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D2.1: CIRCULAR CONSTRUCTION
PRELIMINARY REVIEW

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Executive summary

The main aim of the “Circular Construction - Preliminary review” report is to identify and describe the challenges and opportunities related to the circular economy which are in front of the construction sector.

The Preliminary review is a part of the European Circular Construction Alliance (ECCA) project, an initiative financed by the European Commission under the Programme for the Competitiveness of Enterprises and SMEs. The main goal of the ECCA is to support the development of circular construction approach which builds upon intensive clustering of actors in construction sector and encourages enterprises to reuse of building materials or implement innovative construction solutions (such as modular construction).

The review starts with description of the basic elements of the circular approach and refers to main aspects of EU policy aimed at implementation of circular practices. Afterwards the report presents barriers which limit opportunities for popularization of the circular economy. Moreover, it describes activities that may lead to overcome these problems and shows expected positive impact of the circular approach on EU GDP, labour market, waste policy and resource efficiency. This part of the review also includes prognosis with regard to how the circular approach can improve competitiveness of selected national markets in the EU.

Furthermore, the report identifies current priorities of the EU that are related to the circular economy approach and can be found in the number of EU strategies and reports. Based on different directives, reports and analysis, the Preliminary review also identifies industrial sectors with high potential for cooperation and better implementation of the circular approach. The document focuses mainly on sectors connected with construction industry, showing which types of materials, products and activities can be used for creation of green, closed value chains.

Finally, the report describes new innovative solutions and technologies developed in the construction sector. Taking into account opportunities offered by all these solutions, the Preliminary review pays close attention to SMART building model which combines advantages of new industry technologies, innovative design practices, energy efficient solutions, new information management systems, modular and durable constructions and new practices in the field of urban planning. In this context, the content also analyses the limits and opportunities for development of the SMART buildings and technologies in the EU countries.
1. Circular economy and European Circular Construction Alliance

The main goal of the proposed project is to establish the European Circular Construction Alliance, a wide meta-cluster supporting clusters and business network organizations, their SMEs and other cluster members collaborating for innovation, market-uptake, and marketing of competitive products, services and technologies in the field of circular economy in construction sector, and support SMEs in global competition.

Circular economy approaches “design out” waste and typically involve innovation throughout the value chain, rather than relying solely on solutions at the end of life of products. As it is stressed by experts, “it aims to minimize the input of new materials in the production system, as well as the amount of waste that is created throughout the entire process. It is a holistic perspective that holds that waste does not exist, since products and abiotic materials cycle in closed loops”\(^1\).

![Circular and Linear Approaches - comparison](source: European Commission)

A circular economy system keeps the added value in products for as long as possible and eliminates waste. The circular approach, thus, keeps resources within the economy when a product has reached the end of its life, so that "the resources can be productively used again and again and hence creating further value. Transition to a more circular economy requires changes throughout value chains, from product design to new business and market models, from new ways of turning waste into a resource to new models of consumer behavior"\(^2\). Such an economy goes beyond the 'end of pipe' approaches of the linear economy and seeks transformational changes across the whole value chain in order to

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1 Circular Business Models - Part 1: An Introduction to IMSA’s circular business model scan, IMSA Amsterdam, 2015
2 Towards a circular economy: A zero waste programme for Europe
retain both types of materials in the ‘circular economy loop’ and preserve their value for as long as possible.\(^3\)


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Circular construction adopts the principles of circular economy along the life-cycle of buildings, from the extraction of building materials, design, production, construction, operation/maintenance and retrofitting to the demolition and recycling of materials, water and energy for production, use of recycled materials, reduction of environmental impacts, use of the land, improvements of durability, reduction of waste at retrofitting and demolishing, re-use, modular construction, off-site production, which are some of the challenges of the circular construction.

The construction sector plays an important role in the European economy. It generates almost 10% of GDP and provides 20 million jobs, mainly in micro and small enterprises. The sector consumes large quantities of raw materials, chemicals, electrical and electronic equipment and other materials and energy.\(^4\)

Many of materials which are consumed by the construction industry can be recycled, reused or recovered for energy or other purposes. That group consists of numerous materials, such as concrete, bricks, gypsum, wood, glass, metals, plastic, solvents,

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\(^3\) Rizos V., 2015, The Circular Economy: Barriers and Opportunities for SMEs, “CEPS Working Document”  
asbestos and excavated soil. In spite of the potential for recovery, rates differ between less than 10% to over 90% across the EU. Nevertheless, that rate can be improved by creation of new closed value chains, such as green value chain aimed at recycling the end-of-life concrete in a less downgraded form. As the authors of “Towards Circular Products Initiative in EU” stress, “crushed aggregates now match the quality demands, as also laid down in norms and standards, and can be reused as secondary material in concrete”. The picture below presents different, old and new ways of concrete recycling which allow to close a loop and create well integrated green value chain, instead of keeping traditional linear model (“takes-makes-consumes and disposes”).

Picture 3 Integrated green value chain in the process of concrete production; source: “Towards a Circular Products Initiative in the EU” report

The circular construction builds upon intensive clustering of activities and industry actors in construction sector, and most importantly with other industries (eco-innovative, green technologies, waste management) and stakeholders (such as municipalities or knowledge actors). Taking into account this fact, the general objective of the European Circular Construction Alliance is to:

- Intensify cluster and business network collaboration across borders and sectoral boundaries. ECCA will drive collaboration beyond the borders of the building and construction sector and initiate new cross-sectoral collaborative value proposition schemes, new business models, optionally leading to new industrial value chains,
- Promote the pan-European Strategic Cluster Partnerships to lead international cluster cooperation in new areas. ECCA aims to integrate already competitive

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and globally valuable solutions in the fields of energy efficiency, sustainable building, and eco-innovation with aim to reduce use of natural and other resources contributing to solving the global issue – limited availability of natural resource and capability of the nature to fight will all kind of waste and pollutions,

- Better support SMEs in global competition. ECCA project will stimulate SMEs by offering novel activities and services such as ECCA branding, international brokerage events, promotion and marketing, IPR support, technology transfer, joint entering to foreign markets, and co-development with clusters and SMEs from third countries,

- Help SMEs to contribute to the emergence of new value chains and take a leading position globally. ECCA partnership will be an open alliance for different SMEs to support their ideas, planned innovation projects or developed technologies in the circular construction.

The main aim of the “Circular Construction – Preliminary review” is to strengthen opportunities of the ECCA for achieving the goals mentioned above through identification and description of market trends and state-of-the-art green construction solutions which are strictly connected with the circular economy approach and can be developed as well as commercialized by cooperating construction companies, designers, architects or product manufacturers.

The report, thus, pays close attention to those innovative solutions in building construction industry that are expected to be more and more attractive from perspective of the future market needs, and – simultaneously – may be improved through close cooperation between building companies. Taking into consideration this fact, the report also provides information on potential forms of the collaboration in order to improve chances for implementing the innovative solutions in the field of energy efficiency, sustainable building, and eco-innovation. In addition, the Preliminary review describes tools and policy instruments addressed to all enterprises and organizations interested in improving competitiveness of the construction sector through common development and commercialization of the technologies linked to the circular approach.

To sum up, all information presented in the report can be used for creating clusters and business network organizations and implementing innovative solutions related to the circular economy. The Preliminary review also contributes to the creation of new value chains in the EU construction industry and supports SMEs in taking a leading position in the global market, as the document identifies products, technologies and solutions which can be successfully commercialized on the basis of cross-sectoral and cross-national collaboration.
1.1. The role of circular economy approach in EU policy

Currently, the EU economy is characterized by “growing resource scarcity, volatile price markets, societal unrest and emerging environmental problems such as pollution and rising global temperatures”\(^6\). But moving to more circular economic models promises a much brighter future for the European economy. It would allow Europe to rise to the current and future challenges of global pressure on resources and rising insecurity of supply. Pumping resources back into productive use, cutting waste and reducing dependence on uncertain supplies is a direct route to improving resilience and competitiveness\(^7\). As the authors of “Circular Business Economy” report emphasize, “one of the key principles of a circular economy is that “the goods of today are the resources of tomorrow at yesterday’s prices”\(^8\). By helping to decouple economic growth from resource use and its impacts, it offers the prospect of sustainable growth that will last. The circular economy approach corresponds with existing objectives of EU policy such as reducing greenhouse gases emissions, increasing energy efficiency, sustainable reindustrialisation of the EU economy, and securing access to raw materials.

Picture 4 The main principles of the Circular Economy Approach; Source: Ellen MacArthur Foundation

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\(^6\) Circular Business Models - Part 1: An Introduction to IMSA’s circular business model scan, IMSA Amsterdam, 2015

\(^7\) Towards a circular economy: A zero waste programme for Europe, European Commission, 2014

\(^8\) Circular Business Models - Part 1: An Introduction to IMSA’s circular business model scan, IMSA Amsterdam, 2015
Current EU institutions, such as European Commission, national or local governments, standardization and certification bodies have many instruments which are helpful for implementation of the main principles of the circular economy. For example, British Standards Institution established “Framework for implementing circular economy principles in organisations (BS 8001)” which will help to implement the circular approach through:

- improved understanding of the circular economy by determining how it’s relevant to the organisation and using that information to establish the organisation’s role in taking action to implement the circular economy,
- enhanced control over resources by systematically identifying, prioritising and addressing relevant issues to better retain the technical and economic value of materials,
- stimulating learning, innovation and cooperation by consideration of emerging opportunities through engagement of the value-chain\(^9\).

It should be also noted that the institutions offer not only strategies and law regulations, but also special standards (like BREAAM and LEED which are related to energy efficiency of buildings) and financial instruments that encourage private companies to improve the production cycle and cooperation with other suppliers\(^10\).

The picture presented below shows linkages between instruments aimed at popularization of the circular economy and different stages of the production cycle. Some of the tools prepared by the EU institutions are hailed in the next parts of this report; other documents (e.g. Water Framework Directive) are not taken into account in this report, but it has to be noted that they play crucial role in the creating closed loops, and many important details on these instruments can be found on European Commission website.

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1.2. State of the EU strategies and policies

Current EU policy is based on several strategies and directives which focus on energy efficiency, waste policy, implementation of innovations etc. Having in mind the fact that the circular economy can be seen as an integrative framework for all these detailed strategies, it is necessary to list the most important documents which take into account EU priorities and include references to the circular approach, trying to increase chances for development of so called green value chains. Current EU policy on the circular economy is based on the following documents\(^\text{11}\):

- EU Guidelines on Green Public Procurement,
- EU Environmental Liability Directive,
- EU Eco-design,
- EU Energy Performance of Buildings Directive,
- EU WEEE Directive,
- EU Packaging Directive,

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• EU Emission Trading Scheme,
• EU Ecolabel,
• EU Environmental Technologies Action Plan,
• EU Lead Markets Initiative,
• EU RoHS Directive (prohibits the use of certain hazardous substances),
• EU Product Liability Directive,
• EU Industrial Emissions/IPPC Directive,
• EU REACH Directive (aims to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances),
• Europe 2020 Strategy for smart, sustainable and inclusive growth, 2010-2011 in particular the flagships Resource Efficient Europe, Industrial Policy for the Globalisation Era and Innovation Union,
• The Seventh Environment Action Programme, 2013,
• Horizon 2020: The Framework Programme for Research and Innovation,
• Roadmap to a Resource-efficient Europe, 2011,
• The Bioeconomy Strategy,
• Raw Materials Initiative and the European Innovation Partnership on Raw Materials,
• European Innovation Partnership on Water,
• European Innovation Partnership on Agricultural productivity and sustainability,
• Blueprint for Forest-based Industries,
• Consultative Communication on the sustainable use of phosphorus, 2013,
• Commission’s Communication on Resource Efficiency Opportunities in the Building Sector,
• Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan, 2008,
• Eco-innovation Action Plan, 2011,
• Single Market for Green Products 2013 and Product/Organisational Environmental,
• Footprint pilot 2013 – 2016,
• Green Paper on a strategy on plastic waste in the environment, 2013,
• Communication "For a European Industrial Renaissance", 2014,
• Communication "Social Business Initiative (SBI) - Creating a favourable climate for social enterprises, key stakeholders in the social economy and innovation", 2011,
• A European Consumer Agenda, 2012,
• The revised Common Agricultural Policy The Green Action Plan For SMEs: Enabling SMEs to turn environmental challenges into business opportunities,
• European Eco-Management and Audit Scheme – EMAS,
• EU Environmental Compliance Assistance Programme for SMEs (ECAP).

It is also possible to find ex-post analysis which include many details on current stage of implementation of the Circular Economy Approach. These documents describe successes and failures encountered by institutions and organizations involved in development of green practices in the construction sector:

• REFIT / Evaluation of EMAS and Ecolabel (Study supporting the evaluation of the implementation of the EU Ecolabel Regulation), 2015 (ongoing); Study supporting the evaluation of the implementation of the EU Eco-Management and Audit Scheme (EMAS), 2015 (ongoing),
• Ex-post evaluation carried out by the EEA,
• Ex-post evaluation of five Waste Stream Directives (including the Packaging and Packaging Waste Directive and partly referring to the Waste Framework Directive), 2014,
• European Court of Auditors 2012 report on the use of Regional funds for municipal waste management, including several recommendations to improve the existing EU legislation as well as its effective implementation.

1.3. An EU action plan for the Circular Economy

It should be noted that European Commission is still developing strategies and regulations which should minimise waste, utilise renewable sources of energy and phase out the use of harmful substances. The EU action plan for the circular economy includes over 50 documents aimed at promotion and implementation of the circular approach. They are divided into two main groups:

• The first group describes documents connected with different stages in the product life cycle (production, consumption, waste management, market for secondary raw materials),
• The second group includes documents linked to different economy sectors (plastic, raw materials, construction and demolition, innovation and investments, monitoring)\textsuperscript{12}.

It has to be stressed that not all documents included into the EU action plan are based on the law regulations. Some of them will only encourage local governments, enterprises and other organizations to use technologies and solutions linked to the circular economy. As a result, some of the documents should be seen as promotional activities which show priorities of European Commission but do not require taking any particular actions by the stakeholders. The full list of documents planned for implementation is presented in Appendix 1.

1.4. EU factsheets closing four loops

Apart from the strategies and legislative documents mentioned above, European Commission prepared also reports aimed at closing the four loops which are related to sustainable consumption, production phase, better waste management and recovering resources from wastes. Each report is described separately in reference to activities that should be taken for implementation and popularization of the circular economy.

1.4.1. Helping consumers choose sustainable products and services. The choices made by millions of EU consumers can support or hamper the successful transition to a circular economy. Consumers through their market power can generate

\textsuperscript{12} Closing the loop - An EU action plan for the Circular Economy, European Commission, 2015
demand for improved and new types of products and services and support innovation in technology and business solutions. The strategy described in this point tries to:

- Encourage reuse and repair of products through the revised waste legislation,
- Promote energy savings as well as the reparability, upgradability, durability and recyclability of products in the future work on Ecodesign,
- Improve the enforcement of existing rules on guarantees and step up the action to tackle false green claims,
- Support the higher uptake of green public procurement and increase its focus on issues related to the circular economy,
- Help examine how to improve reliable and adequate consumer information on the environmental impacts of products, such as enhancing the effectiveness of EU Ecolabel and how to address possible practices of planned obsolescence\textsuperscript{13}.

