**KNOWLEDGE RESOURCE FOR CIRCULAR ECONOMY THINKING IN CONSTRUCTION**

**What is a circular economy (CE)?**
- Why is there a need?
- Are there definitions of CE?

**Is there a policy context and driver for CE?**
- What is the European Commission doing on CE?
- What are UK government(s) doing on CE?
- What are local and regional government doing on CE?

**Are there non-governmental drivers for CE?**
- What will the Green Construction Board Circular Economy Working Group focus on?
- What is the Green Construction Board (GCB)?
- What is the GCB Circular Economy Working Group?
- What will the GCB CE Group aim to achieve?
- What is the scope of the GCB Circular Economy Working Group?
- How will the group function?
- Has the GCB done any previous work relating to construction waste and resource efficiency (materials and water)?

**What are/might be the business benefits of applying CE thinking to construction and the built environment?**
- Has anyone tried to quantify the economic benefits of applying CE thinking to construction and the built environment?
- Are there other business benefits to CE Thinking?

**What are likely to be the challenges for CE thinking in the built environment?**

**CIRCULAR ECONOMY**

**What approaches are already happening in the built environment world that contribute to a Circular Economy?**
- There is much already happening in construction that can be deemed to be part of delivering circular economy thinking. The following applies to the UK.
  - What is happening in the client & investor community?
  - What is happening in the design community?
  - What is happening in the manufacturing sector?
  - What is happening in the contracting community?
  - What is happening in the engineering community?
  - What is happening during the refurbishment and end of life stages?
  - Are construction products and materials being reused, remanufactured or reconditioned?
  - What mechanisms and initiatives are taking place to divert construction and demolition waste from landfill?
  - Are there any examples of circular economy business models being used in the built environment sector?

**Measuring and Managing Information for the Circular Economy**
- Does a Circularity Indicator exist?
- Does a formal British, European or international (ISO) standard exist relating to the circular economy?
- Are there existing standards in construction that are evolving to cover circularity issues?
- What is the role for Digitalisation and BIM – Building Information Modelling?

**Construction and Demolition Waste (CDW) – measuring, understanding and eliminating it?**
- Do we know how much construction and demolition waste and the type is produced in the UK?
- How is CDW data collected?
- How much CDW is recovered?
- Do we know how much CDW goes to landfill?
- Do we know how many materials are reclaimed?

**Are there any examples of CE happening in the built environment?**
- Buildings
- Infrastructure
- Materials
- Research projects on CE thinking relevant to construction

**V.3 JANUARY 2017**

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Why is there a need?

Circular economy thinking means maintaining access to materials and resources for continual and future use. With an ever expanding human population and rising standards of living across the globe, it is likely to be the only viable option to maintain standards of living.
**Are there definitions of CE?**

Yes, there are a number of differing definitions and views of CE. Popular ones are:

- Ellen MacArthur Foundation which has produced a series of in-depth think tank pieces, including a definition of CE, an indicator for measuring CE and detailed consideration of the business case for CE. [http://www.ellenmacarthurfoundation.org/circular-economy](http://www.ellenmacarthurfoundation.org/circular-economy)


- The concept of CE is a vibrant subject area in the academic community involving various schools of thought such as cradle to cradle, performance economy, industrial ecology and biomimicry.


- Of course, CE as a concept builds on a mountain of themes relating to waste reduction, recycling, reuse, material efficiency, security of supply, sustainable consumption and production, better design, sharing of resources etc. All these are strands of circular economy thinking.
What is the European Commission doing on CE?


- The European Environment Agency (EEA) will contribute to the knowledge base on circular economy by developing a comprehensive analytical framework by which to better understand it and to measure progress. Its first report "Circular economy in Europe - Developing the knowledge base" was published in January 2016. It looks at four aspects: the concept and benefits, the main enabling factors and transition challenges, metrics for measuring progress and contextual issues that requiring research or policy. [http://www.eea.europa.eu/publications/circular-economy-in-europe](http://www.eea.europa.eu/publications/circular-economy-in-europe)

- Europe 2020 is the EU's Growth Strategy and includes major strands of work including a Resource Efficient Europe which underpins thinking on the wise use of resources. [http://ec.europa.eu/resource-efficient-europe/](http://ec.europa.eu/resource-efficient-europe/)


What are UK government(s) doing on CE?

- The government response to the EU 2015 consultations on its Circular Economy package are available. Defra is the policy lead for the CE and convenes a stakeholder group to discuss the UK input to EU negotiations and plans. https://www.gov.uk/government/publications/circular-economy-and-waste-markets-uk-government-response-to-european-commission-consultations


- A Scottish Institute for Remanufacture (SIR) has been established funded by the Scottish Funding Council and Zero Waste Scotland and is hosted at the University of Strathclyde. http://www.scot-reman.ac.uk/


- The Government / industry Green Construction Board (GCB) has a working group on the circular economy to provide leadership to the construction industry to start to move towards more CE thinking.
What are local and regional government doing on CE?


- Peterborough is developing a Circular City [http://www.peterboroughdna.com/circular-economy/](http://www.peterboroughdna.com/circular-economy/)


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Are there non-governmental drivers for CE?

