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Basic assumptions for introducing circular solutions in the buildings sector

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Abstract: Traditional, linear business models are one of key reasons for unsustainable development, including overuse of non-renewable resources and energy, as well as waste over-generation. An answer to these problems is a circular economy aimed at improving resource- and energy-efficiency in each phase of a product's (service's) lifecycle. The main aim of this paper is to examine, what can be considered a circular product in the buildings sector and what kind of circular products and / or services could be potentially introduced by consulting companies operating inter alia in the buildings sector. First two sections provide a general theoretical background for the concept of a circular economy, a circular product and circular business models. Then, main aspects of introducing an approach based on a circular economy in the buildings sector are elaborated, focusing on key features of circular buildings and solutions which are or can be implemented in different phases of a building's lifecycle. Based on main features of introducing a circular economy in the buildings sector, leading tasks of consulting companies involved in sustainable solutions are presented. In conclusion it is stated that there are many solutions enabling construction of (more) circular buildings, at least in terms of a "better" circularity in one or more phases of a building's lifecycle, but still a complex and system approach is needed in the whole sector and among all actors. For this reason, consulting companies can play a specific role in this field, by the way of raising awareness, developing knowledge, skills and capabilities, creating and showing values and benefits to different actors, developing networks etc.

Keywords: circular economy, buildings, the buildings sector, a building's lifecycle, consulting companies, sustainable development
JEL: Q01, Q2, Q3, Q4, Q5

1. Introduction

This paper presents a discussion on the most important conditions and assumptions regarding products and services in the buildings sector that would meet requirements of a circular economy. Considerations and conclusions are based on a research conducted in the autumn 2015 in the Netherlands during a science and research internship in an international consulting

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company involved in sustainable development in many different sectors. The main aim of the paper is to examine, what can be considered a circular product in the buildings sector and what kind of circular products and / or services could be potentially introduced by consulting companies operating inter alia in the buildings sector.

The author used data and information from both primary and secondary sources. The paper is based on a review of existing publications, including on-line reports, brochures, EU regulations etc., as well as on information received from interviews with representatives of an international consulting company interested in introducing circular solutions in their consultancy services in the buildings sector. First two sections provide a general theoretical background for the concept of a circular economy, a circular product and circular business models. Then, main aspects of introducing an approach based on a circular economy in the buildings sector are elaborated. The focus is on key features of circular buildings and solutions which are or can be implemented in different phases of a building's lifecycle. Based on main features of introducing a circular economy in the buildings sector, leading tasks of consulting companies involved in sustainable solutions are presented. In conclusion it is stated that there are many solutions enabling construction of (more) circular buildings, at least in terms of a "better" circularity in one or more phases of a building's lifecycle, but still a complex and systems approach is needed in the whole sector and among all actors. For this reason, consulting companies can play a specific role in this field, by the way of raising awareness, developing knowledge, skills and capabilities, creating and showing values and benefits to different actors, developing networks etc.

2. Defining a circular economy

Although there are many definitions of a circular economy, the key assumptions and goals of this pretty new concept stay the same in each one. Generally, a circular economy means an opposite to the traditional, linear business models (take – make – waste or take – make – dispose) (Accenture 2014: 12, 22) and it is aimed at more efficient and effective resource use, environmental protection and a required change in people's behaviour towards sustainability. As WRAP (2015) underlines, "a circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the

maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life." According to the European Union (2014) "circular economy systems keep the added value in products for as long as possible and eliminates waste. They keep resources within the economy when a product has reached the end of its life, so that they can be productively used again and again and hence create further value." A great contribution to the development of the concept has been made by the Ellen MacArthur Foundation (2012, 2015), which describes (2013) a circular economy as "one that aims to keep products and materials in use for as long as possible, recirculating them when necessary, aiming towards zero leakage from the system as waste. A key principle is 'tight circles' – recirculating products and materials with little change for fast return to productive use with minimal energy expenditure."

The need for a circular economy arises from various and numerous negative socio-economic and environmental effects of the way of development and resource use that led to welfare, well-being and happiness for many human beings, but cannot ensure neither constant welfare and well-being in a long term nor intra- and intergenerational equity (in terms of different aspects of social, economic and environmental dimensions) all over the world (see also: European Commission 2014, Ellen MacArthur Foundation 2015: 10-29, Ellen MacArthur Foundation 2012). In reality, problems and challenges resulting from unsustainable production and consumption patterns are very complex, interrelated and cause consequences in countless spheres and dimensions, especially that the widely considered vision of welfare is strictly based on linear business models. For this reason, transition to a circular economy requires a complex approach and system thinking, what needs to be taken into account while designing and inventing circular products and services.

3. Circular Principles and Circular Products

According to the Ellen MacArthur Foundation (2015: 23) there are three main principles of the circular economy to introduce:

- "Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows – for example, replacing fossil fuels with renewable energy or returning nutrients to ecosystems.

- Optimise resource yields by circulating products, components, and materials in use at the highest utility at all times in both technical and biological cycles – for example, sharing or looping products and extending product lifetimes.
- Foster system effectiveness by revealing and designing out negative externalities, such as water, air, soil, and noise pollution; climate change; toxins; congestion; and negative health effects related to resource use."

Simultaneously, Ellen MacArthur Foundation (2012: 22-23) outlines key features of a pure circular economy, which are briefly described in Table 1.