1.4.2. The Production Phase of the Circular Economy. The circular economy starts at the very beginning of a product’s lifecycle – smart product design and production processes can help save resources, avoid inefficient waste management and create new business opportunities. In the opinion of EU experts, the actions put forward will not only help save resources, but also boost innovation and cross-border trade in the EU single market. It is planned to focus EU policy on the following four areas:

- Better product design – many valuable materials are lost every year, because it is difficult to recover them from products, such as mobile phones or flat screens. The Commission will support product requirements under the Ecodesign Directive that makes products more durable, and easier to repair and recycle. As a first step, the Commission will propose rules for easier and safer dismantling, reusing and recycling of electronic displays. This comes on top of existing energy efficiency requirements for products, which by 2020 will bring savings of €465 per year, per household on their energy bills,
- Creating incentives – to create a direct economic incentive for producers to make products that can be easily recycled or reused, the Commission will propose to differentiate financial contributions paid by producers in extended producer responsibility schemes on the basis of the end-of-life costs of their products,
- Improved production process - In order to reduce resource use and waste generation in production processes, the Commission will promote best practices in a range of industrial sectors through Best Available Techniques Reference documents for various industrial sectors,
- Innovative industrial processes – The Commission will clarify rules on by-products and on end-of-waste status, which will help support the development of industrial symbiosis – a process by which the waste of one company can become the resource of another company. To promote resource efficient and innovative industrial processes, such as industrial symbiosis or remanufacturing, the Commission supports innovative industrial initiatives under the financing programme Horizon 2020 and through Cohesion Policy funds\textsuperscript{14}.

\textsuperscript{13} Closing the Loop: Helping consumers choose sustainable products and services, European Commission, 2015
\textsuperscript{14} Closing the Loop: The Production Phase of the Circular Economy, European Commission, 2015

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1.4.3. **Clear Targets and Tools for Better Waste Management.** Turning waste into a resource is an essential part of increasing resource efficiency and closing the loop in a circular economy. Europe currently loses around 600 million tonnes of waste materials, which could potentially be recycled or reused. Only around 40% of the waste produced by EU households is recycled, with recycling rates as high as 80% in some areas, and lower than 5% in others. The proposal includes targets, incentives and measurements aimed at improvement of recycling and reusing rates.

- **Targets:**
  - a common EU target for recycling municipal waste of 65% by 2030,
  - a common EU target for recycling packaging waste of 75% by 2030,
  - material-specific targets for different packaging materials,
  - a binding landfill reduction target of 10% by 2030.

- **Measurements:**
  - simplification and harmonisation of definitions and calculation methods to ensure comparable, high quality statistics across the EU,
  - special rules for Member States facing the biggest implementation challenges,
  - simplification of reporting obligations and alleviating obligations faced by SMEs,
  - introduction of an Early Warning System for monitoring compliance with targets,
  - steering Member States towards greater use of economic instruments (such as a landfill tax) to incentivise the application of waste hierarchy, to prioritise prevention, reuse and recycling, with disposal as the last resort.

- **Incentives:**
  - concrete measures to boost reuse activities, including a clearer definition and rules that expand the scope of reuse activities rewarded under the EU targets,
  - general requirements for the operation of Extended Producer Responsibility (EPR) schemes – meaning a producer’s responsibility for a product is extended to the post-consumer stage of a product’s life cycle, aimed at improving their performance and transparency, including direct financial incentives for greener product design,
  - clearer rules on by-products and end-of-waste criteria to stimulate the sharing of by-product resources among industries and markets for recycled materials,
  - new measures to promote prevention, including for food waste and marine litter, and reuse,
  - provisions to improve the traceability of hazardous waste\(^\text{15}\).

1.4.4. **From Waste to Resources.** In a circular economy, materials from products at the end of their lifecycle should be recovered through dismantling and recycling. Re-injecting these materials into the beginning of the product lifecycle reduces environmental impact and costs of production. Nevertheless, the market and the EU single market for recovered and waste materials are still underdeveloped. While

\(^{15}\) Closing the Loop: Clear Targets and Tools for Better Waste Management, European Commission, 2015
45% of waste material from large companies is resold, this figure falls to only 25% for SMEs. It is necessary to create common standards and market tools to improve this. To realise the potential of these so called secondary raw materials, the European Commission seeks to remove the existing barriers to their trade, improve the waste management practices and guarantee high quality standards by implementation of the following tools to encourage and help these processes:

- **Quality standards** - the lack of adequate tools to ensure the quality of secondary raw materials is a barrier to their take-up in the EU economy. The Commission will develop such standards where needed,

- **Common rules on fertilizers** – diverging rules and standards hamper the manufacturing of organic and waste-based fertilisers from inputs such as food waste, sewage sludge or manure. The Commission will revise the EU regulation on fertilizers to help develop an EU-wide market for bio-nutrients while ensuring safety and quality of the EU Fertilisers,

- **Using water again** – reuse of treated wastewater is a promising and under-exploited option in Europe. This can alleviate pressure on natural resources that are already scarce, and the reuse of water in agriculture also contributes to nutrients recycling. The Commission will take a series of actions to encourage the reuse of treated waste water, including legislation on minimum requirements for water reuse,

- **Plastic as a recyclable resource** – smart design and proper sorting can increase the recycling rates of plastics and avoid landfilling, incineration and use of virgin materials. The Commission will elaborate a strategy addressing issues such as recyclability, biodegradability, the presence of hazardous substances of concern in certain plastics, and marine litter,

- **Use of chemicals fitting the circular model** – to increase safety, facilitate recycling and improve the trust in and uptake of secondary raw materials, the Commission will promote nontoxic material cycles involving less and better traced chemicals of concern. The Commission will also examine how chemicals, products and waste legislation can best work together, including proposals to improve the tracking of chemicals of concern in products,

- **Cross-border trade** – to facilitate the cross-border circulation of secondary raw materials, the Commission will simplify cross-border formalities through the use of electronic data exchange. It will also support an EU-wide research on raw material flows through the Raw Materials Information System.\(^\text{16}\)

2. **Challenges of the circular economy approach**

2.1. **Barriers towards circular economy**

Companies are continually working to improve resource management, but they are held back by a range of market barriers which limit the opportunities for development of the circular economy approach on EU level. Important barriers to the circular economy arise from market, governance and regulatory failures, some of which can be linked to EU legislation. The table below shows detailed list of failures related to market and law regulations.

\(^{16}\) Closing the Loop: From Waste to Resources, European Commission, 2015
Table 1 Market, governance and regulatory failures; source: Circular Economy Approach – EU Roadmap

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<th>Governance and regulatory failures</th>
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<td>• Weak price signals due to lack of internalisation of externalities on some commodity markets</td>
<td>• Some ineffective or insufficient policy tools</td>
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<td>• Split incentives for actors across the value chain</td>
<td>• Unaddressed implementation problems</td>
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<td>• Lack of information for investors or consumers</td>
<td>• Lack of coherence between policy instruments</td>
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<td>• Creation of administrative burden and barriers</td>
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<td>• Lack of harmonised standards</td>
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It is also possible to find many cultural and organizational factors which limit possibilities for implementation of the Circular Economy among European enterprises, local governments and consumers. Wide range of these barriers has been identified in the “Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains” and are presented below:

- The lack of internalisation of externalities through policy or other measures and the lack of resource pricing (cost recovery and pricing for the resource itself), which lead to economic signals that do not encourage the efficient use of resources (i.e. as there are greater incentives to use materials more effectively) or a transition to a circular economy (i.e. as resources become more costly there are increased incentives to reuse/recycle materials),
- The lack of skills and investment in circular product design and production,
- The lack of enablers to improve cross-cycle and cross-sector performance due inter alia to non-alignment of power and incentives for transformation between actors within and across value chains,
- The lack of consumer and business acceptance regarding consumer-as user, and performance-based payment models,
- The lack of know-how and economic incentives including for repair and reuse,
- The lack of consumer information on origins and perishability of products,
- The lack of waste separation at source (especially for food waste and packaging),
- The lack of sustainable procurement incentives for public authorities,
- The lack of investment and innovation in recycling and recovery infrastructure and technologies, (related to this is the lock-in of existing technologies and infrastructure),
- The lack of harmonisation of transport flows systems between municipalities, which leads to confusion among shippers and transporters,
- Weaknesses in policy coherence (e.g. bioenergy and waste policies),
- Widespread planned obsolescence within product chains ¹⁷.

Apart from issues mentioned above literature also describes barriers which are encountered particularly by small and medium enterprises. It is possible to identify at

¹⁷ Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains, European Commission, 2014
least eight important barriers which limit possibilities for development of circular economy in the SMEs:

- **Existing infrastructure, business models and technology, together with established behaviour keep economies ‘locked-in’ to the linear model.** Companies may lack the information, confidence and capacity to move to circular economy solutions. The financial system often fails to provide for investment in efficiency improvements or innovative business models, which are perceived as more risky and complex, deterring many traditional investors. Conventional consumer habits can also hinder new products and services development. Such barriers tend to persist in a context where prices do not reflect the real costs of resource use to society, and where policy fails to provide strong and consistent signals for the transition to a circular economy,

- **Environmental culture: **Although there is considerable heterogeneity among SMEs across different sectors, their responses and capacities to take up a ‘green solution’, are usually similar in terms of organisational and management regime. The manager is usually also the owner of the company and thus has significant power on the strategic decisions of the firm,

- **Financial barrier: **In some cases SMEs suffer from lack of the financial resources to establish and manage a recycling scheme. Aside from the direct financial costs, there are also indirect ‘hidden’ costs such as the time and human resources that businesses need to devote to make environmental improvements. In many cases, these indirect costs constitute a critical obstacle to the implementation of ‘green’ innovation due to SMEs’ shortage of time and human capital. Given the significance of the financial barrier, access to finance and suitable sources of funding could be essential for SMEs seeking to improve their sustainability performance and/or introduce an innovation. The smaller a company is the more difficult it is to understand and assess different funding options, such as EU support programmes and government grants, mainly due to staff and management restrictions,

- **Lack of government support and effective legislation: **The lack of government support and encouragement (through the provision of funding opportunities, training, effective taxation policy, import duty, etc.) is widely recognised as a significant barrier in the uptake of environmental investments. In the absence of an effective enforcement mechanism, environmental improvements are mainly driven by managers’ commitment to sustainability. Another obstacle is that most tools for environmental management (such as the European Eco-Management and Audit Scheme - EMAS) are produced for larger companies, without taking into account the specificities of the SME sector. The first assessment of the EU Environmental Compliance Assistance Programme for SMEs (ECAP) highlights the need for a better regulation agenda in terms of the design and implementation of environmental policies. In the case of waste, the EU has made considerable efforts in recent years to improve the management of the various waste streams. However, despite progress on an array of waste management goals, there is considerable room for improvement in the design and implementation of EU waste legislation. In particular, a study produced for the European Commission has indicated that there is a lack of clarity on several concepts of EU legislation such as producer responsibility, quality of separate collection and definitions of recycling, re-use and recovery,
• **Lack of information:** The lack of knowledge about the benefits of the circular economy has been identified as one of the barriers to the implementation of circular economy practices among SMEs. Many SMEs not only neglect the possible financial gains from improving their resource efficiency, but also consider resource efficiency practices to be costly for their business,

• **Administrative burden:** The transition of SMEs to green business practices usually incurs administrative burdens stemming from environmental legislation. The administrative burdens represent a key issue for European SMEs; burdens that frequently demand unaffordable financial and time resources (OECD, 2010). Although SMEs are generally aware of the environmental national legislation, they lack the specific knowledge and capacity to comply with the necessary requirements. As a result, they often rely on external consultants to meet their obligations; this in turn entails an extra cost, which might be significant for very small enterprises,

• **Lack of technical skills:** Many SMEs do not have the technical capacity to identify, assess and implement more advanced technical options that would enable them to reduce their environmental impacts while realising cost savings. As a consequence, they usually prioritise technologies with which they are already familiar and depend on the suggestions of their suppliers for new technical solutions; however, in order to assess the new options they still need a certain level of technical skill and knowledge,

• **Lack of support from the supply and demand network:** Lack of suppliers’ and customers’ environmental awareness is widely recognised as a discouraging factor in the existing literature. Although customers’ purchasing decisions are partly influenced by sustainability criteria, their fulfilment is not usually regarded as a high priority. ‘Green supply chain’ initiatives that require the participation of external stakeholders (such as ‘green purchasing’) have generally been found to have a low adoption level. Added to this, due to their small size and bargaining power, small businesses have little influence on their suppliers’ engagement in sustainable activities.

Authors of the “Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains” report decided to describe the most important challenges which are strictly connected with the barriers discussed in this point. In their opinion, the challenges can be divided into several groups, depending on type of economic sector or stakeholders. The first group consists of general factors that concern the European Union as a whole. The second and the third group is linked to the production activity; fourth describes challenges identified in consumption sector and the last one is related to waste management.

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18 Rizos V., 2015, The Circular Economy: Barriers and Opportunities for SMEs, “CEPS Working Document”
2.2. Challenges faced by the circular economy

The review of challenges and opportunities related to the circular economy allowed to identify two main and some additional challenges faced by the circular economy. The **first general challenge is to get the prices right**, i.e. to make the true cost of resources apparent in prices: proper evaluation of environmental externalities requires the correct understanding of environmental cost, choice of valuation technique, setting the time horizon, assessing distributional impacts and issues at different points in time, and evaluating risk, uncertainty, and ethical considerations. The **second general challenge regards the implementation of economic incentives and fiscal measures** supporting the development of a circular economy. Additionally, it is also possible to identify some more detailed challenges which are linked to lack of skills among workers and enterprises, lack of enablers to improve cross-cycle and cross-sector performance, current consumption patterns and current waste management practices. They are described below.

**Lack of skills in circular product design and production**\(^{19}\)

- Lack of practice and infrastructure for the segregating of biological from technical nutrients and phasing out toxic materials are under-used and are therefore a priority
- Knowledge development for the design process will have to focus on the art of combining constantly evolving standardization with designs that still allow manufacturers to distinguish themselves from their competitors,
- A substituted product does not necessarily help to reduce pressure on the environment but leads to increases in energy consumption e.g. plasma display panels,
- Risk-averse behaviour by local governments regarding innovation (e.g., long wait for licences for technologies unfamiliar to new or low level local government officials,
- Lack of dissemination about best practices – e.g. SMEs and sole traders have difficulties to keep up to speed with what is required due to a lack of funds for popularization of innovative solutions in a field of the circular economy,
- Lack of information about green suppliers,
- Need a champion, i.e. individuals/ businesses who can promote resource efficiency.

