KATCH-e

WP2. SITUATION ANALYSIS REPORT

ANALYSIS OF TRAINING NEEDS, STATE OF THE ART, TRENDS AND POLICIES

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1 FOREWORD

Circular economy (CE) claims to overcome the current production and consumption models based on a so-called "linear economy" or "take, make and dispose". The transition to a CE, where the value of products, materials and resources is maintained in the economy for as long as possible and, the generation of waste is minimized, is an essential to a sustainable, low carbon, resource efficient and competitive economy.

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, and replacing products with services (IMSA, 2013). 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 (EU, 2016), and that the principles of a CE should become an integral part of education programs.

KATCH-e is a knowledge alliance between Higher Education, companies and research centers to promote the building of competences in the field of product-service development for the circular economy and sustainability in the construction and furniture sectors. The present report contains the main outputs of an analysis of the training and competence needs and gaps on topics related to circular economy.

This analysis has been complemented with interviews with multidisciplinary key stakeholders in order to identify the needs and barriers in this transition process within the target sectors and in the higher educational field. In addition, a workshop on "Discussion and prioritization of CE needs in the construction and furniture sectors" has been organized. The key findings of the review and recommendations for future developments and research are included in the present report.

2 INTRODUCTION

The continuous growth of the economic system in the so-called developed world, has led to mass-production of short-lived products, over-exploitation of resources and generation of overwhelming amounts of waste and emissions. The European Union economy is largely linear (take – make – use – dispose) by design, resulting in avoidable environmental and human health impacts (EEA, 2017). At 2012, in Europe, sixty percent of discarded materials were either landfilled or incinerated, while only 40 percent were recycled or reused as materials. In value terms, Europe lost 95 percent of the material and energy value (EMF & MCBE, 2015). Three billion new consumers entering the market worldwide in the next 20 or 30 years will put an enormous pressure on our shared resource base if we continue along the linear way. Under 'business as usual', annual global material

extraction has been projected to reach 183 billion tonnes by 2050 (Schandl et al., 2015, as quoted in UNEP, 2016), more than double the amount in 2015 (Ekins et al., 2016).

Under this context, the European Commission is engaged in fostering the transition from the largely current linear model to the circular one. In this sense, in 2015 it was published the roadmap: "Closing the loop – An EU action plan for the circular economy" (COM(2015) 614 final). This communitarian sets out initiatives including ecodesign among others. In January 2017, the Commission published a Report (EC, 2017) which gives an overview of the actions already delivered in the implementation of the mentioned plan since its adoption, and it introduces key deliverables for 2017. Key actions have been undertaken in areas such as food waste, ecodesign, organic fertilizers, guarantees for consumer goods, and innovation and investments (EC, 2017).

Circular economy (CE) principles have also been gradually integrated in industrial best practices, such as green public procurement, the use of cohesion policy funds, and through new initiatives in the construction and water sectors (EC, 2017). Regarding training needs at higher education level, many sectoral - and regional - initiatives to promote skills have been launched, involving public and private bodies and organizations, although these projects often remain fragmented and their impact on the education and training system is limited (COM(2016) 381 final). As recognized in the EU Action Plan, the transition to a CE will require a qualified workforce with specific and sometimes new skills. If the right skills at all levels are to be developed, they will have to be espoused by the education and training systems (COM(2015) 614 final).

In this sense, studies point to the need of adequate skills and education for CE (CEU, 2016), and principles of CE should become an integral part of education programs and life cycle thinking a sustainability as a core aspect of all projects (Whicher et al., 2018). Future engineers and designers should learn to employ systems thinking to understand the drivers behind the problems and to propose solutions accordingly, without forgetting the social and economic aspects. Therefore, higher education (HE) is already dealing, somehow, with this new context; there have been initiatives in materials, engineering, business and design focusing on CE. Some examples are: 1) students of Design and Product Management (for both Bachelor and Master Degrees) from Salzburg University learn about the "cradle to cradle (C2C)" approach, in an effort to sensitize students about toxicity of materials and closing loops, but there are other variables to be considered, such as origin of resources and mono-materialism (Leube and Walcher, 2017); 2) Leiden University, 2014; Delft University of Technology, 2015; Aalto University, 2016; United Nations University, 2016, among others, include CE topics in the existing courses, but it seems to be not sufficient (Whalen et al.,2017); and 3) The University of Edinburgh with the support of Zero Waste Scotland, conducted a research project to assess how CE is being tackled in Scotland and at the University level and to define future actions in this line (University of Edinburgh, 2015).

Creating a CE requires fundamental changes throughout the value chain, from product design and technology to new business models, new ways of preserving natural resources and turning waste into resources, new modes of consumer behaviour, new norms and practices, education and finance (EEA, 2016). Design is responsible, to a large extent, for defining the circularity potential of products: i.e., their reparability, longevity, proportion of recycled and renewable materials, and their suitability for refurbishment and remanufacture (EEA, 2017). It is also necessary to develop maintenance, repairing, reuse and reverse logistics services; as a matter of fact, new business models and service designs are required for dematerialization through sharing, leasing and renting services, as well as services that deliver performance (Bocken et al., 2016). Consequently, the role of designers is to respond to and meet people's needs and develop technically and economically feasible products and services (WDO, 2017). Thus, designers are challenged by new environmental, social and economic needs and must adopt a holistic approach to problem solving (Bocken et al., 2016) taking into account that most of the characteristics of a product throughout its life cycle are defined at the design stage; it is estimated that 70-80 percent of the environmental impacts are determined in the design phase (ARC, 2013). Despite such challenges and opportunities, knowledge on sustainable design, which includes design for CE, is not mandatory within the profession (Andrews, 2015).

From literature, there are not so many studies identifying or bringing together the required skills and the necessary knowledge in HE to foster a more circular economy from a sector specific approach. Therefore, the rationale of KATCH-e project is a knowledge alliance among HE institutions, companies and research centres to promote the building of competences in the field of product-service development for the CE and sustainability in the construction and furniture sectors. Both sectors are considered a priority to accelerate the CE in the EU (Van Eijk, 2015).

One of the first steps within the project has been to carry out an in-depth review of the state of the art of CE at product-service and production levels, related to the two sectors. The review covered: university training offers and materials, technical papers, tools, learning approaches, new business models, industrial symbiosis, entrepreneurship initiatives and policy trends at European and National level, among others.

Besides this review, a series of interviews and workshops were performed to receive feedbacks from relevant stakeholders. Both activities aim at getting the real opinion of the main stakeholders in the academia and business field to know how CE principles are being applied and how effective they are achieved (Hatcher et al., 2011; Bakker et al., 2014; Lovins et al., 2014; Schenkel et al., 2015; Leider and Rashid, 2016).

All gaps detected during the literature review and the feedbacks from stakeholders have been considered to develop the structure and content of the didactical material of KATCH-e project.

Moreover, to achieve a more specific CE context for the construction and furniture sectors, a new definition of CE was developed covering the main approaches of the target sectors of KATCH-e. In the Annex 1, it is included a discussion paper on CE concept, developed by KATCH-e partners which main output is the KATCH-e CE definition:

> ***"Circular economy is a system that is restorative and regenerative by intention and design, which maximizes ecosystem functioning and human well-being with the aim of accomplishing sustainable development."***
>
> *"It replaces the end-of-life concept with closing, slowing and narrowing the resource flows in production, distribution and consumption processes, extracting economical value and usefulness of materials, equipment and goods for the longest possible time, in cycles energized by renewable sources. It is enabled by design, innovation, new business and organizational models and responsible production and consumption"*.
>
> *See: www.katche.eu*

The present report contains an overview of the situation analysis conducted during the first stages of the KATCH-e project. As it has been mentioned before, the outputs from this analysis has helped to define the structure and contents of the KATCH-e didactical material, which includes feedbacks from main stakeholders, current HE training offers from different Universities and relevant references, among other sources of information. Also, it has been included a summary of the two economic sectors, highlighting some facts and figures, trends and the relevance of these sectors within the circular economy field.

3 OVERVIEW OF TARGET SECTORS

3.1 Construction sector

The construction sector plays an important role in the European economy. It generates almost 10% of gross domestic product (GDP) and provides 20 million jobs, mainly in micro and small enterprises. Construction is also a major consumer of intermediate products (raw materials, chemicals, electrical and electronic equipment, etc.) and related services. Because of its economic importance, the performance of the construction sector can significantly influence the development of the overall economy.

The construction sector was hit particularly hard by the financial and economic crisis in 2008. Since then, the main challenges of the construction sector faces have been:

- **Stimulating demand:** Efficiency improvements in existing buildings and renovations have the highest potential to stimulate demand.
- **Training:** Improving specialised training and making the sector more attractive, in particular for blue-collar workers, technical colleges and universities.
- **Innovation:** More active uptake of new technologies.
- **Energy efficiency and climate change:** Buildings account for the largest share of total EU final energy consumption (40%) and produce about 35% of all greenhouse emissions.

3.1.1 Innovation trends in the construction sector

Designers and other professionals have the opportunity to plan and assess circularity throughout an assets lifecycle by developing innovative and functional solutions launching new circular trends in the construction industry. In this sense, the following trends for the construction sector have been visible the last years is:

1. Skilled labour shortage and recession

During the crisis in 2008 many employees left the construction sector and have not returned ever since, the labour shortage at all levels will continue to plague construction companies which tend to be more selective about the projects they can take and handle.

Residential construction has expanded by 5% in 2016. In the coming years the growth will become progressively less strong, with an expansion by 3.7% in 2017, 2.3% in 2018 and 1.7% in 2019. Non-residential construction grows modestly in the coming years, by 2.3% in 2017, 1.8% in 2018 and 1.2% in 2019.

In Spain and Portugal construction expands more significantly than in Denmark or Austria.

2. Prefab/offsite construction methods

The use of prefabricated products or components is not new, but becomes more and more popular; the alternative building method offers the benefits of reduced construction time, less waste and possible cost savings and with the development of low cost, appealing and environmentally conscious products modular design is put into practice.

3. Smaller, smarter homes

The trend towards smaller, but smarter homes in terms of space use, multifunctional spaces… sets against the raising individual spaces demands of the last decades. Better than bigger due to shrinking family sizes and economic pressure. Innovation: micro houses

4. Open floor plans

Open floor plans allow more light getting into the living space and thus reduces electricity demand and stimulate coexistence of family members, flat mates or colleagues. Innovation: Sharing communities: co-working, co-living… shared spaces/tools/cars/bikes

5. Green building

The awareness raising concerning human health and environmental protection lead to the establishment of a green building movement. The use of local and/or renewable resources like straw or cork and low emission products (e.g. formaldehyde in wood products, PVC in windows) in combination with the reduction of the energy demand of buildings causes less environmental impact and saves resources. Commercial construction has led the pack in green adoption, but the residential sector is starting to catch up.

6. Building Information Modelling

Building Information Modelling has raised much attention and expectations within the construction sector but the development and implementation of comparable and practicable methods and tools is not yet accomplished.

7. Security of buildings

Learning from incidents causing many losses of human life due to insufficient protection against earthquakes or inadequate architectural statics leads to more awareness and legal requirements concerning security of buildings.

8. Booming multifamily sector will slow down as single-family sector picks up steam

Custom homes accounted for 21% of total single-family starts, on a one-year moving average, compared to a 31.5% cycle high in the second quarter of 2009 in the US market.

The gradual slowdown follows recession-era also in US and Europe growth in the share of not-for-sale new housing (as single-family starts tumbled). Now that single-family construction is rebounding, custom homes are accounting for a smaller share of the overall market, according to the NAHB (2017).

9. Laser scanning technology will gain popularity

Laser technology scanning has emerged as a tool for Building information modeling (BIM) professionals as they work to gain access to increasingly accurate and detailed information during the BIM process. BIM are only as

accurate as the information used to create them, which has a parallel impact on their usefulness. In this regard, the data collected through the laser scanning process has found use throughout the lifecycle of a project in a range of ways, due to its accuracy and quantity of data points. Laser technology scanning has a variety of applications on construction projects ranging from new construction to renovations, and the captured data can be useful to the entire project team, including the architects and engineers, from project conception through project turnover. (Yee et al., 2013). The laser scanning technology is actually important to have a basic understanding of the operating principles at work in the construction sector. At list, there are two common operating principles for laser scanning, Time of Flight and Phase Comparison, or Phase Shift, laser pulse (Böhler and Marbs, 2002).

10. Remodelling will have a strong year, especially in the luxury market

Sustainability issues are growing in international level, there is a reason to believe, that rising sustainable development driven costs will impact on pricing, also in apparel different types of industry. Should community demand more sustainable buildings. Consumers are turning more and more to home remodeling as a solution. Remodeling allows owners to take existing homes and re-create them into the space that fits their needs. Luxury is ultimate product level differentiation, which could exploit from these challenges; before CE is adjusted by society, green consumerism for example could drive transformation. Secondly, luxury favors some business models to increase luxury remodeling buildings (Kuivanen, 2016).

11. Homebuyers will seek out simple, walkable communities

A global economy predicated on growth is helping to increase the world's middle class and its purchasing power. This trend is starkly at odds with the finite nature of our natural resources. Ongoing volatility in global commodity markets shows we need to reconsider how society consumes goods. Gradual change is underway. We are already seeing the emergence of a sharing economy. Research suggests that young people are more inclined to rent, lease or share items such as clothes, cars or houses than previous generations. These nascent patterns have spread from the fast-moving consumer goods industry to other areas, including the built environment.

This could mean that fewer resources are needed, assets are used more fully and their lifecycles are extended and diversified.

In order to exemplify the main trends above explained, Table 1 provides different links to some real examples:

Table 1: Compilation of websites as real examples of trends in the construction sector.

Sites related construction trends
http://www.architektur-online.com/projekte/ab-in-die-zukunft
https://www.constructiondive.com/news/10-construction-industry-trends-to-watch-in-2016/411402/
http://www.constructionkenya.com/2539/5-trends-transforming-construction-today/
http://www.euroconstruct.org/jart/prj3/wifo/main.jart?rel=euroconstruct_en&content-id=1496906589254&reserve-mode=active
https://buildingradar.com/de/construction-blog/marktprognose-bauindustrie-europa-2015-2020/
https://www.bdcnetwork.com/blog/green-building-trends-2018-and-beyond
https://www.weforum.org/projects/future-of-construction

3.1.2 Construction sector and circular economy

From the CE perspective, construction sector is relevant as the construction and use of buildings in the EU account for about half of all our extracted materials and energy consumption and about a third of our water consumption . The sector also generates about one third of all waste and is associated with environmental pressures that arise at different stages of a building's life-cycle including the manufacturing of construction products, building construction, use, renovation and the management of building waste.

Under this context, construction and demolition waste (CDW) makes up one third of total waste generated in the EU and presents one of the heaviest and most voluminous waste streams generated. It consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil, many of which can be recycled.

Following the EU waste hierarchy, prevention, re-use and recycling present the most favourable options in terms of maintaining the highest possible value of products or components (Figure 1).

