STEP 5: Set up lesson 1. Outline the iterative approach, using CBCI Living Lab Ghent as an example.
STEP 6: The iterative approach can be expanded, criteria can be drawn up based on the three lessons noted as a preliminary study.

Final goal: A basic design, and expansions in time.

Assessment principles: First complete three lessons, only then can you complete this exercise.

setup - student preparation

STEP 1: Following the lessons on tools for analysis: 'Measuring the social and societal impact of circular and biobased building', 'Life cycle analysis of circular and biobased building' and 'Measuring circularity characteristics of circular and biobased building'.
STEP 2: Study design approach of Chakrabarti.

teaching setup

Lesson 1: Classical explanation of task with presentation. Attention for preparations & Living Lab Ghent (film). Time for questions and start working.
Preparation lesson 2: The student makes one or more sketch designs.
Lesson 2: The student gives a short presentation of the sketches in class. Presentation by the teacher about the iterary design process of Living Lab Ghent & Chakrabarti's method. Start analyzing on the basis of one sketch by the student.
Preparation lesson 3: Analyze and redesign.
Lesson 3: The student gives a short presentation in class of the modified sketch design and the lessons learned. The teacher provides feedback and coaching.
Preparation lesson 4: Analyze and redesign.
Lesson 4: The student gives a short presentation in class of the modified sketch design and the lessons learned. The teacher provides feedback and coaching.
Preparation lesson 5: Analyse and redesign.
Lesson 5: The student gives a short presentation in class of the modified sketch design and the lessons learned. The teacher provides feedback and coaching.
Preparation lesson 6: Analyse and redesign and/or develop design into final design.
Lesson 6: The student presents the modified sketch design and lessons learned. The teacher provides feedback and coaching.

Lesson 7: Final presentations and assessments based on established frameworks and criteria.
Lesson 8: Introducing lesson about tool 1. In advance students study the learning material on this subject.
Lesson 9: Design tests based on tool 1.
Lesson 10: Introducing lesson about tool 2. In advance the students study the relevant learning material.
Lesson 11: Design tests using tool 2.
Lesson 12: Introduction about tool 3. In advance the students study the relevant learning material.
Lesson 13: Design tests using tool 3.
Lesson 14: Final lesson, discussing lessons learned and writing a reflection.

example

In your own garden, design a circular and biobased home workspace, of minimum 10m2 and maximum 20m^2.

variations

- The weight of certain components can be switched. The iterative process can be central, as well as biobased building, or circular building.
- The scale of the design approach can increase or decrease the difficulty.
- The design approach can be executed by a group, or by a single student.
- It can be interesting to add new requirements along the way.

remarks

The CBCI Living Lab Ghent is an example of a potential end result.

references

CBCI D4.4.2 Description of circular bio-based solutions: Multi criteria assessment of the CBCI LL Ghent
CBCI D4.4.1 Description of the design
CBCI A4.4 introduction
'ISO 59020, Measuring circularity framework'
D 3.4.3 Framework for the potential establishment of a label (excel sheet)
O 6.1 A unique practical guide for professional stakeholders with focus on the application of bio-based-materials in commercial construction
Conference papers for SEB21 (Evaluation of Circular Construction Works During Design Phase: An Overview of Valuation Tools) and CLIMA2022
(Application of circular technical services in a living lab in Ghent)
ISO 20887:2020 Sustainability in buildings and civil engineering works - design for disassembly and adaptibility - principles, requirements and guidance

CBCI. (2020). *Design and simulation for CBCI LL Ghent: Introduction* (v.1 Internal). CBCI.
CBCI. (2022). *Construction plans and description of the overall building design* (v.1 Internal). CBCI.
CBCI. (2020). *Description of circular and bio-based solutions* (v.1 Internal). CBCI.
Vergauwen, A. (2020). *Circulair Gebouw: Leidraad meetsysteem* (BETA-versie). WTCB; VCB.
Normcommissie Duurzaamheid van Bouwen. (2020). *Sustainability in buildings and civil engineering works: Design for disassembly and adaptability: Principles, requirements and guidance* (ISO 20887:2020). NEN.
ISO-Werkgroep Measuring circulairity. (2021). *Circulair economy: Measuring and accessing circularity* (ISO 59020, Draft). ISO.

For more information:
scan the QR-code, or
go to the url: **edu.nl/8jynb**

14

Measuring circularity characteristics of circular and biobased construction

How to make the circular characteristics of a construction measurable and insightfull and comparable.

keywords
circular assessment
circular and biobased buildings
making circularity measurable

code: CBCI4ULR010

credit: Léon van Woerkom

overview

The inter-disciplinary learning activity deals with assessing the circularity characteristics and performance of buildings. The focus is on a circular and biobased residential building via a case study from CBCI project.

skills

- analysing
- a questioning attitude
- evaluating
- ordening & structuring
- reflection

characteristics

- individual / group
- course / workshop

duration

90 minute theory course, several workshop sessions (minimum 3) on case study

target group

Bachelor and master students

prerequisites

Basic knowledge on biobased and circular construction principles.

learning outcomes

- The students have basic knowledge on where to find and to some extend the content of existing standards on circular assessment. The students have knowledge on the relevant assessment tools for circular construction on the market.
- The students know how to use a selection of tools and interpret and compare results.

setup - teacher preparation

Lesson 1:
The international standard *'ISO 59020 - Measuring circularity framework'* should be reviewed to provide a background knowledge for students. The iterative design process of the CBCI LL Ghent can be provided to show how assessment fits in a broader project process.

Lesson 2:
The specific exercises should be prepared; an assignment with the needed supporting input material should be provided. A user-friendly platform for discussing in group about the characteristics and methodolgies and hierarchy could be prepared in an online fashion or at a classroom board.

Lesson 3:
For the case study session, the instructor should check D4.4.1 and D4.4.2 for the case of LL Ghent. A user-friendly platform for discussing in group about the multi criteria dilemma could be prepared in an online fashion or at a classroom board.

setup - student preparation

Lesson 1:
Reading the international standard and academic papers for the background information session.

Lesson 2:
Study the relevant literature on the appointed assessment tool and background information on the underlying circulary characteristic.

Lesson 3:
For the case study session, the students should examine the case building and surroundings with regards to the circularity characteristics that were discussed in the first lesson.

teaching setup

Lesson 1. A brief introduction to circularity assessment
STEP 1: Short introduction of '*ISO 59020 - Measuring circularity framework*', the overall goal of circularity assessment and subsequential types of methodologies and tools for the construction sector.
STEP 2: Organize smaller groups of students to discuss relevant circularity criteria and collect existing assessment tools.
STEP 3: Organize a classroom presentation to bring together and share the collected information (= in essence a collectively performed literature study)
STEP 4: Introduce the case study building (description of the building as the object, together with its surrounding context)

Lesson 2. An in depth methodology overview of a selection of assessment tools
STEP 1: Based on the content collected in lesson 1, smaller groups are appointed a selected assessment tool (BCI, CB'23, BBRI-VCB tool,etc.) in preparation of the course. They discuss the methodology in their smaller group.
STEP 2: The individual groups get a specific exercise assigned which is based on the case building (cfr. D4.4.2). In groups they make the calculations and prepare a report on their findings to be presented for the whole group.
STEP 3: The instructor should visit each group and have a short discussion on the methodology
STEP 4: Each group present their assessment and findings. The other groups can react in a group discussion on the methodology and results.

Lesson 3. Multi-criteria assessment dilemmas
STEP 1: The building case multi-criteria assessment is presented by the instructor. All results of different criteria assessment (demountability, reuse potential, spatial reversibility, etc.) are presented.
STEP 2: The student are divided into small groups. Looking back on the collected criteria list (= literature study), the students make a selection and hierarchy of to be considered criteria and argument why.
STEP 3: The small discussions are brought together into a full group discussion on inclusion and hierarchy of criteria (= discussion on weighing factors).

remarks

The European standards on circular construction are under developement untill 2025 and should be regularly checked in order to keep the content of the course in line with the latest development and updates. The same applies for the existing tools on the market; new tools are being developed constantly and are improved over time. Up-to-date information is key to keep the content of the course relevant.

references

CBCI D4.4.1 Description of the CBCI LL Ghent design (section two on the description of the object itself)
CBCI. (2022). Construction plans and description of the overall building design (v.1 Internal). CBCI.
CBCI D4.4.2 Description of circular bio-based solutions: Multi criteria assessment of the CBCI LL Ghent
CBCI. (2020). Description of circular and bio-based solutions (v.1 Internal). CBCI.

Vergauwen, A. (2020). *Circulair Gebouw: Leidraad meetsysteem* (BETA-versie). WTCB; VCB.
'ISO 59020, Measuring circularity framework'

ISO-Werkgroep Measuring circulairity. (2021). *Circulair economy: Measuring and accessing circularity* (ISO 59020, Draft). ISO.

D 3.4.1 Digital support tool to support and enable the uptake of biobased circular construction
D 3.4.3 Framework for the potential establishment of a label (excel sheet)
O 6.1 A unique practical guide for professional stakeholders with focus on the application of bio-based-materials in commercial construction
Conference papers for SEB21 (Evaluation of Circular Construction Works During Design Phase: An Overview of Valuation Tools) and CLIMA2022 (Application of circular technical services in a living lab in Ghent)
ISO 20887:2020 Sustainability in buildings and civil engineering works - design for disassembly and adaptibility - principles, requirements and guidance

Normcommissie Duurzaamheid van Bouwen. (2020). *Sustainability in buildings and civil engineering works: Design for disassembly and adaptability: Principles, requirements and guidance* (ISO 20887:2020). NEN.