**Lack of enablers to improve cross-cycle and cross-sector performance**\(^{20}\)

- Many businesses are unaware of the exact origin or the composition of the raw materials they use,
- Symbiosis requires exchange of information about nearby industries and their inputs and outputs that is often difficult or costly to obtain.

**Barriers related to consumption**\(^{21}\)

- Changing from ownership to usage and performance-based payment models and expanding the product definition to embed it in related services require good knowledge of value chain participants’ needs and ongoing innovation,

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\(^{19}\) Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains, IVM Institute for Environmental Studies, 2010

\(^{20}\) Ibidem

\(^{21}\) Ibidem
• While there has been a discernible societal shift towards access rather than ownership (e.g. carpool), consumer acceptance needs to grow significantly. In addition, there must be a realignment of cultural values and incentives – particularly in the sales functions of businesses (consumers tend to look more at the purchase price of a product and less at the entire lifecycle costs),
• Lack of information on product perishability: there is confusion between ‘Best before’ (BB) and ‘Use by’ (UB) labels,
• Lack of standardization of methodologies applied in different countries for labelling products:, the cost of assessing resource consumption for individual firms, and the absence of a widely recognized, independent organization to award certification on resource efficiency or circular economy criteria,
• Lack of incentives preventing households from generating waste,
• Lack of education on the opportunities and drivers of circular economy.

**Barriers related to waste management**

• Although reduction in the use of raw materials is positive, in the case of some products, economically viable recycling is no longer possible and has led to the suboptimal reuse of materials,
• Availability of products components for repair by independent operators is often blocked by businesses that have a monopoly on supplies of components or products,
• Each city develops its own transport flows system, which leads to confusion among shippers and transporters. Policies between municipalities for transport need to be harmonized (loading times, weights and measures, etc.),
• Network design and management need to be improved and better interconnected so as to switch to a different mode of transport in the case of disruptions,
• European and national regulations still often limit possibilities for the use of construction and demolition waste as sub-products.

**2.3. Future steps for better implementation of the circular economy approach**

In order to reduce the role of the barriers described in the previous point fundamental changes in many areas of the current socio-economic systems have to be implemented. In this context, some requirements need to be met to change current business models, product design, value chains, financing, the values, norms and behaviours of different actors. These changes may create new forms of coordination between different actors, including researchers, businesses, policy makers, financiers, consumers and educators.

Having that in mind, the “Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains” report includes many proposals aimed at implementation of the circular economy approach and addressing it to entrepreneurs, workers, consumers and local governments. This chapter describes the most important instruments which can be helpful for changing habits and practices of the business players.

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22 Ibidem  
As the experts emphasize, it is necessary to:

- Encourage economic players to take into account the economic value of their environmental externalities for example through:
  - Regulatory requirements which promote the integration of environmental costs associated with goods throughout their life cycles into the market price of the products, and, thanks to financial incentives, encourage manufacturers to design eco-friendly products by holding producers responsible for the costs of managing their products at end of life. This policy approach differs from Product stewardship (where responsibility is shared across the value chain of a product), and attempts to relieve local governments of the costs of managing certain priority products by requiring manufacturers to internalize the recycling cost within the product price,
  - Economic incentives and tax measures strong enough to change business behaviour, and to encourage the recovery of more secondary raw materials, such as the phosphate levy which fosters the recovery of phosphate from sewage and the use of high quality, secondary sources of phosphate in agriculture.

- Encourage the development of skills, awareness and investment in circular product design and production, as well as enabling to improve cross-cycle and cross-sector performance, for example through:
  - Support programmes for investment in R&D and eco-innovation (e.g. support investment in 3D printing technology and determine which components are most suitable to it),
  - Support integration of circular design concepts and reusable parts through investment support (e.g. Framework Programme Renewable Resources Germany, € 800 million fund),
  - Development of an extensive raw materials information service, providing – inter alia - data on primary and secondary raw material production, prices, and Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains 13 supply risks, and increase the dissemination of knowledge about the development of new materials,
  - Promotion of cleaner production (CP) methods, in particular in SMEs, by offering a production-integrated environment protection tool (e.g. a guidance manual or electronic tool) where the relevant material flows and current level of production technology are analysed, and where recommendations are made. CP methods emphasize on prevention rather than control of pollution, waste, etc.

- Encourage the improvement of cross-cycle and cross-sector performance, for example through:
  - Development of a free-to-business advice and networking programme at a regional level to identify resource exchanges between companies for sustainable resource management solutions – e.g. National Industrial Symbiosis Programme (UK),
  - Development of local networking for industrial symbiosis opportunities, which would be based on public or private planning agencies who perform every function required to turn the industries’ by-products into feedstocks, including finding appropriate uses, dealing with regulatory agencies, brokering
necessary agreements, and even transporting the materials from the waste/by-product generator to the user.

- Encourage a change in consumption patterns, for example through:
  - Support and promotion of innovative leasing and rental contracts (pay-per-use instead of ownership). When goods vendors embrace the idea of themselves as service providers, this can lead not only to an effective hedge against cost volatility but also strengthens the customer relationship and increases the upsell, such as in Vodafone’s Red-Hot plan,
  - Support and protection of the ‘peer economy’ (collaborative consumption) and of initiatives promoting repair and reuse,
  - Development of consumer knowledge/awareness on perishability of products and on origins of products (certification, labelling),
  - Development of incentives such as PAYT (Pay as you throw) or DIFTAR, a system of differentiated tariffs where citizens are charged according to the amount and type of waste they generate,
  - Regulation to separate food and packaging waste collection at source. The development of obligations for public-sector agencies and government departments to purchase resource-efficient and cradle-to-cradle products.

- Encourage investment and innovation in recycling and recovery infrastructure and technologies for example through:
  - Investment support in regional infrastructure and for companies seeking to develop innovative recycling and recovery technologies,
  - Setting-up of Business parks, Business Improvement Districts and other clusters of SMEs to facilitate collective long term contracts for recyclable waste collections. This will make it cheaper to invest in collection and recycling infrastructure,
  - Harmonisation of the quality criteria of the end-of-waste status across the whole of the EU. Furthermore, progress remains to be made regarding the status of a ‘by-product’ or the concept of ‘reuse’, to comply with the waste management hierarchy, which emphasizes reuse before recycling,
  - Incentives for suppliers and retailers to establish mandatory take-back arrangements if a product remains unsold (magazines, bread, etc.).

- Encourage the harmonisation of transport flows systems between municipalities, which currently often leads to confusion among shippers and transporters for example through:
  - Streamline transport flows and urban distribution which would be based on digitisation as a tool available to shape partnerships. There are at least four types of cooperation:
    - Business-to-business concepts such as Green City Distribution,
    - Business-to-consumer concepts such as DHL,
    - System solutions (partnership between retailers on the same street or by sector/product, as well as cooperation between transport companies),
    - Inviting shippers to develop concepts for city logistics through innovative tendering (i.e. flexible and incentivising) and supply chain-transcending cooperation. Tenders would formulate clear end goals, including noise and air emissions, maximum number of transport
movements, and load factor for both inbound and outbound flows, service logistics, and involvement of all stakeholders,

- Encourage manufacturers to design products with asset recovery in mind and to take into account the true cost of materials,
- Encourage the development of product lines that meet demand without wasting assets,
- Incentivise businesses to source material from within regenerative loops, rather than from linear flows,
- Enable businesses to develop a revenue model that generates value at all parts of the value chain,
- Get customers/consumers to change their consumption and ownership patterns.

In order to unlock investment in the circular economy, the European Commission is going to focus its activity on areas which are related to creating financial and tax instruments, implementing law regulations, preparing promotional materials and integrating policy of EU members.

In the case of financial and tax instruments, the European Commission is going in line with the Resource Efficiency Finance Roundtable which describes innovative financial instruments, reflects resource issues in accounting rules for companies, clarifies the sustainability responsibilities of financial institutions (fiduciary duties), develops methodologies for ‘resource stress tests’ for companies, and explores the potential of the bonds market to channel additional finance for resource efficiency projects. Moreover, the European Commission is planning to shift taxation from labour to the consumption of non-renewable resources and removing VAT from recycled materials. Currently, the EU institutions offer such financial instruments as Innovation Vouchers, Tax compensation for investment in green funds and Horizon 2020 Programme.

As it was mentioned above, the European Commission is also going to create promotional materials and further law regulations that would be useful for the development of green practices among EU enterprises. The list of the legislative solutions is presented in the Appendix 1, but apart from that the European Commission works on guidance with regard to possibilities offered by Green Public Procurement (GPP), prepares a recommendation on monitoring Member States’ performance in achieving the indicative 50% GPP target, supports innovative instruments (e.g. pre-commercial procurement and public procurement for innovation), and facilitates the establishment of GPP networks among public authorities.

The EU policy is also aimed at reduction of administrative burden, in particular for SMEs, as well as for public administrations, by improving definitions and simplifying reporting requirements.

Finally, the European Commission is going to integrate circular economy priorities into EU funding and encourage Member States to use available EU funding in programmes and projects on the circular economy, in particular through the European Structural and Investment Funds.

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24 Ibidem
25 Roadmap to a Resource Efficient Europe, EU Commission, 2011
3. General impact of the Circular Economy Approach

The circular economy approach may create many new business opportunities due to the fact that it encourages creation of products which are based on new production technologies and materials. In the opinion of the European Commission, circularity in EU economy should also improve competitiveness of enterprises, because it may differentiate their activity “through more resource efficient processes, which will also result in financial savings”. The new business opportunities for companies can be an effect of increased demand from consumers for so called green products and services\(^{26}\).

First of all, the circular approach gives economic benefits to the EU construction industry. As the authors of “Circular construction - The foundation under a renewed sector” report calculated, the EU construction sector can save even €1010 billion due to implementation of several technological solutions that are strictly connected with the circular economy approach. The highest non-resource cost savings (related to e.g. lower maintenance costs, longer expected lifetime etc.) can be achieved especially by better urban planning and popularization of shared space in residential and non-residential sector (Picture 18).

In the case of so called resource cost savings, the most important role of renewable and efficient energy use should be stressed. Additional and significant cost savings can be also generated by durable and modular design, as well as by popularization of office sharing and telecommuting. These positive trends would be strengthen by better urban planning and looping, however their economic role is not so important\(^{27}\).

\(^{26}\) Closing the Loop: The Production Phase of the Circular Economy, European Commission, 2015

\(^{27}\) Circular construction - The foundation under a renewed sector, ABN-AMRO, 2014
Additional cost savings can be achieved due to expansion of new ecological solutions which are developed in accordance with the circular approach. They focus on improvement of energy effectiveness and integration of installation technology into structures (e.g. heating method that can produce a high energy profit). Another important aspect of the circular economy is development of ICT innovative methods which give information about the functional and physical characteristics of the building and ensure more effective construction process. ICT solutions (such as Building Information Modelling) are also able to prevent major errors and cost overrun in buildings.

Cost savings can also be achieved by promotion of engineering consultations for ecology expansions, because green products are less cyclical than the construction market and are able to reduce cash flow volatility. Furthermore, these consultancies would also create larger margins and execution of construction activities.

Finally, it should be emphasized that the circular economy promotes not only new, cost effective and ecological products and solutions, but also better logistic practices among construction companies which can reduce the number of shipments and destinations and lead to cost-effective delivery of building products.
Another potential benefit of the circular economy approach is linked to better waste management rules which may reduce not only the amount of waste in EU countries, but also the cost of management of products at their end-of-life. The circular economy can, thus, reduce landfill and tipping fees, as well as help protect the environment preserve essential resources for current and future generations, and create synergies for industries. In addition, implementation of the circular approach can lead to minimisation costs of waste in the construction and demolition phase, because it:

- reduces the quantity of materials,
- allows to earn moneys by recycling practices,
- supports easy and cheap maintenance of buildings,
- limits barriers to psychical activities.

Moreover, the circular economy promotes the use of construction and demolition debris as a substitutes which can replace more expensive raw materials in the manufacturing of construction materials.

Clear rules, common standards and support for the use of more secondary raw materials will create safe and sustainable supply of raw materials to the industry. In that context it is also expected that the circular economy approach will secure Europe’s access to high quality and affordable raw materials, making European economy more competitive in the context of volatile resource prices, political instability, resource scarcity, and increasing global competition concerning the access to raw materials. Furthermore, smarter use of resources will help to protect the environment and reduce climate change for current and future generations.

The circular approach can also accelerate better product design which will make products more durable and efficient. In the opinion of the European Commission experts, companies involved in development of long-lasting, upgradable and reusable device, will be less dependent on volatile and increasing raw material prices.

Additionally, the circular economy may result in increase in reuse and repair of products which will extend their longevity. As a consequence, this will provide consumers with financial gains and reduced waste. As the European Commission stresses, consumers will also benefit from better environmental information and improved enforcement of guarantees. Moreover, they will enjoy the service of a sustainable product without the need to buy it.

The group of beneficiaries includes also public authorities which can reach financial savings because of growing popularity of durable, resource efficient and easily recyclable products which can reduce the need to replace old equipment and cut costs through lower utility bills and disposal costs.

31 Closing the Loop: From Waste to Resources, European Commission, 2015
32 Sustainable Competitiveness of the Construction Sector, ECORYS SCS Group/European Commission
33 Closing the Loop: The Production Phase of the Circular Economy, European Commission, 2015
34 Closing the Loop: Helping consumers choose sustainable products and services, European Commission, 2015
Creation of green value chains on the basis of the circular approach also leads to many **organizational benefits** strictly related to design principles and practices. The group of crucial factors that improve effectiveness and usability of green buildings includes:

- construction of buildings which are able to change functions through time, adapt itself to changing demands or needs,
- use of standard size for the spans and heights of components, what provides re-usage,
- separation of the structural elements from the coverings, what increases the adaptability of the structure,
- separation of installations ad structure of building,
- use of prefabricated components that can be disassembled, offer reversible merging of materials and extensive coordination between actors collaborating from different preassembling sites\(^{36}\).

*Picture 7 Winners and losers of the Circular Economy Approach; source: IMSA Amsterdam*

To sum up, the circular economy offers an opportunity to reinvent EU economy, making it more sustainable and competitive. This approach seeks to cut resource use, reduce waste and boost recycling, what should bring benefits for European businesses, industries, and citizens alike. The circular economy also offers opportunities for creation of new habits among European citizens. As Jo Leinen – member of MEP Substitute of the ENVI Committee – noted “Most of all, citizens and society will benefit from the circular economy in terms of being able to buy services instead of products, moving beyond ownership, exploring leasing and having the opportunity to make responsible consumption choices.”\(^{37}\). In the next section more details on expected contribution of the circular approach to the EU economy and society, are being described, based on analysis prepared by:

\(^{36}\) Circular construction - The foundation under a renewed sector, ABN-AMRO, 2014

The circular economy approach can generate a **significant potential to boost EU GDP**. It is expected that EU green policy will boost EU GDP by 11% by 2030 compared to 4% in current scenario, which is an additional GDP growth of 7%. By 2050, GDP growth in the circular scenario is expected to almost double the current scenario, at 27% vs. 15%. It should be noted, however, that the values mentioned in this paragraph include many types of activities, such as creation of new markets or new products, improvement of energy efficiency and better resource productivity. Impact of these processes on EU GDP is different, therefore it is necessary to describe them separately.

