

# PROCEEDINGS

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## **PROCEEDINGS**

of the

19<sup>th</sup> European Roundtable for Sustainable  
Consumption and Production

Circular Europe for Sustainability: Design,  
Production and Consumption

Editors:

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## **KATCH\_e: Training materials and tools for circular economy in practice**

### **1. Introduction**

The circular economy (CE) represents a fundamental alternative to the linear take-make-consume-dispose economic model that currently predominates. This linear model assumes that natural resources are available, abundant, easy to source and cheap to dispose of, but it is not sustainable, as the world is moving towards, and is in some cases exceeding, planetary boundaries (EEA, 2016). Therefore, we need a fundamental transition into a more sustainable consumption and production system. In a circular model, on the other side, waste and pollution are designed out, products and materials are kept in use and values sustained for as long as possible – and natural systems are regenerated (Ellen MacArthur Foundation, 2012).

The idea of a CE is not new but goes back to the 60s and 70s (Boulding, 1966; Nicholas Georgescu-Roegen, 1975). However, it was not until the beginning of the 90s that the term CE emerged, when introduced by Pearce and Turner in 1990. In 2012, the concept re-emerged as the Ellen MacArthur Foundation published their first of many publications on CE (Ellen MacArthur Foundation, 2012). The CE approach is having a fast development and is receiving increasing attention worldwide to overcome the current production and consumption models based in “linear economy” or “take, make and dispose model” that depletes natural resources and destroys ecosystems.

The concept has spread to the political arena with amongst other the European Commission’s Action Plan to a Circular Economy (European Commission, 2015), and a revision of a number of directives such as the waste framework directive and the directive on packaging waste (European Commission, 2008, EUR-Lex, 2018).

Design plays a crucial role in CE and this is not only about recycling, but also about durability, maintenance, repair, sharing, reuse, refurbishment and remanufacturing. Design has the power of enabling or hindering these features. It determines the circularity potential of products, services and systems. Traditionally, designers would focus exclusively on products, but their role is evolving (De Groene Zaak and Ethica, 2015). Given that the design of a product directly influences the way a value chain will be managed, building circular, globally sustainable value chains inevitably signifies a fundamental change in the practice of design. A variety of new capabilities are key competences to design for a sustainable future; these range from a deeper knowledge of material composition to a rich understanding of social behaviour (De los Rios and Charnley, 2017).

Nowadays designers and “developers need to cooperate to co-create and produce utility in which the possible services and performance, safety, collection, recycling, littering and end-of-life possibilities are taken into account, like cascading, refurbishing, reuse or biodegradation” (Kok et al., 2013:22), and replacing products with services. However, the current knowledge base to turn theory into practice is fragmented and studies point to the need of adequate skills and education for CE (EEA, 2016), and that the principles of a CE should become an integral part of education programs.

This paper presents the European project KATCH\_e - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education. This is a 3-years EU funded project that will be concluded by the end of 2019 and is part of the ERASMUS+ programme of Knowledge Alliances. The project consortium integrates 11 partners from four EU countries to address the challenge of reinforcing the skills and

competences in the field of product-service development for the CE and sustainability in the construction and furniture sectors through the development of innovative training materials and tools addressing professors, students and professionals in the respective industries.

The project contributes to:

1.1 Build a lasting knowledge alliance between universities, companies and knowledge centres by encouraging multidisciplinary relationships and supporting the exchange of information, experiences and materials amongst the partnership and between different stakeholders through the creation of structures to engage students, professors, researchers, companies and other stakeholders in a systematic and efficient way.

1.2 Build competences in design for the CE and sustainability by the development of training materials that follow a problem-based and multidisciplinary learning approach, connecting designers, engineers and other relevant stakeholders to integrate CE thinking in design and development education and define didactic recommendations for teaching. The resources developed will foster entrepreneurial skills leading to innovative products, services and business models.

1.3 Support and promote the dissemination of circular design and sustainability among higher education centres and companies, demonstrating the practicability of the materials, their benefits and innovation potential.

## **2 Circular economy within KATCH\_e – conceptualization and definition**

Despite its popularity, the understanding of the CE concept is far from consensual, as shown in an analysis of 114 definitions performed by Kirchherr et al. (2017). Therefore, in the KATCH\_e project, the consortium developed its own definition of CE, meant to suite the projects' objectives, operational approach and sectors. It has its roots in the definition provided by the Ellen MacArthur Foundation in a report published in 2012, called seminal and "assumed that it has likely impacted the discourse" (Kirchherr et al., 2017: 225) about CE. However, this definition was criticized for not specifying the needs for reducing consumption levels and for not including the social aspects of sustainability.

With these considerations in mind, and in order to frame the development of the KATCH\_e training materials and tools, the Ellen MacArthur Foundation (2012) definition was used as the main source of the project's definition, adding the ideas of slowing, closing and narrowing resource flows and social sustainability, as shown in figure 1.

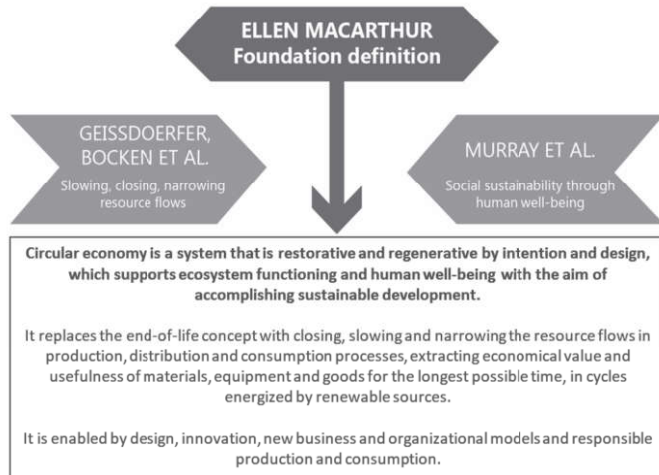


Figure 1. Development of the KATCH\_e definition of CE.