Table 1. Characteristics of a pure circular economy

Feature	**Description**
Design out waste	– by the way of using biological and technical components of products to create a biological or technical materials cycle; "biological materials are non-toxic and can be simply composted and technical materials are designed to be used again with minimal energy and highest quality retention".
Build resilience through diversity	– the key idea is to build resilience by the way of making production and consumption systems, networks, products and services etc. work similarly to natural ecosystems; diversity and flexibility of natural systems is considered a clue for business networks.
Work towards energy from renewable sources	– this topic is well-known and systematically developed in terms of the theory and practice.
Think in systems	– without understanding that the whole world, with environment (natural capital, ecosystems, resources etc.), humans and all their activities is a one system with milliards (or more) of components and interrelationships we won't be able to introduce the circular economy; system thinking basically assumes taking all important elements, impacts, causes and consequences into consideration.
Think in cascades	– "for biological materials, the essence of value creation lies in the opportunity to extract additional value from products and materials by cascading them through other applications". That means that the value can be created by re-using the components, in the same or in a different way till the very end it is possible.

Source: Ellen MacArthur Foundation 2012: 22-23.

Based on definitions presented above, key features of a circular product can be distinguished, which are longevity (durability) and lack of waste after the "last life cycle". This is strictly related to the concept of "tight cycles". The idea is that there should be focus on reusing products with a minimal input of effort and resources, what can be achieved in particular thanks to product maintenance (the tightest cycle), product reuse / redistribution, product refurbishment / remanufacture, product recycling and reprocessing of technical nutrients (see e.g. IMSA

Amsterdam 2013; Ellen MacArthur Foundation 2013: 24). An outline of a circular economy, "tight circles" and cascades are presented in Figure 1.

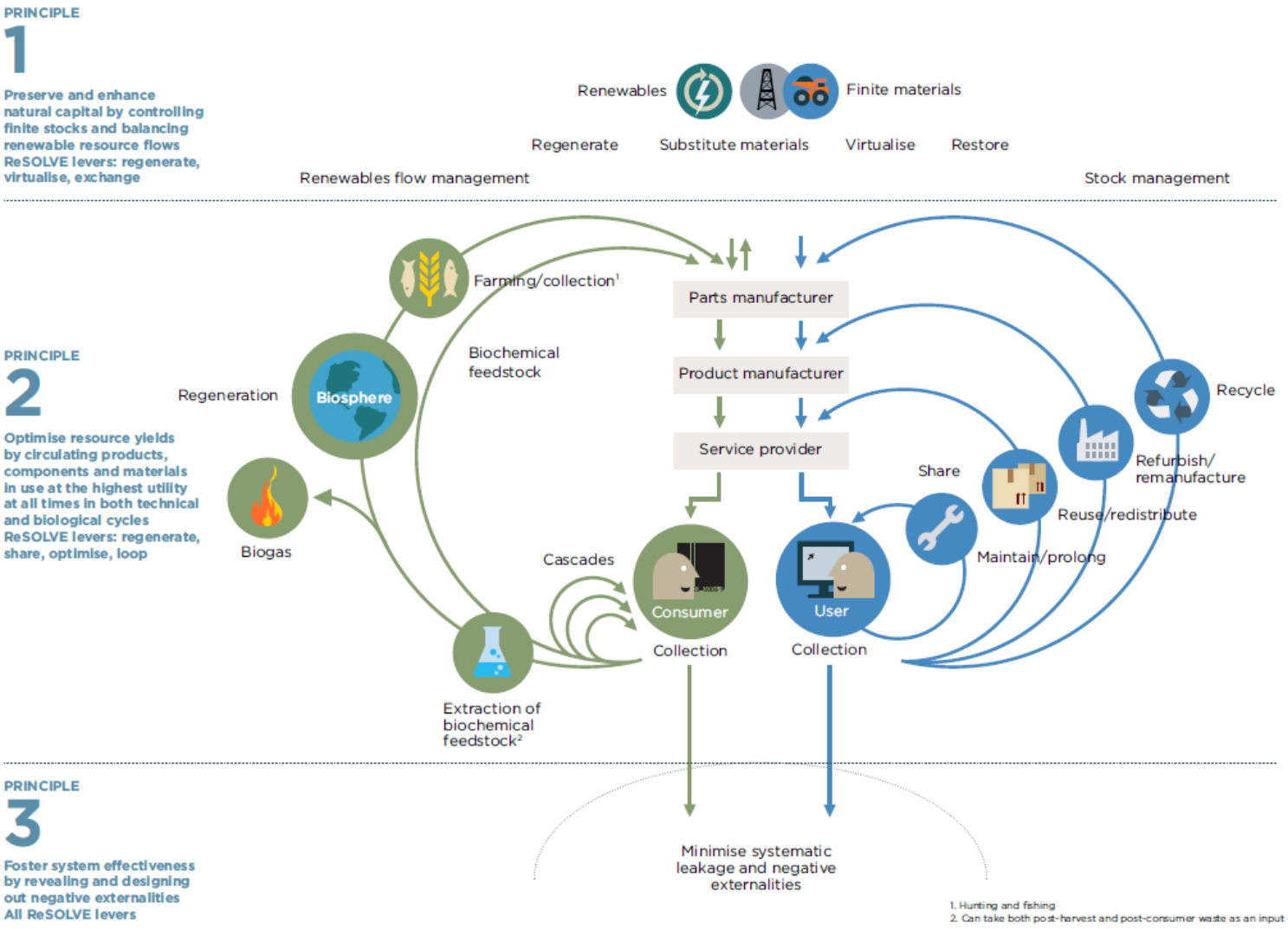
In practice, creating a "really" circular product requires a circular, system, holistic and complex approach during each phase of a life cycle, regarding not only the "main" product, but also each of its components. The simpler product and the easier to disassembly it, the more "circular" it becomes. Although that idea hardly applies to complex and sophisticated products, which are composed of different elements and are produced with advanced technologies etc., it doesn't mean such products cannot be (more) circular. The solution is to make them e.g. more modular, to use different resources to produce them, to reduce resource waste during production etc. On the other hand, numerous and various ways of making products more circular caused that there are a lot of companies offering "circular" products, which – in the opinion of the author– cannot be considered utterly circular i.e.:

(i) products which are leased instead of bought – however, if there are no "other" aspects of the circular economy applied at any phase of the life cycle of this product it can be hardly named "circular". And even if some aspects are applied, it's not "fully" circular. This solution is closer to sharing economy, which has also many positive effects in terms of (more) sustainable development.