Business driven studies based on product-level modelling demonstrate significant material cost saving opportunities for EU industry from circular economy approaches and a potential to boost EU GDP by up to 3.9% by creating new markets and new products and creating value for business. Additional 1% of GDP can be generated by increasing resource productivity, which grew in the EU by 20% in 2000-2011 and – if this rate will be maintained – may increase by further 30% by 2030.

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40 Green Employment Initiative: Tapping into the job creation potential of the green economy, European Commission, 2014
3.2. Creation of new jobs

Circular economy is seen as the only way for European economy to create **sustainable jobs in the future**. There are currently over 4 million people working for eco-industries and over 22 million jobs in so called bio-economy in Europe. The circular economy approach will **boost job creation**, with more than 170,000 direct jobs potentially being created in Europe by 2030. Nevertheless, it is also expected that increasing resource productivity by 30% by 2030 would create 2 million new jobs

Experts from Ellen MacArthur Foundation showed which types of industrial activities would offer the best opportunities for creation of new jobs in sectors related to the circular economy approach. In their opinion, positive contribution to the EU labor market will be generated mainly by waste, recycling and manufacturing sectors and by eco innovations. The reason is the fact that first two sectors are able to generate new jobs from increased recycling, reverse logistics and secondary markets. Second sector – manufacturing of goods and services – may create new jobs due to increasing popularity of upgrading, repairing and remanufacturing activities. Eco innovations are another type of economic activities which can create new jobs in long term perspective, especially if European Commission offers financial instruments aimed at popularization and implementation of the circular economy approach. Apart from the trends described above, it is also expected that

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41 Ibidem
new local jobs will be created, for example, in the design, reuse and repair sectors that are difficult to automate\textsuperscript{42}.

These positive changes can be seen as factors which reduce negative influence of job losses resulted from shifting workplace outside EU, less demand for virgin raw materials and less demand for workers in sectors which focus on new products manufacturing. Generally, it has to be noted that the circular economy approach is able to completely offset the negative consequences mentioned in this paragraph and may even lead to increase the number of jobs in EU.

\textbf{Picture 9 Influence of the Circular Approach on EU labor market; source: Ellen MacArthur Foundation}

\begin{table}
\centering
\begin{tabular}{|c|c|}
\hline
\textbf{Baseline} & EU employment today \tabularnewline
\hline
\textbf{Direct effects} & Waste and recycling sectors \tabularnewline & • 218 million jobs in EU-28, 2014 \tabularnewline & • Unemployment rate: 10.2\% \tabularnewline & • Today -2.3 million jobs, -1\% of EU jobs \tabularnewline & • New jobs from increased recycling, reverse logistics, secondary markets \tabularnewline & • Substitution from raw materials to secondary implies less demand for virgin raw materials \tabularnewline & • Some of the resulting employment loss outside EU \tabularnewline & • Today, 30 million manufacturing jobs, -14\% of EU jobs \tabularnewline & • New jobs due to upgrade, repair, remanufacturing activities (labour intensive) \tabularnewline & • Jobs loss in new products manufacturing \tabularnewline & • Net effect likely to differ substantially between sectors and companies \tabularnewline & • Possible price increase on materials reduce demand \tabularnewline & • Some of the resulting employment loss outside EU \tabularnewline & • Increased consumption driven by lower prices \tabularnewline & • New jobs created by innovation and investments from circular economy transition \tabularnewline & • Overall positive circular economy effect on jobs \tabularnewline & • More important are general labour market policies about gender inclusion, retirement age, and structural barriers regarding entry salaries, etc. \tabularnewline \hline
\textbf{Indirect effects} & Manufacturing sector \tabularnewline & \tabularnewline & \tabularnewline \hline
\textbf{Induced effects} & Raw materials sectors \tabularnewline & • Increased consumption in all sectors \tabularnewline & • “Eco innovation effect” \tabularnewline & \tabularnewline & • Potential new EU employment base \tabularnewline \hline
\end{tabular}
\end{table}

\footnotesize{1} Includes jobs from waste management, waste water management and recycled materials. Based on 2008 data.

\documentclass{article}
\usepackage{natbib}
\usepackage{hyperref}
\begin{document}
\begin{thebibliography}{42}
\bibitem{ellen} Towards the Circular Economy – Accelerating the scale-up across global supply chain, Ellen MacArthur Foundation, 2013
\end{thebibliography}
\end{document}

3.3. Materials efficiency

In the opinion of Jo Leinen, the circular economy brings economic benefits also to private companies which “have an economic interest to make their products more durable and easier to reuse and recycle, because their expenses will be minimized when they use as little virgin raw materials as possible and the product is in good shape when it will be returned to the company”. In this context, the circular economy should be perceived as a tool which offers significant \textbf{material cost-saving opportunities} for EU industry.

Measures such as better eco-design, waste prevention and reuse can reduce material inputs and bring net savings to businesses in the EU. It is estimated that resource efficiency improvements all along the value chains could reduce material input needs by 17%-24% by
2030 and a better use of resources could represent an overall savings potential of €630 billion per year for European industry (around 8% of its annual turnover).43

**Picture 10 Expected influence of circular system on resource effectiveness; source: Ellen MacArthur Foundation**

Taking into account the data presented in the figure below, it is possible to calculate savings from implementation of the circular economy approach in selected types of industry activity. **The best savings can be achieved in subsectors aimed at production of motor vehicles, machinery and electrical machinery.** It has to be also noted that scale of positive results of the circular approach depends on several soft and hard factors, such as:

- Revers-supply-chain competencies,
- Customer acceptance,
- Legal frameworks,
- Cross-chain collaboration,
- Cross-sector collaboration.44

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43 Towards the Circular Economy – Opportunities for the consumer goods sector, Ellen MacArthur Foundation, 2013
The next part of this report describes some of the factors mentioned above and tries to identify chances and barriers to strengthen processes which can lead to increase of material cost savings in construction sector.

Experts from Ellen MacArthur Foundation prepared a report that describes resource costs in three industrial sectors (mobility, food and built environment) and shows potential savings in the long-term perspective. Although current economy policy – based on linear-development scenario – may reduce annual primary resource costs, other cash-out costs and negative externalities, the circular approach is able to strengthen this positive trend and increase potential savings by 25%.\textsuperscript{45}

\begin{itemize}
\item[44] Towards the Circular Economy – Economic and business rationale for an accelerated transition, Ellen MacArthur Foundation, 2013
\end{itemize}
Another positive effect of implementation of the circular economy approach is related to economic benefits which are generated during recovering activity. In traditional life cycle of product, value of assets is systematically reduced, so manufacturers are able to save increasingly smaller amount of money. Contrary to this trend, the circular approach gives an opportunity to increase the value of saved product value due to recycling, reusing and composting. As the figure below shows, the older product, the better chances for recapturing of raw material value.

The experts also decided to analyze the opportunities for saving value of selected products: steel, PET and fiber. In this context, it should be noted that circular economy approach may lead to the greatest reduction of loss value in the case of fiber (75%). A slightly lower savings can be reached during recovery of PET materials (60-70%)\textsuperscript{47}.

**Picture 14 Value loss of selected material categories; source: Ellen MacArthur Foundation**

3.4. Potential influence of the Circular Approach on recycling rate

Taking into account limit to growth (in terms of availability of natural resources), the circular economy should be also seen as an important part of activities which may lead to **better protection of natural resources**, because this approach promotes reusing, recycling and remanufacturing processes. First of all, it has to be emphasized that the circular approach goes in line with the European Commission activities aimed at waste minimization in all Member States. The European Union prepared several targets which should lead to the reduction of different types of waste produced by construction and industry sector (plastics, metals, glass, paper/cardboard and wood)\textsuperscript{48}.


\textsuperscript{48} Additional analysis to complement the impact assessment SWD (2014) 208 supporting the review of EU waste management targets, European Commission, 2015
Table 2 Proposed recycling targets for packaging waste in EU – moderate and high variants; source: Additional analysis to complement the impact assessment SWD (2014) 208 supporting the review of EU waste management targets

<table>
<thead>
<tr>
<th>Packaging waste</th>
<th>‘Moderate’ Targets</th>
<th>‘High’ Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2020</td>
<td>2025</td>
</tr>
<tr>
<td>Overall</td>
<td>55%</td>
<td>65%</td>
</tr>
<tr>
<td>Plastics</td>
<td>40%</td>
<td>55%</td>
</tr>
<tr>
<td>Non-ferrous metal</td>
<td>65%</td>
<td>75%</td>
</tr>
<tr>
<td>Ferrous metal</td>
<td>65%</td>
<td>75%</td>
</tr>
<tr>
<td>Glass</td>
<td>65%</td>
<td>75%</td>
</tr>
<tr>
<td>Paper/Cardboard</td>
<td>80%</td>
<td>85%</td>
</tr>
<tr>
<td>Wood</td>
<td>45%</td>
<td>60%</td>
</tr>
</tbody>
</table>

The European Commission expects that the industry and construction sector will reduce waste generation by 70% by 2020 and around 80-85% by 2030, what may lead to significant savings of energy demand and water use. It may also result in reduction of greenhouse gases emission.

Apart from waste policy, it is also possible to identify other positive consequences of reduced consumption of virgin resources (e.g. for steel, concrete, energy, water, and other commodities). The specialists suggest that more than 500 million tons of greenhouse gas could be avoided between 2015 and 2035, directly by cutting emissions from landfills and indirectly by recycling materials which would otherwise be extracted and processed. In their opinion, “CO2 emissions could drop as much as 48 percent by 2030 and 83 percent by 2050, compared with 2012 levels. Primary material consumption measured by car and construction materials, real estate land, synthetic fertiliser, pesticides, agricultural water use, fuels, and non-renewable electricity could drop as much as 32 percent by 2030 and 53 percent by 2050”49.

3.5. Case studies on circular economy approach

This point pays close attention to expected changes in selected EU countries due to expansion of the circular economic practices. Firstly, it describes results of research analysis conducted in Sweden, Finland, Netherlands, France and Spain. Afterwards, this part of the Preliminary review gives more details on expected changes in Dutch market. Finally, it shows calculations which focuses on economy of Luxembourg and United Kingdom.

The table below includes summary which shows potential benefits resulted from implementation of the circular economy approach in selected EU countries: Sweden, Finland, Netherlands, France, Spain. Taking into account emission reduction, it is expected

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that changes in the mentioned countries will be similar. The same conclusion can be drawn in the case of Trade Balance Effects which are measured in terms of changes in national GDP. On the other hand, it is possible to identify some differences in the number of new jobs which would be created by the circular economy, but the disparities should be seen as an effect of unequal potential of national markets in the described countries.  

Table 3 Potential effect of the Circular Approach in selected EU countries; source: “The Circular Economy and Benefits for Society” report

<table>
<thead>
<tr>
<th>Country</th>
<th>Renewable Case</th>
<th>Energy Efficiency</th>
<th>Material Efficiency</th>
<th>All Three Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SWEDEN</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Emission Reduction</td>
<td>- 50,1%</td>
<td>- 28%</td>
<td>- 5%</td>
<td>- 66%</td>
</tr>
<tr>
<td>Additional Jobs</td>
<td>Up to 15,000**</td>
<td>+ 20,000</td>
<td>+ &gt; &gt; 50,000</td>
<td>+ &gt; 100,000</td>
</tr>
<tr>
<td>Trade Balance Effects</td>
<td>+ 0,4 of GDP</td>
<td>No change</td>
<td>+ &gt; 1 % of GDP</td>
<td>+ &gt; 1,5 % of GDP</td>
</tr>
<tr>
<td><strong>FINLAND</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Emission Reduction</td>
<td>- 50,1%</td>
<td>- 32%</td>
<td>- 4%</td>
<td>- 68%</td>
</tr>
<tr>
<td>Additional Jobs</td>
<td>Up to 15,000**</td>
<td>+ 15,000</td>
<td>+ &gt; 50,000</td>
<td>+ &gt; 75,000</td>
</tr>
<tr>
<td>Trade Balance Effects</td>
<td>+ 0,5 of GDP</td>
<td>No change</td>
<td>+ &gt; 1 % of GDP</td>
<td>+ &gt; 1,5 % of GDP</td>
</tr>
<tr>
<td><strong>NETHERLANDS</strong></td>
<td></td>
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</tr>
<tr>
<td>Emission Reduction</td>
<td>- 50,2%</td>
<td>- 31%</td>
<td>- 3%</td>
<td>- 67%</td>
</tr>
<tr>
<td>Additional Jobs</td>
<td>Up to 50,000*</td>
<td>+ 100,000</td>
<td>+ &gt; 100,000</td>
<td>+ &gt; 200,000</td>
</tr>
<tr>
<td>Trade Balance Effects</td>
<td>+ 0,3 of GDP</td>
<td>+ 0,2 of GDP</td>
<td>+ &gt; 2 % of GDP</td>
<td>+ &gt; 2,5 % of GDP</td>
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<tr>
<td><strong>FRANCE</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Emission Reduction</td>
<td>- 50,1%</td>
<td>- 28%</td>
<td>- 5%</td>
<td>- 66%</td>
</tr>
<tr>
<td>Additional Jobs</td>
<td>Up to 100,000*</td>
<td>+ 200,000</td>
<td>+ &gt; 300,000</td>
<td>+ &gt; 500,000</td>
</tr>
<tr>
<td>Trade Balance Effects</td>
<td>+ 0,4 of GDP</td>
<td>+ 0,4 of GDP</td>
<td>+ &gt; 2 % of GDP</td>
<td>+ &gt; 2,5 % of GDP</td>
</tr>
<tr>
<td><strong>SPAIN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission Reduction</td>
<td>- 50,1%</td>
<td>- 31%</td>
<td>- 10%</td>
<td>- 69%</td>
</tr>
<tr>
<td>Additional Jobs</td>
<td>Up to 100,000*</td>
<td>+ 200,000</td>
<td>+ &gt; 200,000</td>
<td>+ &gt; 400,000</td>
</tr>
<tr>
<td>Trade Balance Effects</td>
<td>+ 0,7 of GDP</td>
<td>+ 0,4 of GDP</td>
<td>+ &gt; 1 % of GDP</td>
<td>+ &gt; 2 % of GDP</td>
</tr>
</tbody>
</table>

The renewable scenario for all five countries led to an estimated 50% reduction in carbon emissions, as renewable energy supply chains generally seem to be less energy and

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carbon-intensive than the fossil fuel energy supply chain. In opinion of the authors, “there was in most cases no significant net effect on employment, unless domestic biomass would increase its market share proportionally more than other renewable energy alternatives to substitute for the fossil fuels”. The experts expect that “the more the agricultural and forestry sectors would get involved in supplying the renewable energy, the more jobs would be created, and mostly in the rural regions, where unemployment often is higher than in urban areas”. As they calculated, up to 15,000 new jobs could in that case be created in Finland and Sweden, respectively, up to 50,000 jobs in the Netherlands, and up to 100,000 in France and Spain, respectively. In that case, the balance of trade with a third to two-thirds of a percentage point of GDP in all the countries was explored.51

The energy efficiency scenario is likely to cut carbon emissions in all five countries by roughly 30%. Here, the effect on employment “would be positive and add new jobs in the range of 15,000 people in Finland, 20,000 people in Sweden, 100,000 people in the Netherlands and 200,000 people in France and Spain, respectively. The trade balance would be improved in most countries, but less so than in the renewable scenario. France and Spain had the largest trade surplus gains in the model runs at 0.4% of GDP. The job increase is partly temporary in nature52.