### 3 State of the art and trends in training for a CE in the construction and furniture sectors

The transition from a linear to a circular economy is a key challenge for all actors in the society, and universities have a central role. Graduates should be able to rethink and co-develop new solutions for CE from a multidisciplinary approach. This is very much in line with the 21st-century learning skills developed by the World Economic Forum, defining key competences such as: critical thinking and problem solving; creativity; communication; and collaboration (Soffel, 2016).

Studies point to the need for adequate skills and education for the CE (EEA, 2016). Thus, it was important to know which skills are needed and how they are covered by the training already offered by higher education institutions in order to prioritize contents and define the didactic materials and learning approaches that should be developed by the project.

To this end, a research was done to describe the current situation of CE and sustainability in higher education mainly in the partner countries and business related to the construction and furniture sectors from the perspective of multidisciplinary key stakeholders (KATCH\_e, 2018).

In order to know the training offer in CE, sustainability and related subjects, a detailed bibliographic review was done on:

- 3.1 Databases and software;
- 3.2 Books and guides;
- 3.3 Related projects;
- 3.4 Websites and platforms;

3.5 Standards and ecolabels; and

3.6 Tools.

Moreover, 73 training offers (official masters, postgraduate courses, and independent courses) from the four KATCH\_e countries related to design, and the furniture and construction sectors were analysed. The main subjects were grouped into three categories: environment, economics and design (table 1).

**Table 1.** Main topics covered by the training offered by universities of the four KATCH\_e countries.

Topics	Main subjects
Environment	Circular economy Resource efficiency Resource cascading Reuse, repair, remanufacture, recycle
Economics	Industrial symbiosis Sustainable business model Product-service systems Circular business model Performance economy
Design	Design for sustainability Circular design Cradle-to-cradle design

Figure 2 shows, for training offers in higher education (HE) related to different thematic areas, the percentage in which each topic is present. In trainings explicitly designated as “Circular Economy”, the CE topic is obviously the most frequent subject (29%) followed by circular business models (14%). Regarding courses on waste management, CE, reuse/repair/remanufacture/recycle and others are present in equal parts. In business related training offers, there are contents, in equal parts (10%), about CE, resource efficiency, sustainable business models, circular business models, performance economy, design for sustainability and social innovation. In the training offers on design, the most frequent topic is design for sustainability, but “others” represents 39% what shows that other aspects about CE, out of the topics considered in this research, are mostly considered.

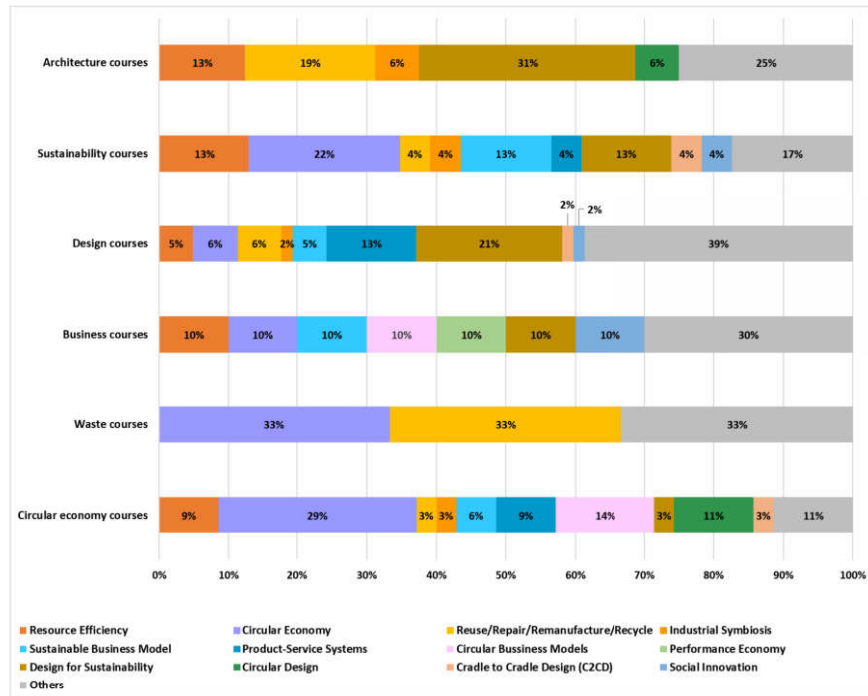


Figure 2. Topics related to CE present in subjects and disciplines (here broadly designated as “courses”) offered in HE.