(ii) products with some elements of circularity in one (or more) phases of the life cycle – in reality, full circularity can be achieved only if the complex approach is applied in all phases of the life cycle.

(iii) products composed of biological components but non long-lasting – this is however a good solution within the circular economy, provided that these products are manufactured in an energy- and resource-efficient way; collection and transportation after the end of the life cycle is energy- and resource-efficient as well; they are not landfilled or incinerated but e.g. transformed into fertilisers or used to produce bio-gas.

Figure 1. Outline of a circular economy



Source: Ellen MacArthur Foundation 2015: 24.

Although none of above-mentioned examples of products can be considered fully circular, they are an important step towards implementation of the circular economy. The transition towards sustainability is expected to cause less uncertainty, instability etc., if it's proceed in a more evolutionary way. According to the Ellen MacArthur Foundation (2012: 65), "[…] products with circular product-design characteristics (such as non-toxic materials, easy to disassemble, modularised), and those with developed reverse cycle processes (such as efficient collection, transportation, and treatment systems) stand the best chance at developing circular business models." In practice, a shift from linear business models and products to (more) circular ones doesn't imply the need of urgency and immediate full re-design of the product. However, the more "features" of the circular economy within a product the better results and value created in terms of main goals of circularity.

Moreover, the Ellen MacArthur Foundation (2012: 58) identified 4 core requirements which are important when shifting towards (more) circular business models. These requirements are presented in Table 2.

Table 2. Building blocks of a circular economy – what's needed to win

Key requirement for a circular economy	**Key aspects of the requirement**
Skills in circular product design and production	• Material choice optimised for circular setup, • Design to last, • More modularization / standardisation • Easier disassembly, • Production process efficiency,
New business models	• 'Consumer as user', • Performance contracts, • Products become services,
Skills in building cascades/ reverse cycle	• Collection systems: User-friendly, cost-effective, quality-preserving • Treatment/extraction technology: optimizing volume and quality
Enablers to improve cross-cycle and cross-sector performance	1. Cross-cycle and cross-sector collaboration facilitating factors e.g., joint product development and infrastructure management through: • IT-enabled transparency and information sharing, • Joint collection systems, • Industry standards, • Aligned incentives, • Match-maker mechanisms, 2. Favourable investment climate – availability of financing and risk management tools 3. Rules of the game to quickly reach scale – regulation in the areas of accounting, taxation, customs tariffs, customer and corporate responsibility, certification, standardisation 4. Education: • Awareness raising in general public and business community, • Integration of circular concepts in university curricula.

Source: Ellen MacArthur Foundation 2012: 58.

Based on information and key assumptions of a circular economy presented above, some general remarks can be made:

- Fully circular products are not easy to design and produce. For this reason, there are a lot of products being close to circularity, but still requiring improvements.
- Circular products shall be built from circular components; in terms of more sophisticated or specific products (e.g. buildings – see section 5) these issues become more complex.
- The shift towards a circular economy cannot be a scope for action only for one company in the logistics chain. For this reason, a mixture of business models is required, but also cooperation with other actors / stakeholders, fresh vision and innovative approach.
- There are a lot of products which have been already manufactured; some of them are long lasting – what are the possibilities not only to recycle them etc., but also to re-use them?

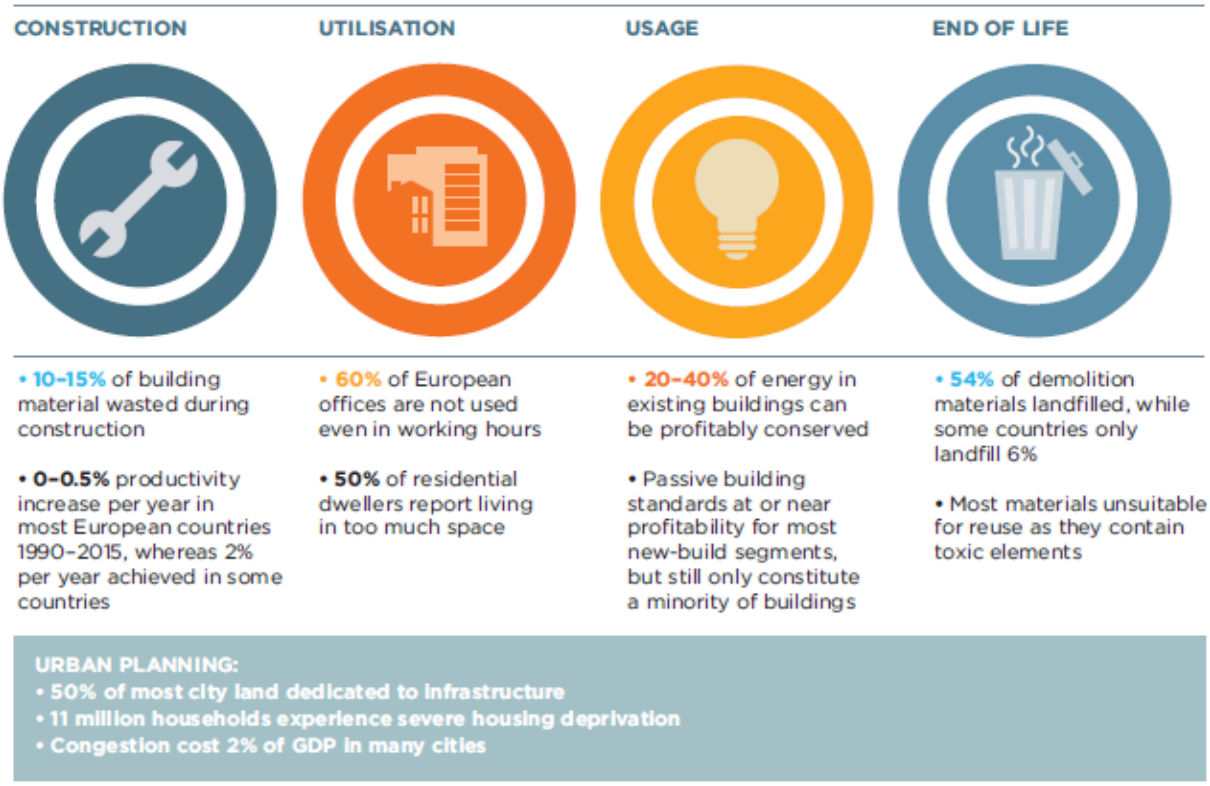
4. Reasons for developing a circular economy in the buildings sector