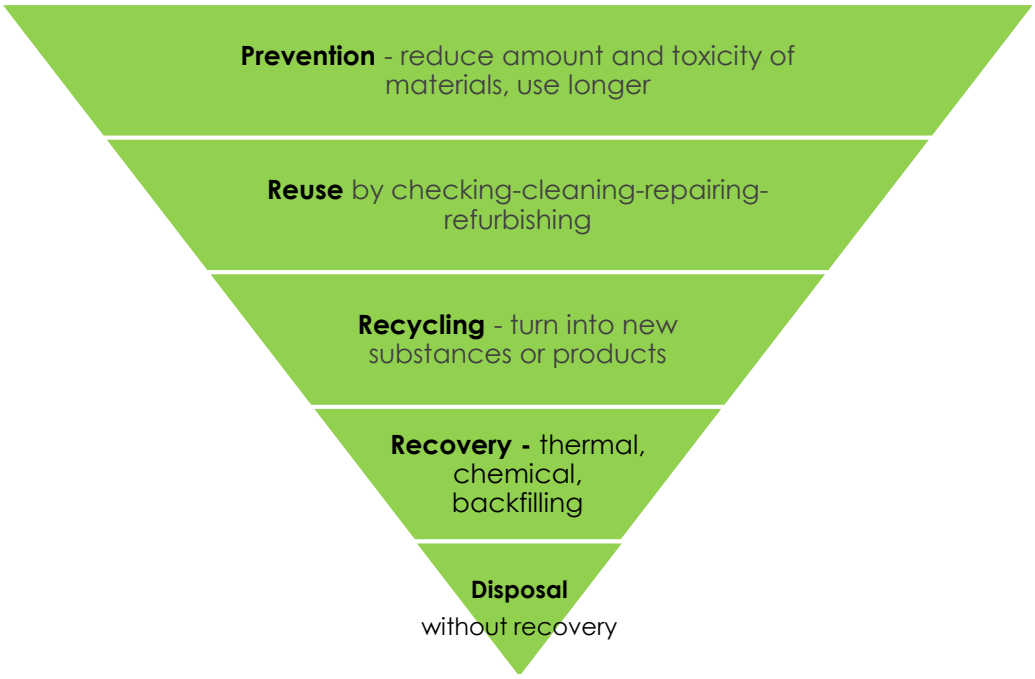

Figure 1. EU waste hierarchy and brief definition.

Currently, it is mainly metals that are recycled due to their high value and existing markets and, there is also a re-use market for aggregates derived from construction and demolition waste in roads, drainage and other construction projects. Re-use of whole components like stairs, windows, insulation materials takes place at pilot projects level for office or apartment buildings whereas in private housing sector the second hand market flourishes.

In this sence, it is clear that current situation of construction and demolition waste (CDW) shows that the high potential for recycling or reuse is not yet exploited as the level of recycling and material recovery of mentioned wastes varies greatly (between less than 10% and over 90%) across the Union. Despite the potential for significant economic and environmental benefits of recycling of CDW, large parts are still landfilled or backfilled (filling of voids after construction or excavation activities). If not separated at source, CDW can contain small amounts of hazardous wastes, the mixture of which can pose particular risks to the environment and can hamper recycling. The correct use of this type of resource is according the status of sustainable architecture that can be pointed as: renewable and local resources; reduce material input, light structures; focus on energy efficiency (passive houses, low energy, plus energy); importance of ambient quality and health aspects; reduction of hazardous substances; energy recovery application and affordable housing.

For more info about construction sector and circular economy perspective, see references section attached in the present report as Annexes 3 to 9. At the end of the project a complete and full detail Resource Center of KATCH-e will be available at KATCH-e website.

3.2 Furniture sector

The furniture industry in the EU is an intensive and dynamic sector, dominated by micro firms and SMEs (small and medium-sized enterprises). The sector employs around 1 million workers in 130 thousand companies generating an annual turnover of around EUR 96 billion (EC, 2017). EU Member States are major consumers of furniture, estimated at €68 billion per year, with the EU27 being a net exporter (EEB, 2017).

The EU is a world leader in the high-end segment of the furniture market (luxury design furniture, made with luxury top quality materials, and designed by design studios, brands or leading designers, such as Vitsœ, Muuto or Normann Copenhagen). Nearly two out of every three high-end furniture products sold in the world are produced in the EU, and a quarter of the world's furniture is produced in the EU.

The European furniture sector faces enormous competition from countries having low production costs, in particular in the low- and mid-range price segments, where the EU share in world furniture trade has significantly dropped in the last decade. China's EU market penetration is growing rapidly and it is now the largest furniture exporter to the EU, supplying more than half of total furniture imports to the EU.

Nevertheless, the furniture sector had a significant drop of companies, jobs and turnover due to the 2008 crisis. In any case, according with the EC (2014), the European furniture market is slowly recovering and constantly opening up. Figure 2 depicted the european trade furniture resume and the balance market around the world.

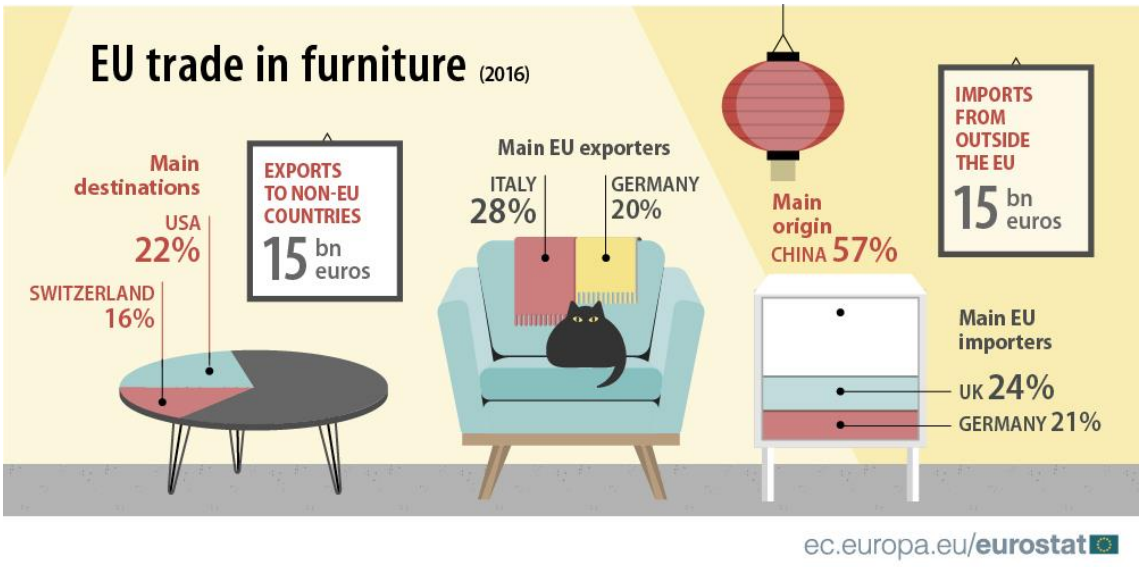

Figure 2: Furniture European trade resume (Source: Eurostat 2018).

3.2.1 Innovation trends in the furniture sector

The EU furniture sector has made significant changes to make it more export-oriented and to focus on upgrading quality, design, and innovation. These changes include restructuring, technological advances, and business model innovations. The main opportunities ahead lie in continuing investment in skills, design, creativity, research, innovation, and new technologies that can result in new products, which are in line with the changing population structure, lifestyles and trends, as well as with new business models and supplier-consumer relationships (EC, 2017).

Follow this way, the European Commission (Renda et al., 2015) identified the main trends of this market in EU. The changing patterns of furniture consumption are generating new demands, bringing interesting opportunities for development, and becoming a very important driver for the furniture market trends, as see bellow:

- The demand of luxury furniture is increasing: with the recovery of the economy, more consumers choose to buy luxury items for their homes and work environments (MarketResearch.com, 2016).
- Multifunctional furniture is on demand: consumers look for portable or foldable furniture, and furniture easy to adapt for smaller spaces (MarketResearch.com, 2016).
- More vendors are developing eco-friendly furniture: several sources pointed out that consumers demand more sustainable products (MarketResearch.com. 2016; EEB, 2017; Eco-Mobilier, 2016).
- Innovation in materials, manufacturing processes, marketing strategies. All these trends are focused to improve competitiveness of the European furniture sector and to reduce environmental impacts (energy and natural resources consumption). More info in this regard has been published in (Renda et al., 2015).

Figure 3 reflects some barriers and opportunities that can be related to the trends described above.

Figure 3. Strengths, weaknesses, opportunities and threats of the EU furniture sector. Source: European Commission (EC), 2014.

3.2.2 Furniture sector and circular economy

In terms of materials used in the referred segments, the most common material used for furniture is wood (56% of the pieces of furniture in the EU 27 in 2011). Metal is the second material most commonly used in furniture industry (12% of items produced), followed by plastics (6% of items produced) and other materials (1% of items produced) such as bamboo, osier, etc. (see Figure 4), (EC, 2013).

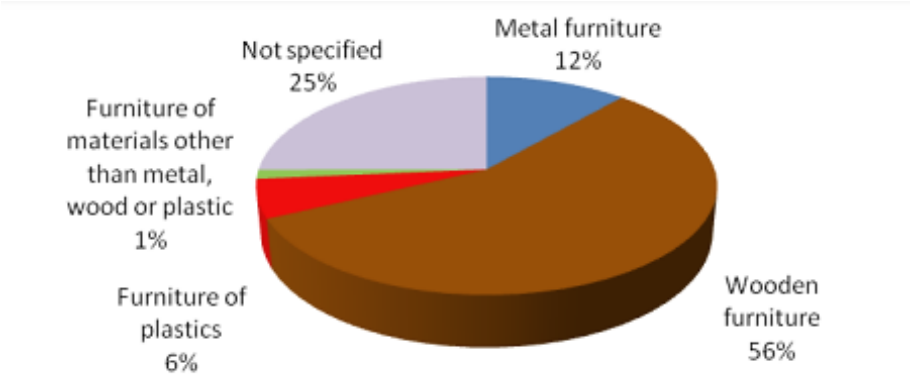

Figure 4. Furniture production in the EU-27 classified by materials (2011). (EC, 2013).

Furniture products can cause very different environmental impacts depending on the type of furniture considered (office, kitchen, etc.), the materials and processes used in the manufacturing, the energy source (fossil fuels, or renewable) and origin of the wood (local, from sustainable forest, etc.). A meta-study based on 13 life cycle assessments and 35 verified environmental product declarations highlighted the relative contribution of different life stages to the impacts (materials, manufacturing, packaging, distribution, use and end-of-use) and main sources of concern (EC, 2013):

- Materials and their processing show the highest share in most impact categories. Metals and plastics have generally bigger impacts than wood. The embedded energy in virgin materials is significant. Wooden materials also require energy in their production processes, e.g. sawing and drying. Transport of materials is less important than processing, but this may not apply when non-local materials are used.
- The second most significant stage of the LCA is manufacturing, where energy consumption (e.g. in relation to drying in painting and coating) is the most important parameter. Impacts related to the use of adhesives and coatings are also important.
- The packaging has a much lower environmental impact, but is not negligible and is related to the materials used.
- Distribution is not deeply investigated in the study since normally only average scenarios are used.
- Use: the impacts are related to maintenance and considered negligible.

– End-of-life's environmental burden varies, depending of the waste treatment scenarios. Landfilling represents a relatively low burden, compared to the other lifecycle stages.

Among all life phases of furniture products, one of the most relevant is the waste generated at the end-of-life's. The total annual EU28 furniture waste equates to 10.78 million tons, the majority of which is destined for either landfill or incineration (EEB, 2017). The graph below shows the distribution per country in absolute numbers (EEB, 2017), where larger countries in population have a higher contribution, but also reflecting national habits of furniture substitution.

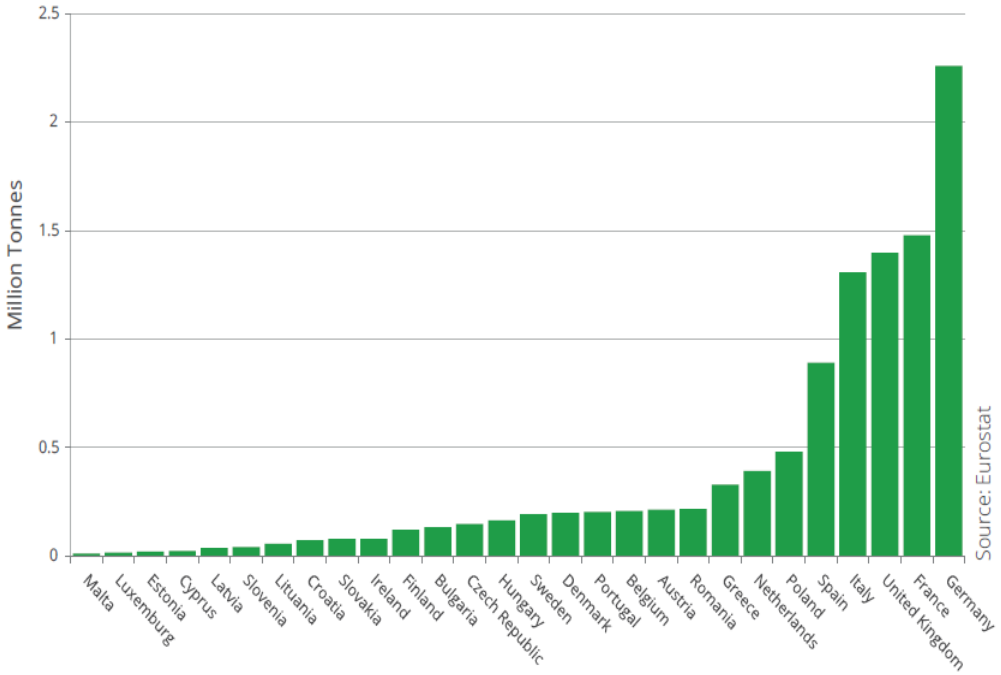

Figure 5. Annual production of furniture waste by EU member state. Source: EEB, 2017

The Waste Framework Directive (WFD) requires 50% of household waste to be recycled by 2020, and according to the EEB (2017), it is estimated that household furniture represents between 2% and 5% of Municipal Solid Waste (MSSW) in the EU28. But, also according the same source, the European Federation of Furniture Manufacturers (UEA) determined that 80% to 90% of the EU furniture waste in MSW is incinerated or sent to landfill and less than 10% recycled. The remanufacturing is less than 2% of the manufacturing turnover in the EU, and the reuse is also very low, where reuse appears only through commercial second-hand shops, social enterprise companies or charities. Considering these figures, it is possible to conclude that the furniture sector has a great potential to conduct initiatives within the CE field, improving the sustainaiblity of this sector along the whole life cycle.

4 POLICY TRENDS, STRATEGIES ON CIRCULAR ECONOMY

4.1 European Level

On 2014, the EU Commission published a number of regulations with the purpose to push towards a more circular economy. Some of these were Directive 2008/98/EC on waste (the Waste Framework Directive, or WFD) and Directive 1999/31/EC on the landfill of waste (the Landfill Directive). This regulations are general and are applicable to both KATCH-e sectors.