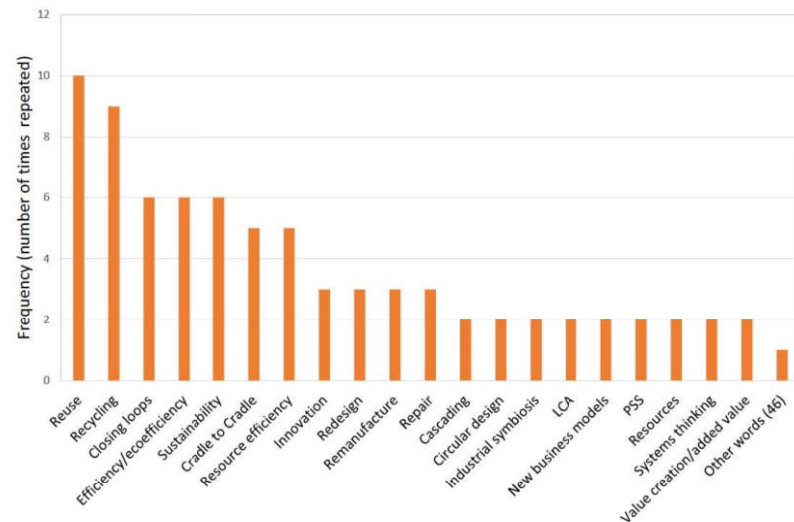
In order to have direct testimonies from the main stakeholders, a series of interviews and several workshops were conducted. The target groups addressed were students, professors, researchers, companies, business associations, public authorities and NGO’s. The answers of 49 interviews and the main findings from the workshops were classified in seven main topics, as described in the following paragraphs.

### Understanding and perceptions of circular economy

The concept of CE is still not clear and harmonized. The variation in understanding and perception was identified as a possible barrier to CE implementation.

The most common concepts used to describe CE are those shown in figure 3. It was observed that the majority (25%) corresponds to the terms “reuse” and “recycling”; and the relationship between CE and social aspects is very rare in the responses.





**Figure 3.** Frequency analysis of the answers to the question “What three words would you say best describe CE?”

### CE implementation and promoting actions

Teachers and students demand CE training and implementation in the curricula in a more systematic way.

Companies are more optimistic when declaring to apply CE strategies than universities.

Regarding promotion of CE, different perspectives were found according to the type of actors: Administration claimed to do an important effort, but that effort seems not being perceived by business associations.

### CE: Demands and needs

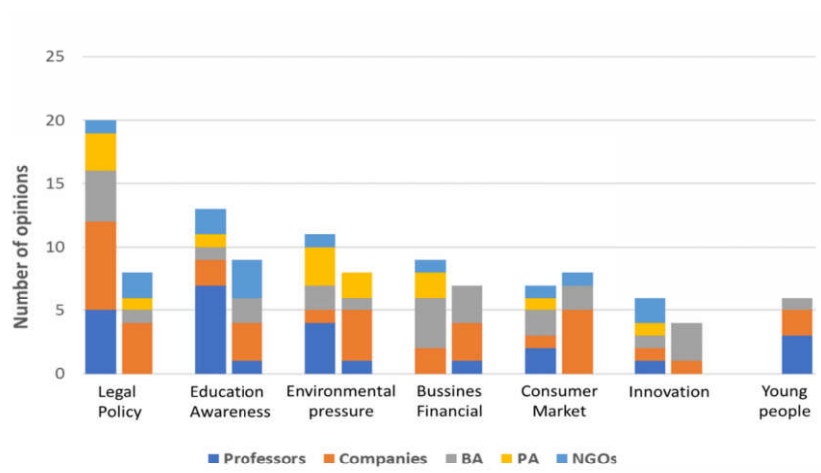
The needs and demands for the transition towards a CE were mainly related to financial support for investments, new business models, and the need to adapt legislation and infrastructures.

The needs and demands for competences related to CE requires skills to solve problems involving more than one stakeholder, with pragmatic tools and methods and multidisciplinary knowledge, which should support fast real-life changes.

### Main drivers to CE

The main drivers identified (in order of relevance) are: legal/policy; education/awareness; environment pressure; business/financial; consumer/market; innovation; and younger generations. Figure 4 shows the

main drivers identified by the different target groups at present and in the future



**Figure 4.** Present (left column) and future (right column) main drivers, according to the different target groups interviewed: Professors, companies, business associations (BA), public administration (PA) and non-governmental organizations (NGOs)

### Barriers in implementing CE

Lack of commitment, time, knowledge, skills and competences were common barriers to implement CE in universities and companies.

At universities: difficulty in introducing new contents in curricula and multidisciplinary. At companies: inability to adapt to developments and changes of new products, services and business models, low demand from market and legal barriers (e.g. waste classification)

### Challenges

From companies' point of view: keeping up with developments and trends, ensuring to adjust the portfolio to the demands of the market and environmental legal requirements. From educational point of view: keeping up with developments and trends, thinking and acting in an interdisciplinary manner and as a service-provider, qualifying future CE experts.

In summary, all these findings were used as a basis for discussing and proposing the necessary competencies to be addressed by KATCH\_c, to foster their implementation at the higher education level with pragmatic methods and tools. The applied methodology guaranteed a holistic and multidisciplinary approach, ensuring that key findings, relevant aspects and recommendations were included.

#### 4 Stakeholders' engagement

Stakeholder Engagement activities were, and are, planned for and conducted throughout the project period in all four countries and in international fora. The purpose was to include the stakeholders' knowledge and recommendations in the development of the training materials, and at the same time disseminate information and create interest for the outcomes of the project.

In the first project phase, relevant stakeholders representing the three main target groups, Higher Education, Business community and Knowledge Centres, and key players within authorities, NGO's etc. were contacted, and around 50 people were interviewed as a part of the training needs analysis. Later, while defining the content of the KATCH\_e modules, key stakeholders with knowledge and experience on circular economy were involved in reading and commenting. Their valuable feedback informed the decision-making on what to include and explain in the training materials.

In the later phases of the project, stakeholder engagement was used as a part of testing and using the training materials, and in building the knowledge alliances that will support after-project activities and use of the KATCH\_e materials.

Through the project period, stakeholder networks were established in all four countries with a total number of members well above 400, and the networks continue to grow. All members receive the KATCH\_e newsletter and information on the project and key stakeholders are actively involved in different ways. For example through participation in the series of workshops taking place during the project period. Table 2 presents an overview of these workshops.