Yes, many think tanks, industries, companies, professional institutions, trade associations and NGOs are pushing forward with CE thinking as they understand the need to change our consumption patterns.

- The Ellen MacArthur Foundation has been a major player in driving understanding of the necessity and benefits of a Circular Economy. [http://www.ellenmacarthurfoundation.org/circular-economy](http://www.ellenmacarthurfoundation.org/circular-economy)

- The World Economic Forum has started an initiative with the Ellen MacArthur Foundation called Project MainStream aimed at accelerating the transition to a circular economy. It has launched three new programs focused on developing ways of scaling the circular economy through materials management, information technology and business model innovation. [http://www.weforum.org/global-challenges/projects/circular-economy/](http://www.weforum.org/global-challenges/projects/circular-economy/)


- The Royal Society of Arts (RSA) ran a project called the Great Recovery: redesigning the future between 2012 and 2016 working with Innovate UK. It looked at the challenges of waste and the opportunities of a circular economy through the lens of design. Access the learning from the project at: [http://www.greatrecovery.org.uk/](http://www.greatrecovery.org.uk/)

- Many industry and business organisations and companies are exploring what CE thinking means for them, including security and scarcity of raw materials, and examining the challenges and opportunities their sector faces. E.g. Gypsum to Gypsum [http://gypsumtogypsum.org/](http://gypsumtogypsum.org/)
What is the Green Construction Board (GCB)?

The Government/Industry Green Construction Board (GCB) is the Sustainability work stream of the Construction Leadership Council. The role of the GCB is to provide leadership and action on the circular economy in the construction sector to deliver more environmentally sustainable outcomes, and be more productive and better placed to exploit the growing global market for sustainable construction.

http://www.constructionleadershipcouncil.co.uk/workstream/sustainability/

Are there any examples of circular economy thinking in the built environment sector?

Possible questions might include:

- What are/are likely to be the challenges for CE thinking in the built environment?
- What will the Green Construction Board Circular Economy Working Group focus on?
- What is the GCB Circular Economy Working Group scope of work?
- What is the role and purpose of the GCB Circular Economy Group?
- What is the Green Construction Board Circular Economy Working Group plan to achieve?
- What is the scope of the GCB Circular Economy Group?
- What is the stream of the Construction Leadership Council. The role of the GCB is to provide leadership and action on the circular economy in the construction sector to deliver more environmentally sustainable outcomes, and be more productive and better placed to exploit the growing global market for sustainable construction.

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Measuring and Managing Information for the Circular Economy
- Does a Circularity Indicator exist?
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- Are there existing standards in construction that are evolving to cover circularity issues?
- What is the role for Digitalisation and BIM – Building Information Modelling?

What is the GCB Circular Economy Working Group?
This is a working group of the government / industry Green Construction Board and its remit is to provide leadership and to promote CE thinking into the construction sector.

http://www.constructionleadershipcouncil.co.uk/workstream/sustainability/

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The Green Construction Board

- What is the Green Construction Board (GCB)?
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- What is the scope of the GCB Circular Economy Working Group?
- How will the group function?
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Are any examples of CE happening in the built environment?
- What is happening in the engineering community?
- What is happening in the contracting community?
- What is happening in the design community?
- What is happening in the client & investor community?
- What is happening during the refurbishment and end of life stages?
- What is happening in the manufacturing sector?

What are likely to be the challenges for CE thinking in the built environment?

- What is required to facilitate the design community to adopt CE thinking?
- What measurement and information management tools are needed?
- What is required to enable the flow of materials?
- What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
- What business models are needed?
- What are the Research and innovation challenges?
What will the GCB CE Group aim to achieve?

- To help catalyse the industry to change its practices so as to adopt a less wasteful, more efficient and CE way of thinking.
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What is happening in the engineering community?

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  - What is happening during the refurbishment and end of life stages?
  - Are construction products and materials being reused?

How will the group function?
A Steering Group of individuals from across the built environment and a Community of Practitioners.

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What are the Research and innovation challenges?

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Has the GCB done any previous work relating to construction waste and resource efficiency (materials and water)?

Yes, the GCB from 2007 to 2013 developed a methodology for measuring construction, demolition and excavation waste (CD&E) to landfill, as well as annual reporting. The group also developed an action plan, [http://www.greenconstructionboard.org/index.php/resources/greening-the-industry/top-tips/waste?id=401](http://www.greenconstructionboard.org/index.php/resources/greening-the-industry/top-tips/waste?id=401)

The construction product sector produced a series of sector Resource Efficiency Action Plans (REAPs), advanced understanding of embodied impact information and with BRE and BSI developed responsible sourcing schemes and standards.

Has anyone tried to quantify the economic benefits of applying CE thinking to construction and the built environment?


- The Ellen MacArthur Foundation/McKinsey Growth Within Report states that around £60 billion of net savings of primary resources could be made by 2030. [http://www.ellenmacarthurfoundation.org/publications](http://www.ellenmacarthurfoundation.org/publications)


Are there other business benefits to CE Thinking?