The material efficiency scenario is likely to cut carbon emissions in all the countries by between 3 and 10%. The gains in terms of employment would be more significant – representing more than 50,000 people in Finland and Sweden, respectively, more than 100,000 in the Netherlands, more than 200,000 in Spain and more than 300,000 people in France. The same goes for the trade balance – the estimated trade surplus improvement would be in the magnitude of 1-2% of GDP. The new jobs generated are permanent in nature, primarily as a consequence of the changes in the goods-to-services ratio in the economy.53

It is also worth to note that Rabobank specialists prepared detailed analysis which focuses on the Dutch market and tries to identify influence of the circular economy approach on national GDP, labor market, natural environment and energy/material efficiency. The experts prepared three scenarios which take into account material prices, government policy, strategies of financial sector and the speed and degree of innovation in circular processes and sentiment (as the Rabobank experts noted, “society in which reuse, use instead of ownership and lower consumption increasingly become the norm will move faster towards a circular economy”).

The first scenario – linear bow – assumes that “it is a small deviation (or bowing) of the current linear path. Government policy is not focused on sustainability, materials prices are still relatively low and the certainty of materials supply is not keeping anyone awake at night. The financial sector is still not involved at all in funding the circular economy. Partly as a result, innovative ideas are not gaining traction”. In the opinion of the experts, “this scenario delivers the least benefit in social terms (EUR 5.7 billion), in GDP growth (0.3% increase in GDP volume) and in the number of new jobs (just over 14,000)”54.

51 Ibidem
52 Ibidem
53 Ibidem
54 Ibidem
The second scenario – **circular go** – “takes into account processes which may result in improvement of circularity in national market. It is assumed that materials prices are higher than today, government policy remains as it is, good circular business models are succeeding in attracting funding (the financial sector is accommodative, but not pioneering)”. In this scenario, “only a small group of people who believe in sustainability while the majority of the population is concerned with other matters. All this leads to a limited degree of innovation”\(^{55}\).

In terms of GDP growth and jobs, the “circular go” scenario assumes that economy of the Netherlands will lose EUR 4 billion, in comparison with “circular flow” scenario. In the experts' opinion, this leaves EUR 4 billion, of which “80% ... will be spent on domestic consumption, thus providing over EUR 3 billion in additional consumption. The effect on the environment would, however, be negative, depending on what is consumed. For employment this would amount to 23,000 additional jobs in the Netherlands”\(^{56}\).

It should be also emphasized that this scenario would have positive impact on natural environment because it predicts “a reduction of CO\(_2\) emissions of around 8%. It is worth noting however that energy use has still not become sustainable. If the share of sustainable energy in energy use according to the EC target of 14% in 2020 is included in this scenario, greenhouse gas emissions would, depending on the energy mix, be significantly further

\(^{55}\) Ibidem  
\(^{56}\) Ibidem
reduced. Achieving the target of a 20% reduction in comparison to 1990 by 2020 is however a remote possibility."\(^{57}\)

**Figure 2 Social value and GDP of circular go; source: Rabobank**

![Social value and GDP of circular economy graph]

The third scenario – **circular flow** – gives the best opportunities for Dutch market and predicts radical shift to a circular economy – approach which is based on “reduced subsidisation of polluting energy sources, reduced taxation of labour (especially at the lower end) and tax and other incentives for more sustainable production and consumption”. As the experts emphasize, the circular flow scenario “requires a financial sector that is willing to assist circular business models instead of simply accommodating them. For example, making funding, knowledge and networks available and using innovative funding products for these models. It would then become easier to create new markets, for example for waste, improve and maintain circular networks and share knowledge of successful circular models."\(^{58}\)

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\(^{57}\) Ibidem
\(^{58}\) Ibidem

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The social value of the circular economy would rise in this scenario to around EUR 31 billion, or 5.1% GDP. The size of the economy would increase significantly less, by about 1.4% or EUR 8.4 billion. Job creation in the circular flow scenario comes to around 83,000, but most of the new jobs would be related to trading in services than trading in products. This scenario would also bring the greatest effects for the environment – it is estimated that greenhouse gas emissions would be reduced by around 23% after 15 years\textsuperscript{59}.

Positive effects related to the implementation of the circular economy approach have been calculated also in the case of Luxembourg and United Kingdom. It is expected that shifting of Luxembourg market towards circular economy may lead to generate €300 million to €1 billion EUR annual net-material cost savings in the medium term. Circularity activities also would “support 7,000 – 15,000 jobs driving more than €1 billion in economic activities in Luxembourg primarily in manufacturing but also buildings, retailing and other areas”\textsuperscript{60}. Accelerating the circular practices may also result in creation of “more than 2,200 jobs in the next 3 years, if robustly applied in the construction, automotive, manufacturing, financial, logistics, R&D, and administrative sectors”\textsuperscript{60}.

Positive effects can be also identified in other EU countries, such as United Kingdom. Between 2005-2013, NISP was actively engaged with 15,000 companies in the UK. Opportunities identified by NISP generated £1 billion in sales and cost reductions of £1.1 billion for the companies. It reduced carbon emissions by 39 million tons, diverted 45 million tons of material from landfill, and saved or created more than 10,000 jobs\textsuperscript{61}.

\textsuperscript{59} Ibidem
\textsuperscript{60} Ibidem
\textsuperscript{61} Ibidem
4. The potential thematic areas of the circular economy approach

A document titled “Towards a circular economy: A zero waste programme for Europe”, COM(2014) 398 includes list of the potential thematic areas related to the circular economy approach. Taking into account the fact that the list is based only on preliminary plans of the European Commission, it is necessary to check which issues are currently the most important from the perspective of the European Union. Therefore, in this paragraph identification of current priorities of the EU, based on the number of EU strategies and reports which are – directly or indirectly – related to the circular economy approach is given:

- EU factsheets which are aimed at closing four loops:
  - helping consumers choose sustainable products and services,
  - the Production Phase of the Circular Economy,
  - clear Targets and Tools for Better Waste Management,
  - from Waste to Resources.
- An EU action plan for the Circular Economy which is described in the first point of this report,
- EU Circular Economy Strategy (Roadmap) which includes information related to studies on circular economy and existing work on the waste review proposal (EU Circular Economy Strategy also was described in the first point of this report),
- Directives of the European Union,
- The European Portal For Energy Efficiency In Buildings,
- The Buildings Performance Institute Europe.

One of the most important goal included in the reports, strategies and law regulations mentioned above is to improve material and energy efficiency in the construction sector. These documents refer to financial instruments that support activities aimed at implementation of more and more efficient solutions (materials and technologies). They also include targets and requirements which have to be implemented by local governments, enterprises and other stakeholders. Taking into account a significance of the energy efficiency, it is possible to select the following potential thematic areas that play a key role in the policy of the European Commission:

1. **Reduction of the quantity of materials** required to deliver a particular service (light weighting),
2. **Reduction of the energy use** in:
   1. Production phase,
   2. Use phase,
3. **Reduction of the material use** in:
   1. Production phase,
   2. Use phase,
4. **Creation of markets for secondary raw materials** (based on standards, public procurement, etc.),
5. **Design of new products** that are easier to maintain, repair, upgrade, remanufacture or recycle (eco-design),
6. **Development of separation and collection systems** that minimise the costs of recycling and reuse,

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7. **Improvement of resource efficiency in building sector,**
8. **Better project planning** which ensures:
   8.1. Use of resources in more efficient way,
   8.2. Greater use of energy efficient products,
9. **Promotion of more resource efficient manufacturing of construction products** by:
   9.1. Using recycled materials,
   9.2. Reusing existing materials,
   9.3. Using waste as a fuel,
10. **Promotion of more resource efficient construction and renovation** by:
    10.1. Reduction of construction waste,
    10.2. Reduction of demolition waste,
11. **Improvement of recycling/re-using materials and products** so that less is sent to landfill.

The topics areas mentioned above provide, thus, good basis for actions which may result in development of CC and eco-innovative products, services, technologies and processes that should become the key competitive advantage of building & construction companies in European and international markets. It also may lead to sustainable growth of these companies and their collaboration with other industrial sectors.

5. **Potential industrial sectors for collaboration**

As it was mentioned at the beginning of the report, the EU policy aimed at creation of circular economy is based on three main principles:

1. Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows,
2. Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles,
3. Foster system effectiveness by revealing and designing out negative externalities.

As the authors of “Growth Within. A Circular Economy Vision for a Competitive Europe” report emphasize, these principles can be translated into six business processes which allow to identify the potential of different business sectors for implementation of the circular economy approach. The report also includes analysis of that potential, as it is necessary to find an answer to the question: which industrial sectors would be most suitable and effective for collaboration? Taking into account conclusions prepared by the authors, this section describes the six business processes and considers their potential for implementation of the circular economy approach in industrial sector:

- **Regenerate.** Shift to renewable energy and materials; reclaim, retain, and regenerate health of ecosystems; and return recovered biological resources to the biosphere. For example, the European power sector is moving rapidly into renewables,
- **Share.** Keep product loop speed low and maximise utilisation of products by sharing them among users (peer-to-peer sharing of privately owned products or public sharing of a pool of products), reusing them throughout their technical lifetime.

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(second-hand), and prolonging their life through maintenance, repair, and design for durability,

- **Optimise.** Increase performance/efficiency of a product; remove waste in production and the supply chain (from sourcing and logistics to production, use, and end-of-use collection); leverage big data, automation, remote sensing, and steering. None of these actions requires changing the product or technology,

- **Loop.** Keep components and materials in closed loops and prioritise inner loops. For finite materials, this means remanufacturing products or components and as a last resort recycling materials. For renewable materials, this means anaerobic digestion and extracting bio-chemicals from organic waste,

- **Virtualise.** Deliver utility virtually – books or music, online shopping, fleets of autonomous vehicles, and virtual offices,

- **Exchange.** Replace old materials with advanced non-renewable materials; apply new technologies (e.g. 3D printing and electric engines); choose new products and services (e.g. multi-modal transport)\(^6\).

Basing on the data collected by the Ellen MacArthur Foundation, it is possible to identify potential forms of cooperation which can be undertaken by various industry subsectors. As it can be found, almost all of the industry activities are able to implement at least two types of processes which are useful for development of the circular economy in EU. The best opportunities related to implementation of this approach in industry sector are provided by the **share, loop** and **exchange** processes. Their role depends on the type of industry activity, therefore the list and table below show opportunities for popularization of these processes among different types of industrial companies:

- **Share process:**
  - Manufacturing of wood and paper products, and printing,
  - Manufacturing of textiles, apparel, leather and related products,
  - Construction,
  - Manufacturing of transport equipment,
  - Manufacturing of furniture.

- **Loop process:**
  - Construction,
  - Manufacturing of transport equipment,
  - Manufacturing of electric equipment and ICT products,
  - Manufacturing of machinery equipment,
  - Manufacturing of rubber, plastic, basic and fabricated metal products,
  - Manufacturing of food, beverages and tobacco products.

- **Exchange processes:**
  - Manufacturing of rubber, plastic, basic and fabricated metal products,
  - Manufacturing of food, beverages and tobacco products,
  - Manufacturing of coke, refined petroleum, chemical products.

Apart from the analysis which shows how the different industry companies can cooperate it is also necessary to show which **types of resources** offer the best chances for implementation of the circular economy approach. Using different European and international reports, the specialists from Ellen MacArthur Foundation tried to find materials and resources that can be considered as most suitable for creating the cross-sectional products. Taking into account the conclusions presented in the “Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains” report, the group of priority materials includes e.g.:

- **Wood and paper** – in the opinion of the experts, there is need “to improve the purity of recovered and recycled materials, with significant savings to be made if ink contamination and quality can be addressed in the reverse cycle for paper and cardboard”;

- **Plastics** – the activities should focus on “improving the purity of recovered and recycled materials in order to best retain value and minimise the environmental and economic costs of production and at end-of-life”;

<table>
<thead>
<tr>
<th>ECONOMIC ACTIVITIES</th>
<th>Regenerate</th>
<th>Share</th>
<th>Optimize</th>
<th>Loop</th>
<th>Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information &amp; Communication services, media and telecommunications</td>
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<tr>
<td>Scientific R&amp;D, other professional, scientific &amp; technical activities</td>
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<tr>
<td>Education</td>
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<td>Human health and social work activities</td>
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<td>Administrative &amp; support services</td>
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<td>Arts, entertainment and recreation</td>
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<tr>
<td>Financial and insurance activities</td>
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<tr>
<td>Legal &amp; accounting head offices, consulting, architecture, TIC</td>
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<tr>
<td>Distributive trades (incl. wholesale and retail trade)</td>
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<tr>
<td>Manufacture of wood and paper products and printing</td>
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<tr>
<td>Public administration and defence; compulsory social security</td>
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<td>Real estate activities</td>
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<tr>
<td>Manufacturing of textiles, apparel, leather and related products</td>
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<tr>
<td>Construction</td>
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<tr>
<td>Manufacturing of transport equipment</td>
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<tr>
<td>Manufacturing of furniture</td>
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<td>Water supply, water &amp; remediation</td>
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<tr>
<td>Manufacturing of electric equipment, computer, electronic and optical products</td>
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<tr>
<td>Manufacturing of machinery and equipment</td>
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<tr>
<td>Manufacturing of rubber, plastics, basic and fabricated metal products</td>
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<tr>
<td>Transportation and storage</td>
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<tr>
<td>Agriculture, forestry and fishing</td>
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<tr>
<td>Manufacturing of food, beverages and tobacco products</td>
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<tr>
<td>Mining and quarrying</td>
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<tr>
<td>Electricity, gas, steam and air-conditioning supply</td>
<td></td>
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<tr>
<td>Manufacturing of coke, refined petroleum, chemicals products</td>
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<tr>
<td>Manufacturing of pharmaceuticals, medicinal chemical, botanical</td>
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<tr>
<td>Accommodation and food service activities</td>
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</tbody>
</table>
• **Metals** – in the opinion of the authors of the report, “iron and steel energy efficiency and end-use steel efficiency are key sub-priorities where opportunities are readily achievable”, but it is also necessary to improve purity for and in the reverse cycle.