*Table 2. Overview of the national KATCH\_e workshops*

	<b>Theme</b>	<b>Period</b>	<b>No. of participants</b>
Workshop I	CE training needs	Spring 2017	100
Workshop II	Use and feedback on KATCH_e materials	Winter 2018	150
Workshop III	Evaluation and future cooperation	Autumn 2019	-

Moreover, three international workshops serve to present and discuss the project with experts and professionals in a wider setting outside the four countries:

- 4.1 Workshop on ERSCP (European Roundtable on Sustainable Consumption and Production) 2018 to discuss the intended content of the training materials
- 4.2 Workshop and presentations on ERSCP 2019 to present and discuss the KATCH\_e training materials and how to use it
- 4.3 Workshop on SEFI (European Society for Engineering Education) conference 2019 with hands-on experiences for the participants.

Finally, a Knowledge Hub is organized on Linked In to stimulate the debate on training for circular economy.

#### 5 Development of the training materials

### Introduction to the development process

The KATCH\_e training materials were developed based on the exhaustive analysis of the state of the art and existing training resources collected within the situation analysis, together with the involvement of the stakeholder network. They are meant to be used in academic teaching, in-classroom context, as well as in companies or workshop settings, and comprise eight KATCH\_e learning modules and seven KATCH\_e tools that support the practical implementation of the knowledge acquired with the modules.

The focus of this project is to facilitate the process of integration of CE aspects in the design process of products and services. Nevertheless, as seen in section 1.3, the CE represents a new way for companies or producers to create value compared to the more traditional linear business model of production, where profit is generated from selling products (Bocken et al., 2016). This calls for the development of new business models such as product service systems, leasing, collaborative consumption, sharing platforms and business models based on maintenance and repair (Bocken et al., 2016). Stahel also introduced in the 1990s the functional service economy with the purpose of selling performance instead of a selling a product (Stahel, 2013). CE is also linked to the sharing economy, where the consumer buys access to a product instead of owning it (Hobson and Lynch, 2016).

With these ideas in mind, the themes of design and business models are central in the KATCH\_e results. Moreover, transformation towards more circular products and businesses requires information about inputs and outputs of systems and processes, measuring their impacts, as well as management of data and data exchange across the value chain. Following this understanding, the modules and tools have been developed according to a framework organized in four main areas:

- 5.1 Basics: Basic knowledge on CE that supports the understanding of the other materials;
- 5.2 Business: The business approach, required for the success of new, more circular and sustainable products or product-service;
- 5.3 Design: Product and product-service system design according to circularity and sustainability criteria; and
- 5.4 Assessment and communication: A support area with contents regarding assessment and communication in circular economy with a life cycle perspective.

The following table (3) presents the framework and the relation with the modules and tools.

**Table 3.** *KATCH\_e modules and tools*

Framework	Modules	Tools
Basics	— Introduction to the circular economy	— KATCH-Up Board Game
Business	— Business models — Value chains	— CE Strategist — CE Value Chains
Design	— Processes and materials — Design and development	— CE Designer — CE Journey
	— Radical innovation and collaborative design processes	
Assessment and communication	— Life cycle perspective — Communication	— CE Analyst — KATCHing Carbon

The modules and tools aim at approaches that promote innovation at HE, the two most important being:

- 5.5 Privileging problem-based learning (PBL), where students are presented with a problem and engage in
- 5.6 active learning in the sense that they have to discover and work with content which is necessary to solve the problem.
- 5.7 Multidisciplinary, which is inherent to the thematic of CE and sustainability: while we focus on product development, we are not limited to design / product design / industrial design education. Other disciplines such as engineering (mechanical, materials, chemical, environmental), environmental sciences, marketing and business and innovation management will be involved.

All materials were tested and validated with the involvement of several stakeholders, in pilot projects and training initiatives carried by the consortium, seeking a high quality of the resources. These phases are presented in the next sections.

#### **Testing and validation of the training materials**

The development of the training materials had an iterative nature also before the testing phase due to the interaction with external stakeholders, students and companies. After the completion of the draft versions of the modules and tools the testing phase that took place in parallel in the four project countries provided valuable insight regarding quality and applicability. It included face-to-face classes, workshops, etc. at universities and internships in the partner companies and delivered valuable feedback to improve and update the materials and the tools that has been gathered through the established evaluation mechanisms. After completion of the Massive Open Online Course (MOOC) in fall 2019 it will also be tested.

The universities played a key role in testing the modules and tools and managed the interaction between students and companies through internships. The intensity and workload for professors and students varied depending on the laid focus, e.g. at one university a semester project was performed, at another a new multidisciplinary course on circular design was introduced while at other university only parts of the materials have been integrated in existing courses or students had to perform self-study and implement selected approaches on their assignments or final thesis. Via external lectures and workshop activities, additional universities, companies and organizations could be involved.

Besides gaining feedback on practicability and relevance of the developed materials for various disciplines and sectors the testing also lead to case studies resulting from the internships of students in the partner companies and conducting of bachelor and master thesis. The results developed by students tutored by professors create direct benefits for the involved companies:

- 5.8 Evaluation of the status of the business strategies on CE
- 5.9 Accustomed business strategies towards CE
- 5.10 Innovative product/product-service concepts

The implementation of the strategies and concepts is not mandatory to the companies and lies out of the scope of the project. Nevertheless, the results from the testing phase will stimulate changes within the project partners. Respecting confidentiality requirements set by the companies the results will be open to public in the knowledge centre of the project webpage in order that they may inspire others.