- Understanding the business risk of availability and price of materials in a world of limited supply and increasing competition, is part of the circular economy debate. It is questionable how much security of supply is an issue for construction materials. Some studies suggest there may be a future supply issue with aggregates (due to planning constraints) and availability of certified timber. There are a number of critical raw materials used in components such as batteries, sensors and PVs.

- Future proofing of business activities, such as investigating the effect of business models compatible with CE thinking and building business resilience in the CE area. There could be an enhanced relationship with customers, if moving to a leasing based business model.

- Is there a competitive advantage to being an early adopter of CE thinking?

Possible questions might include:

- How can CE thinking be promoted in the client community?
- What is required to facilitate the design community to adopt CE thinking?
- What does procuring with CE thinking in mind look like?
- What measurement and information management tools are needed?
- What is required to enable the flow of materials?
- What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
- What business models are required?
- What are the Research and innovation challenges?
What are likely to be the challenges for CE thinking in the built environment?

Much of the work to develop CE thinking to date has been focused on short-lived consumer goods such as phones, computers, washing machines etc. But can this thinking also be applied to buildings and infrastructure that exist for decades if not centuries. Examples of the reuse of buildings or construction materials and products litter the millennia, but how can modern buildings and modern materials be designed to be better used, last longer and be available for similar or alternate purposes at end of life. The challenges for adapting CE thinking in construction are likely to be complex and include:

**Products, buildings and infrastructure:**
- Long life of buildings, infrastructure and products.
- Complexity of buildings.
- Variable lifespans of components of buildings.
- Existing, especially more recent, buildings are not designed for today’s End of Life issues.
- Changes in specification and technology over time mean that many products may become redundant in future.

**Recovery of products/materials:**
- Often a low commercial value of materials/products (apart from metals) at demolition.
- Lack of widespread secondary market mechanisms.
- Lack of quality assurance for secondary and recycled materials.
- Problematic logistics of moving and storing materials.
- Constraints of existing waste legislation.
- Complex materials and products which are increasing in use can be difficult to reuse.
- Viability of extended user responsibility requirements for long-lived buildings and products.
- Changes in legislation may mean that recovered material no longer complies with certain regulations e.g. REACH.

**Business considerations:**
- Value of adopting CE practices.
- Use of discount rates can effectively mean the value of recovered materials in 20 years’ time can be zero.
- Most companies will build in depreciation so the value of products in the future are written off.
- Viable business models e.g. leasing products as a service may only be relevant to short-lived products such as lights and carpet tiles.
- Ownership of resources (IP), testing, warranties, guarantees etc of reused, reclaimed products.

**Other considerations:**
- Understanding life cycle thinking to aid complex decisions, e.g. delivering lower carbon in performance but creating end of life issues? Or the opposite, creating good end of life possibilities but increasing carbon emissions in the process.
- A potential disconnect between developer and constructor, freeholder or leaseholder and occupant make keeping track and benefiting from CE over a building lifecycle difficult.
- Applying systems thinking (i.e. the whole supply chain working together).
- Measuring circularity for complex long-lived buildings and infrastructure made of multiple products and materials.
- Information management and data needs – what information is needed, when is it needed to make informed decisions, who needs this information and in what format.
- Engaging SME businesses.
What is happening in the design community?

There is much already happening in construction that can be deemed to be part of delivering circular economy thinking. The following applies to the UK.

- Whilst many buildings/infrastructure projects are designed with sustainability principles and may incorporate aspects of circular economy, there are few examples as yet, of the ‘full’ application of circular economy thinking.
- A reasonably high level of understanding of the generic principles of designing for deconstruction exist (but there seems little commercial appetite for doing it).
- BRE has produced an outline methodology for designing for deconstruction and written 5 case studies http://brebuzz.net/tag/circular-economy/.
- The Association of Sustainable Building Products (ASBP) also have information on designing for deconstruction http://www.asbp.org.uk/resources/.
- Building rating schemes such as BREEAM, LEED, CEEQUAL, and Ska, address some elements of circular economy such as diverting waste from landfill, reuse of products and designing out waste.
- The British standard BS8895 Part 1 and 2 has been written to address material efficiency at the design stages of buildings. http://shop.bsigroup.com/ProductDetail/?pid=00000000030258602 and http://shop.bsigroup.com/ProductDetail/?pid=00000000030296208. Part 3 focusing on technical design is currently being drafted.
- The Royal Society of Arts (RSA) ran a project called the Great Recovery between 2012 and 2016 working with Innovate UK. It looked at the challenges of waste and the opportunities of a circular economy through the lens of design. Access the learning from the project at: http://www.greatrecovery.org.uk/
- The Re-Use Atlas: A designers guide to the circular economy by Duncan Baker-Brown will shortly be available from RIBA Bookshops.
- Arup has produced research on the circular economy in the built environment http://publications.arup.com/publications/circular_economy_in_the_built_environment and a report on Facade design for the circular economy http://publications.arup.com/publications/ff/facade_design_for_the_circular_economy. They also have produced a couple of videos: https://www.youtube.com/watch?v=s03dNDg_hWQ https://www.youtube.com/watch?v=hgOlMoJFLI.
What is happening in the client & investor community?