Buildings are – in assumption – long lasting products. For this reason, the focus should be on energy and resource efficiency in all phases of a building's lifecycle as well as on both, implementation of other different solutions in terms of circularity and sustainable development (e.g. rainwater harvesting, green roofs and walls, solar panels, energy floors etc.) and required, sustainable behaviour of users (depending of the type of a building: home-dwellers, office workers, passengers, pupils, civil servants etc.). On the other hand, buildings are very often something more than only long lasting products – they are considered shelters, places to live, work, cultural habitat or even symbols (of a city, a story or history etc.). All over the world buildings play a crucial role for people – we live in buildings, work in buildings, usually do shopping in buildings, go to a doctor or to a theatre (into a building), vote for a president candidate etc. Basically, the great majority of our social (including public services), political and economic life requires buildings. However, constructing buildings, living in buildings etc. have a great environmental impact, what leads to direct and indirect consequences in the socio-economic spheres as well. The meaning of the buildings sector is determined not only by the role that buildings play for the socio-economic life of people, but also by its share in the national and

European economy. According to the Ellen MacArthur Foundation (2015: 82) "construction is one of the largest economic sectors of the European economy, representing 8.8% of GDP and almost 14 million jobs". For this reason, the shift to a circular economy should ensure that the contribution to national economies and to the European economy is sustained and job losses in industries belonging to the buildings sector need to be compensated in different ways.

However, nowadays built environment belongs to the group of the most challenging sectors in terms of implementation of principles of a circular economy. For example, as the Ellen MacArthur Foundation (2015: 20) argues, European citizens use office only 35-40% of the time, even during working hours. What is worthy to mention is that this phenomenon refers also to office space on expensive inner-city land. Simultaneously, the buildings sector consumes huge amount of resources. For instance, in the period 2003-2011 1.200-1.800 million tonnes of construction materials were used annually in the EU27 for new buildings and refurbishment (ECORYS, Copenhagen Research Institute 2014: 20). The housing sector is responsible for 30-50% of total material use in Europe (iron, aluminium, copper, clay, sand, gravel, limestone, wood and building stone), and the construction sector for 65% of total aggregates (sand, gravel and crushed rock) use and for approximately 20% of total metals use (ECORYS, Copenhagen Research Institute 2014: 19). Construction materials are not the only resources used in different phases of a building's lifecycle. Energy (embodied and used during the use – phase), water, land as well environmental impact (e.g. GHG emissions, impact on biodiversity or other aspects of natural capital) are of great significance as well (ECORYS, Copenhagen Research Institute 2014: 14). In Europe, buildings are responsible for 40% of the energy consumption and 36% of CO_2 emission (Ellen MacArthur Foundation 2015: 82). Another very important aspect is waste generation in different phases of a building's lifecycle. In Figure 2 there are structural waste in the built environment and some challenges in this field demonstrated in different phases of a building's lifecycle.

Figure 2. Structural waste in the built environment



Source: Ellen MacArthur Foundation 2015: 82.

What is interesting is that the average amount of waste generated in the two important (and the "most waste – generating") phases of construction and demolition looks surprisingly in the European countries when divided per number of inhabitants. It turns out, that countries which are not very advanced in terms of striving for sustainability, like Bulgaria, Latvia, Lithuania or Croatia and Romania, have the least amount of waste per capita. But the Netherlands and Finland – two countries considered ones of the most "sustainable" and green-oriented have the sad record (see ECORYS, Copenhagen Research Institute 2014: 38).

This section presents only few aspects of the negative environmental impact of the buildings sector. There are many various issues causing the need for implementation of (more) circular solutions in all phases of a building's lifecycle with primary focus on:

- reduction of materials used for construction, maintenance and refurbishment,
- reduction of waste, especially in the construction and demolition phases (inter alia by the way of transition from demolition to deconstruction),
- reduction of embodied energy and energy use while using buildings,

- better and more sustainable use of existing buildings,
- better spatial planning to make the buildings more functional both in terms of users' requirements and in terms of its place in and relations to the surroundings (distance to and accessibility of schools, workplaces, shopping centres, offices, administration etc.; design of the building etc.).

5. Key characteristics of the buildings sector and buildings in terms of a circular economy

All over the world there have been numeral solutions continuously introduced in various areas in order to make buildings more sustainable (more energy-efficient, less resource-consuming etc.). This refers to different phases of the life cycle, as well as to different buildings with different use destination. As was mentioned above, the circular economy requires a complex and system approach, though "partial" solutions are possible when talking about the shift towards circularity.