Table 5 Materials which offer the best opportunities for cooperation in the construction sector; source: European Commission

<table>
<thead>
<tr>
<th>Material</th>
<th>Prioritised by</th>
<th>Scarcity and dependence</th>
<th>Environmental impact</th>
<th>Potential savings</th>
<th>Key opportunities and challenges</th>
<th>Identified as a priority?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural products &amp; waste</td>
<td>TNO 2013, WEF &amp; EMF 2014, McKinsey Global Institute 2011</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Need and some scope for improvement; some feasibility issues</td>
<td>Priority</td>
</tr>
<tr>
<td>Wood &amp; paper</td>
<td>WEF &amp; EMF 2014</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Need and scope for improvement</td>
<td>Priority</td>
</tr>
<tr>
<td>Textiles</td>
<td>None</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Some scope for improvement; collection rates</td>
<td>-</td>
</tr>
<tr>
<td>Plastics</td>
<td>Arcadis 2010, WEF &amp; EMF 2014</td>
<td>Medium</td>
<td>High</td>
<td>No info</td>
<td>Need and scope for improvement; purity (PET and polymers) and collection rates (polymers)</td>
<td>Priority</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Green Alliance 2011</td>
<td>High</td>
<td>High</td>
<td>No info</td>
<td>Need and scope for improvement; substitution and improved practices</td>
<td>Priority</td>
</tr>
<tr>
<td>Rock</td>
<td>WEF &amp; EMF 2014</td>
<td>Low</td>
<td>Medium</td>
<td>No info</td>
<td>Scope for improvement; reuse and recycling</td>
<td>-</td>
</tr>
<tr>
<td>Glass &amp; ceramics</td>
<td>WEF &amp; EMF 2014</td>
<td>Low</td>
<td>No info</td>
<td>No info</td>
<td>Scope for improvement; purity of recycled material</td>
<td>-</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>Arcadis 2010, McKinsey Global Institute 2011</td>
<td>High</td>
<td>High</td>
<td>No info</td>
<td>Substantial existing policy coverage; feasibility issues</td>
<td>-</td>
</tr>
<tr>
<td>Other chemicals &amp; compounds</td>
<td>RU 2013, Arcadis 2010</td>
<td>Some high</td>
<td>High</td>
<td>Embedded in savings from improved recycled quality of other materials</td>
<td>Need for improvement; contamination and material purity repercussions for other materials and products (e.g. paper and plastics)</td>
<td>-</td>
</tr>
</tbody>
</table>

**KEY** - Based on available information, outcome warrants priority consideration

Companies which produce wood, paper, plastics and metals can be seen, thus, as the most important stakeholders that are able to create closed-loops and implement the circular economy approach. It is possible, however, to identify some other materials which are produced in the EU and offer interesting possibilities for cooperation between very different enterprises and would create closed-loop system, but in the opinion of the experts, they do not offer as much opportunities as the products mentioned above. This group of materials consists of e.g. chemicals and compounds, fossil fuels, rock, glass and ceramics. As the experts emphasize, these products “do not rival the environmental impact nor the

---

65 Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains, IVM Institute for Environmental Studies, 2010

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economic risk of the materials\textsuperscript{66}. In the case of fossil fuels, the most important barrier to create closed cycles on the basis of this product is connected with “substantial existing policy coverage, regulation, and policy feasibility issues” which limit opportunities for using the fuels in closed-loop systems. As a result, they can be proposed not “as a priority material on their own as such, but rather embedded within each of the priority materials and sectors”\textsuperscript{67}.

Despite the fact that the majority of priority materials (wood, paper, plastics, metals) can be considered on their own because of high potential for creation of the closed-loops, it is also useful to show how to use them within other economic sectors and materials. The experts prepared analysis which describes cross linkages in the EU economy and provides more details on potential cross-sectoral cooperation. The table presented on the next page shows potential applications of wood and paper, plastics, metals, rock, glass, ceramics, fossil fuels, chemicals and compounds in six economy sectors: packaging, food, transport, electronic & electrical equipment, furniture, building & construction, apparel & fabrics and cleaning & cosmetics. The sectors were selected on the basis of their impact on EU economy and natural environment. The experts also evaluated contribution of these products to EU activities aimed at improvement of energy efficiency and reduction of waste streams. It is also worth noting that the analysis not only includes information on usefulness of the products, but also focuses on linkages between economic sectors as a whole.

Taking into account the results presented in the table below, it should be stressed that the construction sector is able to use the most of the priority products (wood, paper, plastics, metals), what means that construction activity offers many opportunities for implementation of the circular economy approach. What is more, the construction sector also offers possibilities for cooperation with producers of machinery and tools, transportation enterprises and manufacturers of energy-efficient equipment.

The authors of the “Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains” report identified also four challenges which are related to abilities of the selected sector to cross-sectoral cooperation:

- **Food**: Scope to limit waste, at end-user and through handling and transport,
- **Electronic and electrical**: Both need and scope to improve collection rates, and design for disassembly and refurbishment,
- **Transport**: Scope to increase refurbishing levels, improve efficiency, and create jobs,
- **Buildings and construction**: Need and scope to improve building energy efficiency, with measures considered highly feasible\textsuperscript{68}.

These challenges set priority action areas which may improve the chances for better and effective implementation of the circular economy approach.

\textsuperscript{66} Ibidem
\textsuperscript{67} Ibidem
\textsuperscript{68} Ibidem
Table 6: Products which offer the best opportunities for cooperation in the construction sector; source: European Commission

<table>
<thead>
<tr>
<th>Material</th>
<th>Health?</th>
<th>Agricultural products &amp; waste</th>
<th>Food</th>
<th>Electronic &amp; electrical equipment incl. phones, home appliances, electrical tools, office equipment</th>
<th>Transport incl. automotive</th>
<th>Furniture</th>
<th>Buildings &amp; construction incl. materials, production &amp; design</th>
<th>Apparel &amp; fabrics</th>
<th>Cleaning &amp; cosmetics incl. soaps, detergents, mainsup, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural products &amp; waste</td>
<td>✓</td>
<td>Food, electronic &amp; electrical, transport, furniture, apparel, cleaning &amp; cosmetics</td>
<td>Packaging, transport, apparel &amp; fabrics, cleaning &amp; cosmetics</td>
<td>Packaging, food, electronic &amp; electrical, furniture, construction, apparel</td>
<td>Packaging, transport, fabrics</td>
<td>Packaging, food, electronic &amp; electrical, furniture, construction, apparel</td>
<td>Electronic &amp; electrical (machinery &amp; tools, long-term lighting &amp; energy-use design), transport</td>
<td>Packaging, transport, food</td>
<td>Packaging, transport, food</td>
</tr>
<tr>
<td>Wood &amp; paper</td>
<td>✓</td>
<td>Paper &amp; cardboard</td>
<td>Some wood in boats etc.</td>
<td>Wood &amp; paper</td>
<td>Wood</td>
<td>Some animal products</td>
<td>Some animal products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td></td>
<td></td>
<td>Textiles</td>
<td>Textiles</td>
<td>Textiles</td>
<td>Textiles</td>
<td>Textiles</td>
<td>Textiles</td>
<td>Textiles</td>
</tr>
<tr>
<td>Plastics</td>
<td>✓</td>
<td>Plastics</td>
<td>Plastics</td>
<td>Plastics used in automotives</td>
<td>Plastics</td>
<td>Plastics</td>
<td>Polyester</td>
<td>Polyester</td>
<td>Polyester</td>
</tr>
<tr>
<td>Metals</td>
<td>✓</td>
<td>Metals used: aluminium, steel</td>
<td>Metals used: Steel, copper, aluminium, rare Earths</td>
<td>Metals used in automotives: Steel, aluminium</td>
<td>Metals used: aluminium, steel</td>
<td>Metals used: aluminium, steel</td>
<td>Polyester</td>
<td>Polyester</td>
<td>Polyester</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>✓</td>
<td>Phosphorus used as fertiliser in agriculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Phosphorus</td>
</tr>
<tr>
<td>Rock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rock used: Aggregates, limestone, gypsum, cement, cement</td>
</tr>
<tr>
<td>Glass &amp; ceramics</td>
<td></td>
<td>Glass</td>
<td>Some glass</td>
<td>Glass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Glass</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td></td>
<td>Energy used in supply + unrecovered energy from waste</td>
<td>Energy</td>
<td>Energy &amp; fossil fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other chemicals &amp; compounds</td>
<td></td>
<td>Chemicals used in production</td>
<td>Chemicals used in production</td>
<td>Coatings, adhesives, paints</td>
<td>Flame retardants, dyes</td>
<td>Paints, etc.</td>
<td>Flame retardants, dyes</td>
<td>Chemicals</td>
<td>Chemicals</td>
</tr>
</tbody>
</table>

**KEY**
- Material has a non-negligible input to the product sector
- Material has a small, non-negligible input to the product sector
- Material input to this product sector is comparatively negligible
- Identified as a priority material

*Key linkages for construction sector*
Opportunities for collaboration of selected industrial sectors can be also identified on the basis of projects and good practices implemented by enterprises which collaborate with other industry companies in order to implement the circular economy approach. Therefore this section presents their profiles and describes selected examples with more details, what is useful to show how to close the loops, improve energy efficiency and reduce resource consumption by designing, constructing and maintaining green infrastructure and buildings. It has to be noted, however, that the examples described below are implemented not only in Europe, but also in other parts of the world.

Table 7 Best practices linked to implementation of the Circular Economy Approach; source: Ellen MacArthur Foundation

The Vauban Quarter (optimise process) - It is the model eco-district of the city of Freiburg. In the past 15 years, residents, architects and housing cooperatives have turned their ideas into a greener and more environmentally responsible urban dwelling reality. In doing so they have created a part of the city that attracts interest, media attention and experts from all over the world. In April 2011, Vauban acquired another sustainability highlight: a modular combined heat and power plant supplied by MTU Onsite Energy. More details: http://www.mtuonsiteenergy.com/1.5_Residential_The_Vauban_Quartier.pdf

AirBnB (share process) - AirBnB is community marketplace for all kinds of accommodations. It enables people to list, discover and book their properties via their website or smartphone applications. Listings range from apartments, villas and tree houses to castles, boats and other eccentric places at any price point imaginable. So far it has over 500,000 listings in 33,000 cities and 192 countries. More details: http://thisisdesignthinking.net/2015/05/airbnb-design-thinking-example/
DIRTT Built better (optimise and loop processes) - DIRT is a leading technology-driven manufacturer of highly customized interiors. DIRT combines its proprietary ICE® 3D design, configuration and manufacturing software with integrated in-house manufacturing of its innovative prefabricated interior construction solutions and an extensive Distribution Partner network across two continents. DIRT is underpinned by a strong entrepreneurial culture and provides a unique, end-to-end customer solution for the inefficient and fragmented construction industry. More details: https://www.dirtt.net/

P-REX (regenerate process) - "Sustainable sewage sludge management fostering phosphorus recovery and energy efficiency", is a demonstration project financed by the 7th Framework Programme, running from 2012 to 2015. The project consortium consists of 15 market stakeholders and research institutes. The participants represent a variety of technology providers, market experts and researchers with in-depth knowledge in phosphorus markets and streams, technical P-recovery, waste water treatment and fertilizer use. The project strives to speed up the implementation of technical phosphorus recovery from the wastewater stream. In order to achieve this scaled-up processes are assessed, nutrient markets and legal framework are analyzed and described and regional implementation strategies are developed. Other research projects focusing on different aspects of fertilizer efficiency, nutrient recovery and reuse include End-oSludge and ManuReSource. More details: http://p-rex.eu/

Zeobond group (exchange process) - Zeobond can legitimately claim to be a global pioneer in commercialising geopolymers, offering a unique combination of leading-edge technology, practical know-how and ability to deliver like no other company in the building materials industry. Zeobond's mission encompasses national priorities of tackling the challenge of climate change by:

- Reducing greenhouse gas emissions with our Portland - cement replacement technology.
- Recycling industrial by-products that might otherwise be sent to land-fill.
- Promoting energy efficiency across the building materials industry.
- Shaping global trends and providing a solution that is truly global in scope.
- Keeping Australia Competitive by creating new jobs and securing existing jobs in the construction industry that could be under threat in a carbon constrained economy.

More details: http://www.zeobond.com/

SFpark (virtualise process) - SFpark was established to use new technologies and policies to improve parking in San Francisco. Reducing traffic by helping drivers find parking benefits everyone. More parking availability makes streets less congested and safer. Meters that accept credit and debit cards reduce frustration and parking citations. With SFpark, we can all circle less and live more. SFpark works by using smart pricing so that drivers can quickly find open spaces. To help achieve the right level of parking availability, SFpark periodically adjusts meter and garage pricing up and down to match demand. Demand-responsive pricing encourages drivers to park in underused areas and garages, reducing demand in overused areas. Through SFpark, demand-responsive pricing works to readjust parking patterns in the city so that parking is easier to find.

More details: http://sfpark.org/
6. The driving force of the circular economy to construction sector (a driver to collaborate with other industries in integrative way)

6.1. Effectiveness of EU construction sector – the most important challenges

The Ellen MacArthur Foundation identified four main negative trends in EU construction sector which resulted in inefficient use of construction and natural resources in building construction and exploitation processes. First of all, building construction sector still loses up to 15% of materials during construction activities, and this process is being limited very slowly (productivity of the sector increase only up to 0.5% per year). Furthermore, some EU countries recover less than 50% of materials which are produced during demolition processes, what means that the circular economy approach is not well implemented in selected European markets. The negative trends are also related to the exploitation of buildings. As the picture below shows, at least 50% of residential and non-residential buildings are too large in comparison with needs of their owners. Moreover, passive building standards are used only in a minority of buildings. Although the number of smart buildings increases due to construction of new dwellings and offices, the green standards are not so popular in refurbishment activities, what significantly reduces energy efficiency of that sector\textsuperscript{70}.

Picture 15 Current trends in building construction sector; source: Ellen MacArthur Foundation

\textsuperscript{70} Ibidem
Additionally, it is also possible to identify several other negative effects of the construction activity that still limit possibilities for implementation of the circular economy approach. First of all, the construction sector is characterized by large-scale use of raw materials, strongly dependent on natural resources (fossil fuels, iron, aluminum, copper, sand, clay, limestone and wood). As the specialists emphasize, “because the harvesting and processing of these materials is so complex, most of them have a high energy value. The necessary energy and CO$_2$ emissions per kilogram of materials are relatively high”\(^\text{71}\). Moreover, it still leads to significant increase of greenhouse gases emissions which contribute to global warming. The construction activity is also responsible for transportation pollutes, such as CO$_2$ emissions, particulate emissions and soil acidification, which are produced during the transportation of resources and building materials.

To sum up, the most significant bottlenecks in the construction chain are related to the following three processes:

- loss of precious, energy-intensive and high-value resources,
- low-value recycling of these resources,
- use of non-sustainable materials\(^\text{72}\).