- A number of clients are involved in circular economy initiatives. Examples include HS2 who are investigating how circular economy principles can be embedded. Other examples include Gatwick Airport and SEGRO [http://www.building.co.uk/data/cost-data/whole-life-carbon/whole-life-carbon-circular-economy/5085228.article]. The Better Building Partnerships are looking at circular economy in their market transformation working group.

- The financial sector, including investors such as ING [https://www.ing.com/Newsroom/All-news/Features/Circular-economy-challenges-financial-business-models.htm] and ABN Amro are also exploring the circular economy [https://www.abnamro.com/en/sustainable-banking/our-focal-points/circular-economy/index.html].
What is happening in the manufacturing sector?

- Many manufacturers recycle their production waste back into their processes.
- There are a number of take back schemes for surplus materials and offcuts as well as packaging such as pallet reuse. This includes for plasterboard, ceiling tiles, mineral wool insulation, bricks and blocks.
- A number of sectors have produced Resource Efficiency Action Plans (REAPs) and are now looking at the challenges and opportunities of the circular economy. Examples include the Gypsum to Gypsum project and PaintCare UK.
- Some sectors are looking at reuse of their products, e.g. Innovate UK is funding several research projects looking at the reuse of steel.
- Some sectors have well established recycling schemes such as Recovinyl, Recofloor and Carpet UK.
- In 2016 Glass For Europe produced an economic study on building glass recycling.
- Life cycle thinking is well established and can be considered a mature approach for understanding environmental impacts, initially due to the BRE Green Guide and now with the more recent adoption of the European standards on measuring and reporting the sustainability performance of construction works and construction products (CEN 350 and EN 15804).
- Many companies and sectors have developed sustainability plans, with targets, indicators and reporting with elements of relevance to circular economy thinking. E.g. Hanson, and the Mineral Products Association.
- The Construction Products Association, the umbrella trade association for UK-based manufacturers and distributors, provides leadership and learning to help catalyse thinking and action by its members on circular economy and broader sustainability and technical issues.
What is happening in the contracting community?

- High levels of diversion of construction waste from landfill are typical for many construction projects, with contractors setting targets including zero waste to landfill.

- Build UK (incorporating the former UK Contractors Group - UKCG) has member commitment to both reduce waste to landfill, as well as reduce the amount of overall waste arising. They have also produced a statement for applying circular economy in construction and are working towards a number of objectives. [http://archive.ukcg.org.uk/fileadmin/clients/UKCG/document/Environment/UKCG_Circular_Economy_statement.pdf](http://archive.ukcg.org.uk/fileadmin/clients/UKCG/document/Environment/UKCG_Circular_Economy_statement.pdf)

- The Chartered Institution of Wastes Management (CIWM) in late 2016 formally adopted a Circular Economy thinking in the built environment sector.


What are likely to be the challenges for CE thinking in the built environment?

- Do we know how much construction and demolition waste (CDW) – and the type is produced in the UK?
- How much CDW is recovered?
- Do we know how many materials are reclaimed?
- What measurement and information management tools are needed?
- What is happening in the client & investor community?
- What is happening in the design community?
- What is happening in the engineering community?
- What is happening in the contracting community?
- What is happening during the refurbishment and end of life of their materials/products within the economy?
What is happening in the engineering community?

- ICE, the Institution of Civil Engineers, has a waste and resource management panel which includes circular economy in its deliberations. A special edition of its proceedings on the circular economy in the built environment will be published in Spring 2017. 
  
  http://www.icevirtuallibrary.com/toc/jwarm/current

- CIBSE has produced guidance on resource efficiency for building services
  
  http://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q200000817f0aas

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**What is happening during the refurbishment and end of life stages?**

- **CIRIA** have produced a guide on environmental good practice for fit-out [www.ciria.org/c757](http://www.ciria.org/c757).

- The demolition industry recovers much of the waste that is produced at end of life, but a large proportion may be downcycled. In 2012, the National Federation of Demolition Contractors (NFDC) members reused or recycled 94% of demolition waste [http://demolition-nfdc.com/news/poststat.html](http://demolition-nfdc.com/news/poststat.html).

- The National Federation of Demolition Contractors (NFDC) has produced a series of ‘Demolition and Refurbishment Information Sheets (DRIDS) to encourage the industry to reuse and recycle materials wherever possible. [http://demolition-nfdc.com/page/drids.html](http://demolition-nfdc.com/page/drids.html).


- **BRE** along with a number of other organisations such as Build UK are producing a code of practice for pre-demolition audits. BRE has also produced guidance on difficult demolition waste [https://www.brebookshop.com/details.jsp?id=327123](https://www.brebookshop.com/details.jsp?id=327123).


Are construction products and materials being reused, remanufactured or reconditioned?