Table 3 presents key questions to be raised in the different phases of a building's life cycle to ensure more circularity. The life cycle is analysed from the point of view of an actor responsible for constructing a building and / or a main user or owner (e.g. construction companies, municipalities that for example introduced circular procurements regarding new buildings etc.).

Table 3. Question to be asked while implementing a circular economy in the subsequent phases of a building's lifecycle

Phase of the life cycle	Examples of main questions
Manufacturing, including raw materials extraction and building materials production	• What kind of materials are needed for the construction of a building? • How are the raw materials extracted? What is the effectiveness of extraction? How resource and energy efficient is the process of extraction of raw materials and of production of building materials? • What is the general (environmental, social and economic) impact of the process of extraction of raw materials and of production of building materials? • Which suppliers should be chosen to buy and use (more) circular building materials? • How to check if the supplier really offers (more) circular products?
Construction	• What kind technology should be chosen? What kind of technologies are available in terms of introducing the concept of the circular economy? What is the real impact of a technology on the environment, society, economies? • What kind of waste is generated while constructing a building? Is it landfilled or can it be recycled etc.? • What kind of tools, solutions should be implemented to e.g. reduce waste generated while constructing a building? • What kind of design will ensure resource and energy efficiency while constructing a building? • What kind of design will ensure circularity while using the building's space? • What kind of solutions should be implemented to ensure both functionality of a building and meeting the requirements / principle of the sustainable development, including the circular economy? • What kind of design will ensure circularity while maintenance & refurbishment? • What kind of technical requirements should be met and what kind of materials should be used while constructing a building to ensure its easy, sustainable and circular maintenance & refurbishment? • How to ensure that a building will be deconstructed and not demolished at the end of its life cycle? What kind of technology should be chosen for that • What kind of technical requirements should be met and what kind of materials should be used while constructing a building to ensure its easy, sustainable and circular maintenance & refurbishment?
Use	• What kind of design / retrofit will ensure circularity while using the building's space? • What kind of other tools, solutions etc. could be implemented to ensure sustainable and "circular" use of a building's space (e.g. in terms of influencing users' behaviour, but also in terms of equipment installed, retrofit etc.)
Maintenance & refurbishment	• How to ensure resource and energy efficiency while maintaining and refurbishing a building? What kind of materials should be used? How to reduce waste etc.? What companies offer "circular" maintenance & refurbishment services?
Demolition / deconstruction	• How to ensure resource and energy efficiency while demolishing / deconstructing a building? What kind of technology should be used? How to reduce waste etc.?
Recycling	• What kind of recycling technologies are available for different kind of materials from deconstruction? • How to reduce waste while recycling? • What kind of companies offers recycling of materials from deconstruction?

Source: Author's own elaboration, based on sections 2-5.

Table 3 presents only examples of some very general key questions that should be raised while planning to construct new buildings. However, when thinking about the essence of a circular economy, other priority questions should be asked and answered:

1. Do I really need to construct new buildings or can I RE-USE existing ones?
2. What kind of existing buildings could I RE-USE?
3. Which of these buildings are the most appropriate to adjust them to:
    a. my demands (demands of my customer)?
    b. principles of a circular economy (and other principles sustainable development)?
4. How to rebuild a building to meet the principles of a circular economy? (here some questions from Table 3 play an essential role).

Questions presented in Table 3 are strictly related to some key areas of value creation in a circular economy (see Accenture 2014: 6). Table 4 presents these areas and some examples of solutions which can be implemented in the buildings sector in order to meet the principles of a circular economy.

Table 4. 4 key areas of value creation in a circular economy in terms of making the buildings sector more circular

Area of value creation	**Examples of solutions / actions in the buildings sector**
Long-lasting resources that can be regenerated, recycled and re-used many times, improving efficiency and effectiveness of resource use (40% of the value)	- using raw materials and building materials in such a way that allows to recover them easily (see e.g. Institute for Local Self-Reliance 2006; EPA 2009) and to use them as many times as possible (circularly) for buildings' construction or other purposes, - implementing construction solutions and technologies enabling it to deconstruct buildings in an easy way (e.g. modular construction, 3D printing etc.), - implementing solutions enabling it to use renewable resources in the use – phase of a building's lifecycle (solar panels, green roofs, rainwater harvesting, re-use of greywater etc.), - implementing solutions and providing equipment aimed at longevity and resource – efficiency (e.g. kitchen and bathroom or office equipment that are resource – efficient, stimulate sustainable behaviour of users etc.).

Area of value creation	**Examples of solutions / actions in the buildings sector**
Different than "traditional" approach to products on markets. Markets operate in such a way that products can be services (e.g. renting) or can be common goods (e.g. sharing) etc. (10% of the value)	In terms of the buildings sector sharing economy seems to be a good and more and more common solution. This applies to: - shared office space / desk rental (see e.g. The People Who Share), shared office equipment, shared cars at work etc., - shared outdoor and indoor space in housing blocks, e.g. gardens, kitchens, as well as some equipment; car sharing etc. However, there are also other approaches and business models available or they can be developed, e.g.: - offering services instead of products (manufacturer, seller); becoming user instead of owner (consumer) (this can be to some extent achieved within the sharing economy), e.g. leasing office equipment and / or retrofit, developing markets for leasing household equipment (is such a shift of consumer behaviour possible?; how to change the way people are acting?). The question is if products leased are produced in a sustainable way (e.g. by the use of renewable / non-toxic resources, with little embodied energy, if they are easy to re-use and / or to disassembly and recycle etc.).
Improved longevity and durability of products, longer life cycles of products (30% of the value)	This, first of all, regards to the basic question which was presented above: "Do I really need to construct new buildings or can I RE-USE existing ones?" - Revitalisation, renovation, urban renewal, re-construction of existing buildings are of great importance. But of course focus should be on introducing the principles of sustainability and of the circular economy in each phase of these processes. Buildings (at least most of them) are characterised by long life cycles, though the life cycles can be extended (e.g. by the way of using durable and long-lasting modules and / or construction materials, provided that they can be re-used or recycled and do not turn into waste after the re-construction, demolition or (hopefully) deconstruction of a building). The principle (or area of value creation in the circular economy) of long life cycles plays a crucial role in terms of retrofitting both residential, commercial and other buildings. All the retrofit should be adjusted to the principles of a circular economy (what can be achieved in different ways).
Cooperation between value and supply chains in order to eliminate waste, waste is changed into valuable resources again (20% of the value)	This area is related to the above one, as well as to re-using materials used to construct buildings. Some examples are presented in the further part of this section.