First findings and conclusions have been presented and discussed at the second national stakeholder workshops and pedagogic materials for the future application in various university and company settings will be constituted.

#### **Evaluation of the training materials**

In order to identify whether the training materials and tools meet the objectives of the project and the needs and expectation of the users of the resources, the consortium developed an evaluation methodology. The stages defined for this purpose are:

- 5.11 Definition of the evaluation needs
- 5.12 Design and development of the evaluation procedure
- 5.13 Application of the evaluation procedure and analysis of results
- 5.14 Evaluation of long-term indicators and outcomes

To this date, the first two stages have been completed, and are presented in this section, together with preliminary results of step 3.

Hence, the first step of the evaluation procedure was to establish the evaluation needs of the project:

- 5.15 How suitable are the training materials?
- 5.16 To what extent do the materials promote the CE?
- 5.17 How clear are the materials?
- 5.18 Degree of satisfaction with the contents.

The evaluation procedure (step 2) was based on questionnaires, and two types have been developed: one to be filled in by the people who have read or applied the training module or tool, typically professors (Type A) and another to be filled in by the trainees who were exposed to the module or tool and a learning environment, such as a lecture or a workshop (Type B).

Table 4 summarizes the type A questionnaires for the modules and for the tools. Given the explanatory character of the former, the related questionnaires are much more comprehensive than the latter. And since the learning objectives specified in the modules were part of the evaluation criteria, there was one questionnaire per module, unlike what happened with the questionnaires for the tools.

**Table 4. Contents of the type A questionnaires.**

Type A questionnaires for modules	Type A questionnaires for tools
Identification of the respondent and date	
Whether or not the full module was tested. If not, which chapters?	
Performance of the module in view of the learning objectives (semi-open question with a field for justification)	
<u>Opinion on the module or tool (semi-open question with a field for justification or improvement suggestions):</u>	
<ul style="list-style-type: none"> <li>— The language of the module is adequate</li> <li>— The content is understandable and well structured</li> <li>— The text is versatile enough to be applied in all target groups</li> <li>— The module has a practical and didactic approach</li> <li>— Additional reading was needed to understand the module</li> <li>— The assignments are relevant</li> <li>— The examples are relevant</li> </ul>	<ul style="list-style-type: none"> <li>— The tool is intuitive and easy to understand</li> <li>— The tool is easy to apply to real practical cases</li> <li>— The results make sense and are easy to understand</li> <li>— The results are in accordance with the time and effort to use it</li> <li>— The results are useful and applicable to the development of new products and services</li> </ul>
Open questions regarding what the respondent liked and disliked the most about the module and suggestions for improvement.	

As for type B questionnaires, they were filled in by trainees, online or on paper. These questionnaires are presented in table 5.

**Table 5. Contents of the type B questionnaires.**

Type B questionnaires for modules	Type B questionnaires for tools
E-mail address of the respondent and date	
Name of the respondent (optional)	
Module/Tool (closed question, multiple choice)	
Degree of previous knowledge about the content of the module (closed question, 3 points scale – low, medium, high)	
<u>Opinion on the module or tool (open questions):</u>	
<ul style="list-style-type: none"> <li>— Which content did you find more interesting?</li> <li>— Which content did you find less interesting?</li> <li>— Which content did you find confusing?</li> <li>— How did you like the assignments?</li> <li>— Suggestions for improvement</li> </ul>	<ul style="list-style-type: none"> <li>— Is the tool intuitive and easy to understand?</li> <li>— Is the tool easy to apply to real practical cases?</li> <li>— Do the results make sense and are easy to understand?</li> <li>— Are the results are in accordance with its time and effort of use?</li> </ul>
	— Suggestions for improvement

Once the questionnaires were designed, each partner had an assigned number of tests to carry out about (a) specific module(s) and tool(s) (see the previous section). They chose the adequate professionals, companies, institutions or students to do so, depending on the target group of the tester and the kind of content of the module or tool that was going to be tested. Then, the compilation of the evaluation forms and questionnaires was organized and all the evaluation information was merged and analysed. As an example of the evaluation results, a summary of strengths and weaknesses of the modules is presented in table 6.

**Table 6.** Excerpt of the evaluation of the modules: strengths and weaknesses.

Type A questionnaires	Type B questionnaires
<b>STRENGTHS</b>	
<ul style="list-style-type: none"> <li>— Brief definitions, clearly explained contents, even for non-experts</li> <li>— Key words &amp; summary tables help understanding</li> <li>— Reference to further reading</li> <li>— Good, illustrative &amp; helpful examples</li> <li>— Tools very relevant for companies' use</li> <li>— Clarifying figures, images and tables</li> <li>— Different, reflective, adequate assignments to consolidate contents</li> </ul>	<ul style="list-style-type: none"> <li>— "Assignments make us think creatively"</li> <li>— Very useful concepts and tools to apply in design</li> <li>— Debates / discussions are positively valorated to learn from others' points of view</li> </ul>
<b>WEAKNESSES</b>	
<ul style="list-style-type: none"> <li>— More detailed instruction of how to complete the assignments is needed</li> <li>— Not enough examples to consolidate theoretical concepts</li> <li>— Explained case studies needed to understand concepts</li> <li>— No mention to other modules</li> <li>— Some assignments difficult to understand</li> <li>— More explanation on some figures needed</li> <li>— Better description of tools desired</li> <li>— Too theoretical, more graphics desirable</li> <li>— How to put that theoretical info into practice is not clear</li> <li>— More detail needed for professionals' target group</li> </ul>	<ul style="list-style-type: none"> <li>— Too much information: More visual and attractive presentations needed</li> <li>— They need time to assimilate concepts to apply them in the assignments</li> <li>— More real life examples welcome</li> <li>— More practical examples</li> <li>— Clear instructions and guidance in assignments desired</li> </ul>

Through the evaluation procedure, it has been possible to register and collect valuable feedback from the people who have tried the materials or who have been trained with them. They have been very useful to show to what extent the materials and training generated in the project meet the project objectives, to depict how far has the material helped to increase the CE knowledge, as well as to display how the contents are applicable in the real context of the companies. Moreover, the feedback was used to further improve the materials.