For more information:
scan the QR-code, or
go to the url: **edu.nl/pv6n7**

15

Cooperation models in circular construction projects

How to work together in circular construction projects.

keywords
cooperation models integral approach projectmanagement

code: CBCI4ULR009

credit: stock.adobe.com

overview

Realising circularity requires a collective effort. Working closely and constructively together both in project and on a sector level is the way to go. In this module, the lessons learned from the CBCI Living Lab of KU Leuven concerning the initiation phase of cooperations are shared. The acquired insigths and principles from the case study of the Living Labs are used and applied in a workshop.

skills

- a questioning attitude
- formulating a common goal
- ordening & structuring
- reflection

characteristics

- group
- case study / workshop

duration

60 min theory, 2 x 60 min workshop

target group

Master students

prerequisites

- Basic knowledge on construction project processes and management.
- Followed the modules on circular construction.

learning outcomes

- Knowledge about the added value of the multiple helix approach.
- Understanding of roles dynamics in construction projects.
- Understanding the importance of the planning and kick-off phases in construction project.

setup - teacher preparation

Lesson 1:

- Watch the CBCI informational video.
- Watch the CBCI Living Lab of KU Leuven experience video.
- Read the D4.6.1 report on the process followed in the CBCI LL KUL case.
- Study and prepare a presentation on the different methodologies used (kick-off, outputspecs, venn-diagram, morphological chart) to be shown and explained to the students.
- Prepare the information about the CBCI case studies to be assigned to the different groups. Decide what case studies to include and make the information shareable for the students on an online platform.

Lesson 2:
Study the assigned case studies and fill in the required methodology templates in prepartion off giving feedback and evaluating the reports of the students.

setup - student preparation

Lesson 1:
Watch the CBCI informational video.
Watch the CBCI Living Lab of KU Leuven experience video.

Lesson 2:
Study the assigned case study and shared methodologies in preparation of the workshops.

teaching setup

Lesson 1. Case study of the CBCI Living Lab of KU Leuven
STEP 1: The lesson starts with an introduction on the CBCI Living Lab of KU Leuven. The experience video is shown as an introduction to the course.
STEP 2: In a group discussion, insights of the students on how the cooperation was organised and what should be taken into account is collected. (ambitions, knowledge in the team, plan of approach)
STEP 3: The knowledge clip of the KU Leuven Living Lab is shown to the students.
STEP 4: The teacher explains both the methodology and the case study content of the Kick-off session, the brainstorm session and the morphological chart.
STEP 5: The assignment of lesson 2 and 3 is explained, the students are divided into groups and get assigned one of the CBCI case studies.

Lesson 2 & 3. Workshop on integrational cooperation
In this second and third lesson, the insights from lesson 1 are applied to a case study that was assigned in lesson 1. The students work in groups to collect and process the following information using the methods introduced in the first lesson.

- All stakeholders involved, their role in the project and specific knowledge available. How do these relate to each other?
- The most important ambitions of the project based on the contract/tender documents/project information.
- If starting this project, what would be the largest questions/challenges to tackle and how would you go about tackling them? (output specification, venn-diagram, morphological chart).
- Make a plan of approach summarizing the collecting information.
- All the information is collected in a report that is evaluated by the teacher.

example

The Wiegenlied case of BAST architects as CBCI case study is used for the workshops. It is a Design&Build cooperation in which architect and contractor work closely together with the client to tackle their biggest challenge; how to apply biobased materials in a high-requirement environment for material finishes of day-care facilities.

variations

Lesson 2 and 3 in which the case studies are used to apply the acquired insights and principles, can be others than the CBCI case studies. If the teacher has other case studies beter known to him/her, it could be an advantage to change the case study.

remarks

In order to prepare for this workshop, the teacher has read the CBCI paper on cooperation models as well as study the evaluation reports of the two CBCI Living Labs.

references

D1.1.5 Cooperation Models
D4.6.1 Evaluation report and the Living Lab Logbooks
A4.6 annexes (brainstorm sessions)

Lefevre, L., Versele, A., Jacobs, L., Beaujean-Kuijsters, A., Koster, M., Van der Burgh, F., Verspeek, S., Emitt, S., Van Maldegem, A., Van Son, H., & Ronda, P. (2019). *New cooperation models accelerating circular & bio-based building in the contruction industry* (Desk research Report D1.1.5). CBCI.

For more information:
scan the QR-code, or
go to the url: **edu.nl/bnud6**

16

Social economy and corporate social responsibility

Service learning, social economy and CSR.

keywords
social economy **CSR** **economy of communion**
commons **quadruple helix model**

code: CBCI3ULR019

credit: Jonathan Ramael

overview

Circularity helps with realising sustainability goals. Closing the loop is all about material efficiency, neglecting to some degree the social pillar of sustainability. Participants are introduced to social economy and corporate social responsibility (CSR) and how it can contribute to both sustainability and circularity via the educational method of Service learning.

skills

- academic learning
- reflection
- serving
- situation awareness

characteristics

- group
- service learning / course

duration

4 hours of lecture + 20 hours of service

target group

Master students

prerequisites

The student has a basic understanding on building management, and the principles of economy.

learning outcomes

- The student develops awareness of The broader social context around construction in circular economy.
- The student is prepared to question and adjust his/her own linear thinking and actions.
- The student is willing to acknowledge deficits in knowledge; skills and attitudes about social and circular economy.
- The student is aware of and can reflect on The social role of an engineer/architect.
- The student develops empathy; ethics and a sense of social responsibility.
- The student can apply her/his academic knowledge and skills to his future construction activities.

setup - teacher preparation

The teacher should read up and understand the concepts of service learning, social economy, theory of change, CSR, and social impact assessment by checking the reference section, and prepare a lecture to educate the students.

To prepare for service learning, the teacher must identify possible cooperations with initiatives with a social benefit (a non-profit, ...) and establish connections with them to start up a mutually beneficial partnership.

setup - student preparation

- The student should self-study the principles of service learning.
- The student should prepare his work with the organisation by timely contacting them and preparing for the poster before working with the organisation by studying the assessment method and bringing it into the field.
- Creation of the poster by assessment method of the theory of change method.

teaching setup

STEP 1. A lecture on the following topics:

- What are the social/societal challenges within business development and management in the construction sector?
- What is service learning?
- What is social economy?
- How to define a theory of change?
- How to assess social impact of CSR in construction?

STEP 2. Service

- Selection of the company / initiatieve in the social economy.
- Start learning in the field

STEP 3. Output creation

A poster is generated that contains an answer to the questions (related to the company or initiative):

- What are the social/societal challenges the initiative is tackling?
- What is the vision and the mission of the initiative?
- How is the theory of change?
- What are the (social/societal) impacts of the initative?

references

For the service learning principles https://www.servicelearningvlaanderen.be/
For the application of social economy 4.4.1. section: social economy
Theory of change: https://www.theoryofchange.org/library/publications/

CSR: https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
European Commission. (n.d.). Corporate sustainability reporting: EU rules require large companies to publish regular reports on the social and environmental impacts of their activities. Retrieved May 23, 2022, from https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

Economy of the common good: https://www.ecogood.org/what-is-ecg/
Economy for the common good. (n.d.). What is ECG. Retrieved May 23, 2022, from https://www.ecogood.org/what-is-ecg/