Source: first column: Accenture (2014: 6); second column: author's own elaboration.

Answering the question what can be considered a circular product in the buildings sector is the scope of this brief paper. Thus, short examples listed in Table 5 are to some extent developed below with regard to each phase of a building's lifecycle.

Manufacturing phase (including raw materials extraction and building materials production)

In this phase, focus should be on using raw materials and construction materials which are extracted / produced in a way that applies the principles of the circular economy. In particular, this embraces using raw materials that are extracted in an energy and resource-efficient way, using recycled building materials[1], modules as building materials (modular buildings), bio-materials etc. The question is, to what extend raw materials and building materials being offered on existing markets meet these requirements. Moreover, there are other issues, such as transportation, storage etc. that should be taken into consideration in terms of their social, economic and environmental impact. For instance, services of local suppliers of building materials are much more required, as many of externalities resulting from transportation for long distances can be mitigated. There is some good practice in constructing buildings partially from recycled building materials (see e.g. Finpro 2007). An example can be WRAP (Waste & Resources Action Programme) – a programme (and company) developed in UK, aimed at reducing waste in selected sectors. In one of the reports (WRAP, 2009) they describe good practice in construction and demolition materials recovery facilities in UK. What is worthy to mention is that they focus on different aspects of waste recovery, from the technical process, through e.g. human resource management to environmental and health impacts.

Construction phase (including retrofitting)

This phase is essential in terms of introducing the concept of a circular economy to the buildings sector. Many various factors need to be discussed, considered and implemented, including e.g.:

- Renting a room, office space, an existing building etc. instead of constructing new ones (the “tightest cycle”).
- Re-construction / renovation (refurbishment, revitalisation) of existing buildings with ensuring sustainable / circular standards and solutions instead of constructing new buildings. A cost-benefit analysis in this approach play a crucial role. Depending on the main stakeholders, the analysis should include direct and indirect economic, social and environmental costs and benefits. For this reason, it has a great potential in terms of value

[1] Assuming, that the process of recycling is energy- and resource-efficient as well.

creation for municipalities (social and environmental benefits), as well as for stakeholders interested e.g. in indirect benefits (NGOs or companies aimed at improving their image) or in close cooperation to municipalities. Renovation / urban renewal / refurbishments of buildings seem to ensure a tighter circle in a circular economy than e.g. constructing a new building, even when recycled materials are used.

- Urban planning plays a significant role in terms of making buildings more functional both in terms of users' requirements (e.g. design of the building) and in terms of its localisation (e.g. accessibility of public services, workplaces, shopping centres etc.). The more compact city, the better achievements in building a circular economy can be achieved (not only in the buildings sector). Considering urban planning at the heart of construction processes seems to be more consistent to a system approach (see Ellen MacArthur Foundation 2015: 32).
- Design enabling implementation of sustainable solutions aimed at energy efficiency, waste reduction, as well as resource-efficiency during the construction and following phases, including easy and resource-efficient maintenance and refurbishment, deconstruction instead of demolition, as well as easy re-use and / or recycling of raw and building materials.
- Analysis of stakeholders should be conducted at the very beginning of a building's lifecycle whilst creating a strategy based on the concept of circular economy. Then, in the construction phase, a contribution of various stakeholders (in the form of e.g. co-financing, implementing a circular technology or other solutions) can enable achieving better circular outputs. Analysing stakeholders seems to be crucial for creating network for effective shift towards the circular economy.
- Retrofitting with equipment manufactured in accordance to the principles of a circular economy (long lasting, produced from recycled materials or biomaterials, easy to disassembly after the end use phase etc.). At the same time, this equipment should be able to be used in a "circular" way, enabling inter alia minimisation of waste, and energy- and resource-efficiency. This can apply to e.g. office retrofit, kitchen and bathroom equipment, garden tools etc.

A good example of implementing solutions based on the concept of a circular economy in this phase are buildings in so called Park 20|20 in Hoofddorp (the Netherlands), which was

developed by Delta Development according to the Cradle to Cradle philosophy (see ABN AMRO, 2014). Another example can be development of office and residential retrofit which meets the principles of a circular economy (see Benli et al. 2015; RAP 2011). 3D printing is considered to enable big progress in sustainable and circular buildings sector. WINSUN is a Chinese company which uses 3D printing technology to construct buildings (leaving aside that it is suspected to steal the technology) with a 60% saving in buildings materials and a 70% saving in time needed to construct a similar typical building (Sevenson, 2015).