## 6 Results

The KATCH\_e results are available for free on the project website ([www.katche.eu](http://www.katche.eu)), where users can access the Knowledge Platform (KP) upon registration. The KP hosts all educational resources produced within the project:

### 6.1 Tools and training materials:

- 6.1.1 KATCH\_e modules
- 6.1.2 KATCH\_e tools
- 6.1.3 Didactic recommendations targeting HE institutions willing to use the project's materials
- 6.1.4 Glossary

### 6.2 The KATCH\_e online course, with a duration of 10 hours (MOOC)

- 6.2.1 Overview of the modules (video and table of contents)
- 6.2.2 Narrated presentations of the KATCH\_e modules
- 6.2.3 Links to the KATCH\_e tools with a short tutorial
- 6.2.4 Links to the case studies



- 6.2.5 Quizzes
- 6.2.6 Final exam
- 6.3 Other materials
  - 6.3.1 Case studies that resulted from the internships in partner companies
  - 6.3.2 Business strategies on CE from the partner companies
  - 6.3.3 Database of examples of the implementation of CE strategies in the target sectors
  - 6.3.4 Situation analysis report and executive summary
  - 6.3.5 The 10 Essentials of working with circular economy
  - 6.3.6

In the next sections the modules and tools, which were the most innovative and comprehensive results of the project, will be presented.

### The KATCH\_e modules

The testing and evaluation phases allowed for many suggestions for improvement to be integrated in the final versions of the KATCH\_e modules.

Each module begins by asking a main question which acts as a guide for readers/users. Modules are organized into chapters and include various assignments and examples to support teachers and trainers in preparing training sessions, or as a self-learning exercise.

There is no predetermined order and each module can be used independently, except for the “Introduction to the Circular Economy” module, which should be the first, especially for someone unfamiliar with the concept of CE. However, each module includes an indication of the required prior knowledge, which may have been obtained elsewhere or through another KATCH\_e module. This independence character is illustrated in figure 5.

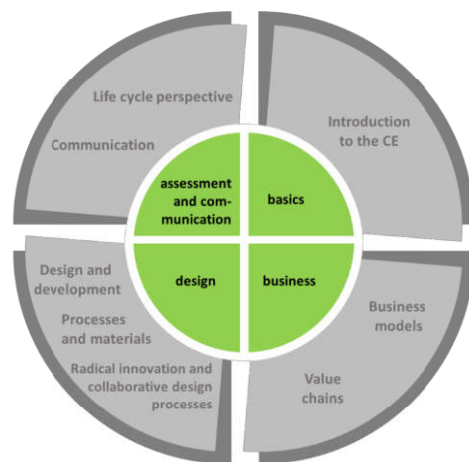


Figure 5. KATCH\_e modules

The four areas' framework was kept, as shown in the figure. The modules vary in length, between 51 and 85 pages and follow a common organization:

- 6.4 Learning objectives
- 6.5 Previous knowledge (recommended, cross-referencing other KATCH\_e modules)
- 6.6 What (is the module about), who (would be interested), where (in which context does it make sense to read it), when (does it apply in the development process), why (is it relevant) and how (can the knowledge be applied)
- 6.7 Questions the module addresses
- 6.8 Executive summary
- 6.9 Main chapters (with assignments in all chapters)
- 6.10 Examples
- 6.11 Bibliography

Besides, in all modules the most important terms and expressions are highlighted and available in an online glossary. An image of the cover page of one of the modules is shown in Figure 6.



Figure 6. Cover page of the "Introduction to the Circular Economy" module.

Table 7 provides an overview of the contents of the eight modules.

**Table 7. Overview of the KATCH\_e modules**

Module	Main question the module addresses	Contents (main chapters)
<b>Introduction to the circular economy</b>	What is CE and what is needed to work from a circular approach?	<ul style="list-style-type: none"> <li><input type="checkbox"/> The global sustainability challenge and why we need a new approach to production and consumption</li> <li><input type="checkbox"/> Defining CE and the underlying principles and strategies</li> <li><input type="checkbox"/> CE in the construction and furniture sectors</li> <li><input type="checkbox"/> Design and innovation for a CE</li> <li><input type="checkbox"/> CE requires new business models</li> <li><input type="checkbox"/> Main challenges and drivers in shifting to a CE</li> <li><input type="checkbox"/> EU policy and legislation for CE</li> <li><input type="checkbox"/> Sustainable production and consumption</li> <li><input type="checkbox"/> CE in the construction and furniture sectors</li> <li><input type="checkbox"/> Tools for introducing the CE</li> <li><input type="checkbox"/> The 10 essentials of working with CE</li> </ul>