- An established Reclamation industry exists, particularly for high value architectural products such as stone, parquet flooring, fireplaces etc. [http://www.salvo.co.uk/]

- Salvo has published an article on the carbon benefits of reusing reclaimed building material [http://www.salvonews.com/story/the-carbon-benefit-of-reusing-reclaimed-building-material-x97870x9.html]

- Material exchanges are springing up such as:
  - Recipro [http://www.recipro-uk.com/]
  - Construction Material Exchange [http://cme.resourceefficientscotland.com/]
  - Enviromate [http://enviromate.co.uk/]
  - Trade Leftovers [http://www.tradeleftovers.com/]
  - Loop Hub [http://loop-hub.co.uk/]

- Community Reuse schemes are growing in number, though they can struggle if based on a sponsorship model. Examples include:
  - Community Wood Recycling [http://www.communitywoodrecycling.org.uk/]
  - Reuseful UK [https://www.scrapstoresuk.org/]
  - Community Repaint [http://www.communityrepaint.org.uk/]
  - Furniture Reuse Network [http://www.frn.org.uk/]

- A number of companies remanufacture construction equipment. There is the Scottish Institute for Remanufacturing. [http://www.scot-reman.ac.uk/]
What mechanisms and initiatives are taking place to divert construction and demolition waste from landfill?

- The Landfill Tax in the UK, is a key fiscal measure that has encouraged the avoidance of waste to landfill. [https://www.gov.uk/green-taxes-and-reliefs/landfill-tax](https://www.gov.uk/green-taxes-and-reliefs/landfill-tax) Landfill Tax has now been devolved to Wales and Scotland. In Wales, Landfill Disposals Tax (LDT) will replace Landfill Tax from April 2018 [http://gov.wales/topics/environmentcountryside/epg/waste_recycling/disposal/landfill/tax/?lang=en](http://gov.wales/topics/environmentcountryside/epg/waste_recycling/disposal/landfill/tax/?lang=en)

- There has been much funding from organisations such as Innovate UK, WRAP and EPSRC to increase the recovery of wastes, including construction and demolition.

- The waste industry and in particular waste transfer stations are becoming ever more efficient at managing waste.

- A number of material focused organisations, as well as the waste industry, continue to undertake work on developing recycling routes for construction and demolition waste. For example, Carpet Recycling UK [http://www.carpetrecyclinguk.com/](http://www.carpetrecyclinguk.com/) and Composites UK [https://compositesuk.co.uk/](https://compositesuk.co.uk/)

- The paint industry has developed Paintcare - a programme aimed at tackling the large quantities of leftover paint. [http://www.paintcare.org.uk/](http://www.paintcare.org.uk/)

- The Environment Agency had an End of Life Committee to assess when a waste product can be deemed no longer a waste but a new resource and thus not subject to waste regulations for storage, transport and disposal. This Committee has been disbanded.

- BRE has produced a guide for material efficiency in construction [https://www.brebookshop.com/details.jsp?id=327790](https://www.brebookshop.com/details.jsp?id=327790)
Are there any examples of circular economy business models being used in the built environment sector?

- There are few examples, though business models are beginning to emerge which focus on relatively short-lived products such as carpet tiles, lighting and mechanical and electrical equipment.
**What needs to happen next to deliver CE thinking in the built environment sector?**

This is very much the focus of the Green Construction Board Circular Economy Working Group: how to help catalyse the practical action to deliver the business benefits that are predicted with circular economy thinking. Possible questions might include:

<table>
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<td>How will the group function?</td>
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<tr>
<td>Has the GCB done any previous work relating to waste and resource efficiency (materials and water)?</td>
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**How can CE thinking be promoted in the client community?**

- Has the economic case been made to convince clients to adopt CE thinking in their projects?
- What is needed to change the demand of the client community?
What is required to facilitate the design community to adopt CE thinking?

- Are there suitable design tools and information to facilitate designing for circularity including deconstruction?
- Are there existing lesson learning?
- Can the demolition industry provide advice?
- What needs to be done to shift theory to practical action?
- Does infrastructure need different tools than buildings?
- Which organisations will lead on transitioning to this thinking?
What does procuring with CE thinking in mind look like?

- What needs to be thought about and asked for?
- What issues can be practically addressed? It is more than just recycled content and recyclability.
- What information do procurers need, in what format and when to make choices?

Measure and Manage Information for the Circular Economy

- Does a Circularity Indicator exist?
- Does a formal British, European or international (ISO) standard exist relating to the circular economy?
- Are there existing standards in construction that are evolving to cover circularity issues?
- What is the role for Digitalisation and BIM – Building Information Modelling?

Is There a Policy Context and Driver for CE?

- What is the European Commission doing on CE?
- What are UK government(s) doing on CE?
- What are local and regional government doing on CE?

What will the Green Construction Board Circular Economy Working Group focus on?

- What is the GCB Circular Economy Working Group focus on?
- What is the scope of the GCB Circular Economy Working Group?
- What will the GCB CE Group aim to achieve?
- How will the group function?
- Has the GCB done any previous work relating to construction and the built environment?
- Are there non-governmental drivers for CE?

What are/might be the business benefits of applying CE thinking to construction and the built environment?

- What is happening in the contracting community?
- What is happening in the manufacturing sector?
- What is happening in the design community?
- What is happening in the client & investor community?
- What is happening in the engineering community?
- What is happening in the client community?

What approaches are already happening in the built environment world that contribute to a Circular Economy?

- There is much already happening in construction that can be deemed to be part of delivering circular economy thinking. The following applies to the UK.
- What is happening in the manufacturing sector?
- What is happening in the client & investor community?
- What is happening in the design community?
- What is happening in the contracting community?