The Commission adopted in December 2015 an ambitious new Circular Economy Package to stimulate Europe's transition towards a circular economy. The Action Plan included several legislative proposals, in the first place on waste setting clear targets for waste recycling and establishing an ambitious long-term path leading towards waste prevention and recycling. Furthermore there were other proposals such as for example, online sales of goods.

The key delivers since the adoption of the Action Plan (in chronological order of their completion) are:

- Legislative proposal on **online sales of goods**: protect consumers from defective products and incentivization to produce higher quality and more durable products and legal guarantee for second hand goods.
- Legislative proposal on **fertilisers**: to boost those ones made from secondary raw material.
- Launch of the Innovation Deals through "**Innovation deals for a CE**". This helped to identified the barriers to implement the measures. The topics covered were: water, waste and energy sectors.
- **Eco-design**: Focused on energy efficiency but also explore durability, reparability, design for disassembly in order to ease of reuse and recycling. This Work Plan is focus on ICT products at the moment.
- **Food waste**: EU Platform on Food Losses and Food Waste launched 2016.
- **Waste-To-Energy**: To ensure the energy from waste in the EU supports the objectives of CE Plan.
- Proposal to amend the directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment: **RoHS Directive**
- The **Platform to support the financing of circular economy**.

Other initiatives delivered in 2016 were:

- *Guidance on CE into BREFs* (Best Available Techniques Reference) for several industrial sectors: to reduce waste generation, boost recycling and reduce resource uses.
- *Green Public Procurement*: for office buildings, roads and computers & monitors.

- *Updated Guidance on Unfair Commercial Practices Directive-Action on environmental claims*: this directive includes specific elements to make green claims more trustworthy and transparent.
- *Stepping up enforcement of the revised Waste Shipment Regulation*: A tool for setting out a preliminary correlation table between customs and waste codes.
- *Good practices in waste collection systems*: promotion the goods practices for separate waste collection across EU Member States.
- *Water reuse*: Strategy for Water Framework Directive to integrate water reuse in water planning management.
- *Construction and demolition*: to improve the identification, source separation and collection waste, as well logistics, processing, quality and management; all in order to improve the quality of recycled materials and its use in the construction sector.
- *Biomass and bio-based products*: Only efficient conversion of biomass to electricity should receive public support.
- *Support for circular economy through cohesion policy funds and smart specialization strategies*: Some example of funding programs for the CE implementation are: Cohesion Policy Funds, Horizon 2020 and LIFE programme.
- *Research and Innovation*: Horizon 2020 gives a strong impetus to the re-industrialization of the EU. Additional calls: Factories of the Future, Sustainable Process Industries and Bio-based Industries
- *Technology services to accelerate the uptake of advanced manufacturing for clean production by manufacturing SMEs*. The Commission has supported SMEs in their transition to CE through implementation of the Green Plan for SMEs (boosting resource efficiency, energy efficiency and innovation in manufacturing and production). A European Resource Efficiency Excellence Centre for SMEs started operating January 2017, including a self-assessment tool and provide networking opportunities and support activities to SMEs.

The KEY sectors to be addressed according to the Circular Economy Action Plan are: fertilizers, ICT products (mobile, computers), water reuse, construction and demolition waste and ensure the quality and hazards of the waste and its later reuse.

During the 2017, the European Commission published a report summarising the status of each initiave proposed in 2015 and, it is established other KEY initiatives such as:

- *Plastic Strategy: economic, quality, uptake of plastic, recycling and reuse.*
- *Technical and practical problems of interface of chemical, product and waste legislation that may hinder the transition of recycled materials, in order to improve information of substances of concern found in recycled materials and enhance the uptake of secondary raw materials.*

- *Look forward propose a legislative proposal with the minimum quality requirements to promote the safe reuse of treated waste water (environment safety and food production).*
- *2017 could be considered a crucial year to develop a policy dialogue with stakeholders. Launch the Circular Economy Sakeholders' platform (conference 9/10 March 2017 in Brussels).*

4.2 CE National strategies

The present section summarizes which are the currently policy trends and national strategies in the regard of CE in each KATCH-e partner countries.

4.2.1 Status of policy trends fostering Circular Economy in **Austria**

A circular economy goes further than recycling. It is concerned with Ecodesign, thinking in systems (connecting different stakeholders and supply chains), the promotion of "inner cycles" (such as repair, remanufacturing, reuse, refurbishment, etc.) and the establishment of new business models (such as product service systems), which enable these principles. This overview of policy trends in Austria should give a first insight on existing programmes and legal frameworks for enabling CE principles in the construction and furniture sector.

In its latest EU Environmental Implementation Review (EIR) country report for Austria (SWD(2017) 33 final), the EU concludes that concerning waste management, Austria is among the top performers of the EU. The recycling rate of municipal waste is well above the EU level (in 2014: 58% in Austria vs. 44% EU average) while the landfilling rate (4% vs. 28%) is far lower. Nevertheless, in relation to CE and the fostering of inner cycles the EU report concludes that to date "no overarching circular economy policy programme exists". However, "a number of measures and initiatives have been set up by different government bodies [..] relating to eco-innovation and - to a limited extent – to circular economy." In that regard, the report highlights the Austrian Resource Efficiency Action Plan (REAP) (Manstein & Tertschnig, 2012) and The new resource efficiency initiative (RESET2020 initiative) (Federal Ministry for Sustainability and Tourism, Austria, 2016).

The main goal of the REAP, which was introduced in 2012, is to double the resource efficiency (defined as Gross Domestic Product [GDP]/Domestic Material Consumption [DMC]) until 2020 (in relation to 2008). It also introduces the term Circular Economy as one of the proposed fields of action, which mainly deals with the improvement of waste management systems ("outer cycles"). The fostering of "inner circles" is hardly mentioned.

The follow-up initiative to the REAP is the RESET2020 initiative. Its fields of action go further and constitute a more holistic approach. The aim is to explicitly integrate principles of a circular economy within the fields of production and consumption, e.g. by fostering eco-design methods and integrating

environmental management systems. Still, the approach is a generic one, with the aim of supporting projects, studies and conferences which coincide with these goals.

An important legal development in relation to the Austrian construction sector is the amendment of the "Recyclingbaustoffverordnung", BGBl. II. Nr. 290/2016, in force since October 2016. The regulation aims to improve existing recycling options for mineral construction waste, by introducing certain standards for recycled materials, which then can be marketed and sold as new building materials. Furthermore, it introduces the compulsory application of the Austrian ÖNORM B3151 – a standard for a value-oriented building dismantling process – if the affected building mass exceeds 750 tons. The regulation is mainly concerned with fostering recycling and does not give targets for other potentials of a CE, e.g. the reuse of whole components. However, the amendments set binding guidelines on the dismantling process of buildings and separation of components and materials. Components and materials which could hamper the recycling process of mineral construction material need to be determined, which, in fact gives the opportunity to identify e.g. re-use potentials for like stairs, windows or floors.

Every six years the ministry of Agriculture, Forestry, Environment and Water Management puts forward a federal waste management plan ("Bundesabfallwirtschaftsplan 2017 - BAWP"), which portrays the current waste situation and proposes measures for waste avoidance and treatment. In 2017 a new plan has been published.

Because the construction waste is quantitatively the most important waste source in comparison to other waste flows, the BAWP has defined it as one of the main areas of activity. The plan proposes a wide range of measures which aim to foster "inner cycles". These include for example:

- the development and the introduction of training materials concerned with improving the life cycle performance of buildings,
- the integration of dismantling processes at the end of life standard,
- collecting the data needed for an "Urban Mining cadaster",
- the use of recycled materials, etc.

In the case of the furniture sector it is included in another cross-sectoral area of activity where the concern is related with maximizing reuse potentials. The measures include the fostering of reuse-networks and platforms, and the promotion of product service systems.

In conclusion, there are various initiatives, which aim to move in the direction of a circular economy. Still, environmental policies in the construction and furniture sector are mainly concerned with energy efficiency in production and during usage, recycling and human health. The more innovative CE approaches that promote a holistic economic system with efficient resource cycles (reuse of construction elements, furniture leasing, product service systems, etc.) are in the early stages. They are not yet systematically integrated into the socioeconomic

framework, but there are a number of research and pilot projects which aim to lay the focus on this.

4.2.2 Status of policy trends fostering Circular Economy in Portugal

The Action Plan for the Circular Economy, approved on 23/11/2017, is organized in seven actions that either consolidate ongoing initiatives by the Government (e.g. the National Strategy for Combating Food Waste), or introduce complementary ones. It has three levels of operation: the national level, with dedicated policy instruments (e.g. green taxation and voluntary agreements), and the sectoral and regional levels (e.g. industrial symbiosis networks, circular cities, circular companies). Mechanisms for implementation through the development of solutions such as planning, education, technology development, etc. are identified: The Environmental Fund, the Fund for Innovation, Technology and Circular Economy and the Portugal 2020 program).

More are some specific initiatives such ECO.NOMIA portal, promoted by Portuguese government is to boost the Circular Economy in Portugal. The Portal is a space of knowledge sharing: On the one hand, disseminating to consumers and companies the advantages of CE and opportunities of financing and, on the other hand, launching an interaction forum for collaborative investment projects in CE. The Portal is also a repository of knowledge targeting public institutions, companies and the community.8

In the field of research and education, Portugal has its in National Strategy for Environmental Education (ENEA 2020). This strategy aims to establish a collaborative and cohesive commitment in the construction of environmental literacy in Portugal, through an inclusive citizenship that leads to a change of civilizational paradigm, translated into sustainable models of conduct in all dimensions of human activity.

The actions of the Strategy are focused on three essential pillars, one of which is: Making the economy circular through dematerialization, collaborative economy and sustainable consumption, product design and efficient use of resources and waste recovery.

On the other hand, the Portuguese Foundation for Science and Technology has promoted a process of elaboration of fourteen Research and Innovation Agendas, which includes a specific agenda dedicated to the Circular Economy. This Agenda constitutes a strategic vision of R&I in a medium and long-term perspective (2030) that enhances the sustainability, resilience, inclusion and competitiveness of society. The agenda is developed around four dimensions: Design and development of new products, processes and services; Sustainable management of resource cycles; Governance and territory; New business models, behavior and consumption (Fundação para A Ciência e a Tecnologia, 2017). To support all of these initiatives, the government has developed several financial mechanisms:

- **Fund for Innovation, Technology and Circular Economy**

The purpose of this fund, created in December 2016, is to support the stimulation of creativity and innovation in all fields as they are essential to the successful response to social, economic and environmental challenges. In this context, supporting the innovation of the national economic fabric through the efficient use of resources, accelerating the transition to a circular economy through supply new products and services and new companies and entrepreneurs, and innovating in technological, organizational and marketing processes (Decreto-Lei n.º 86-C/2016; Portaria n.º 258/2017).

- **Environmental Fund**

The purpose of the Environmental Fund is to support environmental policies for the pursuit of sustainable development objectives, contributing to the achievement of national and international objectives and commitments, including those related to climate change, water resources, waste and nature conservation and biodiversity.

The Fund finances entities, activities or projects that fulfill certain objectives, including the "Transition to a Circular Economy".

- **Tax Incentives System for Business R&D (SIFIDE)**

SIFIDE aims to increase the competitiveness of companies by supporting their research and development effort through deductions in the Corporate Income Tax from R&D expenses.

Recently, an accretion to the deduction was approved in case the R&D

project concerns eco-design. This measure will be in operation from 2018 (Sistema de Incentivos Fiscais à I&D Empresarial, 2018)

- **Operational Sustainability Resource Efficiency Program (PO SEUR)**

The Operational Sustainability Resource Efficiency Program (PO SEUR), integrated in the PORTUGAL 2020 Programme, aims to contribute to sustainable growth, responding to the challenges of transition to a low-carbon economy based on a more efficient use of resources and promoting greater resilience to climate risks and disasters. PO SEUR has several types of support for the contribution to the waste sector to other national strategies and priorities, including reducing GHG emissions and promoting the circular economy (Pinheiro de Azevedo, 2016).

4.2.3 Status of policy trends fostering Circular Economy in **Denmark**

By launching the resource strategies "Denmark without waste I and II (Danish Government, 2015).

in 2013, respectively 2015, the Danish government aimed at ensuring a greater extent of recycling. For decades, Denmark has given priority to incineration of waste for generation of heat and power. With the new resource

strategies, the generation of waste should be minimized, and resources used more efficiently before they are incinerated.

Also in 2015, the Ellen MacArthur Foundation (EMF) published the report "Delivering the circular economy – a toolkit for policy makers" based on Denmark as a case study. The report aimed at identifying circular economy opportunities, barriers and policy interventions to overcome these barriers. Key barriers proved to be unintended consequences of existing regulations, social factors such as lack of experience, and market failures such as imperfect information and unaccounted, negative externalities.

The report looked into five sectors, where Construction and real estate showed the largest, economic potential. Figure 6 gives an overview of these potentials, and of the key barriers and identified policy options.

CONSTRUCTION & REAL ESTATE

Industrialised production and 3D printing of building modules, reducing time and material cost of construction and renovation, could lead to a net value of EUR 450–600 (40–60) million p.a. by 2035 (2020).

Key barriers include:
- inadequately defined legal frameworks;
- immature 3D printing technology;
- custom and habit and capabilities and skills in the industry.

Identified policy options include:
- augmenting building codes;
- supporting the development of module production facilities;
- setting a clear legal framework for 3D printing materials.

Reuse and high-value recycling of components and materials, enabled by, e.g., design for disassembly and new business models, could lead to a net value of EUR 100–150 (10–12) million p.a. by 2035 (2020).

Key barriers include:
- split incentives and lack of information across the construction value chain;
- custom and habit;
- capabilities and skills.

Identified policy options include:
- augmenting building codes;
- running industry-wide training programmes;
- creating support for material inventory software and databanks.

Sharing and multi-purposing of buildings to increase the utility of existing floor space could lead to a net value of EUR 300–450 (100–140) million p.a. by 2035 (2020).

Key barriers include:
- inadequately defined legal frameworks;
- unintended consequences of existing regulation.

Identified policy options include:
- clarifying the existing legislation;
- providing financial incentives or support to new business models;
- creating portals for public building availability.

Figure 6: CE opportunities in the Danish Construction and real estate sector (Source: EMF, 2015)[i]

To expand the knowledge from the EMF report, the Danish Government established an Advisory Board for Circular Economy in Denmark with the aim of developing a set of recommendations. The Advisory Board, consisting of 12 CEOs from different business sectors, launched in June 2017 a vision on Denmark as a locomotive for CE initiatives and solutions, and added 27 specific recommendations. The recommendations covered four areas:

- **The circular value chain** (9 recommendations)
- **Design and production** (7 recommendations)
- **Consumption** (6 recommendations)
- **Recycling** (5 recommendations)

To realize some of the recommendations, the Danish Environmental Protection Agency has launched a website on CE targeted towards SME's (www.cirkvirk.dk), and companies can ask for financial grants to develop new, circular solutions.

Moreover, Danish local authorities are engaged in developing more circular systems thinking, especially in the way they deal with public procurement. The Federation of Danish Municipalities has published a guideline and a number of cases to illustrate how it can be done (Kommunernes Landsforening, 2017).