Comparing the bottlenecks with key elements of the circular economy approach, the most important changes which have to be implemented in the construction sector can be identified. They are linked to:

- reducing the impact in the use phase (lower electricity, heating and water demand) for both new construction and the existing supply after renovation,
- optimising and re-using existing buildings and infrastructure,
- designing circular construction (focused on disassembly, re-use and modification),
- choosing circular materials (smarter, lighter, stronger, non-damaging).

### 6.2. Factors and innovations accelerating development of the circular economy in the EU construction sector

As the authors of “Circular construction - The foundation under a renewed sector” report noted that the construction sector has to move towards an approach which is radically different from the current linear chain. In their opinion, buildings and infrastructure have to be designed to maximise lifespan and dismantling. They should also “offer space for changing functions and they can be aesthetically or technologically modified. In the use phase, use will only be made of renewable resources”\(^\text{73}\). This point focuses on instruments and changes useful for creation of linkages between manufacturers, designers and construction companies and moving the EU construction sector to the circular approach.

The cooperation based on the products and serviced described below may lead to collaboration of the construction sector with other industries in integrative way. It may also result in better implementation of the circular economy approach and,

\(^{71}\) Circular construction - The foundation under a renewed sector, ABN-AMRO, 2014  
\(^{72}\) Ibidem  
\(^{73}\) Ibidem
simultaneously, in reduction of negative environmental impact caused by the construction and demolition activity. The analysis starts from description of processes needed to accelerate development of the circular economy approach in the EU construction industry. Following part of the report describes new solutions which can be identified in EU building construction activity. Subsequently, it presents three potential scenarios for the next two decades. Finally, information on how new generation of green, environmentally friendly buildings will be performed, is presented.

Due to the fact that the EU construction and demolition sector is encouraged to resign from short-term perspective and to implementation of lifecycle approach, high-value recycling of components and resources that are recovered in the End of Life phase get a large share. The further shift towards the circular economy will be possible, however, only if construction and demolition companies are able to use pre-fabricated components, which will lead to the greater reduction of waste production during the construction, renovation and deconstruction processes. Taking this fact into consideration, it is necessary to identify factors which would accelerate development of the circular economy in EU construction and demolition industry.

The tables presented below include the most important steps which – in opinion of the experts – have to be taken to develop the green, closed loops in the described sector. The steps are considered with reference to:

- crucial stages of life-cycle of buildings (such as design, production, construction, operation/maintenance, retrofitting and CDW management),
- six business processes (regenerate, share, optimize, loop, virtualize and exchange) presented in chapter 5.

Please note, however, that some cells are blank, which means that construction stakeholders can still develop innovative solutions aimed at creation of the green value chains in construction industry. The tables presented in this chapter can be thus seen not only as summary description of existing solutions, but also as incentive to create new, environmentally friendly ways to improve current circular practices.
### Table 8 Most important steps in the field of planning

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>ACTORS</th>
<th>REGENERATE</th>
<th>SHARE</th>
<th>OPTIMIZE</th>
<th>LOOP</th>
<th>VIRTUALISE</th>
<th>EXCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planning offices</td>
<td>Brown fields management and eco remediation</td>
<td>Promoting compact urban growth</td>
<td>New urban planning</td>
<td>Shifting land use patterns (more effective use of land)</td>
<td>Taking advantage of inner-city vacant land</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Municipality planning</td>
<td>Smart districts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regional district planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 9 Most important steps in the field of production

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>ACTORS</th>
<th>REGENERATE</th>
<th>SHARE</th>
<th>OPTIMIZE</th>
<th>LOOP</th>
<th>VIRTUALISE</th>
<th>EXCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extractors of virgin materials</td>
<td>Remove use of non-sustainable materials</td>
<td>Off-site production of modules in a factory</td>
<td>Choosing circular materials (smarter, lighter, stronger, non-damaging)</td>
<td>Strengthening of standard construction materials by adding nano-materials (e.g. carbon nanotubes can make concrete stronger than steel, so that the demand for steel can be decreased)</td>
<td>Manage loss of precious, energy-intensive and high-value resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Producers of materials and components</td>
<td>Creating bio-adaptive facades</td>
<td>Using components that can be disassembled and provide an reversible merging of materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Producers of new products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Producers of prefabricated products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off-site production of modules in a factory</td>
<td>Using components that can be disassembled and provide an reversible merging of materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choosing circular materials (smarter, lighter, stronger, non-damaging)</td>
<td>Strengthening of standard construction materials by adding nano-materials (e.g. carbon nanotubes can make concrete stronger than steel, so that the demand for steel can be decreased)</td>
<td>Manage loss of precious, energy-intensive and high-value resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strengthening of standard construction materials by adding nano-materials (e.g. carbon nanotubes can make concrete stronger than steel, so that the demand for steel can be decreased)</td>
<td>Manage loss of precious, energy-intensive and high-value resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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| ACTORS     | PROCESS   | REGENERATE                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | SHARE                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | OPTIMIZE                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | LOOP                                                                                                                                                                                                                      | VIRTUALISE                                                                                                                                                                                                                                                                                                                                 | EXCHANGE                                                                                                                                                                                                                           |
|------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Architects | REGENERATE| Designing circular construction (focused on disassembly, re-use and modification)                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Creating buildings which are able to change in function through time or adapt itself to changing demands or needs of the user                                                                                                                                                                                                                                                                                                                                                     | Separating the structural elements and installations from the coverings (what increases the adaptability of the structure)                                                                                                                                                                                                                                                                                                                                                                                                                  | Using standard sizes for the spans and heights of structural components (what provides re-usability)                                                                                                                                                                                                                                                                                                                                                                                                                             | Popularization of easy-to-use software to design an interior in a few hours, calculate the price during design, and press “print” to deliver exact specifications for components.                                                                                     |
### Table 11 Most important steps in the field of engineering and construction

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>REGENERATE</th>
<th>SHARE</th>
<th>OPTIMIZE</th>
<th>LOOP</th>
<th>VIRTUALISE</th>
<th>EXCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACTORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Separating concrete with plasma</td>
</tr>
<tr>
<td>Subcontractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Using 3D printing technology</td>
</tr>
<tr>
<td>Installers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEMOLITION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REFURBISHING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECYCLING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REUSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 12 Most important steps in the field of retrofitting and CDW management

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>REGENERATE</th>
<th>SHARE</th>
<th>OPTIMIZE</th>
<th>LOOP</th>
<th>VIRTUALISE</th>
<th>EXCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEMOLISH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Infusing life into unattractive buildings and avoiding demolition</td>
</tr>
<tr>
<td>RETROFITTING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Using new recycling techniques for concrete (recovery of high-value fractions)</td>
</tr>
<tr>
<td>CDW MANAGEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECYCLING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REUSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REUSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 13 Most important steps in the field of Operation and maintenance

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>REGENERATE</th>
<th>SHARE</th>
<th>OPTIMIZE</th>
<th>LOOP</th>
<th>VIRTUALISE</th>
<th>EXCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTORS</td>
<td>Owners</td>
<td>Housing organisations</td>
<td>Operators of public and private buildings</td>
<td>Maintenance services providers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimising and re-using existing buildings and infrastructure</td>
<td>Flexible seating, desk-sharing, office hoteling, tele-working, and audio and video conferencing are major trends in the real estate marketplace that are winning acceptance among European workers who appreciate the flexibility and adaptability</td>
<td>Reducing the impact in the use phase (lower electricity, heating and water demand) for both new construction and the existing supply after renovation</td>
<td>Using energy management tools (smart metres and connected devices, lighting controls, and smart thermostats)</td>
<td>Creating new model of ownership (special consortium delivers space for living or working as a service, so that the resources remain the property of the producer)</td>
<td>Creating common spaces in new development projects across Europe (many new buildings offer guest rooms, lounge areas for working and socialising, terraces with outdoor kitchens, drying rooms for laundry—all shared by the owners of the flats)</td>
</tr>
</tbody>
</table>
There are several political and organizational factors that can accelerate process of creation and diffusion of the green solutions presented in this chapter. As the authors of the “Circular construction - The foundation under a renewed sector” report noted, the construction stakeholders should use materials passports which make materials traceable through the entire chain. This gives insight for each material into its origin, supply and environmental performance (in order for these to be eligible for re-use, they must be visually inspected and tested. With this insight, re-use becomes more achievable because it is possible to exclude structural damage)\textsuperscript{74}.

To promote the circular solutions in the EU, national and regional public institutions should also make a shift towards new model of taxation (from labor to resources) what may improve attractiveness of recycling and reusing practices which are not often profitable due to high labor costs. In addition, it is necessary to promote a new role of the EU construction sector which should not be seen as a supplier of a set of outputs, but as a service provider. That change can be supported by concession agreements and multi-year service with a guarantee of environmental performance.

It should also be pointed out that all technological solutions and materials described in this chapter and presented in the picture below can be considered from the perspective of different cycles which were identified in the construction industry by the experts from Ellen MacArthur Foundation and IMSA Amsterdam.

\textit{Picture 16 Innovative green solutions in construction sector; source: Ellen MacArthur Foundation}

\textsuperscript{74} Circular construction - The foundation under a renewed sector, ABN-AMRO, 2014
Each product or technology fulfills criteria related to at least one of the following cycle:

1. Short cycle: maintenance, repair and adjustment of existing products and services,
2. Long cycle: extending lifetime of existing products and processes,
3. Cascades: creating new combinations of resources and material components, and the purchasing of upcycled waste streams,
4. Pure circles: 100% reusing resources and materials,
5. Dematerialized service: shifting physical products to virtual services. This implies resource savings and productivity gains,
6. Produce on demand. Only produce when demand is present\textsuperscript{75}.

Additional information on the cycles can be found in the table presented below.

\textit{Picture 17 Potential cycles in the EU construction sector; source: IMSA Amsterdam}

\begin{table}
\begin{tabular}{ll}
\hline
\textbf{1. Short cycle} & \\
1 Pay per use & One time payment to use product or service \\
2 Repair & Product life extension by repair services \\
3 Waste reduction & Waste reduction in the production process \\
4 Sharing platforms & Products and services are shared among consumers \\
5 Progressive purchase & Pay periodically small amounts before purchase \\
\hline
\textbf{2. Long cycle} & \\
6 Performance based contracting & Long term contract and responsibility with producer \\
7 Take back management & Incentive to ensure product gets back to producer \\
8 Next life sales & Product gets a next life \\
9 Refurbish & Product gets a next life after adjustments \\
\hline
\textbf{3. Cascades} & \\
10 Upcycle & Materials are re-used and its value is upgraded \\
11 Recycling (waste handling & repurpose) & Materials are cascaded and reused, recycled or disposed \\
12 Collaborative production & Cooperation in the production value chain leading to closing material loops \\
\hline
\textbf{4. Pure circles} & \\
13 Cradle to cradle & Product redesign to 100% closed material loops \\
14 Circular sourcing & Only sourcing circular products or materials \\
\hline
\textbf{5. Dematerialized services} & \\
15 Physical to virtual & Shifting physical activity to virtual \\
16 Subscription based rental & Against a low periodic fee consumers can use a product or service \\
\hline
\textbf{6. Produce on demand} & \\
17 Produce on order & Only producing when demand is present \\
18 3D printing & Using 3D printing to produce what is needed \\
19 Customer vote (design) & Making customers vote which product to make \\
\hline
\end{tabular}
\end{table}

\textsuperscript{75} Circular Business Models - Part 1: An Introduction to IMSA’s circular business model scan, IMSA Amsterdam, 2015
6.3. Strategic change to green, innovative services in the EU construction sector

Taking into account the opportunities offered by the new, green products and technologies described in the previous point, the most important strategic change that should be implemented by the EU construction sector is a more intensive development of SMART building model. This idea combine advantages of new industry technologies, innovative design practices, energy efficient solutions, new information management systems, modular and durable constructions and new practices in the field of urban planning. 

Picture 18 SMART building; source: Ellen MacArthur Foundation

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SMART new and renovated buildings are characterized by reduced impact on natural environment due to:

- Implementing innovative solutions, such as automatized lighting, heating, ventilation and humidity,
- Creating facades, windows, doors, floors and structural elements from resources which can be recycled and reused in a high-value way,
- Disconnecting the exterior, architectural characteristics from the structure, this increases the adaptability of the building,
- Using sensors in materials and structures which allow to monitor maintenance requirements more precisely,
- Sharing information within value chain, for example via BIM (Building Information Modelling) and materials passports for resources,
- Connecting assets to a digital library which reveal up-to-date condition of the assets’ components and play a role of platform for a secondary materials market. It is the way for closing the material loops for the largest source of waste in modern society,
- Designing buildings on the basis of components that can be disassembled77.

The SMART building approach can be seen as the best way to integrate the chain in the construction and demolition sector, from design to construction and from renovation to demolition. The SMART buildings use many new, innovative solutions (design patterns, technologies and products) and, thus, offer well opportunities for creating closed loops. It also means that this approach may lead to effective implementation of the three principles strictly related to the circular economy approach and mentioned at the beginning of this report:

- Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows,
- Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles,
- Foster system effectiveness by revealing and designing out negative externalities78.

6.4. Scenarios for the future – barriers and opportunities

On the basis of the factors mentioned above, the Ellen MacArthur Foundation prepared two scenarios for the future which show how the construction and demolition sector would implement the circular economy approach, depending on economic, social, organizational and political changes in EU. In the opinion of the experts, “built environment could take very different development paths to 2050”, but despite this fact they decided to pay close attention to the two following scenarios79.

77 Ibidem
Table 14 Scenarios for the future of EU construction sector; source: Ellen MacArthur Foundation

**Scenario 1:** On the current development path, the levers would likely play out independently and at different paces. Sharing, tele-working, and energy efficiency would advance rapidly, supported by the digital revolution, while modularity and industrial processes would progress more slowly. The European built environment would probably see lower construction costs and operating expenses but increased sprawl and relatively little system optimisation (urban planning). Urban sprawl would have negative impact on the economy, society, and the environment.

**Scenario 2:** A development path predicated on circular principles and a system-based approach with urban planning at the centre would create an enjoyable and smart built environment that took advantage of high-value unlocked land in urban areas to create more durable, modular, and shareable buildings. This circular scenario would lower household costs; protect land from degradation, fragmentation, and unsustainable use; reduce negative environmental impact; and make cities more liveable and convenient.

The first scenario is related to current socio-economic changes in EU countries. Therefore, it is expected that the European building construction industry would see lower construction costs and operating expenses, but increased sprawl and little optimisation of urban planning system. These negative effects cannot be reduced because of the following barriers which limit opportunities for development and popularization of the new solutions described in the previous point:

- Residential sharing would likely continue expanding, but its current strong growth could slow, due to regulatory issues increasingly raised by legislators,
- Tele-working and office-sharing would likely continue to grow but would not fully solve the optimisation issue,
- Durability and modularity would likely remain prevalent in only pockets of the economy,
- Land-take offers a way to quantify the expansion of urban sprawl because of intensive development of infrastructure (roads, railway stations, filling stations)\(^{80}\).