What are likely to be the challenges for CE thinking in the built environment?

- What is required to facilitate the design community to adopt CE thinking?
- What does procuring with CE thinking in mind look like?
- What measurement and information management tools are needed?
- What is required to enable the flow of materials?
- What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
- What business models are required?
- What are the Research and innovation challenges?
What measurement and information management tools are needed?

- What already exists that is helpful and to whom? – Circularity Indicator, CEN 350, EN15804, BIM etc.
- Do existing measurement methodologies need revising, adapting?
- How will data and information be managed?
- What is the future role of BIM and digital asset management in the context of CE?
- What else is needed?
What is required to enable the flow of materials?

- How do we develop technical solutions for products that are currently difficult to recover?
- How do we ensure that material flows continue at the highest value possible?
- What technologies do we need to separate complex products and buildings?
- Do we need to develop viable market mechanisms for secondary materials?
What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?

- Can the same performance be delivered with less, or different material, through better design?
- Can more use be made of secondary materials in a product’s manufacture without increasing the environmental impact?
- Do technologies such as 3D printing enable more bespoke and less wasteful products?
- Does the design stage for the product consider end of life issues?
- Will extended producer responsibility have a part to play?
- Is it logistically and financially viable to set up take back schemes – surplus, offcuts and at end of life?
- What role does packaging play in the CE?
### What business models are required?

- **Leasing is an option but how widespread is its application for long lived products and buildings?**

- **Are issues of IP, warranties, insurance, testing etc going to be major hurdles to the reality of material and product flows?**

### Measuring and Managing Information for the Circular Economy

- Does a Circularity Indicator exist?
- Does a formal British, European or International (ISO) standard exist relating to the circular economy?
- Are there existing standards in construction that are evolving to cover circularity issues?
- What is the role for Digitalisation and BIM – Building Information Modelling?

### Are there non-governmental drivers for CE?

- Are there any examples of CE happening in the built environment?
- What approaches are already happening in the built environment world that contribute to a Circular Economy?
- How much CDW is recovered?
- Do we know how much construction and demolition waste is produced in the UK?
- How much CDW goes to landfill?
- How much CDW is recovered?
- How many materials are reclaimed?

### What is required to facilitate the design community to adopt CE thinking?

- What is required to enable the flow of materials?
- What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
- What business models are required?
- What are the Research and innovation challenges?
What are the Research and innovation challenges?

- What new knowledge and practical demonstration is needed to advance a circular economy for the construction sector?
- What pieces of research are needed which could turn a barrier into a hurdle?
- What new innovations have the potential to have a transformative effect on the sector?
  - Examples could include "switchable" adhesive materials with tuneable properties which could deactivate under a particular set of conditions, to allow for disassembly and separation of components; tools for more rapid identification of valuable materials from end-of-life buildings, the modular reuse of functioning parts of a building, new technologies for remanufacturing, novel materials using waste etc.
- What potentially are the main sources of funding for research into circular economy thinking in construction?
  - Innovate UK. [https://www.gov.uk/government/organisations/innovate-uk](https://www.gov.uk/government/organisations/innovate-uk)
  - EPSRC – the Engineering and Physical Sciences Research Council. [https://www.epsrc.ac.uk/](https://www.epsrc.ac.uk/)
  - Obtain information about research competitions through the Knowledge Transfer Network. [http://www.ktn-uk.co.uk/](http://www.ktn-uk.co.uk/)

The Green Construction Board
**Does a Circularity Indicator exist?**


- Is it suitable and relevant for construction? Or does it need to be adapted?
  - The published indicator is well suited to short-lived consumer goods and is probably less likely to be useful for long-lived products or buildings.

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**Research projects on CE thinking relevant to construction**

- What is happening in the client & investor community?
  - What mechanisms and initiatives are taking place to divert construction and demolition waste from landfill?
  - What are the Research and innovation challenges?
  - Does a Circularity Indicator exist?
  - What mechanisms and initiatives are needed?
  - What does procuring with CE thinking in mind look like?
  - Are there any examples of circular economy business models being used in the built environment sector?
  - What is required to enable the flow of materials? 
  - What are the challenges for CE thinking in the built environment?
  - What is the role for Digitalisation and BIM – Building Information Modelling?

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**What is the Green Construction Board Circular Economy Working Group focus on?**

- What will the Green Construction Board Circular Economy Working Group focus on?
  - What is the scope of the GCB CE Working Group?
  - Has the GCB done any previous work relating to construction and the built environment?

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**What is a circular economy (CE)?**

- Why is there a need?
  - Are there definitions of CE?
- Are there other business benefits to CE Thinking?
- Has anyone tried to quantify the economic benefits of applying CE thinking to construction and the built environment?
- Is it suitable and relevant for construction? Or does it need to be adapted?

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**What approaches are already happening in the built environment world that contribute to a Circular Economy?**

- What is happening in the contracting community?
  - What is happening in the engineering community?
  - What is happening in the design community?
  - What is happening in the refurbishment and end of life?
  - What is happening during the construction phase?
  - What is happening in the manufacturing sector?
  - Are construction products and materials being reused, remanufactured or reconditioned?
  - Are there local and regional government doing on CE?
  - What are UK government(s) doing on CE?
  - What are the European Commission doing on CE?
  - What are the Research and innovation challenges?
  - What business models are required?
  - What measurement and information management tools are needed?
  - What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
### Does a formal British, European or international (ISO) standard exist relating to the circular economy?