4.2.4. Status of policy trends fostering Circular Economy in **Spain**

The Spanish Circular Economy Strategy is developed on the basis of the corresponding Action Plans, the first of which is for the period 2018-2020. This Action Plan has a transversal character, fundamentally but not exclusively affects the actions of the General State Administration and makes it possible to coordinate a great diversity of activities of actions and group them together within a framework of initiatives aimed at achieving a common goal: the transition towards a circular economy. In this context, a total of 70 actions are planned under the 2018-2020 Action Plan.

Table 2 includes the main lines of action of the new action plan on the circular economy in Spain.

Table 2: Spanish main lines of Action Plan for the Circular Economy.

MAIN TOPICS
PRODUCTION AND DESIGN
CONSUMPTION
WASTE MANAGEMENT
SECONDARY RAW MATERIALS MARKET
WATER RECYCLING
RESEARCH, INNOVATION AND COMPETITIVENESS
PUBLIC AND PRIVATE PARTICIPATION AND AWARENESS
EMPLOYMENT AND TRAINING

On the one hand, the State Framework Plan for Waste Management 2016-2022 establishes objectives for 15 different waste categories, including the construction and demolishing waste. Qualitative objectives regarding construction waste are defined with the aim of improving the quality of the material to be treated, while the quantitative objectives are related to the management and reuse of non-hazardous waste. This plan is supported by the

State Program for the Waste Prevention 2014-2020, that aims at achieving a 10% of waste reduction in 2020, in comparison to the waste generated in 2010.

The Spanish Bio-economy Strategy Horizon 2030 sets the objectives of promoting an efficient use of the bio-resources, the dissemination of best practices regarding the biomass cascade and supporting the innovation in the bio-economy. However, at regional level three circular economy strategies can be identified, even if in the last two cases the concept of "Circular Economy Strategy" has not explicitly been mentioned:

- The Strategy to Promote a Green Economy and a Circular Economy, approved by the Catalonian Government in 2015;
- The IV Environmental Plan of the Basque Country, along with the initiative "Circular Economy in the Basque Country – Demo projects for the reuse of materials";
- And the Andalusian Bio-economy Strategy.

Finally, it is worth noting that there are some other plans and programs at National level, although not being focused on the Circular Economy topic, that are in line with some of the requirements specified by the European Circular Economy Package, as described in Table 3. All these programs are developed within the framework of the Spanish Sustainable Development Strategy 2007.

Table 3: Other National plans and programs in line with the European Circular Economy Package (Morató et al., 2017)

Main topics addressed	Plan and Programs
Ecodesign	Spanish Science, Technology and Innovation Strategy 2013-2020.
Sustainable production	Spanish Science, Technology and Innovation Strategy 2013-2020. CDTI Horizon 2020 Program. Action Plan for Energy Efficiency.
Sustainable consumption	Green Public Procurement Program. Action Plan for Energy Efficiency.
Plastics related	Not identified.
Agri-food	National Overall Plan for Animal Origin By-products not aimed at human consumption.

5 UNIVERSITY TRAINING OFFERS

The training offers about CE in higher education in the four KATCH-e countries (Portugal, Spain, Austria and Denmark) has been analyzed. Also, it has been considered training offers from reference Universities in the field of CE (pioneers ones). The main goal of this activity has been to detect gaps in the offers reviewed in order to cover them with new didactical material (KATCH-e material) for the target sectors and for the target academic field.

To carry out the analysis, it has been established a list of topics about Circular Economy, grouped in three categories: Environmental, Economics and Design:

- **Environment**: Circular Economy topic, Resource Efficiency, Resource Cascading and Reuse / Repair / Remanufacture / Recycle in Environmental group.
- **Economics**: Industrial Symbiosis, Sustainable Business Model, Product-Service Systems, Circular Business Model and Performance Economy in Economic group.
- **Design**: Design for Sustainability, Circular Design, Cradle to Cradle Design (C2CD), Social Innovation and Design for Social Innovation in Design group.

The steps followed to identify the National University training offers are as follow:

1. To identify the offers with contents about CE. Providing that designers, architects, engineers and business people are the main professional profiles that will make decisions that will help to implement CE in practice, the courses selected are those about design, sustainability, waste, architecture and business.
2. To analysis the content of the offers contents, all the design offers have been analysed. There is a large offer of Spanish universities so, for the other fields, only the 25% of the universities are studied. The criteria to select the 25% is: all the technical universities plus those with more students, that is, the bigger ones.
3. To review the study plans to find how many items in their modules coincide with the CE topics and subtopics.
4. To quantify the results.

The analysis includes a total of 73 offers between official masters, postgraduate courses, and independent courses. The offers analyzed are distributed in 33 Masters of Design, 3 Masters of Waste, 13 Masters of Sustainability and Environment, 10 Masters of Architecture and Construction and 4 of Business and Management. Also, there are 10 reference courses (those which deal with Circular Economy as a concept, not just with some related topics). Out of the total of the offers analyzed, only 11 (15 %) are distance learning or offer the possibility not to attend to all the lessons.

Tables 4 to 9 summaries the analysis. When "Others" is written, it means that the course/master talks about Circular Economy at some point, but out of the topics, for example sustainable manufacturing or design optimization. Although there is no detailed information about all the masters and courses (it is indicated in the tables when there is not information). The present analysis has been done with the information available.

Table 4. Reference courses

		REFERENCE COURSES										TOTAL
		Master in Applied Circular Economy	*Innovation, Enterprise and Circular Economy*	*Circular Economy in industry*	*Innovation, Design and Quality for the Circular Economy*	*Circular Economy: An Introduction*	*Technology Innovation and Management for Circular Economy*	*Introductino to the Circular Economy*	*Business Models for the Circular Economy*	*Postgraduate in Circular Economics - Environment as a Sustainability factor*	*Curso Experto en Economía Circular: principios de la sostenibilidad*	*10*
	INSTITUTION	Universidad San Jorge and Cámara de Comercio de Barcelona	University of Bradford - School of Management	Coordinador estatal de ciencias ambientales	JKU Johannes Kepler University Linz	Delft University	Cranfield University	Harvard University	Aarhus University	Lusófona University	CERpIE - Universitat Politècnica de Catalunya	
TYPE	MASTER	X	X				X					3
	POSTGRADUATE COURSE									X		1
	COURSE			X	X	X		X	X			6
	BACHELOR/UNDERGRADUATE										X	0
MODE	ON-SITE	X			X		X		X		X	5
	E-LEARNING		X	X		X	X	X				5
	DURATION	1.000 hours	2-6 years	60 hours	4 ECTS + 3 ECTS for practice	7 weeks	2 years	15 weeks	2 weeks	no info	4 créditos	
		KATCH_e TOPICS										
ENVIRONMENTAL	Circular Economy	X	X	X	X	X	X	X	X	X	X	10
	Resource Efficiency						X	X		X		3
	Resource Cascading											0
	Reuse/Repair/Remanufacture/Recycle							X				1
ECONOMIC	Industrial Symbiosis							X				1
	Sustainable Business Model						X			X		2
	Product-Service Systems				X	X		X				3
	Circular Business Models	X	X			X		X	X			5
	Performance Economy											0
DESIGN	Design for Sustainability					X						1
	Circular Design				X	X	X	X				4
	Cradle to Cradle Design (C2CD)					X						1
	Social Innovation											0
	Design for Social Innovation											0
	Others		X				X		X		X ámbito normative. Estrategias	4
		2	3	1	3	6	5	7	3	3	2	

Table 5. Design courses

		Ecodesign	Design and Product Management	Sustainable Product Design: innovation and management	Design for Sustainability	Postgraduate in Design Thinking and Prototyping	Postgraduate in Design for Life	Product Design - Ceramic and Glass	Sustainability in Product Development	Business and Design (Furniture Design)	Engineering in Materials Science and Product Devecpment	Sustainable Design	Industrial Design Master	Industrial Design Engineering Master	Installation and Product Design Master	Computer Aided Design and Manufacturing Master
	INSTITUTION	FH Wiener Neustadt/University of Applied Science	FH Salzburg/University of Applied Science Salzburg	IED Barcelona	Universitat Oberta de Catalunya (UOC)	IADE-U Instituto de Arte, Design e Empresa - Universitário	IADE-U Instituto de Arte, Design e Empresa - Universitário	ESAD - College of Arts and Design Caldas da Rainha	Copenhagen Business Academy	VIA University College	VIA University College	Aalborg University	Universidad de Nebrija	Universidad Politécnica de Madrid	Universidad de Sevilla	Universidad politénica de Valencia
TYPE	MASTER	X	X	X								X	X	X	X	X
	POSTGRADUATE COURSE				X	X	X									
	COURSE								X							
	BACHELOR/UNDERGRADUATE							X		X	X	X				
MODE	ON-SITE	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	E-LEARNING				X											
	DURATION	2 years	4 semesters	750 hours	325 hours	9 months	10 months	6 semester	7 ECTS	18 months	18 months	3 + 2 years	750 h	750 h	750 h	750 h
ENVIRONMENTAL	Circular Economy	X		X								X				
	Resource Efficiency	X			X			X								
	Resource Cascading															
	Reuse/Repair/Remanufacture/Recycle			X										X		X
ECONOMIC	Industrial Symbiosis														X	
	Sustainable Business Model					X	X	X								
	Product-Service Systems					X	X					X				
	Circular Business Models		no info						no info	no info	no info					
	Performance Economy															
DESIGN	Design for Sustainability			X	X	X	X	X						X	X	X
	Circular Design															
	Cradle to Cradle Design (C2CD)			X												
	Social Innovation															
	Design for Social Innovation															
	Others					X	X	X				X	X	X	X	X
		2		4	2	4	4	4				3	1	3	3	3

Table 6. Design courses (II)

DESIGN COURSES																		TOTAL
Design Engineering Master	*Design and Manufacturing Master*	*Product Design Engineering Master*	*Strategic Design of Products and Services*	*Product Design Master*	*Product Concept Postgraduate*	*Product Development Postgraduate*	*Furniture Design Master*	*Furniture Design for Collectivities, Contract and Urban posgraduate*	*furniture Design for habitat postgraduate*	*Industrial Design Engineering Master*	*Expert course in Product Design for Kitchen and Table*	*Product Design and Development Master*	*Smart Produts Design Master*	*Digital Design and Manufacturing Master*	*Architecture, Design ad Innovation Master*	*Design engineering Master*	*Master de estudios avanzados en diseño*	*33*
Universidad Politécnica de Valencia	Universitat Jaume I	Universidad de Zaragoza	Universidad de Mondragón	Universidad CEU Cardenal Herrera	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	Universidad Autónoma de Barcelona	Universidad Europea de Madrid	Universidad Europea de Valencia	UNED	Universidad de Barcelona	
X	X	X	X	X			X			X		X		X	X	X	X	20
					X	X		X	X				X					8
											X							2
																		4
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			30
															X	X		3
750 h	937,5 h	750 h	1500 h	750 h	375 h	375 h	750 h	375 h	375 h	750 h	187,5 h	750 h	375 h	750 h	750 h	750 h	60 créditos	
KATCH_e TOPICS																		
										X								4
																		3
																		0
	X																	4
																		1
																		3
X		X	X									X		X				8
																		0
																		0
X	X	X					X	X										13
																		0
																		1
X																		1
																		0
X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		24
4	3	3	1	1	1	1	2	2	1	2	1	2	1	2	1	1	0	

Table 7. Waste and Business courses

		WASTE COURSES			TOTAL	BUSINESS COURSES				TOTAL
		Master in Sustainable Waste Management	*Master Propio en Gestión, tratamiento y aprovechamiento de residuos*	*Economía circular y gestión de residuos*	3	*Social Economics*	*Bachelor in Economics: course in innovation economy*	*Innovation Management applied to Product expert course*	*Máster en Comunicación social*	4
	INSTITUTION	Universidad Politécnica de Madrid (and Catedra Ecoembes)	Universidad de Valencia	Universidad Politécnica de Madrid		Universidade de Minho	Aalborg University	Universidad Europea del Atlántico	Complutense de Madrid	
TYPE	MASTER	X		X	2	X			X	2
	POSTGRADUATE COURSE		X		1					0
	COURSE				0		X	X		2
	BACHELOR/UNDERGRADUATE				0					0
MODE	ON-SITE	X		X	2	X	X		X	3
	E-LEARNING		X		1			X		1
	DURATION	750 hours	62 créditos	90 créditos		2 years	5 ECTS	380 h	120 cr	
	KATCH_e TOPICS									
ENVIRONMENTAL	Circular Economy	X		X	2		X			1
	Resource Efficiency				0	X				1
	Resource Cascading				0					0
	Reuse/Repair/Remanufacture/Recycle	X		X	2					0
ECONOMIC	Industrial Symbiosis				0					0
	Sustainable Business Model				0	X				1
	Product-Service Systems				0					0
	Circular Business Models				0	X				1
	Performance Economy				0	X				1
DESIGN	Design for Sustainability				0			X		1
	Circular Design				0					0
	Cradle to Cradle Design (C2CD)				0					0
	Social Innovation				0	X				1
	Design for Social Innovation				0					0
	Others	X comunicación	X aprovechamiento de residuos		2	X		X	x comunicación	3
		3	1	2		6	1	2	1	

Table 8. Sustainability courses

		SUSTAINABILITY COURSES													TOTAL
		Environmental Management and Ecotoxicology	*International Master in Sustainable Development and Corporate*	*Postgraduate in Green Economy*	*Conducting a Life Cycle Assessment (LCA): from Theory to Practical Application*	*Master in Cities and Sustainability*	*Environmental Management and Sustainability Science*	*Civil engineer in Environmental Technology*	*Master Universitario en Intervención Sostenible en el Medio construido*	*Master's degree in sustainability science and technology*	*Master's degree in environmental engineering*	*Máster en Eficiencia Energética, Cambio*	*Máster en Análisis y Gestión Ambiental*	*Máster en Ingeniería Ambiental*	*13*
	INSTITUTION	FH Technikum Wien/University of Applied Science	Escuela de Organización Industrial (EOI), Madrid	Universitat de Vic and Colegio de Economistas de Cataluña	University College London	Aalborg University	Aalborg University	University of Southern Denmark	Universidad Politécnica de Cataluña	Universidad politécnica de Cataluña	Universidad politécnica de Cataluña	Universidad de Alcalá	Universidad de Málaga	Univ. Santiago Compostela	
TYPE	MASTER	X	X			X	X	X	X	X	X	X	X	X	11
	POSTGRADUATE COURSE			X											1
	COURSE				X										1
	BACHELOR/UNDERGRADUATE							X							1
MODE	ON-SITE	X	X	X	X	X	X	X	X	X			X	X	11
	E-LEARNING											X			1
	DURATION	2 years	600 hours + final project	no info	2 days	2 years	2 years	3 + 2 years	60ECTS	120 ECTS	no info	60 cr	60 cr	60 cr	
		KATCH_e TOPICS													
ENVIRONMENTAL	Circular Economy	X		X	X	X	X								5
	Resource Efficiency	X						X					X		3
	Resource Cascading														0
	Reuse/Repair/Remanufacture/Recycle									X					1
ECONOMIC	Industrial Symbiosis									X					1
	Sustainable Business Model	X	X	X											3
	Product-Service Systems									X					1
	Circular Business Models										no info				0
	Performance Economy														0
DESIGN	Design for Sustainability								X			X	X		3
	Circular Design														0
	Cradle to Cradle Design (C2CD)									X					1
	Social Innovation														1
	Design for Social Innovation														0
	Others				X		X	X		X					4
		3	1	2	2	1	2	2	1	4		1	1	1	