Economy of communion: -

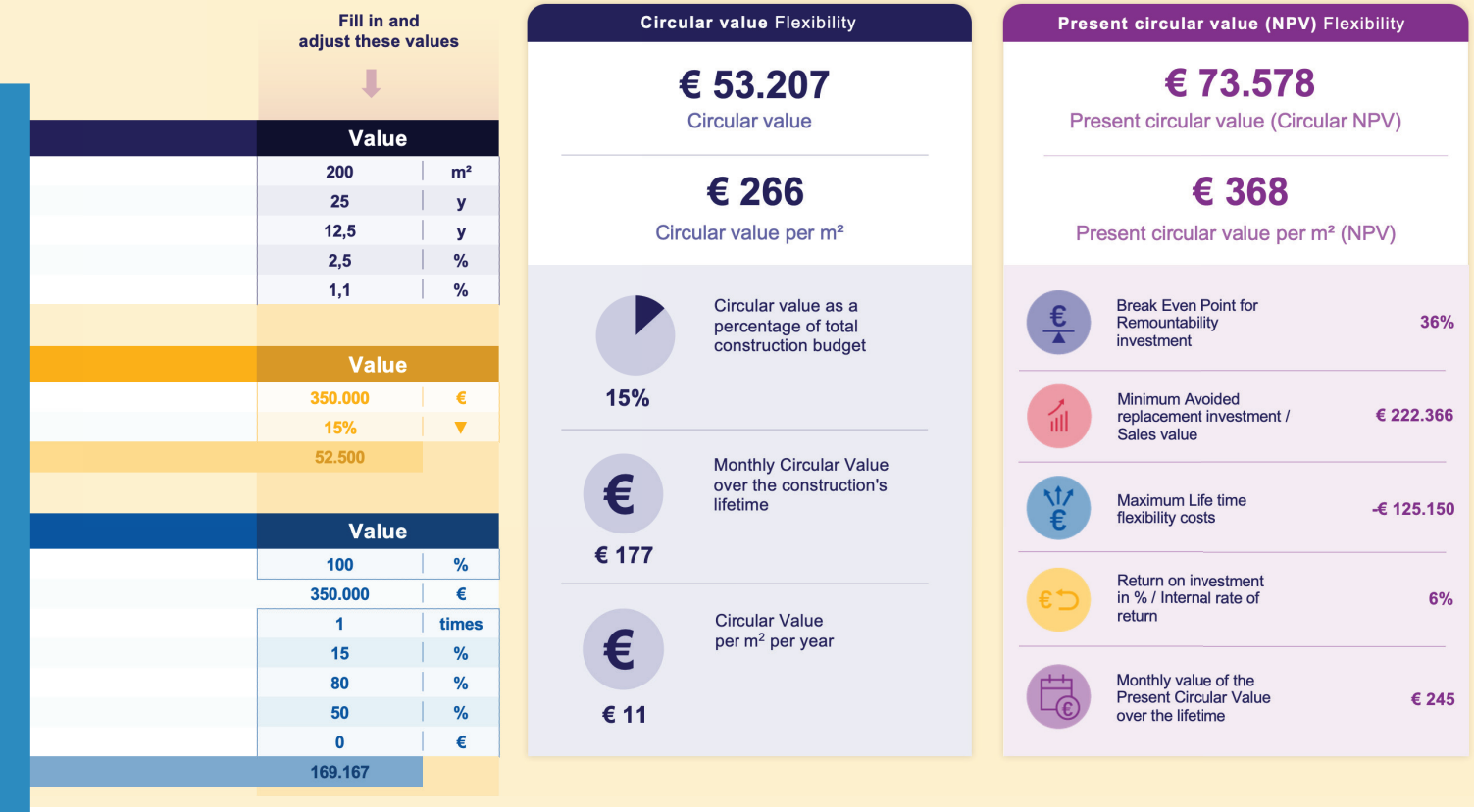
Bruni, L., & Grevin, A. (2016). *Léconomie silencieuse*. Nouvelle Cité.
Bruni, L., & Zamagni, S. (2004). *The 'Economy of Communion': Inspirations and Achievements'. Finance & Bien Commun*, (20), 91-97. https://doi.org/10.3917/fbc.020.009120, 91-7
Bruni, L., & Uelmen, A. (2006). *Essays: Religious values and corporate decision making: The economy of communion project*. Fordham Journal of Corporate & Financial Law, 11(3), 645–680.

For more information:
scan the QR-code, or
go to the url: **edu.nl/6y4yu**

17

Flexibility & end-of-life calculators

Calculating the value of flexibility and the End-of-Life value.



credit: stock.adobe.com

keywords
end-of-life flexibility cost calculation circular economy residual value

code: CBCI3HZR022

overview

Financial calculations of the costs and benefits of circular building with biobased materials. In these calculations, particular attention is paid to the so-called end-of-life value of a building, as well as to the economic value of flexibility in the context of fundamental conversion or even relocation of the building.

skills

- analysing
- a questioning attitude
- evaluating
- reflection

characteristics

- group
- practical course / workshop

duration

2 x 90 minutes

target group

Master students

prerequisites

Familiarity with architecture and engineering and/or business administration.

learning outcomes

- The student can distinguish a traditional cost calculation for a building from a 'circular' calculation that takes re/demountability, reallocation and relocation features into account.
- The student can compute the 'circular value' and the 'circular NPV' by making use of the CBCI-calculators.
- The student can demonstrate how the independent variables in the CBCI-calculators impact the outcome for the 'circular value' and the 'circular Net Present Value'.
- The student can determine the 'circular' costs and benefits for a given construction plan.

setup - teacher preparation

Lesson 1:

- Watch the two minutes introductory video on the Circular Biobased Construction Industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**
- Watch the videos *Flexibility Circular Value Calculator - A guided tour on calculating the value of Flexibility; End of Life Circular Value Calculator - A guided tour on calculating the End of Life value.*
- Read in the white paper "*Five essentials for successful circular bio-based construction initiatives*" the sections about the following three essentials: Affordable, Flexible and Traditional Ownership. Pay particular attention to the cases: Emergis (p.12), Tijdelijke Rechtbank (p.14), Science Museum Group (p.18) and Adnams Brewery (p.21).
- Take a look at the slides 6-8 and 10 from the Learning Session about Essential 5: Traditional ownership https://edu.nl/kjjpd
- Take a look at the slides 7-18 and 22 from the Learning Session about Essential 2: Flexibility **https://edu.nl/jufj6**
- Search one or more building plans that can be shared with students to make calculations in the CBCI calculators.
- Use the selected building plans to experiment with the CBCI calculators yourself.

setup - student preparation

Lesson 1:

- Read in the white paper *"Five essentials for successful circular bio-based construction initiatives"* the sections about the following three essentials: Affordable, Flexible and Traditional Ownership. Pay particular attention to the cases: Emergis (p.12), Tijdelijke Rechtbank (p.14), Science Museum Group (p.18) and Adnams Brewery (p.21).
- Watch the video *Introduction to social LCA Measuring the social and societal impact of circular and bio-based buildings.* Duration 15 minutes.

Lesson 2:

- Teams of up to four students prepare a presentation that will be presented to the other students during Workshop 2. Teams with only Business Administration students focus exclusively on Learning Outcome 4, whereas teams of only Architecture and Engineering students, and interdisciplinary teams could take on the challenges as described under Variations.
- Watch the Masterclass *Measuring the social and societal impact of circular and bio-based buildings.* Duration 40 minutes.

teaching setup

Lesson 1. Practical course (Learning Outcomes 1-3)
STEP 1: The teacher and the students together watch the introductory video on the Circular Biobased Construction Industry as published by CSTC WTCB BBRI on YouTube: **https://youtu.be/vtBeyPj4OZw**
STEP 2: The teacher explains the following three essentials from the white paper "Five essentials for successful circular biobased construction initiatives": Affordable, Flexible and Traditional Ownership.
STEP 3a: The teacher shows how the CBCI calculator can be used to calculate the end of life value.
STEP 3b: The teacher shows how the CBCI calculator can be used to calculate flexibility value.
STEP 4: The students work in pairs to investigate how the independent variables from the CBCI calculators affect the final outcome of the business case.
STEP 5: Under the guidance of the teacher, the students discuss in class their findings regarding the functioning of the CBCI calculators.
STEP 6: The teacher divides the class into teams of up to four students, multidisciplinary or not, and explains the assignment that each team has to complete in preparation for next session.
Lesson 2: Workshop (Learning Outcome 4, possibly completed with alternative Learning Outcomes as described under Variations)
STEP 1: Each team presents the results of their calculations of both the End-of-Life value and the Flexible value. They shall pay particular attention to the way in which the values of the independent variables affect the outcome of the business cases. The students conclude their presentation with at least two recommendations to improve the CBCI calculator.
STEP 2: The teacher shares the recommendations with the author of the CBCI calculator: mjj.koster@gmail.com.

variations

- For Architecture and Engineering students, Learning Outcome 4 can be made more challenging and formulated as follows: "The student can illustrate how to calculate the 'circular' costs and benefits of a building based on a construction plan (s)he worked on in the past or is currently working on."
- Interdisciplinary teams including both Business Administration students and Architecture and Engineering students can take on an additional challenge, formulated as the next Learning Outcome: "The student can compare and contrast the 'circular calculations' for the given construction plan to those of a building based on a construction plan (s)he worked on in the past or is currently working on."

remarks

Under variations, you will find two additional learning outcomes tailored to the specific composition of the student teams.

references

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White paper - Five essentials for successful circular bio-based construction initiatives, pages 11-19 (essentials 1 & 2) and pages 29 -31 (essential 5)
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CBCI Calculators:
CBCI Calculator - End-of-life.xlsx (+ download URL for future updates)
CBCI Calculator - Flexibility.xlsx (+ download URL for future updates)

Calculator workshop presentations:
Learning Session 1 - Presentation - Essential 5 - Ownership & end of life scenario's.pptx (slide 6-8, 10)
Learning Session 2 - Presentation - Essential 2 - Flexibility.pptx (slides 7-18, 22)

For more information:
scan the QR-code, or
go to the url: **edu.nl/34vnc**

18

Measuring the social and societal impact of circular and biobased building

How to conduct a social life cycle assessment.

keywords
social impact
multistakeholder approach
social LCA
circular and biobased buildings

code: CBCI2ULR001

credit: Josue Isai Ramos Figueroa

overview

The inter-disciplinary learning activity deals with measuring the social and societal lifecycle impact of buildings. The focus is on a circular and biobased residential building via a case study from CBCI project.

skills

- analysing
- evaluating
- formulating a common goal
- serving

characteristics

- group
- course / workshop

duration

180 minutes

target group

Bachelor and master students

prerequisites

Basic knowledge on impacts of construction works.

learning outcomes

- Students are able to understand the social impact of construction industry.
- Students are aware of the multiple benefits (and hazards) of construction works and have basic knowledgable about the social conditions of different stakeholders in the construction industry.
- Students are able to conduct basic assessment on social impact of construction works.

setup - teacher preparation

Lesson 1:
It's necessary to review the Guidelines for Social Impact Assessment (UNEP, 2020) to provide a background knowledge for students. NBN-EN_16309+A1_2014 should be provided as a method for measuring the social impact of circular and biobased buildings.