Use phase

Energy- and resource-efficiency in this phase is strongly dependent on three main factors: the way a building was constructed (eventually – renovated), the way it was retrofitted and finally, the way in which users behave. As the first two factors are briefly elaborated above, this section focuses on some selected aspects of users' / consumer behaviour. First of all, appropriate retrofit as well as some other solutions can enhance users to save resources and energy. On the other hand, some solutions based on sharing economy can be implemented (e.g. shared office space in commercial buildings or shared kitchen / garden in residential buildings; shared office retrofit or household equipment). According to PwC (2015) "five key sharing sectors – travel, car sharing, finance, staffing, and music and video streaming – have the potential to increase global revenues from roughly $15 billion today to around $335 billion by 2025". The most popular example of sharing economy in the buildings sector is Airbnb, offering more than one million different spaces for rent in more than 34,000 cities all over the world (Ellen MacArthur Foundation 2015: 25). Similar companies but with much narrower geographical range of their activities are CasaVersa – a company offering home exchange for people that are travelling (CasaVersa 2015), and REGUS – a company offering shared offices (REGUS 2015).

Maintenance & Refurbishment

This phase was briefly discussed above. The focus should be on design, construction and using materials that enable easy, cheap and resource-efficient maintenance and refurbishment of buildings.

Demolition / Deconstruction & Recycling

This phase is strictly related to the "first" one, namely to manufacturing building materials. EPA (2009: 2) provided some guidelines for a demolition of a building with respect to basic principles of a circular economy. What is important is that different issues need to be considered in this phase, e.g. local regulations or companies with experience in construction, recycling etc. Main steps to successful demolition of a building with respect to the principles of the circular economy include (EPA 2009: 2):

- Pre-planning:
    - local policies and regulations should support and / or promote activities that lead to reuse and recycling of buildings materials,
    - contractors should be experienced in reuse and recycling of buildings materials,
    - Request for Proposal should use language that takes into consideration reuse and recycling of buildings materials.
- Planning:
    - A
    - a special plan should be developed, with clear goals of recycling, identification of materials that should be recycled, defined and assigned roles and responsibilities of people involved in recycling activities; markets should be identified as well for recovered resources.
- Demolition:
    - Materials should be salvaged and not turned into waste,
    - the quantity and quality of materials recovered should be maximised,
    - recovered materials should be donated and / or sold,
    - deconstruction projects should be linked with existing or being developed renovation and construction projects to use recovered materials effectively.

There are still many obstacles to overcome to re-use raw materials and building materials, mostly related to available technologies and finding funds for circular solutions, which are often still more expensive than traditional ones. Moreover, the network of building materials recycling facilities and suppliers offering recycled building materials hasn't been enough developed so far, but it is expected to expand, mostly due to new regulations of the EU (see European Commission 2015) and increasing popularity of the concept of a circular economy in the buildings sector and

among different actors. An example of companies, which declare real interest in a circular economy, is the ROCKWOOL Group, offering "solutions for fire safe, energy-saving and environmentally friendly thermal insulation" (ROCKWOLL Group 2015), and his "cradle to cradle partner" Van Gansewinkel. Another example is Edge Environment Pty Ltd commissioned by the Department of Sustainability, Environment, Water, Population and Communities (Australian Government), which prepared a "Construction and demolition waste guide" (2011) for different stakeholders and actors in the supply chain. In the guide several drivers were described, including governmental regulations, incentives from the government to improve sustainability of buildings and the retrofit, and some economic factors (e.g. costs of landfilling).

6. Discussion on the potential role of consulting companies in the process of making the buildings sector (more) circular

The discussion presented above plays an important role in terms of a potential meaning of consulting companies for creating and implementing products and services in the buildings sector that would stay compliant with the concept of a circular economy. These companies are significant stakeholders influencing choices and decisions of numerous actors in the buildings sector, spatial planning and spatial management and in local policies. For this reason, they can have an impact and stimulate application of circular solutions in different phases of a building's lifecycle, from designing, localization and destination of a building, to the use phase and possibilities of deconstruction, as well as recycling of buildings materials. The potential role of consulting companies can embrace a wide range of multiple aspects, including the most important ones:

- raising and strengthening awareness of different actors in terms of the need for introducing the concept of a circular economy in the buildings sector,
- promoting business models based on the concept of a circular economy,
- identifying and showing to actors participating in different phases of a building's lifecycle, especially to municipalities and developers making the final decisions on

localisation, construction technology, construction materials etc., all values and benefits resulting from circular solutions in all phases of a building's lifecycle[2],

- creating networks and building trust among numerous actors in order to stimulate and facilitate cooperation and to reduce transaction costs resulting from introducing a circular economy in the buildings sector,
- developing and disseminating know-how, know-who, knowledge, skills, abilities and capabilities etc. to introduce circular solutions,
- minimising risks related to an involvement in projects aimed at introducing a circular economy in the buildings sector.

7. Conclusion

Introducing the concept of a circular economy in the buildings sector is not an easy task. Many challenges need to be faced, such as a shift from traditional linear business models used by companies involved in supply and value chains in different phases of a building's lifecycle, as well as a change in behaviours and mental models of buildings' users. Buildings are specific products. They are long-lasting and are necessary for nearly all socio-economic activities. Introducing the idea of a circular economy in the buildings sector to make buildings more resource- and energy-efficient requires at least a reduction of materials used for construction, maintenance and refurbishment, a reduction of waste, especially in the construction and demolition phases, reduction of embodied energy and energy use while using buildings, more sustainable use of existing buildings, as well as better spatial planning to make the buildings more functional both in terms of users' requirements and in terms of its place in and relations to the surroundings. Defining these needs allows to delineate some functions and tasks of consulting companies in terms of easier, faster and more complex implementation of circular solutions in the buildings sector. It seems that the role of consulting companies should be first of all qualitative, i.e. it should focus on building institutional and market foundations, as well as on creating

[2] These issues are more deeply elaborated in the second paper of the author, which presents findings and conclusions resulting from the study conducted during international placement in a consulting company in the Netherlands within the Programme Pioneers into Practice 2015. The second paper discusses different, direct and indirect values and benefits for two main actors: companies and municipalities.

adequate attitudes of actors involved in the buildings sector. Thus, consulting companies should create and disseminate values and benefits resulting from a circular economy in the buildings sector, they should develop knowledge, skill, abilities and capabilities, as well as create networks and stimulate cooperation between different actors.