Table 9. Architecture courses

		ARCHITECTURE AND CONSTRUCTION COURSES										TOTAL
		Green Building	*Bachelor Smart Building and Master Smart Cities*	*Architecture*	*Building Science and Technology*	*Civil Engineering*	*Professional Bachelor in Architectural technology and Construction management*	*Máster en representación y diseño en ingeniería y arquitectura*	*Master Universitario en Construcción Avanzada en la Edificación*	*Máster Universitario en Ciudad y Arquitectura Sostenibles*	Master's degree in advanced architecture, landscape, urban planning and design	10
	INSTITUTION	FH Campus Wien/University of Applied Science	FH Salzburg/University of Applied Science Salzburg	Vienna University of Technology, Department of Architecture and Spatial Planning	Vienna University of Technology, Department of Architecture and Spatial Planning	Vienna University of Technology	Copenhagen Business Academy	Universidad de Málaga	Universidad Politénica de Barcelona	Universidad de Sevilla	UPV Valencia	
TYPE	MASTER		X	X	X	X		X	X	X	X	8
	POSTGRADUATE COURSE											0
	COURSE											0
	BACHELOR/UNDERGRADUATE	X	X				X					3
MODE	ON-SITE	X	X	X	X	X	X	X	X	X	X	10
	E-LEARNING											0
	DURATION	3 years	no info	4 semesters	120 ECTS	120 ECTS	10 months	60 cr	90 ECTS	60 cr	60 ECTS	
		KATCH_e TOPICS										
ENVIRONMENTAL	Circular Economy		no info				no info					0
	Resource Efficiency	X				X						2
	Resource Cascading											0
	Reuse/Repair/Remanufacture/Recycle					X			X		X	3
ECONOMIC	Industrial Symbiosis											1
	Sustainable Business Model											0
	Product-Service Systems											0
	Circular Business Models											0
	Performance Economy											0
DESIGN	Design for Sustainability	X						X	X	X	X	5
	Circular Design											1
	Cradle to Cradle Design (C2CD)											0
	Social Innovation											0
	Design for Social Innovation											0
	Others			X	X	X			X			4
		2		1	1	3		1	3	1	2	

The main objective from this review was to identify all training offers regarding CE and Design for sustainability in order to detect gaps from these offers, trying to fulfill these gaps with KATCH-e didactic material. All information from training offers can be check in Annex 9.

For the REFERENCE offers, the most frequent topics group is "environment". 10 offers include the Circular Economy topic. In this group, there is not content about Resource Cascading, Performance Economy, Social Innovation and Design for Social Innovation. The "Master in applied Circular Economy" talks also about strategies and tools for companies, as well as, opportunities that CE introduction can provide them. On the other hand, the "Circular Economy in Industry" course includes some content about CE management in companies (Table 4).

For the DESIGN offers, all topic groups (environment, economic and design) are covered, and the most frequent is "Design". The most common topic is "Design for Sustainability". Any of the 33 design offers include Resource Cascading, Circular Business Models, Performance Economy, Circular Design and Design for Social Innovation. Within this offers group, it has been identified 4 undergraduate courses (Tables 5 and 6).

There are just three WASTE offers, two of the three offers have explicit modules about Circular Economy concept and about Reuse/Repair/Remanufacture/Recycle. It has been found only 4 BUSINESS Master offers that includes specific content about Circular Economy in the program description, but the three topics groups are covered. There are content about Circular Economy, Resource Efficiency, Sustainable Business Models, Circular Business Models, Performance Economy and Social Innovation. It is remarkable the Social Economics Master, from Minho University, includes 6 of the 15 topics (Table 7).

For the SUSTAINABILITY offers, contents about Environment are the most common. The Master's Degree in Sustainability Science and Technology offered by the Universitat Politècnica de Barcelona is the offer within this group with more topics covered: Industrial Symbiosis, Product-Service System, Cradle to Cradle Design and Others. As well as in Design offers group, it has been considered one undergraduate offer (Table 8).

For the ARCHITECTURE offers, 5 of the master's present specific contents about Design for Sustainability, the most common topic. Three of them talk also about Reuse/Repair/Remanufacture/Recycle and two about Resource Efficiency. One talks about industrial symbiosis and another one about Circular Design. Three bachelor offers have been considered (Table 9).

Table 10 shows the number of appearances of each topic as a specific module, subject or item in the 73 offers studied. In overall, Design for Sustainability is the most frequent one, followed by Circular Economy. Resource Cascading and Design for Social Innovation are not address, at least by this denomination.

Table 10. Summary of items from the 73 offers analysed.

	Reference	Waste	Business	Design	Sustainability	Architecture	
Circular Economy	10	2	1	4	5	0	22
Resource Efficiency	3	0	1	3	3	2	12
Resource Cascading	0	0	0	0	0	0	0
Reuse/Repair/Remanufact	1	2	0	4	1	3	11
Industrial Symbiosis	1	0	0	1	1	1	4
Sustainable Business	2	0	1	3	3	0	9
Product-Service Systems	3	0	0	8	1	0	12
Circular Bussiness Models	5	0	1	0	0	0	6
Performance Economy	0	0	1	0	0	0	1
Design for Sustainability	1	0	1	13	3	5	23
Circular Design	4	0	0	0	0	1	5
Cradle to Cradle Design	1	0	0	1	1	0	3
Social Innovation	0	0	1	1	1	0	3
Design for Social	0	0	0	0	0	0	0
Others	4	2	3	24	4	4	41
	35	6	10	62	23	16	

Figure 7 shows, for each of the groups of offers, the percentage in which each topic is present.

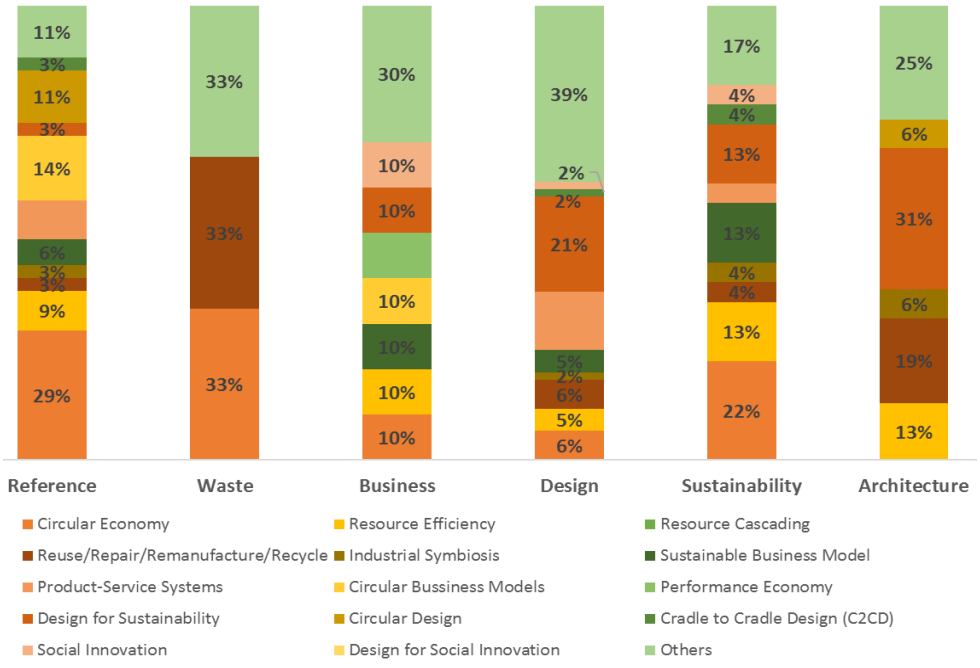

Figure 7. Topics covered by the different training offers identified during the present analysis.

5.1 Learning approaches and training offers in KATCH-e partners countries

This section presents an overview of the CE related training offers from the different partner countries and a brief explanation of the most common learning approaches applied by the University KATCH-e partners in their classes, where KATCH-e will be applied.

5.1.1 Learning approaches and overview on CE related training offers in **Spain**

The training offered about CE in higher education in Spain has been analyzed. The analysis includes a total of 51 offers between official masters, postgraduate courses and expert courses. The offers analyzed are distributed in 24 masters of design, 2 masters of waste, 8 masters of sustainability and environment, 10 of architecture and construction and 2 of business and management; 5 of the courses or masters (10%) cover the Circular Economy as a full concept, focusing on some aspects of it, 13 of the masters analyzed (25%) do not have modules on target topics and the others (65%) integrate just some concepts from those included at Circular Economy.

On the other hand, most of the training offers are face-to-face, out of the total of the offers analyzed, only 9 are distance learning or offer the possibility of not to attend to all the lessons.

There is no detailed information about the planning's of each of the masters, the offer related to the aspects that are collected under the CE umbrella is very diverse, it is between 1 subject and the full master.

There are 20 offers with CE aspects from the perspective of design, 13 which provide modules with CE aspects from an environmental perspective and 5 from an economic perspective. There are not offers that provide modules on all of the topics.

As a conclusion, in 38 of the 51 offers analyzed, the 75%, some of the CE topics are imparted and the three perspectives (design, economy and environment) are covered, but none of the courses involve the full CE concept."

Among the teaching methods applied, there are usual students centered methods, especially at master's level. Teaching methods such as problem-based and project-based learning (PBL), in which students learn, sometimes in groups and sometimes individually to provide a solution to a design problem. For that, they have facilities and resources such as laboratories, software and other facilities. There are several origins for the students' design projects. Sometimes an external client or promoter, such as a company or an association ask for a product. Other times the project is a design contest.

5.1.2 Learning approaches and overview on CE related training offers in **Denmark**

Circular economy as a topic is on the agenda in Denmark, especially with a focus on turning waste into resources by recycling, redesigning, etc., and on developing more sustainable materials. Courses related to these topics can be found on several Danish

universities and University Colleges. Broader curriculae or courses on environmental/sustainability management are also available through a few generic study programs on e.g. Sustainable Design or Environmental Management and Sustainability Studies. However, most training offers are courses up to 5 (European Credit System) ECTS that are integrated in study programs with a broader focus. This is also the current situation in studies related to furniture design and design related to building materials and construction.

There seems to be a gap in education specifically targeting circular economy, especially with a holistic, cross-disciplinary approach that looks into materials, products, business models, value chain cooperation, planning and management for CE, etc.

Danish universities with design related education are teaching from a Problem Based Learning approach. It means that the students have a mix of classroom lectures and projects where they have to apply the knowledge on a case (fictive or real-life). Cooperation with companies are relatively common. The length of the projects varies from a few weeks up to a full semester. The shorter cases are often an integrated part of a specific course, while the semester-long ones run in parallel with a number of courses. In the latter case, the project may account for 10-15 ECTS, out of the 30 ECTS for a full semester.

5.1.3 Learning approaches and overview on CE related training offers in **Portugal**

Design courses in Portugal have similar approaches in both study cycles, in the undertaking of the main disciplines. Among the most widely applied methods, are Problem-Based learning and team-based activities focused on process. This type of course is relatively common and tends to fall into two main groups. The first is where students study the artefacts and designs of others. This may be broadly labelled as "case-based learning", and several examples are reviewed. In the second group, students engage in designing, making and testing objects of their own creation.

The development of projects, individually or in groups accompanied by the teachers, is encouraged through the bipartite research mentioned before: with a theoretical component to support the project, and a mandatory practical part for the development of the projects.

The narrowing between the academic and professional design environments is promoted through strategies of proximity to the real context of the themes to be studied. Students interaction with companies is encouraged, and at least one project throughout the course is developed starting from a company brief, or a contest program. Students usually develop these exercises both within workshop environment and classroom context.

As a specific case of innovative learning approaches, the University of Aveiro pedagogical strategy promotes multidisciplinarity collaborative practices between

different scientific areas through the active participation of several disciplines and departments. Specifically, in Design courses at the Department of Communication and Art, it is important to consider the new emerging areas of Design and its connection with traditional methods of teaching and Design practices. The methodological proposal adopted maps the divergent and convergent stages of the design process, showing the different modes of thinking that designers use, allowing the division of the design process into four distinct phases of project development: Discover, Define, Develop and Deliver.

5.1.4 Learning approaches and overview on CE related training offers in **Austria**

In Austria, the teaching approach is application-oriented and mainly dependent on the students' interest. Ecodesign topics are mainly present within the master's program in the compulsory elective module called "methods of product development and Ecodesign" with a scope of 14 ECTS points. Within this module different types of courses are being offered. To cover the theoretical background (such as methods like LCA, QFD-Analysis, Value Analysis) lectures are being held. Some of the learnt methods can then be applied to products the students choose which can be considered as the main portion of the module. The approach can be described as project-based, where the lecturers mainly guide the process. The process follows the general product development process towards the development of a green product. To help with this process, there are also tools provided, such as the Ecodesign PILOT, which has been developed by the research area Ecodesign and is constantly refined and adapted for new purposes. To deepen the knowledge in this field there is also the possibility of writing a master or even a PhD thesis with a focus on Ecodesign.

The training offered about CE in higher education in Austria has been analyzed. The analysis includes a total of 8 offers between masters and undergraduate courses, all of them realized on-site. The offers analyzed are distributed in 6 masters mostly of construction sector. About the Circular Economy as a full concept, focusing on some aspects like resources efficiency, design for sustainability and sustainable business model.

6 LITERATURE REVIEW ON CE & RELATED TOPICS

This review aims to identify the training necessities of companies and the education offer. This identification is fundamental to define an educational programme and the training materials for high education suitable to encourage cross-curricular learning, connecting mainly designers with engineers and other relevant stakeholders.

To success in this identification process, it is strategic to carry out a comprehensive review of several aspects related to CE, sustainability, design and education sources as:

- Training offers and materials, technical papers, tools, innovative learning approaches and methodologies regarding CE, sustainability, new business model, industrial symbiosis, entrepreneurship;
- Policy trends at European and national level.

The extensive literature reviewed are in KATCH-e database on Resource Center of the project. The Resource Center is divided in 7 main topics. Each topic is organized in several fields that must be filled in order to help to have a general idea of what the resource is about, and its relevance for the project.