Lesson 2:
For the case study session, the instructor should check the architectural scenarios for the case of LL Ghent. A user-friendly platform for discussing about the stakeholders, impact categories and indicators could be prepared in an online fashion or at a classroom board, D 2.3.1 miro platform forms an example.

Lesson 3:
Inviting stakeholders (companies, workers, community representatives etc.) and conduct a workshop for brainstorming on improving social impacts. Arrangement of a meeting room or preferably meeting the stakeholders in a community building is required.

General: Make sure that the assignments for the papers fit your approach.

setup - student preparation

Lesson 1:
Reading the guidelines and academic papers for the background information session. Prepare a short report about social impact measurement in the construction sector.

Lesson 2:
For the case study session, the students should examine the case building and surroundings with regards to the social impact categories that were discussed in the first lesson. Prepare a short paper on the case building and submit before the lesson, conclude about a particular challenge.

Lesson 3:
For a multi-stakeholder workshop, it is important to acquire some information about participating stakeholders. Prepare a SWOT anaylsis about the stakeholders that are effected by the case study.

teaching setup

Lesson 1. A brief introduction to social and societal impact assessment

STEP 1: Organize smaller groups of students for a discussion on short reports prepared by the students.
STEP 2: Collect commonly shared questions about the concept and methodology.
STEP 3: Organize a classroom presentation to fill in the gaps.
STEP 4: Introduce the case study building (description of the building as the object, together with its surrounding context).

Lesson 2. A case study on measuring the social impact of a building (i.e. CBCI Living Lab Gent - refer to D4.4.1 Report):

STEP 1: Organize smaller groups and appoint a stakeholder impact category (refer to SLCA guidelines) to each group.
STEP 2: The instructor should visit each group and have a short discussion about their impact category.
STEP 3: Provide a validated list of indicators (refer to sLCA guidelines) and ask for identification of the most significant or new indicators for measurement of the impact category.
STEP 4: Ask groups to hypothetically rate the case building depending on the indicators.
STEP 5: Ask groups to review the assessment of other groups.

Lesson 3. Workshop with multiple stake holders (optinal)

STEP 1: Communicate with local community and arrange a date and place for workshop.
STEP 2: Provide hypothetical assessment of student groups to relevant stakeholder.
STEP 3: Conduct the workshop in a multi-stakeholder approach. A quadruple helix methodology can be adopted. Each student group needs to collect the comments of the stakeholder and compare it with their previous assessment in lesson 2.
STEP 4: Ask students to combine their previous reports together with the case study assessment and workshop results.

It is considered that each lesson would form the basis for next recommended sessions (3 x 90 mins). The natural sequence is first to provide the background information about the social impact of construction works. Then, a case study on a specific building to test the theory by identifying impact categories and indicators and calculating the social impact. Lastly, a workshop with relevant stakeholders (users, workers, community and society) for validating the results from the case study.

example

Lesson 1:
A classroom presentation for providing the background information on the concept of social and societal impact of construction works by utilizing the sLCA standard, sLCA guideline. Multiple benefits of circular and biobased construction are included by providing real-life examples.

Lesson 2:
A case study is provided on a circular and biobased building to test the theory on a building with emerging concept which are supposed to have 'positive' social impact. The students discuss in a group work about the relevant stakeholders to the given case. Then, impact categories that are significant are identified together with indicators for measurement. Methods of data collection for each indicator (qualitative or quantitative) are discussed.

Lesson 3:
A workshop with stakeholders from the local community is conducted for validating the results from lesson 4. In this workshop, individual experiences of groups that are supposedly impacted by the case study should be overlapped with the measurement results.

variations

Lesson 1:
The classroom presentation can be conducted by a civil society partner.

Lesson 2:
The case study can be a different building. It is ideal that the case building is an example in the local neighbourhoods. Several case study examples can be provided to each student group.

Lesson 2 and 3:
It is possible to merge step 2 and 3, and conduct the social impact assessment together with the stakeholders from the local community. In this case, additional preparation should be provided for the stakeholders.

Lesson 3:
This workshop can take place in a role-play format (without actual stakeholder representatives).

remarks

- It is quite important that students get in contact with the stakeholders (users, workers, community, civil society) during the course conduction.
- Target group can also includes students from social studies.

references

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For more information:
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19

In situ testing of biobased and circular construction

Assessment and ensuring qualitative construction by building testing.

keywords
performance tests comfort quality assurance

code: CBCI2ULR002

credit: stock.adobe.com

overview

In this module it is described what (inter) national standards of the two-seas region and what rules of good practice should be taken into account when testing the performance of buildings and how to report on findings. This can be hygrothermal, accousting or structural testing, but also considers circular aspects like demountability, reusability potential and the process. This module considers the building scale.

skills

- analysing
- evaluating

characteristics

- group
- course / workshop

duration

180 minutes

target group

Bachelor and master students

prerequisites

The students need to have an advanced level of construction and a good understanding of the following topics structural engineering, building physics, indoor air quality and acoustics. Preparatory courses that educate on these specific topics and/or a refreshing of these topics by the students on an independent basis before the course starts can be relevant preparations.

learning outcomes

- Course outcome: students are aware of how to test housing quality and performance criteria.
- Workshop outcome: students are able to use testing equipment to check on building quality and have used it in a case of biobased construction.

setup - teacher preparation

- Study report 2.4.4 (and if necessary norms for more info) and learn how and where to test the criteria.
- Document what specific prototyping testing can be performed at your teaching organisations' facilities and that are suitable for the curriculum of the students. Look into what tests and results of the CBCI research project can be used as a case for exemplary purposes.
- Specifically for a testing workshop; make all preparations necessary for the students to organise themself, preparations for the test can be a specific part reserved for the students and have an educational purpose.
- Choose x of the suggested tests or make your own setup with a teaching goal in mind (how to monitor, compare two buildings/rooms, ...). Bring testing equipment to right location, prepare room for tests*, prepare equipment for tests.

*ex. blowerdoor test tape all exhausts of the building

setup - student preparation

- For the testing workshop: make all preparations necessary to have a successful test.
- Read the instructions in advance and bring necessary equipement.
- Prepare reporting files.

teaching setup

STEP 1: the teacher teaches the course material on in-situ testing. The course will give an overview of testing criteria that can be performed in a real-life building and its application. The tests discussed are:

- Outdoor and indoor climate (T, RH, black bulb T, indoor comfort, CO2, VOC, PM).
- Building envelope (air permeability, draught rate, whole space heat loss, infrared scan).
- Light quality (light intensity).
- Energy (monitoring of use phase).
- Water (monitoring of use phase water usage, rainwater collection, or water purification if applicable).

STEP 2: The teacher gives an assignment to the students to monitor x amount of criteria. He makes the preparation sheets for the class and helps them get started.

STEP 3: The workshop is done with students using the equipment, collecting and monitoring data.

example

CO2 concentration test by students. Monitor the room for a few hours and compare with another room, different situations and different construction types (biobased vs traditional).

references

Report D2.4.1 (testing protocols)
Report D2.4.4 (testing report summary of KUL tests)
or alternatively, directly from the ISO norms:
-> Outdoor & indoor climate (T, RH, black bulb T, indoor comfort, CO2, VOC, PM)
Measurement protocol Flanders, NBN ISO 16798, NBN ISO 7243, NBI ISO 7726, NBN ISO 7730, NBN ISO 15251, NBN ISO 13779, BS ISO 16000-31:2019, EN 12341,
-> Building envelope (air permeability, draught rate, whole space heat loss, infrared scan)
Bauwens and Roel (2014), NBN ISO 6781, Katrien Maroy (2015)
-> Light quality (light intensity)
NBN ISO 12464-1
-> Energy (Energy use monitoring)
NBN ISO 6946
-> Water (Water use monitoring, rainwater collection or water purification if applicable)
BS 8542:2011, BS EN 16941, BS ISO 20468 (part 1, part 2, part 5)

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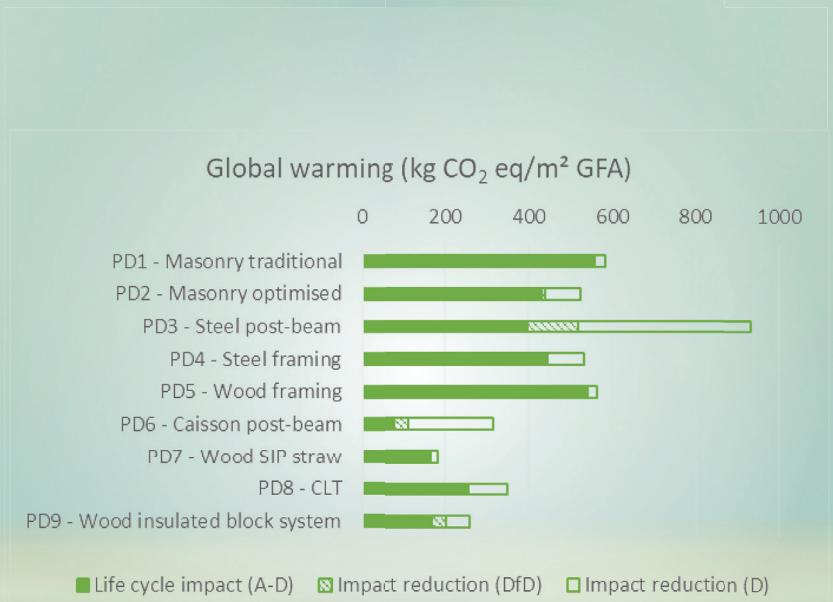
20