The conducted research and the answer to the main research question points to the following main conclusions:

1. Implementing a circular economy in the buildings sector requires **a complex and system approach**, partial solutions remain still partial solutions. For consulting firms, which would like to become leaders and / or frontrunners in this field, it is of great importance to persuade customers to introduce circular solutions in the **whole supply and value chains**.
2. **Developing networks**, gaining and convincing new partners and stakeholders of a circular economy to cooperate plays a crucial role. The most important stakeholders seem to be:
    - Municipalities – in the field of revitalisation of existing buildings, local regulations, implementing circularity at the local level (other customers can get some additional profits due to involvement in circular buildings if they can show the specific benefits to the municipalities),
    - Constructors – they need to learn the needs for and benefits from a circular economy,
    - Operators and users – they can get many benefits from circular buildings in the use phase,
    - Suppliers – they need to adjust to the changing environment, including requirements of a circular economy (e.g. local / national regulations),
    - Competitors – cooperation in some fields can create advantages for each party,
    - Innovators and frontrunners in terms of e.g. technology, inventing new buildings materials etc.,
    - Organisations and networks involved in developing a circular economy, etc.
3. First of all, **re-using buildings** can ensure the closest loops (tightest circles) in the buildings sector. Involvement in **urban renewal / buildings renovation (revitalisation)** could be a profitable area of interest and maybe a good starting point with the circular solutions for consulting companies. Some other issues can be an argument for such direction of actions, for example:
    - municipalities are involved in urban renewal all the time,

- very often municipalities are interested in: (i) popularity and attractiveness of the project for different stakeholders, thus implementation of circular solutions would be a good promotion tool; (ii) low costs in the use phase, and low costs of maintenance & refurbishment; (iii) attracting different users (depending on the ownership of buildings as well as their destination). These interests can be to a large extent fulfilled with help of circular solutions,
- involvement in urban renewal means a pretty big market not only in Europe, but all over the world.

4. Some **new tools** could (should) be created or developed within consulting companies in the buildings sector and within networks to work more closely with other partners, to measure progress in a circular economy and to have evidence of success. These new tools could embrace for example new kinds of agreements or letters of intent etc., in which partners would covenant to reduce waste / use recycled buildings materials etc.
    - a set of indicators for different partners to measure progress towards the circular economy,
    - a joint platform to share information and data / good practice etc.,
    - some other solutions which can be developed if needed.
5. A **coherent strategy** within consulting companies is needed.
    - developing know-how, know-who etc., skills and capabilities to develop circular approach in the buildings sector across the world,
    - a team with a "leader" involved in and responsible for the shift towards a circular economy,
    - personal commitment of staff members directly and indirectly involved in activities,
    - answering the most important questions:
        - Why do we want or need to involve in?
        - What kind of benefits will we gain?
        - What kind of resources do we need?
        - What kind of partners do we have / need?,
    - assessment of current and required capabilities within consulting companies,
    - division of responsibilities,
    - developing networks.

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Główne założenia dotyczące wdrażania w sektorze budownictwa rozwiązań opartych na gospodarce o obiegu zamkniętym

Streszczenie:

Tradycyjne, linearne modele biznesowe są jedną z głównych przyczyn braku zrównoważonego rozwoju, nadmiernego wykorzystywania zasobów nieodnawialnych i energii, a także nadmiernego wytwarzania odpadów. Odpowiedź na te problemy stanowi koncepcja gospodarki o obiegu zamkniętym, której celem jest poprawa wydajności w gospodarowaniu zasobami i energią w każdej fazie cyklu życia produktu (usługi). Głównym celem niniejszego artykułu jest określenie, co może być uznawane w sektorze budownictwa za produkt w ramach gospodarki o obiegu zamkniętym, a także, jakie rodzaje takich produktów i / lub usług mogłyby być potencjalnie wykorzystane przez firmy doradcze funkcjonujące między innymi w sektorze budownictwa. Pierwsze trzy punkty zawierają ogólne teoretyczne założenia związane z pojęciem gospodarki o obiegu zamkniętym oraz tworzonych w jej ramach produktów i usług i funkcjonujących modeli biznesowych. Następnie omówiono podstawowe aspekty wdrażania podejścia opartego na gospodarce o obiegu zamkniętym w sektorze budownictwa. Głowna uwaga została skupiona na kluczowych cechach budynków zgodnych z założeniami tej gospodarki, a także rozwiązaniach, które można zastosować w różnych fazach cyklu życia budynku. Bazując na głównych aspektach wdrażania analizowanej koncepcji w sektorze budownictwa, przedstawiono wiodące zadania firm doradczych zaangażowanych w zrównoważony rozwój. We wnioskach stwierdzono, że istnieje wiele rozwiązań pozwalających na konstruowanie budynków spełniających w mniejszym lub większym stopniu założenia gospodarki o obiegu zamkniętym, przynajmniej w jednej lub większej liczbie faz cyklu życia, lecz nadal występuje potrzeba całościowego i systemowego podejścia w całym sektorze i pośród wszystkich podmiotów. Dlatego też firmy doradcze mogą odgrywać tutaj specyficzną i ważną rolę poprzez podnoszenie świadomości, rozwój wiedzy, umiejętności i potencjału, tworzenie i ukazywanie podmiotom wartości i korzyści wynikających z nowych rozwiązań, budowanie sieci itp.

Słowa kluczowe: gospodarka o obiegu zamkniętym, budynki, sektor budownictwa, cykl życia budynku, firmy doradcze, zrównoważony rozwój

JEL: Q01, Q2, Q3, Q4, Q5