In sequence you find a description of the taxonomy KATCH-e has been used in each topic:

- **Databases, Software** (Focus on: Specific information from the previous fields)
- **Books, Guides, etc.** (Focus on: ist of choices: CE: Circular Economy; RE: Resource efficiency; RC: Resource Cascading; R: Remanufacturing, Recycling, Repair, Reuse; IS: Industrial Symbiosis; SBM: Sustainable Business Model; PSS: Product-Service-System; CBM: Circular Business Model, PE: Performance Economy, DfS: Design for Sustainability; CD: Circular Design; C2CD: Cradle to cradle Design; SI: Social Innovation, DfSI: Design for Social Innovation, OTH: Others).
- **Related project** (same list than in previous topics)
- **Websites and Platforms** (same list than in previous topics)
- **Universities training offers** (same list than in previous topics)
- **Standards & Ecolabels** (same list than in previous topics)
- **Tools** (same list than in previous topics)

For more information, please access the webpage: http://www.katche.eu

7 FEEDBACKS FROM STAKEHOLDERS: Interviews & Workshops

As part of the situation analysis, a series of interviews and several workshops were conducted in order to validate the method and processes used in this research. These activities are appropriated to gather valid and reliable information (Saunders et al., 2003) and provide in-depth understanding of concepts through posing direct questions to the interviewee (Jupp, 2006). To the interview process, in order to obtain more relevant and accurate results, different profiles were grouped and coded as follows: T01, Students; T02, Professors; T03, Researchers; T04, Companies; T05, Business Associations (BA); T06, Public Authorities (PA); and; T07, NGO's. All stakeholders were related, in some way, in the design field of furniture and construction sector.

7.1 Interviews

The structure responds to a semi-structured interview, allowing for flexibility by asking follow-up questions. The interview scripts were comprised of different open-ended questions to offer the interviewees the possibility to explain their point of view, supporting it with examples when needed (See Annex 2).. Each group was subjected to a different type of interview, preparing a total of seven interview models, with common questions. The scripts were divided in 2 sections: a specific section to collect background information; and another section with the questions related to CE. A total of 49 interviews (Table 4) were conducted, mainly face to face, as well as by phone or by email in particular cases.

Due to the relevance and the degree of required depth, the opinions of professors and researchers, companies and BA, were analysed more in detail.

Regarding to the data analysis, as the answers obtained from the open-ended questions were textual or narrative, the constant comparative analysis of Grounded Theory was applied (Lozano et al., 2015), which is based on selective coding trying to reduce the concepts into core categories (Hallberg, 2006).

The steps followed were: (1) Data reduction, to select and organise relevant data and transcript the information in a synthesized way and subsequent compiling in Excel sheet templates for each target profile; (2) Data display, different descriptive terms were used to present the results, for instance "high", "very specific", etc., whenever possible. Tables and graphs were drafted to showcase in a synthetic and visual way; and (3) Conclusions, to establish relations between the answers of some profiles and others regarding the same subject.

As a consequence of this procedure, the following codes were defined: Meaning of the CE; Training received; Training provided; University curriculum; Needs; Projects; Gaps; Complaints; Knowledge; In-company implementation; Business activities; CE-based products; Product development decisions; Design management; User-centered design; Drivers; Barriers; Promotion actions. The categories detected in the comparative analysis were summarized in the following result sections: understanding and perception of CE; CE implementation; CE promoting actions; CE demands and needs; CE drivers in present and future; barriers in implementing CE; and challenges for implementing CE.

7.2 Workshops

The workshops took place in June 2017, with a total of 100 participants from HE, Business community and Knowledge centres, which were selected and invited personally. Guided questions were answered, organizing the participants into multidisciplinary groups, and a general discussion was also held, either at the beginning of the session or immediately after the teamwork session. Table 5 shows a summary of the workshops in each country.

Minutes were prepared after each of the workshops, and following the coding groups used during the interviews, inputs and recommendations were pinpointed related to the themes. Since the workshops allowed for open discussion within a common framework, the results should be regarded as examples on how the participants understand CE, related barriers and drivers and what type of competences are needed in HE.

7.3 Limitations of the research method

The interviews were conducted by 15 researchers with very different backgrounds and professions including design professors and sustainability teachers, researchers from public centres without sectoral orientation as well as private centres with sectoral orientation, chemists, engineers, designers and environmentalists, among others. Inevitably, the depth of the responses could slightly vary. Something similar happened in the workshops, where each country applied a slightly different approach. Nevertheless, the exploitations and treatment of all the information obtained through the interviews and the workshops was carried out by only one person, so there was a solid coherence in this activity. The interviewees provided good answers in general, but in some cases, they did not have enough knowledge to cover all the questions raised (e.g. the question regarding the actions to implement CE in HE). Moreover, the number of responses from each professional profile were not equally balanced. In view of this situation, the answers from some stakeholders have not been considered representative enough and they are not included in the analyses, e.g. NGOs, that were considered at the testimonial level. The nature of the responses did not allow to include in-depth statistical computations.

The answers of the 49 interviews and the main findings from the workshops were classified in seven main topics and the analysis was done considering the different profiles and nationalities, highlighting the main differences per profile and country when it seemed significant.

7.4 Main findings

The concept of CE is still not clear and harmonized (Rizos et al., 2017). According to Kirchherr et al., (2017), who analysed 114 definitions were analysed, the variation on perceptions of CE can be a barrier to the concept. To grasp the understanding of the interviewees regarding CE, the concept perception from their personal point of view and related words were asked.

Regarding the concept, those who were familiar with the concept referred to the model from Ellen MacArthur Foundation, either directly or indirectly, by mentioning the loops. They defined the novelty of a CE by its strong focus on the economy and creating new types of business value. Those who were less familiar with the CE concept, typically related it to something about recycling but also added many other topics, depending on their own background. Some had difficulties in seeing what the innovations a CE

implies compared to related topics like sustainability, resource efficiency, recycling, etc. Students put the focus on terms related to resource efficiency while the other groups show more complex and complete perspectives, including economic and social aspects.

Similar to Kirchherr et al., (2017), respondents were classified in two groups: academia and practitioners. In this study, academia was composed by researchers, professors and students, and practitioners included companies, BA, NGO's and PA. The most repeated CE meanings of each group are presented in Table 6.

As shown in Table 6, no significant distinction between the responses by scholars and practitioners were found in our sample. This was not aligned to the analysis by Kirchherr et al., (2017), in which several differences were identified between the practitioners' and peer-reviewed approaches (Kirchherr et al., 2017). The reason of this no coincidence could be the classification of "academia" and "practitioners", since some of the professors interviewed were also practitioners, and newly employed students (in a company) still had some academic viewpoints.

When asked to describe CE using three words, 133 words or expressions were obtained. Due to repetitions, it was identified 76 different words and only 20 were mentioned more than once. Of this 25% corresponded to the terms "reuse" and "recycling". The most used expressions and their frequency of used are depicted in Figure 8.

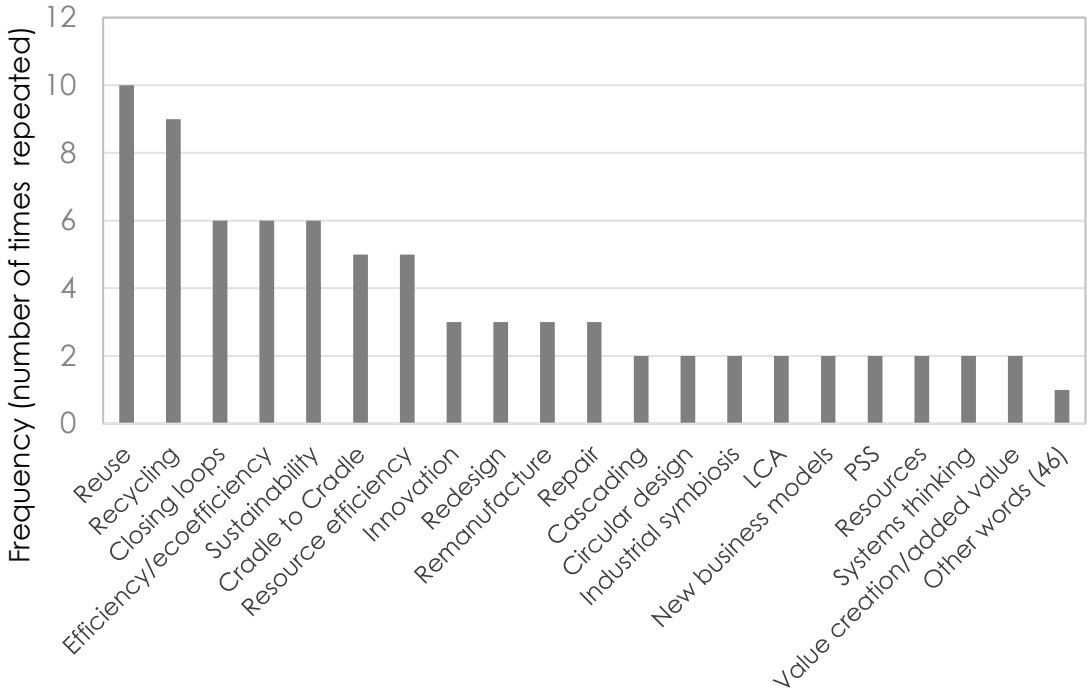

Figure 8: Frequency analysis of the answers to the question "What three words would you say best describe CE?".

Subsequently, the answers were clustered in six main categories (Figure 9): Materials (and energy, to a lesser extent); Production; Services and business models; Product durability; Broad concepts related to circularity and sustainability; Broad concepts not related to circularity and sustainability.

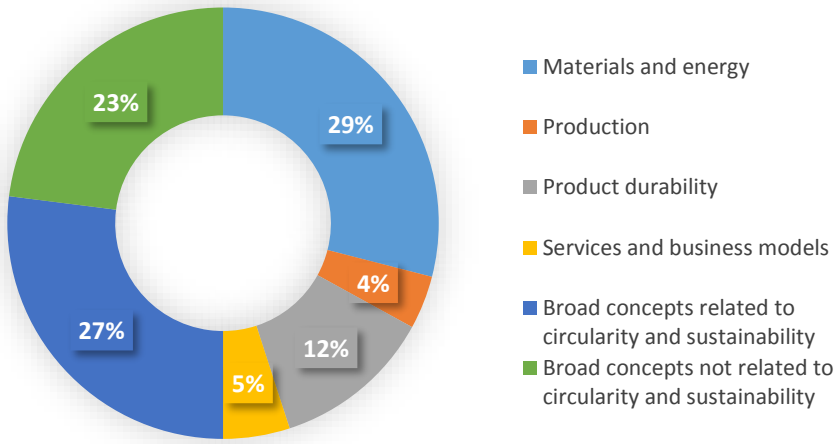

Figure 9: Distribution of the words/expressions used by interviewees to answer the question "What three words would you say best describe CE?" per category.

Half of the answers were related to broader concepts, either related to sustainability and circularity (e.g., sustainable production and consumption, linked economic and natural cycles, regeneration and restoration) or not (e.g., creativity, innovation, public-private-citizens partnerships, systems thinking). So, in the interviewees minds, there is a systems perspective related to CE. This is consistent with Kirchherr et al., (2017), which showed that there is a significant emphasis on this perspective, especially from 2012 onwards, strongly influenced by the work of the Ellen MacArthur Foundation. Twenty-nine percent of the answers are related to materials and energy (recycling, clean materials and energy, resources productivity, efficiency, avoiding down cycling, for instance). Product durability follows with 12% of the total terms and expressions, most of them given by academia, however companies contemplated this strategy could entail a potential decrease in revenues. The services and business models cluster represents only 5% of the answers, which contradicts the findings from question related to concept perception, but again is not remarkably different from the analysis performed by Kirchherr et al., (2017), according to which circular business models are mentioned in only 11% of the definitions.

The number of answers related to social aspects was very low, which is in line with Kirchherr et al., (2017), who claimed that the CE concept largely neglects social equity. There has been criticism regarding the value of using interviews with stakeholders, because it is difficult for them to give thoughtful responses ad-hoc (Dahlsrud, 2008; Johnston and Beatson, 2005; Kirchherr et al., 2017). But our research found no significant difference between published definitions (Kirchherr et al., 2017) and the responses from the interviews. This is very interesting because while the CE concept is complex and has many perspectives, it seems that it has been captured by our stakeholders. The fact that they have been pre-selected as being familiar with CE explains this result. Nevertheless, to advance to a more sustainable society, there is the need of a stronger and scientifically based consensus around the concept and its application.

7.5 CE implementation

The interviewed students, mostly industrial design engineering students, indicated that CE was not taught in a specific way but was included horizontally within other disciplines related to environmental science and sustainability. Some indicated that they had not received any related training and all agreed that the received training was insufficient. The teachers agreed with this vision. CE was not present as a course in the curricula, but some related topics were included in other subjects such as eco-design, life cycle assessment or industrial ecology. This perception was similar to the results found by Whalen et al., (2017) and Whicher et al., (2018). In general, teachers justified this with the low level of knowledge they had, being necessary to delve into it more deeply and introduce it in the curricula in a more systematic way. Therefore, the framework of a CE was perceived as a necessary and new field, while its topics were partially addressed throughout other courses as stated in The University of Edinburgh (2015).

From the companies point of view, the 11 interviewed organizations said to be implementing CE related strategies in some way. Most of the Spanish and Portuguese companies were engaged in activities which were not developed systematically. In Austria and Denmark, it was possible to find companies with a greater focus on CE and some of them included strategies at a business level. Anyway, CE related company strategies were still niche-oriented and not mainstream. In the furniture sector, some companies produce long-lasting and high-quality furniture, which is relevant for certain market segments and could be regarded as a CE approach even if the companies did not choose it as a part of a defined CE strategy.

Sixty percent of the researchers carried out research on sustainability in the target sectors but did not integrate issues related to business models, while 40% had a more holistic vision of CE in their research applied to companies.

Figure 10 shows the stakeholders perspective of CE implementation according to the following criteria: 1) Specific: the environmental, social and business models were cited or specific reference to the CE was done; 2) Not very specific: environmental or social

aspects of business models were cited, but neither in an integrated manner nor specifically to CE; and 3) Not specific: nothing related to the CE was provided, neither training in HE nor applied in companies.

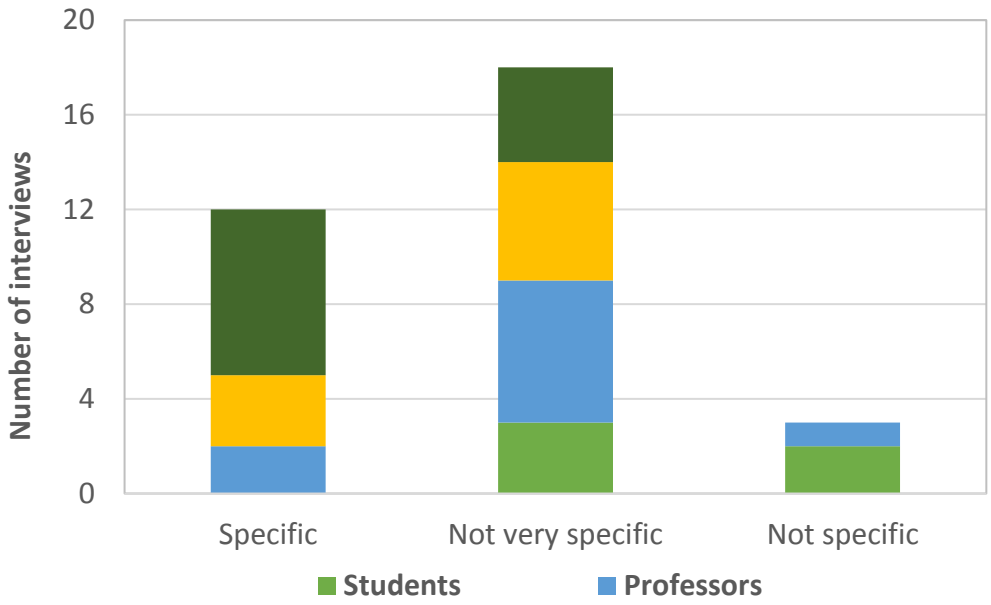

Figure 10: Stakeholders perspective of CE implementation.