Life cycle assessment of circular and biobased construction

Beyond boundaries: Biogenic carbon, end-of-life scenarios and module D.



credit: stock.adobe.com | infographic: CBCI

keywords

LCA
ecological material
biogenic carbon
module D
end-of-life scenarios

code: CBCI2ULR004

overview

The module explains the key issues with regards to calculation of life cycle ecological impacts with LCA of circular and biobased construction: how to account for biogenic carbon and end-of-life, also including impacts outside systemic boundaries (module D).
The case material for calculation comprises of materials and whole buildings selected and designed within CBCI and can be used to make an assignment on the material or a variation on it.

skills

- analysing
- a questioning attitude
- critical awareness
- evaluating
- ordening & structuring

characteristics

- group
- course

duration

3 x 90 minutes

target group

Master students

prerequisites

The students need to have a basic level of construction knowledge to be understanding of LCA study on the topic and the prerequired knowledge on LCA to understand the implications of specific practices.

learning outcomes

- The students will know the impact of different LCA methodologies to assess the benefit and importance.
- Firstly, system boundaries and its effect on circular construction and reuse potential become familiar concepts. Secondly bio-based construction materials are looked into with special regards to biogenic carbon cycle.
- Methodologically the student knows the importance of the different impact categories, the durability of materials, temporal aspects of emissions and the duration of both the assessment and life cycle stages and their impact on the overall assessment.

setup - teacher preparation

To do the exercise, the teacher needs to get a license for LCA software (SimaPro, GaBi, OpenLCA or OneclickLCA) or work with a nationally established tool (TOTEM).

Lesson 1
In case of an existing course on LCA is not present, the teacher needs to prepare basic LCA teaching material to complete the gap.

Lesson 2
For an overview on the complications and procedures for resolving these issues within LCA methodologies for circular and biobased construction, the teacher reads D2.1.2. with primary focus on biogenic carbon. Then, the teacher progress with D2.1.5 to understand the ecological impact of CBCI on the material level and end-of-life. Finally, for understanding the ecological impact of CBCI on the building level and end-of-life, the teacher goes for D4.4.4.

Lesson 3
For preparation of an assignment on LCA calculation, the teacher needs to provide a case study for the student groups. The LCA calculation can be conducted on a material level (i.e. a specific biobased insulation material) or a component (components that were developed in D 4.4.4 that includes biobased materials). It is advised that the case study is prepared in line to the context of the course, it is better to select a building in the local neighbourhoods.

setup - student preparation

Lesson 1
Reading the existing LCA standards and preparing short reports.

Lesson 2
Read about a specific number of local biobased construction materials, try to understand the characteristics relevant to LCA (find out if an EPD is available, or an EPD of a similar material can be reviewed). Prepare report on appointed material and component afterwards.

Lesson 3
Further investigate the material and component examples that were provided in lesson 2.

teaching setup

Lesson 1 - Introduction
STEP 1: Overview of LCA methodology (life cycle stages, method of assessment and environmental indicators) by using recommended standards in D 2.1.2.
STEP 2: Have presentations from student groups on their short reports on LCA standards.

Lesson 2 - Theory
STEP 1: Introduction to LCA of biobased construction and considerations for end-of-life scenarios.
STEP 2: Display good practices about material level LCA by using D 2.1.5. Form groups of students and appoint certain material to each and faciliate discussions.
STEP 3: Display good practice about building level LCA by using D 4.4.4. Form groups of students and appoint components (facade, roof, floor, wall) to each and faciliate discussions.

Lesson 3 - LCA assignment
STEP 1: Analysis of the case study: material quantities and environmental data.
STEP 2: Selection of an LCA tool or excel-based calculation.
STEP 3: Form student groups (or continue from the groups in lesson 2).
STEP 4: Discussion on reporting the LCA results.
STEP 5: Compare the results of different student groups.

example

Lesson 1: A classroom presentation on the general overview of LCA concept is conducted and then is followed by discussion on the short reports of student groups. One group presents on the steps of LCA (goal and scoping, LCI, LCIA and interpretation). The other group focus on the life cycle phases of a building.

Lesson 2: A classroom presentation on the advanced concepts on biogenic carbon and end-of-life scenarios. In addition and assessment of module D, benefits beyond the system boundaries. The presentation is then followed by a focus on LCA of cellulose insulation and a demountable facade component that is filled with cellulose. Both presentations then results in a discussion on end-of-life scenarios of component and cellulose.

Lesson 3: Depending on previously given material and components (demountable facade component with cellulose insulation), an LCA inventory is created by using the pre-calculated quantities. A short discussion is conducted on a selection of environmental indicators, resulting in focusing on global warming potential. Students groups continue with their case study with the selected LCA tool and compared the results with each.

variations

Lesson 1: If there is already an existing course on LCA, lesson 1 can be skipped.

remarks

Teachers who teach in the Dutch language can expand the lesson with an introduction lesson and a Masterclass by Stijn Verdoodt, one of the authors: *" Introductie op de LCA, de Life Cycle Analysis"*, duration 20 minutes; *"Masterclass uitwerking van een LCA voor een bouwproject met praktijvoorbeeld"*, duration 1 hour. These video are available on the website. The Masterclass is an extensive lesson in which the viewer looks over the shoulder of an expert researcher to become familiar with the use of the materials, digital tools, protocols. The explanation ends with the interpretation of all the data collected for the LCA.

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D2.1.5 Life-cycle assessments to develop the second life of the used CBCI materials
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21

Overview and application of circular assessment tools

Circular built, demountability index, CB'23.

keywords
circular assessment
circular building
demountability
CB'23
material flow

code: CBCI3ULR018

credit: stock.adobe.com

overview

The focus of the module is on the assessment of circularity with validated tools in order to standardise and introduce clear communication on what it means to build in a circular way. For this purpose, the course includes assessment on the material flows, demountable joints and components, ... (to be added by Circular Built content), along the decision making process, with attention for existing tools and reference documents in the Belgian and Dutch context and the possibility for case-study focus in a practical and comparable manner.

skills

- evaluating
- formulating a common goal
- sound decision making

characteristics

- group
- course / workshop

duration

4 x 90 minutes

target group

Master students

prerequisites

Blueprint 14 can be taught previous to this course.

learning outcomes

- Students gain an overview of existing tools for assessing circularity in building design (you can control what you can measure!).
- Students can express circularity in a concrete number for diferent specific building design options.

setup - teacher preparation

General:
Require the license of software such as BCI. Teacher should have basic information on the usage of the tools.

Lesson 1:
Prepare background information on circularity. Background information might be retreived from D 3.4.3, 3.4.1 or O6.1 in the case of the Circular Built Tool and D 4.4.2 for CB'23/Demountability index. For the combined utilization of the tools, SEB21 conference paper can be utilized. Teacher should Identify a case study or prepare a context for requesting case study from the students. A proper case study is one in which the building was designed with circularity in mind, making it possible to adapt/change/relocate it. This will be tested through the indepth analysis of the building in lesson 2-4 focusing respectively on circular principles, material requirements and end-of-life, and demountability of the construction.

Lesson 2, 3 and 4:
Prepare presentation or request presentation from students groups on basics of each tool. Prepare each tool for utilization in a lab or have students to prepare the tool ready in their laptops (in an online course setting). Make sure the case study has adequate information to fill in the tools. Utilize CLIMA2022 paper to have deeper understanding of circularity on technical services.

setup - student preparation

The student can read the conference papers for SEB21 and CLIMA2022 to get the correct understanding of how the tool works. In the case of a longer exercise (lesson 2-4), the students need to prepare the exercise and calculate the results. If students are requested to choose a case study, between lesson 1 and 2-4, the students will need to select the proper case study and prepare the needed info (such as mass flow or connection detail).

teaching setup

Lesson 1. An introduction to assessment of circularity
STEP 1: Organize a classroom session for presenting background information on circularity / parameters
STEP 2: Continue classroom session on existing circularity evaluation tools
STEP 3: Organize smaller groups to work on each tool (this can be moved to following lessons)
STEP 4: Introduction of a case study, or request from students to identify a case. This case will be their focus for the exercises given in the following lessons (2-4). The exercise include a calculation of the tools and can be evaluated by the teacher by means of a written report, or/and a presentation.

Lesson 2. Indepth analysis of Tool 1: BBRI-VCB Circular Built
STEP 1: Explanation of the specific tool focus.
STEP 2: Organize smaller groups to work on the tool.
STEP 3: Exercise on the application of the tool on a case study.
STEP 4: Reflect on the results between groups of students.

Lesson 3. Indepth analysis of Tool 2: CB'23 material flow
STEP 1: Explanation of the specific tool focus.
STEP 2: Organize smaller groups to work on the tool.
STEP 3: Exercise on the application of the tool on a case study.
STEP 4: Reflect on the results between groups of students.

Lesson 4. Indepth analysis of Tool 3: Demountability index
STEP 1: Explanation of the specific tool focus.
STEP 2: Organize smaller groups to work on the tool.
STEP 3: Exercise on the application of the tool on a case study.
STEP 4: Reflect on the results between groups of students.