Module	Main question the module addresses	Contents (main chapters)
<b>Business models</b>	How can companies work towards the aims of CE by adopting circular strategies within their business model?	<ul style="list-style-type: none"> <li>What is a business model?</li> <li><input type="checkbox"/> The circular business model</li> <li><input type="checkbox"/> Revenues and costs – financial implications of CBMs</li> <li><input type="checkbox"/> From linear to circular business models</li> </ul>
<b>Value chains</b>	How should value chains and value networks be understood and managed to get benefited from a CE?	<ul style="list-style-type: none"> <li><input type="checkbox"/> Introduction to the concept of circular value chains and networks</li> <li><input type="checkbox"/> Why change to a circular value network?</li> <li><input type="checkbox"/> How to optimize supply chains through reverse networks</li> <li><input type="checkbox"/> Business strategies/models that support the implementation of circular value networks</li> <li><input type="checkbox"/> Stakeholders engagement and management: how to establish a circular value network</li> <li><input type="checkbox"/> Existing tools for the management of value chains towards sustainability</li> </ul>
<b>Processes and materials</b>	Which are the most relevant characteristics of materials and processes to carry out CE strategies for product and product service development?	<ul style="list-style-type: none"> <li>Contextualization of the role played by processes and materials in CE</li> <li><input type="checkbox"/> Characteristics of materials and processes from a CE perspective</li> <li><input type="checkbox"/> Design and development strategies vs. characteristics of materials and processes</li> </ul>

		<ul style="list-style-type: none"> <li><input type="checkbox"/> Compilation of processes and characteristics of materials examples and references</li> <li><input type="checkbox"/> Possible trade-offs (and some methods used to deal with it) when making decisions and creating potential contradictory effects</li> </ul>
<b>Design and development</b>	How can the design of products and services contribute to the CE?	<ul style="list-style-type: none"> <li><input type="checkbox"/> Concept: From ecodesign to design for the CE and sustainability</li> <li><input type="checkbox"/> The role of design in CE</li> <li><input type="checkbox"/> KATCH_e design strategies for a CE</li> <li><input type="checkbox"/> Product and service design step-by-step</li> <li><input type="checkbox"/> Design for CE in the building sector</li> <li><input type="checkbox"/> Tools for product and service design for CE</li> <li><input type="checkbox"/> Examples and case studies</li> </ul>
<b>Radical innovation and collaborative design processes</b>	Considering the impacts of the design activity on industry and society at large, how can radical innovation change behaviours and mind-sets, specially related to sustainable consumption and environmental education?	<ul style="list-style-type: none"> <li><input type="checkbox"/> Introduction to innovation</li> <li><input type="checkbox"/> CE as an input for the innovation process</li> <li><input type="checkbox"/> Product-service system design</li> <li><input type="checkbox"/> Collaborative and participatory design for innovative processes</li> <li><input type="checkbox"/> Open-source as a mean to feed innovation and disseminate results</li> </ul>
<b>Life cycle perspective</b>	What information is needed to assess circularity along the life cycle of products or services?	<ul style="list-style-type: none"> <li><input type="checkbox"/> Introduction to life cycle thinking</li> <li>• Impact assessment along the life cycle</li> <li>• The life cycle of products and discussing circular loops</li> <li>• Assessment &amp; communication on building and component level</li> <li>• Case studies of construction and furniture products</li> </ul>
<b>Module</b>	<b>Main question the module addresses</b>	<b>Contents (main chapters)</b>
<b>Communication</b>	How could the advantages of circular products and services be communicated?	<ul style="list-style-type: none"> <li><input type="checkbox"/> Introduction to communicating circularity</li> <li><input type="checkbox"/> Guidelines and techniques for communicating circularity</li> <li><input type="checkbox"/> Specific circular communication tools</li> <li><input type="checkbox"/> Environmental labelling and product declarations and their relation to CE</li> <li><input type="checkbox"/> Examples of circularity communication in the furniture and construction sectors</li> </ul>

Most of the modules' contents is applicable to any kind of products. Sector-specific contents have been included and the examples are related to the construction and furniture sectors. They are included in the modules and available online in a database.

### The KATCH\_e tools

The tools are developed with the intention to complement the theoretical inputs of the modules. However, the tools also stand on their own and can be applied individually without the background information in the modules.

Figure 7 shows an overview of the seven developed tools and their relationship to the defined framework

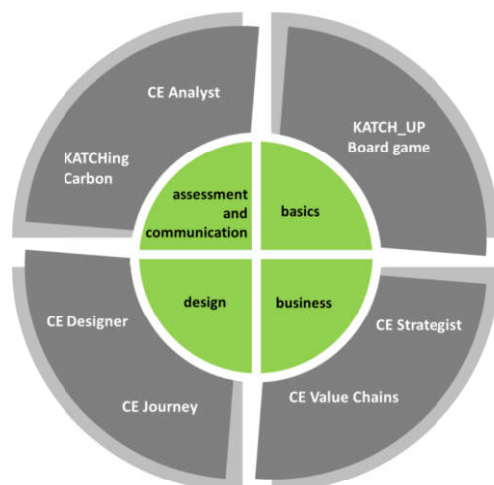


Figure 7. KATCH\_e tools

The term “tools” within KATCH\_e refers to a wide range of different practice-oriented instruments. The seven tools developed consist of three webtools (which will be available under [www.katche.eu](http://www.katche.eu)), two Excel-based tools, a board game and a workshop-template for visualizing CE potentials.

The three webtools – the CE Designer, CE Strategist and the CE Analyst - are developed as an interlinked package uniting the three major issues of the KATCH\_e-framework showing how CE strategies affect the product design, the business model and the environmental product profile.

Table 8 summarizes the tools purpose, results, method and platform. The tools are currently in the process of being evaluated, tested and adapted. The final versions will be available at the end of the project period (12/2019).