Companies are more optimistic when declaring to apply CE strategies than HE stakeholders, who are more theoretical and therefore accurate in the application of terms used. In this sense, no company stated not to apply any CE strategy in their companies.

7.6 CE promoting actions

The different target groups promote CE according to their interests and capacities. Professors encourage CE in the design degree through participation in different projects, seminars, etc. BA, on the other hand, endorse CE through the participation in committees, networks, working groups, platforms, among others. However, their initiatives are focused on isolated strategies such as recycling, industrial symbiosis, funding schemes, etc. Finally, PA support and promote CE in each country through the development of specific legislation, funding schemes, tax incentives, dissemination activities, etc. Nonetheless, a difference of perception was found between PA and BA regarding the actions made by PA to promote CE: PA claim to do an important effort, however, this effort was not perceived by the BA.

Some examples of promoting CE actions are: the "Recommendations for the Danish Government" with 27 concrete policy proposals published by The Advisory Board for Circular Economy, 2017; Portugal supports CE in the state budget through economic incentives for ecodesign projects, a funding program for CE, FITEC (Decreto-Lei n.º 86-

C/2016), the Action plan for CE in Portugal (Resolução do Conselho de Ministros nº190-A/2017) and other initiatives such as the Environmental education strategy (Resolução do Conselho de Ministros n.º 100/2017), which includes a full chapter on CE and the National agenda on research and innovation for CE (Fundação para a ciência e tecnologia, 2017); and finally, Whicher et al., (2017) compiles different initiatives related to design and CE in Scotland such as Scotland Re:Design or the Community Resources Network Scotland (CRNS).

7.7 CE demands and needs

This section looks into the CE demands and needs from two different perspectives: the first one assesses the needs and demands to boost transition to CE, while the second approach looks into the expressed demands and needs for competences related to a CE.

The needs and demands for the transition towards a CE were mainly related to financial support for investments, new business models, processes; the need for policies and the need to adapt legislation and infrastructures. As pointed out by EEA (2016), managing the transition will also needs a better understanding of broad societal trends and the drivers of production and consumption patterns to be able to manage all natural resources efficiently and, above all, sustainably, with respect for planetary boundaries.

Regarding competences for a CE, both, literature (Leube and Walcher, 2017; Luna et al., 2012; Manzini and Coad, 2015) and the outcomes of the interviews and workshops stated that designing in the CE era is more about designing network than designing "stuff". Hence, skills developed for CE and sustainability should support real-life changes and preferably be developed in cooperation with partners outside academia with practical methods and tools. This new paradigm requires a holistic approach to problem solving, responding to different social, cultural, economic and environmental needs and to be able to deal with complexity as any product or solution has to function in the overall social and technical system. Designers must change their design linear model thinking and practices towards circularity (Andrews, 2015), shaping the situations in which people make choices (Leube and Walcher, 2017).

The research team found generic demands pointing at the need for multi-disciplinary knowledge, practicality and usefulness of the training materials as core elements of developing CE competences at HE institutions as mentioned by Watson et al., (2013) and Ramos et al., (2015). A challenge to multi-disciplinary approaches is the difference in terms and concepts used in different disciplines (Whicher et al., 2018). The curricula will have to clarify where the essential differences are, and explain and bridge those (Hollander et al., 2017; Lewandowski, 2016; Peck et al., 2015). The target groups interviewed demonstrated a great variety in the needs they focused on – in line with their perceived roles.

Professors and Researchers expressed needs related to the framework for developing the knowledge base and CE changes in the curricula, including, for example, time, financial resources and possibilities to cooperate with relevant stakeholders.

Students' demands were aligned with the demands and needs stressed by the companies in relation to improving their knowledge on CE and related new business models, markets and industrial network, among others. Companies considered that, to succeed in this matter, they should have the opportunity to co-create new solutions, be creative in their problem-solving and having cross-disciplinary competences, including understanding the different types of CE business models, ability to reflect, analyse different potentials, dilemmas, etc., coinciding with Leube and Walcher (2017), who add that understanding of the functionality, impacts and recyclability of materials and products in a life cycle perspective are also needed. Finally, how students learn the best was not included in the interviews and workshops, but lessons learned suggest that integration of participatory approaches (Disterheft et al., 2015), and the use of games (Bevilaqua et al., 2015) may be relevant. Moreover, there is a need to translate technical language into language known or recognizable to designers (Peck et al., 2015).

7.8. CE drivers in present and future

From the responses, 7 main categories of drivers were identified: Legal/Politic; Education/Awareness; Environment pressure; Business/Financial; Consumer/Market; Innovation; and Younger Generations. All the target groups made references to all driver's categories except Younger Generations which was classified as a future driver. Figure 11 shows the main drivers that the different target groups have defined.

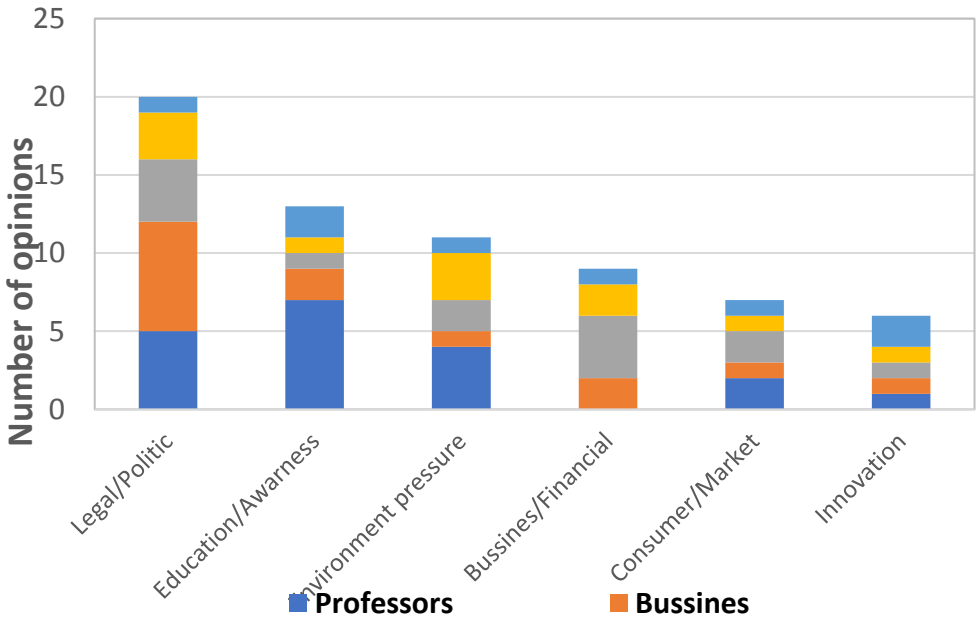

Figure 11: Main drivers according to the different target groups interviewed.

Legal and political commitment was the most mentioned driver during the interviews, either through legal requirements or political priorities or plans. The other drivers were: education and awareness; environmental pressure due to the scarcity of raw materials; new business, business potential and need for external financing, e. g. through tax incentives; pressure from markets and consumer demands; and need of innovation to increase competitiveness.

These drivers are supported by the close research literature in the field. For example, Bicket et al., (2014) studied the policy options to support a circular economy in the EU, focusing on the role of regulatory instruments and approaches in encouraging circularity. Whicher et al., (2018) found out in a similar study, that business support and findings were a prime motivator for increasing the engagement in design for a CE as well as the low level of bureaucracy. The study of Ranta et al., (2017), who compare the regulative and normative drivers in CE of China, the US and Europe. Other authors give more importance to other factors, as De Jesus and Mendoça (2018), that points the institutional/regulatory as a "soft factor". Moreover, several authors identified design-innovation as a key role in growth within the EU (Verganti, 2009; Cooke and De Propris, 2011).

During the workshops, the perspective of market trends and demands became more nuanced through examples: purchase power function, e.g. customers saving money on renting instead of buying or on replacement of damaged parts instead of whole unities. In the furniture sector, office furniture with large quantities drive the market for refurbishment and there is an existing market for reused products. However, this market is "taken" by other organizations, so the furniture producers have to find out if and how they can develop reusable products without hampering (too much) their traditional production, "a true business dilemma!". Also within the furniture sector, a retro-trend among private consumers is driving the market for reuse and refurbishment.

For teachers, the most important present driver is education, as expected. For companies, BA and PA, legal and political commitment, although the BA also believe that funding schemes would be needed to facilitate the transition to a CE and the PA are also aware that the pressure on the environment will force the economy to take a more circular character, coinciding with NGOs (Figure 12).

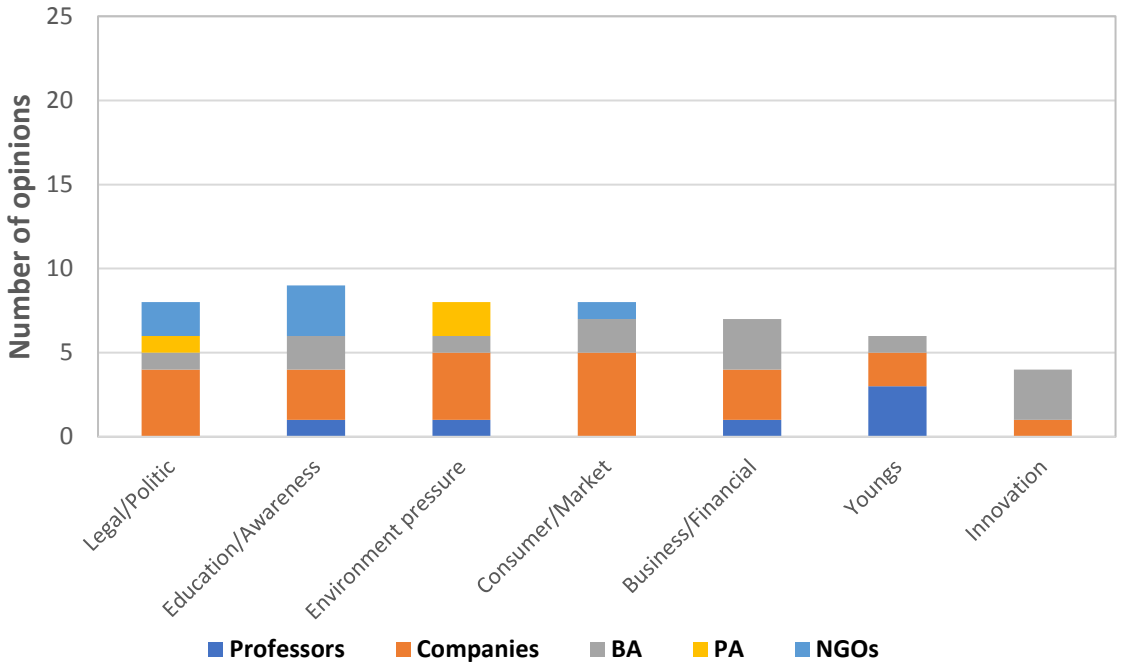

Figure 12: Future main drivers according to the different target groups interviewed.

Education and awareness-raising activities seem to be fundamental to empowering the CE. Other studies related to education in circular economy (Kopnina, 2017a, 2017b; Pitt and Heinemeyer, 2015), agree with the results obtained from of this study. This main choice is followed by policy and legal implications of governments, scarcity of natural resources, climate change and other environmental impacts, and demand from markets and consumers alike. The need for funding, future generations and the development of innovative solutions are mentioned by more than one target group.

Teachers have their expectations set on future generations of young people, similar results were found in Whicher et al., (2018). During the workshops, some examples of the role that young people play in the impulse of the CE were shown. Linkages to sharing economy perspectives, including the use of ICT and social media may stimulate CE. For example, in Denmark, the young generation living in the larger cities are slowly changing their lifestyle: they prefer access to the functionality of a product instead of buying the products.

The business world believes that it will be the market and customers, who will force the system to be more circular. Those who mostly agree that the pressure on the environment is crucial to address the circularity of the economy are PA, while NGOs believe that education is the main driver. It is worth to say that innovation is the less mentioned driver, however, studies as the one done by De Jesus et al., (2018) discusses how eco-innovation can promote circularity.

7.9. Barriers in implementing CE

Traditions and culture among politicians, authorities, companies, educational institutions are regarded as a main barrier since the social structures and infrastructures are adapted to a linear practice.

From the point of view of the professors interviewed, the main barriers to implement CE in University studies are described in table 11.

Table 11: Mains barriers to implement CE in University studies

Barriers	Description
CE in University studies	Lack of University commitment as organizations
	Lack of time and motivation to get updated in this subject
	Difficulty in introducing CE contents in a sector specific training curricula owes to the multidisciplinary requirements of CE (design, materials, management, marketing, business models, value chains, engineering, etc.)

The interdisciplinary character of CE means that an own Chair for CE may not be reasonable which can slow down the implementation at University level.

Most of these barriers were identified in similar studies, such as The University of Edinburgh (2015). The main barriers to the companies can be summarized in the table 12.

Table 12: Mains barriers to implement CE in companies.

Barriers	Description
CE in Companies	Lack of awareness for global resource depletion, scarcity and negative environmental, economic and social effects
	Lack of knowledge, skills and competences to adapt business concepts and implement CE strategies although a lot of information is available
	Legal barriers, such as the problem of waste reclassification (i.e: waste can only be reclassified legally as sub-product if a market has been identified for it previously). In addition, purchasing secondary raw materials raises guarantee of performance/quality issues and manufacturers avoid it
	Stuck in daily business, inability to adapt to development and changes. Moreover, CE is not recognized as a success factor yet
	Low demand from the market, low recognition and acceptance of the consumers to CE practices and products

Resistance accepting new products, services or business models, issues related with the confidentiality aspects (sharing of data, information, etc.) in the internal business policies.

7.10 Challenges

Considering the previous results, this section presents the main challenges for implementing CE within companies and universities. This list should be considered as non-prioritized (Table 13)

Table 13: Main challenges identified for implementing CE within companies and universities

Challenges	Description
For Companies	Constantly keeping up with developments and trends and developing strategies on how to adjust the portfolio to the demands of the market, the environment and the legal requirements, as well as anticipating future developments under the CE perspective while remaining profitable
	Meeting customer demands and work with or influence consumer view for new products or features within CE strategies
	Meeting customer demands and work with or influence consumer view for new products or features within CE strategies
	Meeting customer demands and work with or influence consumer view for new products or features within CE strategies
	Meeting customer demands and work with or influence consumer view for new products or features within CE strategies
	Meeting customer demands and work with or influence consumer view for new products or features within CE strategies
	Shift from producing products to selling services (or combinations)
	Transition from sectoral specialization to objectives and services, therefore, trying to survive the transition from linear towards CE
For Universities	Think and act in an interdisciplinary manner, exchange and communicate with other disciplines, faculties, universities
	Act as a service provider for companies on qualifying future CE experts
	Co-create and influence industrial/business developments

	Develop innovative strategies and ways to implement CE
	Constantly keeping up with developments and trends

Exchange knowledge with companies in order to support the implementation of CE strategies.