- The British Standards Institution (BSI) began in 2015 the development of BS 8001 Framework for implementing circular economy principles in organisations. There is no EU or ISO standard or work stream in progress.
Are there existing standards in construction that are evolving to cover circularity issues?

- **CEN 350** is a suite of European standards for measuring the sustainability performance of buildings and construction products and is wrestling with how to measure different end of life scenarios.

- **EN 15804** is the methodology for measuring the embodied impacts of construction products and for producing an EPD (an Environmental Product Declaration); it already measures the impact of recycled content and recyclability at end of life and is assessing additional indicators for resource efficiency. Its Module D looks at End of Life of products and is developing ways to calculate the impact of when a product is reused or recycled at End of Life. A new work programme for 2017 will see six task groups look in much greater depth at how to measure / report the potential impact of different end of life scenarios. This is a very important activity.

- The Belgian Building Research Institute is doing a lot of work to look at end of life scenarios. This is a very important activity.

New knowledge is always welcome – join the debate at #cethinking
What is the role for Digitalisation and BIM – Building Information Modelling?

- Digitalisation means the everyday use of common data and is essential for the industry to deliver BIM Level 2. A huge amount of work is going on to develop the systems to manage the information about buildings. The BIM Task Force led the work in the UK. [http://www.bimtaskgroup.org/](http://www.bimtaskgroup.org/) In October 2016, the UK BIM Task Group evolved into the UK BIM Alliance a new cross-industry alliance established to lead the industry-wide drive for awareness, education and adoption of BIM Level 2 compliance. The aim of the organisation is to provide a common and clear point of reference for built environment companies of all disciplines to enable and support their digitalization journey. [http://www.ukbimalliance.org](http://www.ukbimalliance.org)

- BIM4M2 is the subgroup focused on materials and is preparing the templates that will be required to identify material objects onto which information such as Environmental Product Declaration will hang. [http://bim4m2.co.uk/](http://bim4m2.co.uk/)

Do we know how much construction and demolition waste and the type is produced in the UK?

- Yes; in 2014, in the UK, 55.4 million tonnes of C&D waste was generated. Of this 450,585 tonnes was hazardous. In England, 49.1 million tonnes of C&D waste was generated; of this 260,000 tonnes was hazardous. 93% of the UK C&D waste is mineral waste (by tonnage).

How is CDW data collected?

- In the UK, CDW data is collected on a yearly basis. It is collected through the environmental protection agencies using waste management data from licensed waste management facilities as well as other sources such as industry data related to recycled aggregates. This may also be supplemented by surveys. Whilst efforts are made to synchronise approaches across England, Scotland, Wales and NI, methodologies are not identical and are under review. [http://ec.europa.eu/environment/waste/studies/mixed_waste.htm](http://ec.europa.eu/environment/waste/studies/mixed_waste.htm)
How much CDW is recovered?

- In 2014, of the 55 million tonnes of non-hazardous CDW generated in the UK, 49.9 million tonnes was recovered, representing a recovery rate of 89.9%. This was calculated in accordance with the EC Waste Framework Directive. For England, the recovery rate is 91.4%.
  

- For Scotland, the recovery rate in 2014 was 89.2%.
  
  [https://www.sepa.org.uk/media/219149/wfas-2014-commentary-final-v141.pdf.]

**Possible questions might include:**

- How can CE thinking be promoted in the client community?
- What is required to facilitate the design community to adopt CE thinking?
- What does procuring with CE thinking in mind look like?
- What measurement and information management tools are needed?
- What is required to enable the flow of materials?
- What can Manufacturers do to facilitate the ongoing flow of their materials/products within the economy?
- What business models are required?
- What are the Research and innovation challenges?
Do we know how much CDW goes to landfill?

- Yes, a methodology was devised by the Strategic Forum for Construction in 2010 and subsequently adopted by the Green Construction Board (both joint industry/government initiatives). This methodology is being further developed by Defra in England with industry input. [http://www.greenconstructionboard.org/otherdocs/Waste_report_4_draft_22-3-10V4.pdf]

- This measured construction, demolition and excavation waste (CD&E) to landfill from 2008 to 2012, both in absolute and relative terms to construction output using the ONS data. The baseline in 2008 was 66.5 tonnes of CD&E waste landfilled / £ million construction output, and by 2012 was 119.5 tonnes of CD&E waste landfilled / £ million construction output. The rise was largely due to excavation waste. [http://www.greenconstructionboard.org/images/resources/Report%2023%20Waste.pdf]

- One of the key findings was that annual "Excavation" data can be very variable and rises and falls because of a range of variables including changes in legislation, especially in regard to what is legally allowed to be considered exempt.

- If excavation waste is excluded then over a 5 year period, C&D waste to landfill has reduced by 29% relatively from a baseline of 50 tonnes / £ million construction output in 2008 to 34 tonnes / £ million construction output. This is around 1.5 million tonnes.