Lesson 5. Reflect on the tools
STEP 1: Value the used instuments, their strengths and shortcomings and advise about the of numbers based on usability, acceptability, and feasibility for a chosen technique.

variations

- BCI tool can be utilized instead of demountability index for more automated process. This would require purchase of a licence.
- Instead of tool-specific modules as suggested in the teacher setup, another suggestion is to combine the theory (lesson 1 and step 1 in each lesson) and combine the exercises (lesson 2-4). This would lead to fewer sessions. Additionally, this structure can be kept but the exercises replaced with presentations from the students they need to prepare, which is a way to have them engage in the exercise and present it to others. The first lesson should, in that case, include preparation for the students to follow.

remarks

The BCI tool is added as a more in-depth calculation tool compared to the demountability index method. In order to use the BCI tool, a license needs to be purchased. (There might be a need for purchasing licence for circular built, this is to be clarified).

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D 3.4.1 Digital support tool to support and enable the uptake of biobased circular construction
D 3.4.3 Framework for the potential establishment of a label (excel sheet)
O 6.1 A unique practical guide for professional stakeholders with focus on the application of bio-based-materials in commercial construction
D 4.4.2 Description of circular bio-based solutions

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For more information:
scan the QR-code, or
go to the url: **edu.nl/kw9bt**

22

Excursion Living Lab Ghent

See and feel the details of the challenge of scalability.

credit: CBCI

keywords
flexibility reuse connections
demoutability

code: CBCI4AHS025

overview

Directions for an excursion to the Living Lab KU Leuven @ Ghent and suggestions for observation assignments.

skills

- a questioning attitude
- observing
- reasoning

characteristics

- individual
- excursion

duration

45 minutes and 2 hours, plus time for travel

target group

Bachelor and master students

prerequisites

Basic knowledge on impacts of construction works.

learning outcomes

- Students train to observe materials use and construction in the context of an actual building.
- Students train to discuss materials in the context of an actual building.
- Students train the skill of investigating on site through observations and through questioning the field trip leader.

setup - teacher preparation

- Read the paragraph in this book about Living Lab Leuven.
- Get in touch with G. Friant, secretary educational program 'bouwkunde' KU Leuven. https://iiw.kuleuven.be/onderzoek/building-physics-and-sustainable-design/Contact.
- Watch the video named *"Living Lab Circular and Bio-based Construction Industry".*

setup - student preparation

- Watch the "video *"Teaser Living Lab Circular and Bio-based Construction Industry".*
- Check the glossary on the terms 'Bio-based', 'Circular', 'Flexible', 'Adaptible', 'Building components', Demountability, Disassembly, Durabiility' and 'End of Life'.

teaching setup

Lesson 1. Joint preparation of the meeting
STEP 1: Activation
Put these questions back in the group and let them be answered in small groups.
STEP 2: Orientation on research
Define what typifies a living lab by asking the following questions:

- What is a living lab set up for?
- What does it mean for a building to be a living lab at the same time?
- Brainstorm on research activities to link with a living lab for circular construction and select a question for the visit to Living Lab Ghent from here.

Lesson 2. excursion
STEP 1: Observing with a focus.
Divide the group into pairs and at the entrance or beforehand give various observation tasks. Have photos with a verbatim caption shared on a digital environment such as Padlet or Pinterest.
Each participant gets two general questions plus the assignment for one theme A, B, C, D.

General part of the assignment:

- Take a photo with a detail that fascinates you.
- Find at least 5 reused materials in building X. Take pictures.

Theme part of the assignment:

- Observation A. Theme joints: Check the connections of the building on disassembly. What can you still see of them? How is the detailing on both sides of the material transition?
- Observation B. Theme infrastructures and piping: Examine the infrastructures for water, wastewater, electricity, and air in steps and describe the system with the litobox. Look at the maintainability and the circular possibilities.
- Observation C. Theme reuse: Find at least 10 materials in this building that can be reused. How easy will that be? What steps do you have to go through to make reuse possible? Mention that choices for serial construction characterize this building. Where do you see this in the practice of this building X?
- Observation D. Theme flexibility: Study the floor of building X. Characteristic is here that several sizes can be laid with the same materials. How is this provided? Find out how this building can still adapt to variable plot sizes without much work in the prefabrication. Explore the solutions for the floor, wall, and roof modules.

STEP 2: Plenary sharing of highlights and insights (max group size 12)
Exchange observations by showing each other around or by projecting pictures.
Draw three conclusions on the main lines of the concept and three findings regarding details.
Discuss the final question: What do you think of the dimensions of the building compared with the volume?

- To critical observers: Can you specifically mention the disadvantage?
- To positive evaluators: Can you concretely mention the disadvantage?
- To positive evaluators: Can you concretely mention the disadvantage?

variations

- If the visit starts with a guided tour, the assignments can be handed out afterwards. Make the distribution moment an official one, it will provide focus.
- Open with a guided tour that does no more than show you the way. Use the assignments to come up with interview questions. Do the second long tour based on the interview questions and let students ask their own questions.

remarks

- The living lab is located in Ghent.
- This excursion can be combined with a visit to Expo C at Kamp-C in Westerlo, Belgium, in 2022 to at least 2024. The distance is 35 km.
- The exposition is, just like these educational blueprints, based on the knowledge from research program CBCI. Kamp C is a knowledge center for Sustainability and Innovation in construction.

references

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For more information:
scan the QR-code, or
go to the url: **edu.nl/qa9qq**

23

Excursion Living Lab Emergis

Biobased Building for a healing environment.

credit: CBCI

keywords
flexibility reuse demoutability
healing environment

code: CBCI4AHS026

overview

Directions for an excursion to the Living Lab Emergis @ Kloetinge and suggestions for observation assignments.

skills

- a questioning attitude
- observing
- reasoning

characteristics

- individual
- excursion / course

duration

45 minutes and 2 hours, plus time for travel

target group

Bachelor and master students

prerequisites

Basic knowledge on impacts of construction works for a (mental) healthcare organisation / situation.

learning outcomes

- Students train to observe materials use and construction in the context of an actual building.
- Students train to discuss materials in the context of an actual building.
- Students train the skill of investigating on site through observations and through questioning the field trip leader.

setup - teacher preparation

- Read the paragraph in this book about living lab Emergis.
- Orientate on the topic of healing environment.
- Get in touch with René Brugman, Projectleider, vastgoed & facilitair, Emergis. [brugman@emergis.nl]
- Watch the video, in map on CBCI teams: *Introduction film on the living lab Emergis Kloetinge CBCI4AHS026.url*

setup - student preparation

- Orientate on the concept of a healing environment.
- Watch the teaser.
- In map on CBCI teams: *Introduction film on the living lab Emergis Kloetinge CBCI4AHS026.url*
- Check the glossary in this book on the terms: Biobased, Circular, Flexible, Adaptible, Building components, Demountability, Social impact.

teaching setup

Lesson 1. Joint preparation of the meeting
STEP 1: Activation. Discuss the video material
STEP 2: Orientation on Living Lab research Method.
Define what typifies a living lab by asking the following questions.

- What is a living lab set up for?
- What does it mean for a building to be a living lab at the same time?
- Brainstorm on research activities to link with a living lab for circular construction. Select a question for the visit to Living Lab Emergis from there.

Lesson 2. Excursion
Guided tour + 60 minute unguided period in the building.
STEP 1: Observing with a focus
Visit in pairs beforehand and give various observation tasks. Require photos with a verbatim caption shared on a digital environment such as Padlet or Pinterest. Each participant gets two general questions plus one theme ABCD assignment.
General part of the assignment:

- Take a photo with a detail that fascinates you.
- Find at least 5 materials that may easely be reused in the future in the modules. Take pictures.

Theme part of the assignment:

- Observation A Theme Healing Environment. Observe artefacts in the building that express the healing environment ambitions.
- Observation B Theme infrastructures. Observe the air treatment, the entry of fresh air, the cleaning. Reveal and discuss the practicalities; secondly observe the solutions used for cabling.
- Observation C Theme reuse. Can you see what materials and construction in this building have a second life? Register at least five examples.
- Observation D Theme flexibility. Study the floor of building X. Characteristic is here that several sizes can be laid with the same materials. How is this provided?
- Observe the modules, and how they are arranged among themselves. explore what variations of buildings can be built with these modules. What conditions in the design make this possible?

STEP 2: Plenary sharing of highlights and insights (max group size 12)
Exchange observations by showing each other around or by projecting pictures.
Draw three conclusions on the main lines of the concept and three findings regarding details.
Discuss the final question: What do you think of the dimensions of the building compared with the volume?

- To critical observers: Can you specifically mention the disadvantage?
- To positive evaluators: Can you concretely mention the disadvantage?

example

For healing environment in this context you might study another example, the award winning RIVM study 'afdeling Psychiatrie in het Radboudumc'.

remarks

Discuss rules of conduct of the site well, consider that the visit is a delicate matter. Because students enter the world of vulnerable people and professionals at work.
To increase the chance of being able to set up the excursion, please try to organise the site visit on a friday afternoon (preferably after office hours).

Tips for the working method. Agree in advance on the exact time and place of interim plenary group moments.
Provide focus by means of assignment-sets per studentteam. Print 4 assignment sets ABCD. The working method is to distribute assignments on the spot in an envelope.
This excursion can be combined with a visit to Expo C at Kamp-C in Westerlo, Belgium, in 2022 to at least 2024. Dinstance from the Emergis site to Westerlo is 103km.
The exposition is, just like these educational blueprints, based on the knowledge from research program CBCI. Kamp C is a knowledge center for Sustainability and Innovation in construction.