8 CONCLUSIONS

8.1. Recommendations for KATCH-e content

According to the results, the topics that the KATCH-e training materials should deal with are summarised in Table 11.

Table 11. Summary of recommendations to develop KATCH-e training materials.

Topics	Description
Understanding CE with social developments and trends	Contribute to a common vocabulary and a better understanding of the CE concept and related issues, i.e. principles and implications of the new paradigm, which means opposition when CE comes to implementing new strategies and solutions.
	Promote the CE with positive messages and clear information for the final user. This is, to get CE demanded because society realizes that it is convenient for all of us.
Understanding CE related policies and trends	To discuss and show the companies and students how EU policies and regulations on CE can be articulated with global competition how to make companies more competitive and simultaneously make the economy more circular.
	Take into account the National Agenda for Research and Innovation on CE and its areas of knowledge that need to be explored.
	Identify the possible existing tax and financial incentives that in some way could support the CE initiatives and/or the creation of new and specific for the CE in companies.
Combination of design and business models' solutions	Include in the training material case studies and practical examples, with a heightened focus to generate business models in CE.
	Include information about the new business models and the capability to adapt the theory to the type of companies (sizes and position).
	Introduce in the training the thematic of value chains analysis, rather than (or complementary to a sectoral approach in the project.

Topics	Description
Combination of design and CE solution	Include in the project training in materials and substitute materials, which designers lack.
	Include not only product design, but also service design in the project. Clarify the possibilities of integrating CE principles with other existent strategies (such as labelling, environmental, quality, energy, H&S, and other management systems, innovation tools, etc.) already tested and implemented in companies.
Learning approach	Promote a multidisciplinary approach to teach, implement and test CE principles and also, bring different stakeholders to the discussion (e.g. companies, universities, public sector, NGO's etc.).
	Validate the in-classroom training through case studies developed in partnership between universities, companies and other entities.
	Include in the project visits to companies for students to structure knowledge based on practical case studies.
	Compile the most relevant information on CE and adapt it according to the needs and demands identified during the situation analysis. Moreover, KATCH-e should act as a filter of relevant resources for the target sectors.
	Develop simple and easy tools and methods to perform a self-checking in companies.

8.2. Perspectives of future work

As pointed out during the interviews and workshops, building bridges between the linear and the CE 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 as Critical thinking and problem solving; Creativity; Communication, and Collaboration (Soffel, 2016).

This research revealed that we still need a deeper understanding of where the specific combined business and design related competences required for a CE differ from those needed in the linear economy, and which competences to give the highest priority. Can an "ideal" for CE skills be defined – and thus taught at the universities, or is it rather the ability to rethink and break new paths that are key to a successful transformation towards CE?. Such questions are relevant for future research, involving businesses, universities and other relevant stakeholders.

Summarizing, all these findings provide insights that will help to develop new training materials on the application of CE. The next steps consist in considering these conclusions and the compiled information to propose the contents for the training materials. Moreover, these results can be used as a baseline to discuss and propose the necessary competences in CE to foster its implementation at the

higher education level, considering that a holistic and multi-disciplinary approach is required together with pragmatic methods and tools. Next tasks under the framework of the KATCH-e project will be to develop and test the new training materials and the proposed skills with relevant and expert stakeholders in order to obtain their feedback. This assessment will help guarantee no key ideas are disregarded as well as other relevant aspects and recommendations may be included.

References

Action and Research Centre (ARC), 2013. The Great Recovery Report (Report1): Investigating the role of design in the circular economy.

Andrews, D. (2015). The circular economy, design thinking and education for sustainability. Local Economy, 30(3), 305-315.

Bakker, C., Wang, F., Huisman, J., & den Hollander, M. (2014). Products that go round: exploring product life extension through design. Journal of Cleaner Production, 69, 10-16.

Bevilacqua, F., Backlund, P., & Engstrom, H. (2015, September). Proposal for non-contact analysis of multimodal inputs to measure stress level in serious games. In Games and Virtual Worlds for Serious Applications (VS-Games), 2015 7th International Conference on (pp. 1-4). IEEE.

Bicket, M., Guilcher, S., Hestin, M., Hudson, C., Razzini, P., Tan, A., ... & Watkins, E. (2014). Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains.

Bocken, N. M., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308-320.

Böhler, W., & Marbs, A. (2002). 3D Scanning Instruments--CIPA. In Heritage Documentation-International Workshop on Scanning for Cultural Heritage Recording-Corfu, Greece–2002.

Caitlin Stewart. 5 Top Trends in the Furniture Industry. MarketResearch.com, recovered from http://blog.marketresearch.com/5-top-trends-in-the-furniture-industry, accessed on the 30th November 2017.

COM(2015) 614 final (2015). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Closing the loop - An EU action plan for the Circular Economy. Brussels, Belgium: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614 (Accessed 30 November 2017)

COM(2016) 381 final (2016). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the

Committee of the Regions. A new skills agenda for Europe: Working together to strengthen human capital, employability and competitiveness. Brussels, Belgium: European Commission

Cooke, P., & De Propris, L. (2011). A policy agenda for EU smart growth: the role of creative and cultural industries. Policy Studies, 32(4), 365-375.

Council Directive on the landfill of waste 1999/31/EC OJ L 182/1.

Council of the EU (CEU). (2016). Council conclusions on the EU action plan for the circular economy. Press release 367/16.

Custom Home Building Market Growth Slows. http://eyeonhousing.org/2017/05/custom-home-building-market-growth-slows/ (Accessed 1 June 2018)

Danish Government (2013 and 2015): Denmark without waste I and II. Report. https://eng.mst.dk/air-noise-waste/waste/ (Accessed 1 June 2018)

De Jesus, A., & Mendonça, S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. Ecological Economics, 145, 75-89.

Decreto-Lei n.º 86-C/2016 de 29 de dezembro de 2016. Diário da República, 1.ª série — N.º 249 — 29 de dezembro de 2016. http://www.ifd.pt/pt/ifd-assume-a-gestao-financeira-do-fundo-de-inovacao-tecnologia-e-economia-circular/ (Accessed 1 June 2018)

den Hollander, M. C., Bakker, C. A., & Hultink, E. J. (2017). Product design in a circular economy: Development of a typology of key concepts and terms. Journal of Industrial Ecology, 21(3), 517-525.

Disterheft, A., Caeiro, S., Azeiteiro, U. M., & Leal Filho, W. (2015). Sustainable universities–a study of critical success factors for participatory approaches. Journal of Cleaner Production, 106, 11-21.

Eco-Mobilier (2016). Guide des Eco-participations. www.eco-mobilier.fr (Accessed 2 June 2018)

EEA (2016). Circular economy in Europe: Developing the knowledge base, EEA Report No 2/2016, European Environment Agency, Copenhagen.

Ekins, P., Hughes, N., Brigenzu, S., Arden Clark, C., Fischer-Kowalski, M., Graedel, T., ... & Hertwich, E. (2016). Resource efficiency: Potential and economic implications.

Ellen MacArthur Foundation and McKinsey Centre for Business and Environment (EMF & MCBE). (2015). Growth Within: A Circular Economy Vision for a Competitive Europe. https://www.ellenmacarthurfoundation.org/publications/growth-within-a-circular-economy-vision-for-a-competitive-Europe.

European Commission (EC). (2013). Wooden Furniture. Background Report Revision of Ecolabel and Green Public Procurement criteria for the product group. Joint Research Centre, Institute for Prospective Technological Studies (IPTS). JRC Scientific and Policy Reports.

European Commission (EC). (2017a). Growth. Internal market, industry, Entrepreneurship and SMEs. Furniture industry. https://ec.europa.eu/growth/sectors/raw-materials/industries/forest-based/furniture (Accessed 30 November 2017)

European Environment Agency (EEA). (2016). Circular Economy in Europe: developing the knowledge base. Report No 2/2016. https://www.eea.europa.eu/publications/circular-economy-in-europe (Accessed 22 December 2017).

European Environment Agency (EEA). (2017). Circular by design: Products in the circular economy.

European Environmental Bureau (EEB). (2017). Circular economy opportunities in the furniture sector.

European Environmental Bureau (EEB). (2017). Circular economy opportunities in the furniture sector.

Eurostat (2018) EU trade in furniture around the globe. http://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20180124-1?inheritRedirect=true on 10/07/2018 (Accessed 10 July 2018)

Fundação para A Ciência e a Tecnologia, 2017 https://www.fct.pt/agendastematicas/ecocirc.phtml.pt (Accessed 12 April 2018)

Hatcher, G. D., Ijomah, W. L., & Windmill, J. F. C. (2011). Design for remanufacture: a literature review and future research needs. Journal of Cleaner Production, 19(17-18), 2004-2014.

Kommunernes Landsforening (2017): Den cirkulære kommune (The circular local municipality) Report.

Kopnina, H. (2017). Discussing Practical and Educational Challenges in Teaching Circular Economy. In Global Opportunities for Entrepreneurial Growth: Coopetition and Knowledge Dynamics within and across Firms (pp. 507-522). Emerald Publishing Limited.

Kuivanen, P. (2016). Remodelling fashion via circular economy driven luxury concept. International Business and Logistics, FlexIBL. Thesis. Helsinki Metropolia University of Applied Sciences.

Leube, M., & Walcher, D. (2017). Designing for the next (Circular) Economy. An appeal to renew the Curricula of Design Schools. The Design Journal, 20(sup1), S492-S501.

Lewandowski, M. (2016). Designing the business models for circular economy—Towards the conceptual framework. Sustainability, 8(1), 43.

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. Journal of Cleaner Production, 115, 36-51.

Lovins, A., Braungart, M., Stahel, W. A., Birkeland, J., Goerner, S., Spicer, D., ... & Mulhall, D. (2014). A New Dynamic: effective business in a circular economy. Ellen MacArthur Foundation Publishing, 172.

Manstein, C. & Tertschnig, W. (2012) Österreichischen Ressourceneffizienz Aktionsplan (REAP). Federal Ministry of Agriculture, Forestry, Environment and Water Management. https://www.bmlfuw.gv.at/umwelt/nachhaltigkeit/ressourceneffizienz/ressourcennutzung_daten_trends/aktionsplan.html (Accessed 13 April 2017)

Morató, J., Tollin, N., & Jiménez, L. (2017). Situación y Evolución de la Economía Circular en España. Fundación COTEC para la Innovación, 15-17.http://cotec.es/media/informe-CotecISBN-1.pdf. (Accessed 1 June 2018)

NAHB (2017). National Association of Home Builders Discusses Economics and Housing Policy.

Peck, D., Kandachar, P., & Tempelman, E. (2015). Critical materials from a product design perspective. Materials & Design (1980-2015), 65, 147-159.

Pinheiro de Azevedo, H. (2016) Apoio à Economia Circular no Portugal 2020…O caso do PO SEUR. Financiamento da Economia Circular. Conferencia 11.04.2018. https://poseur.portugal2020.pt/media/38785/20160411_financiamentoeconomiacircularposeur.pdf (Accessed 1 June 2018)

Portaria n.º 258/2017 de 21 de Agosto de 2017 Diário da República, 1.ª série — N.º 160 — 21 de agosto de 2017. https://dre.pt/application/file/a/108029684

Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring institutional drivers and barriers of the circular economy: a cross-regional comparison of China, the US, and Europe. Resources, Conservation and Recycling, 135, 70-82.

Renda, A., Pelkmans, J., & Schrefler, L. (2015). The EU furniture market situation and a possible furniture products initiative. Submitted to the European Commission DG Enterprise and Industry, 2014. https://ec.europa.eu/growth/content/study-eu-furniture-market-situation-and-possible-furniture-products-initiative-0_en (Accessed 17 December 2017)

Schandl, H., Hatfield-Dodds, S., Wiedmann, T., Geschke, A., Cai, Y., West, J., ... & Owen, A. (2016). Decoupling global environmental pressure and economic growth: scenarios for energy use, materials use and carbon emissions. Journal of Cleaner Production, 132, 45-56.

Schenkel, M., Caniëls, M. C., Krikke, H., & van der Laan, E. (2015). Understanding value creation in closed loop supply chains–Past findings and future directions. Journal of Manufacturing Systems, 37, 729-745.

Sistema de Incentivos Fiscais à I&D Empresarial, 2018. http://sifide.adi.pt/index.php?cat=4 (Accessed 1 June 2018)

Soffel, J. (2016, March). What are the 21st-century skills every student needs. In World Economic Forum (Vol. 10).

SWD(2017) 33 final (2017). The EU Environmental Implementation Review Country Report – AUSTRIA. Brussels, Belgium: European Commission. http://ec.europa.eu/environment/eir/pdf/report_at_en.pdf (Accessed 17 December 2017)

The Federal Ministry for Sustainability and Tourism, Austria, 2016. RESET2020 - The new resource efficiency initiative. https://www.bmnt.gv.at/umwelt/nachhaltigkeit/ressourceneffizienz/aktionsplan_ressourceneffizienz_reset.html (Accessed 13 April 2018)

The Federal ministry of Agriculture, Forestry, Environment and Water Management, Austria 2017. Bundesabfallwirtschaftsplan 2017 – BAWP.

https://www.bmnt.gv.at/umwelt/abfall-ressourcen/bundes-abfallwirtschaftsplan/BAWP2017-Final.html

The University of Edinburgh, (2015). Circular Economy thinking and Action at the The University of Edinburgh. https://www.ed.ac.uk/files/atoms/files/zws_uoe_circular_economy_report_final_may_2015.pdf. (Accessed 21 December 2017).

Van Eijk, F., (2015). Acceleration Report: Barriers and drivers towards Circular Economy. https://www.circulairondernemen.nl/uploads/e00e8643951aef8adde612123e824493.pdf. (Accessed 21 December 2017).

Verganti, R. (2009). Design driven innovation: changing the rules of competition by radically innovating what things mean. Harvard Business Press.

Whalen, K. A., Berlin, C., Ekberg, J., Barletta, I., & Hammersberg, P. (2018). 'All they do is win': Lessons learned from use of a serious game for Circular Economy education. Resources, Conservation and Recycling, 135, 335-345.

Whicher, A., Harris, C., Beverley, K., & Swiatek, P. (2018). Design for circular economy: Developing an action plan for Scotland. Journal of Cleaner Production, 172, 3237-3248.

World Design Organization (WDO). (2017). Definition of Industrial Design. http://wdo.org/about/definition/ (Accessed 19 April 2018).

Yee, P., Fischer, M., & Kam, C. (2013). Prospective validation of virtual design and construction methods. Journal of Information Technology in Construction (ITcon), 18(11), 214-239.

ANNEXES

Annex 1. Discussion paper on CE definitions

Annex 2. Interviews instructions document

Annex 3. Literature review 2017- Books & others

Annex 4. Literature review 2017- CE Related projects

Annex 5. Literature review 2017- Databases

Annex 6. Literature review 2017- Tools

Annex 7. Literature review 2017 - Ecolabels and Standards

Annex 8. Literature review 2017 - Webs and platforms

Annex 9. Literature review 2017 - University training offers