- More recent figures, show that for 2014, in England, 48 tonnes / £ million construction output of C&D waste was landfilled.

- There has been a considerable increase in the amount of excavation waste produced in England. In 2014, 58 million tonnes was produced, a rise of nearly 10 million tonnes compared to 2012.
Do we know how many materials are reclaimed?

- There is a downward trend in the amount of materials reclaimed. In 2011, it was estimated to be around 750,000 tonnes, compared to 1.8mt in 2007 and 2.3mt in 2008. There are no up-to-date figures available.

http://salvonews.blogspot.co.uk/2008/12/bigrec-survey-shows-predicted-decline.html
KNOWLEDGE RESOURCE FOR CIRCULAR ECONOMY THINKING IN CONSTRUCTION

BY JANE THORNBACK, CONSTRUCTION PRODUCTS ASSOCIATION AND KATHERINE ADAMS, BRE AND LOUGHBOROUGH UNIVERSITY

Is there a policy context and driver for CE?
- What is the European Commission doing on CE?
- What are local and regional government doing on CE?
- What are UK government(s) doing on CE?
- What is a circular economy (CE)?
- Are there definitions of CE?
- Are there non-governmental (NGO) actors taking action on CE?
- What will the Green Construction Board (GCB) Circular Economy Working Group focus on?
- What will the GCB Circular Economy Working Group aim to achieve?
- What is the scope of the GCB Circular Economy Working Group?
- How will the group function?
- Has the GCB done any previous work relating to construction and the built environment?
- Has anyone tried to quantify the economic benefits of applying CE thinking to construction and the built environment?
- What are/might be the business benefits of applying CE thinking to construction and the built environment?
- What are likely to be the challenges for CE thinking in the built environment?
- What is happening in the client and investor community?
- What is happening in the engineering community?
- What is happening in the contracting community?
- What business models are required?
- What is a circular economy thinking in the built environment sector?
- What does procuring with CE thinking in mind look like?
- Are there any examples of circular economy business models being used in the built environment sector?
- What are/might be the business benefits of applying CE thinking to construction and the built environment?
- What are/might be the challenges for CE thinking in the built environment?

Buildings:

There are buildings that are designed and constructed with a number of circular economy aspects, such as adaptability, design for deconstruction, the use of reclaimed products and recycled materials. The examples listed represent those buildings that have the most circular aspects.

- ABN Amro Pavillion
- Brumen Town Hall
  [http://www.ellenmacarthurfoundation.org/ce100/directory/royal-barn-group]
- Circular Building
  [http://circularbuilding.arup.com/]
- Cradle to Cradle inspired buildings
  [http://epea-hamburg.org/en/content/cradle-cradle-inspired-buildings]
- ICEhouse
  [http://www.mcdonoughpartners.com/projects/icehouse/]
- Land Rover Ben Ainslie Racing Building
  [http://www.slideshare.net/cethinking/designing-for-the-circular-economy-land-rover-ben-ainslie-racing-building-portsmouth-cethinking]
- Liander
  [http://www.rau.eu/]
- Park 20/20
- The Ellen Macarthur Foundation has published 12 case studies on circular economy in the built environment
  [https://www.ellenmacarthurfoundation.org/assets/downloads/Built-Env-Co.Project.pdf]

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**Infrastructure:**

Materials:

- Creating a Circular Economy for leftover decorative paint in the UK [http://www.paintcare.org.uk/]
- Gypsum to Gypsum [http://gypsumtogypsum.org/]
- Steel [http://www.asbp.org.uk/resources/]

Take back schemes (manufacturer specific) including:

- Knauf Armstrong [http://www.armstrong.co.uk/commclgeu/eu1/uk/gb/environment_recycling_program.html]
- Kingspan Insulation [http://blog.kingspaninsulation.co.uk/waste-take-back-scheme/]
- Recoflor [http://www.recofloor.org/]
- Recovinyl [http://www.recovinyl.com/]
Research projects on CE thinking relevant to construction


- EU funded ‘Buildings as Material Banks’ (BAMB) [http://www.bamb2020.eu/]

- EU funded ‘Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste’ (HISER) [http://www.hiserproject.eu/]

- The EC commissioned a study to look at the management of C&D waste across the EU and provide recommendations [http://ec.europa.eu/environment/waste/studies/mixed_waste.htm]

- WellMet 2050 [http://www.lcmp.eng.cam.ac.uk/wellmet2/introduction]

- REBus is an EU Life+ funded partnership project, which has developed resource efficient business models (REBMs) for a circular economy. [http://www.rebus.eu.com/]

- EU Funded ‘Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain’ (FISSAC) [https://fissacproject.eu/en/project/]

- Innovate UK has funded a number of projects in this area including:
  - A tool to identify and reclaim high value materials at end of life.
  - The reuse of structural steel.
  - The development of a reclaimed wood certification mark
  - Novel materials from waste
  - A design approach to reusable construction components and houses that are adaptable and fully deconstructable at end of life

A full list can be seen on the Innovate UK website. [https://ktn-uk.co.uk/articles/innovate-uk-projects-on-circular-economy-in-the-built-environment-sector]