For more information:
scan the QR-code, or
go to the url: **edu.nl/6b7qe**

24

Excursion Living Lab Kamp C, Belgium

Get to know the concept at an inspiring guided tour.

keywords
exhibition circular biobased sustainable ambitions

code: CBCI4AHS027

credit: kamp C

overview

The expo at Kamp C is an introduction to and thematic exhibition about bio-based and circular construction. The focus of the expo is on the Living Labs of KU Leuven and Emergis as cases on respectively residential and healthcare buildings with a sustainable ambition. Come take a closer look and see how the buildings were conceptualised and designed, and how research and cooperation guided the process.

skills

- a questioning attitude

characteristics

- group
- excursion

duration

45 minutes (tour) + 15-30 minutes (discussion)

target group

Bachelor and master students
Everyone who is interested in architecture; engineering, urban planning; and circular design.

prerequisites

none

learning outcomes

The student becomes aware of the following:

- What are the basic principles of circular and bio-based construction?
- A few advatages/disadvantages of circular and bio-based construction.
- What were the research questions of each Living Lab and why did they choose a certain solution?
- A few advantages/disadvantages of the chosen solutions.
- What is the point of the cooperation between partners, and what was the benefit?
- In addition, the student can reflect on his point of view.

setup - teacher preparation

- The teacher reads the first white paper of the CBCI project to understand the principles of bio-based circular construction. She/he prepares by watching the videos about the Living Labs and becomes aware about the research questions both teams had before designing the Living Labs.
- The teacher prepares for the interactive discussion point with statements by reading the statements in the expo.

setup - student preparation

Before the exhibition, the student is to set an ambition that he tries to realise after the visit. This could be to design without concrete or with demountable joint structure, or it could be to support reuse financially, etc.

teaching setup

STEP 1. In one of the teacher's courses the exhibition is discussed. During this first mention of the exhibition, the teacher sets up a thought experiment in which the students are tasked to note a specific ambition (or set of ambitions) to realise.

STEP 2. The exhibition is visited. The tour guides the students around:
- Principles of circular and bio-based construction
- Interactive discussion point with statements
- The Living Labs (design, ambitions, research) shown through panels, videos and 3D models
- The cooperation between researchers, contractors, ...
- Research through prototypes and testing

At the end of the tour, a discussion is organised on the ambitions and realised potential of circular and bio-based construction, especially in relation to the Living Labs.

STEP 3. The teacher can continue the thought experiment requested in step 1 by asking the students how they would realise their own set up ambition. The expo can serve as inspiration for this.

example

The models of the Living Lab are a showcase of their demountability. It is possible to visualise the concept of removable and attachable panels or entire rooms within this setup, and to introduce students to the concept of demountability. The spin-off CIRCL from the KU Leuven Living Lab can additionally inspire as on how to work as a contractor with innovative or sustainable concepts.

variations

An added value to the expo visit on the site of Kamp C is the surrounding building: the exploded view, the Centrum, the 3D printed house - since Kamp C is the innovation center for the construction sector, these other buildings can also inspire on other topics in the industry such as 3D printing of materials; ...

The thought experiment can be performed in groups and showcase interdisciplinary working by dividing students into groups and setting a role for each participant (architect, contractor, client, ...) and perform an assigment based on cooperation. Within this role play exercise, ambitions between participants can differ and a total solution can be found.

Alternatively a workshop for professionals can be given after the exhibition.

references

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Hexagonen expo Kamp C (statements)

Principles:
Hexagonen mobiele expo (principles)
White paper - Five essentials for successful circular bio-based construction initiatives.pdf
White paper - Vijf bouwstenen voor succesvolle circulaire biobased bouwinitiatieven.pdf

Videos:
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For more information:
scan the QR-code, or
go to the url: **edu.nl/ybbpj**

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9

Glossary

9

Glossary

In the following overview, key terms that appear in the lessons are defined.

a

adaptable

Feasible to change or take into account future adaptations in relation to spatial and technical needs. Building designs are adaptable to the extent they are able to be become suitable for another particular purpose.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

awarding criteria

Criteria related to procurement of a building that are used for the final selection of a contractor from the list of applicants to the tender.

b

biobased

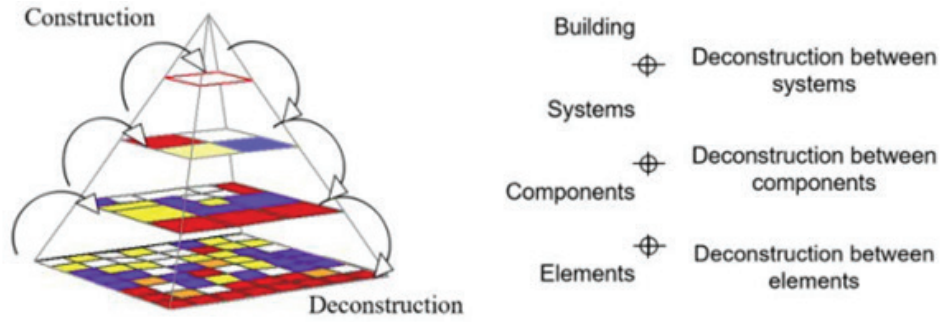
"Biobased products are wholly or partly derived from materials of biological origin, excluding materials embedded in geological formations and/or fossilised. In industrial processes, enzymes are used in the production of chemical building blocks, detergents, pulp and paper, textiles, etc. By using fermentation and bio-catalysis instead of traditional chemical synthesis, higher process efficiency can be obtained, resulting in a decrease in energy and water consumption, and a reduction of toxic waste. As they are derived from renewable raw materials such as plants, biobased products can help reduce CO2 and offer other advantages such as lower toxicity or novel product characteristics (e.g. biodegradable plastic materials)."
(EC, **https://ec.europa.eu/growth/sectors/biotechnology/bio-based-products** *visited on 21/04/22)*

biogenic carbon

Refers to the carbon stored in a product from biological origin. The carbon content is amassed by natural processes such as photosynthesis. Related to the calculation of environmental impact of greenhouse gasses of products in which a distinction between biogenic and anthropomorphic is used to differentiate between the natural and the carbon emitted over manmade processes.

building component

Refers to an intermediate level of interconnection, ranging from separate materials to full building. Description useful in defining stages for design for disassembly and material database building.



Transformable building structures: Design for disassembly as a way to introduce sustainable engineering to building design & construction.
Credits: Elma Durmisevic, 2006

c

circular

Circularity is part of a transformation of industry towards and the underlying economy from a linear economy to a circular economy by keeping products or materials at their highest utility and value at all times, with the aim of tackling global challenges such as climate change, biodiversity loss, waste, and pollution. Its application can be economical by including business models that stimulate reuse, refurbishment and recycling strategies, and technical by redesigning products to eliminate waste and make take-backs and/or prolonged use feasible.
On a construction sector, this relates to the solution of three problems: 1. due to the frequent functional changes the 'use life cycle' of materials is often shorter than the 'technical life cycle' of materials; 2. materials are often integrated into a fixed assembly; the replaceability of one element means the demolition of others; 3. the end of the life cycle of buildings is associated with demolition and waste generation. These three problems are countered by design for disassembly, flexible and adaptable spaces.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)
(EC, **https://eur-lex.europa.eu/legal-content/EN/T/?qid=1583933814386&uri=COM:2020:98:FIN** *visited on 21/04/22)*
https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview
(Transformable building structures: Design for disassembly as a way to introduce sustainable engineering to building design & construction - Elma Durmisevic, 2006)

civil society

Refers to the layer of society of the private sphere, including families. Used to refer to the will of citizens and interests of non-governmental organisations distinct from two other players, government and business.

cooperation model

A model describing the approach to collaboration and integration between partners. Relying on shared values, the collaboration process brings about shared risks and rewards by a process of pursuing both their own goals within the respective autonomous organisations, and orienting their abilities to put effort to achieve larger objectives of a project, essential to system thinking and transitioning to a circular economy.

corporate social responsibility/ CSR

Contributions from private business to societal goals with ethical practice at the center. CSR is defined by self-regulation, where businesses' ethical, philantropist, activist or charitable actions are supporting change in the sector. This can be described as internal organisation policy or strategy that in its initial stage helps company brand name, but has grown into a more overreaching industry-wide change by helping develop (inter)national laws over the past decades.

d

decision making chart

Chart to facilitate decision making by logging options, pro's and cons (in this context related to the design).

deconstruction

See disassembly.

demountability

Ability to be disassembled related to mounting building elements. Demountable construction is a principle in which the components of buildings and components of buildings and building elements are used in such a way that they can be removed easily and without damage for reuse, repair, maintenance or replacement.
(OVAM, 24 Ontwerprichtlijnen veranderingsgericht bouwen)

design for disassembly

Approach to the design of a product that allows it to have a greater ability of building, component or material to be demounted without damaging the product, allowing to keep it in use.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

disassembly

Stage of the construction in which the building, component or material is taken apart without destroying it.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

durability

Level of wear a product can take before reaching an unsatisfactory level of functionality.

e

end-of-life.