Table 8. Overview of the KATCH\_e tools

Tool	Platform	Purpose	Methodology
CE Designer	Webtool	semi-quantitative checklist-tool for prioritization, assessment and idea finding of circular solutions for product	<ul style="list-style-type: none"> <li>— Choose the most relevant CE-Strategy for a specific reference product</li> <li>— Evaluate the fulfilment of the corresponding criteria</li> <li>— Define potential design improvements</li> <li>— Compare the improved version and the</li> </ul>

		and/or service (re)design	reference product
CE Strategist	Webtool	Identify Circular Business Opportunities and provide guidance along the Business Model Design process	<ul style="list-style-type: none"> <li>— Describe the current Business Model with a Business Model Canvas (BMC) Template (optional)</li> <li>— Evaluate the applicability of predefined CE Business Strategies</li> <li>— Learn from examples and choose the best-fitting strategy/strategies)</li> <li>— Define the (adapted) CE-oriented Business Model with the help of highlighted influences related to the chosen strategies</li> </ul>
CE Analyst	Webtool	Quantitative LCA-based tool to estimate the impacts of CE strategies on its carbon footprint	<ul style="list-style-type: none"> <li>— Enter the Product Carbon Footprint (PCF) data of a “linear” reference product system for all life cycles</li> <li>— Evaluate and compare the potential to reduce carbon emissions through different CE Strategies and choose one</li> <li>— Estimate the impacts through the corresponding variables</li> <li>— Repeat the previous two steps with a different strategy or compare the PCF of different product systems</li> </ul>
Value Chains	Excel	Prioritization and identification of external and internal stakeholders for a specific CE strategy	<ul style="list-style-type: none"> <li>— Map current stakeholders and assess their relevance</li> <li>— Identify new stakeholders needed for the CE project</li> <li>— Assess all stakeholders according to their relevance and capacity and interpret the resulting scatter plot</li> <li>— Define an action plan</li> </ul>

CE Journey	Printable Canvas with Cards	Visual representation of the material- and stakeholders- “journey” of a Product- or Service- system over its the whole life cycle	<ul style="list-style-type: none"> <li>— Preparation (define the product system, gather materials and groups)</li> <li>— Assign roles to the participants (Materials, Producer, Partner, User)</li> <li>— Pick a set of “Superpower”-cards according to the assigned role and discuss the questions on it and fill it out</li> <li>— Pick a set of “Challenges”-cards according to their assigned role discuss its questions and fill it out</li> <li>— Fill out the Canvas with pins and threads; identify touchpoints and reflect on them</li> </ul>
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Tool	Platform	Purpose	Methodology
KATCH-Up	Board Game	Generation of CE-inspired Ideas for predefined challenges	<ul style="list-style-type: none"> <li>— Preparation (print board and cards, gather groups of 3 to four people)</li> <li>— Scenario-phase: Pick a problem-context card with a specifically defined CE challenge</li> <li>— Idea-phase: Pick one design card and the corresponding business card</li> <li>— Planning phase: Define a Business Model with available templates</li> <li>— Presentation: Present the idea and score the others</li> </ul>
KATCHing Carbon	Excel	Product Carbon Footprint (PCF) Calculation	<ul style="list-style-type: none"> <li>— Easy to use Product Carbon Footprint calculation for products from the building and furniture sector</li> <li>— Data input along the five life cycle phases raw materials, manufacturing, distribution, use and end- of-life</li> <li>— Results can be used for the CE Analyst tool</li> </ul>

## **7 Conclusions and further developments**

It is perhaps too early to draw conclusions since the KATCH\_e consortium is still deeply involved in finalizing all the project's results, and there are many, more than those promised in the application. One of the reasons for this, something the consortium views as a success, is the very high interest this project raised in the four countries. From the beginning, partners were aware that Austria and Denmark were ahead of Portugal and Spain in the field of CE. Nonetheless, formal stakeholders and other interested parties from the four countries got proactively involved in KATCH\_e, and this was particularly visible in the extensive testing that was performed. Often, it was the stated interest of professors, business associations and others that offered the possibility of performing an extra

lecture, offering the materials for test or conducting a new workshop, beyond the initial plan

Since the start of the project in January 2017 many educational resources, reports, scientific publications, legislation etc. have been published or are in preparation. The CE topic has not lost momentum and the main aim of the KATCH\_e project, to produce training materials and practical tools to be integrated in HE and in business environments, is still valid. Although not as systematically as in the situation analysis phase, the consortium observes there are many gaps to be filled in when it comes to education and training in CE. Therefore, the exploitation of the project's results after the funded period is crucial for the achievement of its goals in the short and in the long terms.

Therefore, an exploitation plan has been co-created by KATCH\_e partners and national stakeholders participating in the project from the beginning. This plan establishes the route that each partner will follow for an efficient exploitation of results at regional, national and European level after the project conclusion. The continuous contributions received from the four national stakeholders networks' members have been essential to define the steps to follow throughout and beyond the project. The activities and the partnership will be sustained beyond the project lifetime with the aim of maintaining its results and to keep the exchange of ideas and experiences on CE among stakeholders, by enhancing its know-how, financial and human resources. Additionally, the project website, the Knowledge Hub and Knowledge Platform will be kept alive by core partners and other relevant stakeholders, at least for the five next years.

The valorisation of the KATCH\_e results will take place at four different levels: educational level, company level, research level and European level. Indeed, KATCH\_e results are going to be used not only by project participants, but by their stakeholders networks, the educational organisations that will deliver the KATCH\_e contents to their students, the business organisations, business clusters, chambers of commerce as well as research and technological centres that will disseminate the contents among their members. This way, the KATCH\_e course, modules and tools, case studies and other innovations will be useful tools to train, encourage, make aware and spread CE approaches to a larger academic community, business and expert community, institutional bodies and public in general.

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which may be made of the information contained therein.

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