Moreover, the experts from Ellen MacArthur Foundation analyzed situation in Dutch construction and demolition sector to describe the most important bottlenecks which would limit possibilities for implementation of industrialised production and 3D printing of building modules, recycled components and materials, and creation of shared and multi-purposed buildings. Despite the fact that they focused on selected national market, conclusions presented in the “Delivering the Circular Economy: a Toolkit for Policy Makers” report illustrate a general situation of the EU construction and demolition market. As the table presented below shows, group of the most important barriers which limit opportunities for shifting EU economy to the circular approach consists of:

- Small capital intensive and uncertain payback times,
- Limits of technology which is still not fully available at scale,
- Externalities which are not fully reflected in market prices,
- Imperfect information that negatively affect market decisions,
- Split incentives when two parties to a transaction have different goals,
- High transaction costs,
- Inadequately defined legal frameworks,
- Unintended consequences of existing regulations,
- Lack of capabilities and skills at reasonable cost,
- Ingrained patterns of behavior by consumers and businesses\(^ {81}\).

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\(^{80}\) Ibidem

\(^{81}\) Ibidem
Table 15 Potential barriers in the EU construction sector; source: Ellen MacArthur Foundation

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Industrialised Production and 3D printing of building modules</th>
<th>Reuse and high-value recycling of components and materials</th>
<th>Sharing and multi-purposing of buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economics</strong></td>
<td></td>
<td></td>
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<tr>
<td>Not profitable for businesses even if other barriers are overcome</td>
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<tr>
<td>Capital intensive and/or uncertain payback times</td>
<td></td>
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<tr>
<td>Technology not yet fully available at scale</td>
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<tr>
<td><strong>Market Failures</strong></td>
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<tr>
<td>Externalities (true costs) not fully reflected in market prices</td>
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<tr>
<td>Insufficient public goods / infrastructure provided by the market or the state</td>
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<tr>
<td>Insufficient competition / markets leading to lower quantity and higher prices than is socially desirable</td>
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<tr>
<td>Imperfect information that negatively affects market decisions, such as asymmetric information</td>
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<tr>
<td>Split incentives (agency problem) when two parties to a transaction have different goals</td>
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<tr>
<td>Transaction costs such as the costs of finding and bargaining with customers or suppliers</td>
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<tr>
<td><strong>Regulatory</strong></td>
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<tr>
<td>Inadequately defined legal frameworks that govern areas such as the use of new technologies</td>
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<tr>
<td>Poorly defined targets and objectives which provide either insufficient or skewed direction to industry</td>
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<tr>
<td>Implementation and enforcement failures leading to the effects of regulations being diluted or altered</td>
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<td></td>
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<tr>
<td>Unintended consequences of existing regulations that hamper circular practices</td>
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<tr>
<td><strong>Social Factors</strong></td>
<td></td>
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<tr>
<td>Capabilities and skills lacking either in-house or in the market at reasonable cost</td>
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<tr>
<td>Custom and habit ingrained patterns of behaviour by consumers and businesses</td>
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7. Conclusions

One of the most important factors which shape development and competitiveness of the construction sector in EU would be well integrated value chain which strengthens work relations, helps to reduce failure costs and drives innovation in the construction sector. Taking into account this fact, the circular economy approach tries to make “radical shift in attention from the traditional hand-over period (design, build and leave) to the years beyond”, because it may be useful for creation of closed loop and green value chains.

The shift from being a technology supplier to an experience provider can be seen as a key trend which has positive impact on growth, international competitiveness and collaboration of the sector. Having this in mind, many experts emphasize that it is necessary to continually encourage economic players to e.g. develop cross-cycle performance and new solutions in recycling, take into account the economic value of environmental externalities of production and construction processes, improve harmonization of transport flows or change consumption patterns of consumers.

The objectives of the European Circular Construction Alliance correspond with the main goals of the circular construction approach and the suggestions of the experts. Therefore, the “Circular Economy – Preliminary review” takes these facts into account while identifying technologies, products and solutions aimed at strengthening the collaboration between construction companies and implementing the circular approach in the construction sector.

As the previous sections show, the majority of identified technologies, products and solutions are strictly related to the SMART building model which integrates the chain in the construction and demolition sector. To better implement this approach the potential stakeholders should be described in regard to complementarity, compatibility and interest for collaboration in EU and worldwide. As it was mentioned at the beginning of the report, all activities taken in the project can be addressed to the following groups of construction actors potentially interested in development of circular construction approach:

- **Cluster/business networks** – a system of “interconnected institutions to create, store, and transfer the knowledge, skills, and artefacts which define new technologies”\(^\text{82}\). Clusters established in the construction sector consist of manufacturers, constructors, designers, architects, public institutions, scientific organizations “jointly and individually contribute to the development and diffusion of new technology”\(^\text{83}\). Taking into account this fact, they offer good possibilities for creation of the closed loops and green value chains based on new, innovative construction technologies and solutions,

- **Large Enterprises** – as the authors of “Breaking down the barriers to firm growth in Europe” report noted, large companies are “more productive, pay higher wages, enjoy higher profits and are more successful in international markets”\(^\text{84}\). Therefore, it is necessary to identify large construction firms interested in collaboration aimed at

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\(^{82}\) Verbeeck H., 1999, Innovative Clusters. Identification of value-adding production chains and their networks of innovation, an international studies

\(^{83}\) Ibidem

\(^{84}\) Rubini L. et. al., 2012, Breaking down the barriers to firm growth in Europe
development of the circular construction approach as they improve competitiveness of the construction sector and are able to strengthen chances for development and implementation of the new, innovative technologies and solutions in the construction activity,

- **SMEs (member of cluster particularly interested in this field, other SMEs)** – despite the fact that the large enterprises are characterized by e.g. higher productivity, they also meet many issues which limit opportunities for implementation of innovative solutions. As authors of the “Driving Innovation In Large Corporations I: Challenges Faced by Large Corporations” report emphasize, “Innovation comes naturally to most small, entrepreneurial companies because it is vital to their survival and growth. Innovation in large companies presents more significant challenges, since they tend to be more financially driven and less tolerant of risk”. Therefore it is not only necessary to overcome barriers faced by the big companies, but also to strengthen market position of SMEs which are more suitable for creating and developing innovative solutions aimed at implementation of the circular construction approach. What is more, the EU policy stresses important role of the SMEs in creating economy growth, therefore the ECCA project should contribute to improving competitiveness of the small businesses in EU,

- **Research organisations and other knowledge providers** – universities, facilitators, governments, special business services, but also suppliers, clients, competitors, business networks etc. As the experts at Institute for Advanced Social Studies stress, “innovation depends on the capacity to recombine knowledge which comes from different partners. The firms that assign importance to a diversity of sources are also those that more frequently recombine knowledge adapted to their innovation processes”. In opinion of the experts, contacts with the listed actors play, thus, very important role in detecting new opportunities, and in incorporating tacit knowledge into innovative business,

- **Expert/devoted individuals** – as in the case of research organisations and other knowledge providers, they are able to provide information useful for development and commercialization of innovative product, solutions and technologies created by clusters, business networks and other manufacturers.

It has to be noted that the chapter 7 presents products, solutions and technologies which correspond with the SMART building approach and should attract attention of the construction actors because of opportunities for creating closed loops and green value chain. Taking this fact into consideration, the ECCA activities will be particularly addressed to companies involved in green urban planning, development of green buildings and materials, commercialization of shared office and residential space and promotion of durability and modularity in the construction sector.

The construction actors will be selected on the basis of available information sources such as Members of the ECCP, members of ECTP and of other technological platforms; social networks, EU sources on finished and running EU projects. Special attention will be on ongoing EU wide actions, networking activities, and professional association working in

---

86 Fernander-Esquinas M., 2009, Key knowledge providers as sources of innovation in firms
closely related field such as waste management, resource efficiency, eco-innovation and sustainable building. As a result, the ECCA project will contribute to the creation and implementation of the circular economy approach due to **intensification of cluster and business network collaboration aimed at more intensive development of the green value chains in the EU construction sector.**
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## Appendix 1 An EU action plan for the Circular Economy

### Production

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<tr>
<th>Activity</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on circular economy aspects in future product requirements under the Ecodesign directive.</td>
<td>2016 onwards</td>
</tr>
<tr>
<td>Ecodesign work plan 2015-2017 and request to European standardisation organisations to develop standards on material efficiency for setting future Ecodesign requirements on durability, reparationability and recyclability of products.</td>
<td>December 2015</td>
</tr>
<tr>
<td>Proposal for an implementing regulation on televisions and displays</td>
<td>End 2015 or beginning 2016</td>
</tr>
<tr>
<td>Examine options and actions for a more coherent policy framework of the different strands of work of EU product policy in their contribution to the circular economy</td>
<td>2018</td>
</tr>
<tr>
<td>Include guidance on circular economy into Best Available Techniques reference documents (BREFs) for several industrial sectors</td>
<td>2016 onwards</td>
</tr>
<tr>
<td>Guidance and promotion of best practices in the mining waste management plans</td>
<td>2018</td>
</tr>
<tr>
<td>Establishing an open, pan-European network of technological infrastructures for SMEs to integrate advanced manufacturing technologies into their production processes</td>
<td>2016</td>
</tr>
<tr>
<td>Examine how to improve the efficiency and uptake of the EU Eco-Management and Audit Scheme (EMAS) and the pilot programme on environmental technology verification (ETV)</td>
<td>2017</td>
</tr>
<tr>
<td>Develop an improved knowledge base and support to SMEs for the substitution of hazardous substances of very high concern</td>
<td>2018</td>
</tr>
</tbody>
</table>

### Consumption

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better enforcement of existing guarantees on tangible products, accompanied by a reflection on improvements (upcoming Commission proposal for online sales of goods, and Fitness Check of consumer legislation)</td>
<td>2015-2017</td>
</tr>
<tr>
<td>Action on false green claims, including updated guidance on unfair commercial practices</td>
<td>2016</td>
</tr>
<tr>
<td>Analysis of the possibility to propose horizontal requirements on repair information provision in the context of Ecodesign</td>
<td>2018</td>
</tr>
<tr>
<td>REFIT of EcoLabel, to be followed by actions to enhance its effectiveness</td>
<td>2016</td>
</tr>
<tr>
<td>Assessment of the possibility of an independent testing programme on planned obsolescence</td>
<td>2018</td>
</tr>
<tr>
<td>Subject to evaluation of the current ongoing pilots, explore the possible uses of the Product Environmental Footprint to measure and communicate environmental information</td>
<td>2016 onwards</td>
</tr>
<tr>
<td>Action on Green Public Procurement: enhanced integration of circular economy requirements, support to higher uptake including through training schemes, reinforcing its use in Commission procurement and EU funds</td>
<td>2016 onwards</td>
</tr>
</tbody>
</table>

### Waste management

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised legislative proposal on waste</td>
<td>Dec 2015</td>
</tr>
<tr>
<td>Improved cooperation with Member States for better implementation of EU waste legislation, and combat illicit shipment of end of life vehicles</td>
<td>2015 onwards</td>
</tr>
<tr>
<td>Stepping up enforcement of revised Waste Shipment regulation</td>
<td>2016 onwards</td>
</tr>
<tr>
<td>Promotion of industry-led voluntary certification of treatment facilities for key waste/recyclate streams</td>
<td>2018 onwards</td>
</tr>
<tr>
<td>Initiative on waste to energy in the framework of the Energy Union</td>
<td>2016</td>
</tr>
<tr>
<td>Identification and dissemination of good practices in waste collection systems</td>
<td>2016 onwards</td>
</tr>
</tbody>
</table>

### Market for secondary raw materials

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of quality standards for secondary raw materials (in particular for plastics)</td>
<td>2016 onwards</td>
</tr>
<tr>
<td>Proposal for a revised fertilisers regulation</td>
<td>Early 2016</td>
</tr>
<tr>
<td>Proposed legislation setting minimum requirements for reused water for irrigation and groundwater recharge</td>
<td>2017</td>
</tr>
<tr>
<td>Promotion of safe and cost-effective water reuse, including guidance on the integration of water reuse in water planning and management, inclusion of best practices in relevant BREFs, and support to innovation (through the European Innovation Partnership and Horizon 2020) and investments</td>
<td>2016-2017</td>
</tr>
<tr>
<td>Analysis and policy options to address the interface between chemicals, products</td>
<td>2017</td>
</tr>
</tbody>
</table>
and waste legislation, including how to reduce the presence and improve the tracking of chemicals of concern in products

| Measures to facilitate waste shipment across the EU, including electronic data exchange (and possibly other measures) | 2016 onwards |
| Further development of the EU raw materials information system | 2016 onwards |

**Sectorial action**

**Plastics**

| Strategy on plastics in the circular economy | 2017 |
| Specific action to reduce marine litter implementing the 2030 Sustainable Development Goals | 2015 onwards |

**Critical raw materials**

| Report on critical raw materials and the circular economy | 2017 |
| Improve exchange of information between manufacturers and recyclers on electronic products | 2016 onwards |
| European standards for material-efficient recycling of electronic waste, waste batteries and other relevant complex end-of-life products | 2016 onwards |
| Sharing of best practice for the recovery of critical raw materials from mining waste and landfills | 2017 |

**Construction and demolition**

| Pre-demolition assessment guidelines for the construction sector | 2017 |
| Voluntary industry-wide recycling protocol for construction and demolition waste | 2016 |
| Core indicators for the assessment of the lifecycle environmental performance of a building, and incentives for their use | 2017 onwards |

**Biomass and bio-based materials**

| Guidance and dissemination of best practice on the cascading use of biomass and support to innovation in this domain through Horizon 2020 | 2018-2019 |
| Ensuring coherence and synergies with the circular economy when examining the sustainability of bioenergy under the Energy Union | 2016 |
| Assessment of the contribution of the 2012 Bioeconomy Strategy to the circular economy and possible review | 2016 |

**Innovation and investments**

| Initiative "Industry 2020 and the circular economy" under Horizon 2020 | October 2015 |
| Pilot project for "innovation deals" to address possible regulatory obstacles for innovators | 2016 |
| Targeted outreach to encourage applications for funding under EFSI, and support the development of projects and investment platforms relevant to the circular economy | 2016 onwards |
| Targeted outreach and communication activities to assist Member States and regions for the uptake of Cohesion Policy funds for the circular economy | 2016 onwards |
| Support to Member States and regions to strengthen innovation for the circular economy through smart specialisation | 2016 onwards |
| Assessment of the possibility of launching a platform together with the EIB and national banks to support the financing of the circular economy | 2016 |
| Engagement with stakeholders in the implementation of this action plan through existing fora in key sectors | 2016 onwards |
| Support to a range of stakeholders through actions on public-private partnerships, cooperation platforms, support to voluntary business approaches, and exchanges of best practices | 2015 onwards |

**Monitoring**

| Development of a monitoring framework for the circular economy | 2017 |