Final disposal stage of a product, at the end of the life cycle.

environmental impact

Influence of a product on environmental issues such as climate change, acidification, eutrophication, formation of ozone layer, etc. ...
Social impact. Influence of a product on social issues such as gender equality, human rights, working conditions, etc. ...

environmental product declaration/ EPD

Standardised form of product-level LCA, declaring the environmental impacts of a specific product at the companies' production site.

expandable

Ability of a design or technical characteristics of a system to accommodate substantial changes that support or facilitate the addition of new spaces, features, capacities, or capabilities.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

f

flexible

Feasible to change or take into account future functionality in relation to spatial needs and technical potential to make the needed change. Building designs are flexible to the extent they are allow the change by using in the design technical flexibility aspects such as accessibility, replaceability, reconfiguration and separation, and allow with this technical potential for extendability, free partitioning, multifunctionality, and functional mutation.
(Transformable building structures: Design for disassembly as a way to introduce sustainable engineering to building design & construction - Elma Durmisevic, 2006)

h

hygrothermal

Refers to the movement of heat and moisture through buildings.

l

life cycle

The lifetime of a product, which can be understood as 1. its technical life cycle or durability, and 2. use life cycle or time spent as a functional object, 3. full life cycle from the acquisition of raw materials or generation of natural resources to produce the product to use stage to final disposal.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)
(ISO NBN 14040 Environmental management – Life cycle assessment – Principles and framework)

life cycle assessment/ LCA

Evaluation of inputs, outputs and potential environmental impacts of a product system throughout its life cycle.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

m

module D

Description used in LCA methodology to discuss benefits falling outside systemic boundaries. When the systemic boundaries are described as being 'a building', benefits of additional functions can be calculated in this section of an LCA. This includes reusability of components (by demounting instead of demolition), energy production (of materials incinerated with energy recovery) or material recycling at end-of-life.

multi-criteria (decision) assessment

Multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis (MCDA) is a sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision making (both in daily life and in settings such as business, government and medicine). In this context, multi-criteria assessment can be used for design decision making to score and evaluate multiple criteria of a selection of designs, or actual constructions.

p

prototype

Refers to a test setup that mimics a real case. In this context, the prototype refers to building components and materials tested for representing biobased and circular construction designs and biobased materials.

q

quadruple/ quintuple helix model

A framework for innovation describing interactions in the knowledge economy. The framework is built up from the triple helix model in which three sectors come into play: academia (university), industry, and government. In the quadruple and quintuple helix model, respectively the public (citizen) and environment, are added as stakeholders. Focusing on interactions between these sectors, the model focuses on the passage of information and knowledge in society and the economy.

r

reusability

Ability of a material, product, component or system, to be used in its original form more than once and maintain its value and functional qualities during recovery to accommodate reapplication for the same or any purpose.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

s

selection criteria

Criteria related to procurement of a building that are used for the selection of a contractor.
Limitation for contractors to be selected as possible applicants to start construction works.

service learning

An approach to education in which learning objectives are combined with community service, volunteering or internships which brings about practical experience for the student and combines it with a societal need that develops students' personal development and awareness of societal issues. In this respect, learning is complemented by engagement and reflection. As the student's work is beneficial to the company or recipient of the service, the approach helps create advantages for both groups.

social economy

The social economy consists of companies and initiatives that primarily want to realise a specific social added value, while respecting certain principles:

- employment and competence enhancement (with attention to the position of people from disadvantaged groups)
- sustainable development
- priority of labour over capital
- democratic decision-making
- social embedding
- transparency
- quality and sustainability

(https://www.vlaanderen.be/sociale-economie)

social impact

Influence of a product on social issues such as gender equality, human rights, working conditions, etc.

social life cycle assessment/ SLCA

Evaluation of inputs, outputs and potential social and societal impacts of a product system throughout its life cycle.
(ISO NBN 20887 Sustainability in buildings and civil engineering works – design for disassembly and adaptability – principles, requirements and guidance)

systemic boundaries

Description used in LCA methodology to define the product. Used to discuss which inputs and outputs are related to the production, use or end-of-life of the product and which are not, therefore falling outside the boundaries. Can be used to better define the product and compare it to others. Relates to product level on spatial level (which spaces are included on a building level), functional (which inputs guarantee these functions), and temporal (time scale of the product, including which stages of life cycle).

t

theory of change

A methodology for planning, managing and evaluating a setup for societal change by defining long-term goals in advance and at completion linking successes by identifying preconditions and mapping backwards the roadmap to the intended change. By identifying the pathway to those long-term outcomes, the process, its (success) factors and logical relationships between factors are described.

10

Colophon

about the authors

Lidwien Jacobs lectures for the bachelor programme Energy transition and wellbeing economy. She is experienced in applied pedagogies and system thinking.

Cihan Kayaçetin lectures on International Masters programme for Civil Engineering and coordinates research on socio-ecological construction. His expertise is social and environmental LCA.

Lode Lefevre researches technical and legal aspects of circular construction. He's eager on translating theory into practice and has done so in leading the realisation of the CBCI Living Lab in Ghent.

Frank Peeters researches how new technologies offer small and medium enterprises opportunities to design and implement sustainable business models that take on 21st-century challenges.

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Monique Voet lectures for the bachelor programme Built Environment. She is specialised in architecture and is keen to put these skills into practice in a broader field, such as in graphic design.

picture: Tine Desodt, from left to right: Stijn Verdoodt, Lidwien Jacobs, Frank Peeters, Lode Lefevre, Cihan Kayaçetin, Alexis versele, Monique Voet

about Avans University of Applied Sciences

The basic principle of Avans University of Applied Sciences is rooted in and springs from its social environment. To maintain and expand its value within its environment, Avans continues to meet the changing demands of the labor market and the world of work. It is Avans' ambition to educate versatile and resilient professionals who will contribute to - and do applied research for - a sustainable society.

Research Group Centre of Expertise Bio-based Economy (CoE BBE)
The Centre of Expertise (CoE) for Sustainable Business focusses mainly on issues related to continuous improvement, sustainable enterprise and balanced economic development. Its research helps businesses and institutions to respond to the major changes which are taking place in our economic and social environment: rapid innovations, scarcity of raw materials, shifts in political power and swift developments in the labour market. In exploring the business models of the future and the new role organizations play within society, The CoE for Sustainable Business contributes to a more sustainable society.

about KU Leuven

KU Leuven is dedicated to education and research in nearly all fields. Its fifteen faculties offer classes and degree-granting academic programmes, whilst research activities are organised by departments and research groups. These faculties and departments are clustered into three thematic groups: Humanities and Social Sciences, Science, Engineering and Technology (SET), and Biomedical Sciences. KU Leuven is a research-intensive, internationally oriented university that carries out both fundamental and applied research. It is strongly inter- and multidisciplinary in focus and strives for international excellence. To this end, KU Leuven works together actively with its research partners at home and abroad

Research group Building Physics and Sustainable Design (DUBO), Ghent Technology Campus, of KU Leuven, Belgium
KU Leuven DUBO has extensive knowledge and experience in the holistic view of sustainable buildings via integrating research into practice. Four lines of research have currently been set up that focus on improving the performance of materials and components throughout the life cycle of a building, namely: i) energy performance, ii) renewable construction materials, iii) community scale sustainability and iv) holistic design, construction and operation of high-performance buildings. KUL DUBO uses a design research approach and realized several living labs. CBCI Living Lab Gent is the latest product of the unit which lays basis for several teaching materials in this book.

about HZ University of Applied Sciences

HZ University of Applied Sciences is a small university with a personal approach, located in the South-West of the Netherlands. HZ offers high-quality study programmes. Since 2011, HZ has been in the top three Dutch multidisciplinary universities of applied sciences. As a university of applied sciences, HZ focuses on practice-based education and research opportunities. Close cooperation with the business world, various research centres and a global network of partner universities is of paramount importance. Within the CBCI project, there is tight cooperation between the following research groups and study programme: Centre of Expertise Biobased Economy, HZ Knowledge Centre Entrepreneurship & Innovation, and the bachelor study HZ Engineering. Applied research has taken place on issues of engineering, sustainable innovation and entrepreneurship.

HZ Knowledge Centre Entrepreneurship & Innovation
HZ Knowledge Centre Enterprise & Innovation, or KCOI in short, is a knowledge centre of HZ University of Applied Sciences. In close cooperation with Zeeland's government bodies, businesses, partner educational institutions and other social organisations, KCOI develops and disseminates knowledge to support sustainable entrepreneurship and innovation. In terms of content, KCOI's work ties in with the core themes on which HZ University of Applied Sciences focuses: water, energy, vitality and food. For each of these domains, KCOI manages a Body of Knowledge with descriptive information, good & bad practices in the context of sustainable value creation, and up-to-date market insights and customer knowledge. Materials from this Body of Knowledge are gratefully used by policy makers, organisational managers and educational experts alike.

creative commons

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scan the QR-code, or
go to the url: **edu.nl/ce9ae**

Building tomorrow aims to become the single most important source of guidance for educators training and coaching the construction professionals of the circular future.

It unlocks current know-how derived from practical research about the technical, financial, social and legal aspects of circular building with biobased materials. By exploiting circular economy principles, using biobased materials and applying newly developed approaches and instruments, it covers all major steps needed to realise sustainable buildings.

24 educational blueprints for circular constructions

The educational blueprints are suitable for both bachelor's and master's curricula. Students will learn about today's sustainable construction industry based on insights, methods and authentic examples gained during the three-year CBCI project promoted by EU Interreg 2 Seas.

The teacher can choose from 24 teaching modules, each with clearly described subjects, learning outcomes and educational approach.

Every blueprint offers a ready-selected package of literature and educational materials that perfectly match the objectives and assignments. Together they demonstrate how to design a building project with sustainable goals in mind and offer various methods and tools to compare and contrast alternative building solutions. Nevertheless, each module can be studied independently from the others.

Through shortened URLs and QR-codes that are provided with each blueprint, teachers and students have unlimited access to permanently updated online materials at no cost.

about the authors

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