Creating Buildings with Positive Impacts

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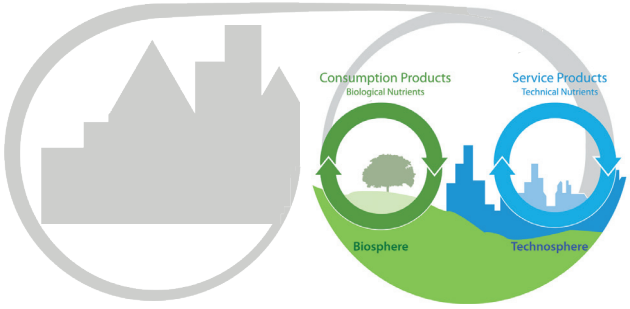

Douglas Mulhall, Michael Braungart & Katja Hansen

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Creating Buildings With Positive Impacts

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1. Introductions & Overview

1.1 Acknowledgements

Until recently the concept of buildings with positive impacts was foreign to designers and developers. Most concepts were directed at minimizing negative impacts. The idea of positive impacts with healthy abundance was often seen as unrealistic. However, that has changed.

Re-generation and healthy abundance are being embraced through approaches like urban farming, grid-competitive solar power, and healthy buildings. We'd like to acknowledge this new movement and its pioneers, and wherever possible in this new edition we bring attention to their achievements.

Historically, our appreciation also goes to the Rotterdam Sustainability Initiative Foundation (RSI), whose generous support made an earlier version of this book possible, to EPEA GmbH for donating the time of its scientists as well as information about its methodologies, and to Technische Universität München for publishing.

The Guide is also written in association with the department of architecture, Delft University of Technology, The Netherlands and Technische Universität München, Germany, where some of the authors are associate researchers. Thanks also go to +Impakt in Luxembourg who contributed sections.

Many individuals and organizations contributed to this publication. They include in alphabetical order;

Steven Beckers, Otto Friebel, David Gillanders, Hans Goverde, David Johnson, Werner Lang, William Lavesson, Martin Luce, Lars Luscuere, Peter Luscuere, William McDonough, Alastair Reilly, Jeannot Schroeder, Paul Schossler, Leo Visser, Ljliljana Rodic-Wiersma, Hein van Tuijl, Coert Zachariasse, Owen Zachariasse, Rafaela Zanatta, Rijksgebouwendienst personnel, as well as many others. As well Johan Sandberg, and the municipality of Ronneby, and EPEA team in Hamburg and Eindhoven.

Appreciation to Martina Lindgren for support with book design.

For those who might have been overlooked; please tell us so they can be added. This Guide is a work in progress!

1.2 Intended Uses Of This Guide

The aim of this publication is to provide tools to generate a big healthy footprint for buildings.

The focus is planning, financing and goal setting for development and renovation. Limited guidance is also provided for the construction, operations, and decommissioning phases.

Users

- Practitioners familiar with Circular Economy methods, who want to learn more about how buildings could have positive impacts.
- Practitioners familiar with Cradle to Cradle® (C2C) who work with Stakeholders.
- Experts who are not familiar with C2C or the Circular Economy, but want to learn about them and how to plan for maximum benefits. In this case, it is advised to do this in a workshop with qualified advisors, as part of a systematic approach.

Building Types

The guidelines contained here are sufficiently broad to be applied to diverse building types and area developments in diverse geo-climatic zones. Applicable building types include; Education, Healthcare, Logistics, Manufacturing, Mixed use, Offices, Recreation, Residential, and Retail.

Green Building Certifications

Positive impacts are being recognized in building certifications. LEED, BREEAM and DGNB are among the more established ones moving in that direction. WELL *https://www.wellcertified.com/en* and RESET™ *https://www.reset.build* are dedicated to positive impacts through emphasis on healthy buildings and indoor environmental quality.

Practitioners who use this guide for their buildings could improve their scores for these certifications. For example, C2C certified™ products gain extra points in some certifications, while measurble indoor air quality improvemens are rewarded in others.

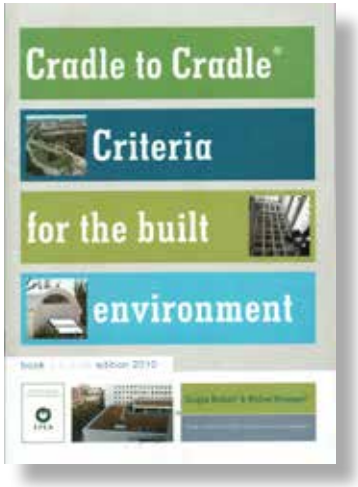
Emphasis On Goal-Setting At Every Stage.

Deciding which positive impacts you want your building to have is one of the most challenging parts of the process. Goal setting can occur at any stage of planning, construction & operation. You do not have to start at the beginning. For example, the planning stage might focus on overall concepts for a building, whereas the operations stage might focus on maintenance goals. As a result, selecting the stage you want to start at is a prerequisite for success.

1.3 Companion Publication

As background for this Guide read: *Cradle to Cradle® Criteria for the Built Environment*, Douglas Mulhall & Michael Braungart, CEO Media 2010 *https://www.c2cplatform.tw/upload/file/Cradle%20to%20Cradle%20Criteria%20for%20the%20built%20environmen.pdf*

The Criteria are the basis for this Guide and contain specific definitions for C2C and Circularity.



1.4 Aim: Add Value For Stakeholders

Until only a few years ago, traditional environmental methods tried to minimize environmental impacts, or minimize our environmental footprint.

Figure 1 describes a new approach transitioning from the conventional approach of minimizing footprints to creating positive footprints.

This approach acknowledges that buildings have big footprints, and those footprints could be positive rather than just less negative.

A healthy footprint is more than green; it adds quality and value by making buildings actively beneficial in diverse ways. It goes beyond being passive. It generates added value for Stakeholders by;

- Improving the economic, social & ecological quality of materials, energy & life.
- Constant improvement during planning and operations until the building is disassembled and its materials used for other purposes.
- Going beyond the traditional sustainable approach of minimizing negative impacts of buildings to include the approach of healthy abundance.
- Adapting to procedures already used by Stakeholders instead of requiring added bureaucracy, regulation or certification.
- Being adaptable in major climate regions, from tropical to temperate.

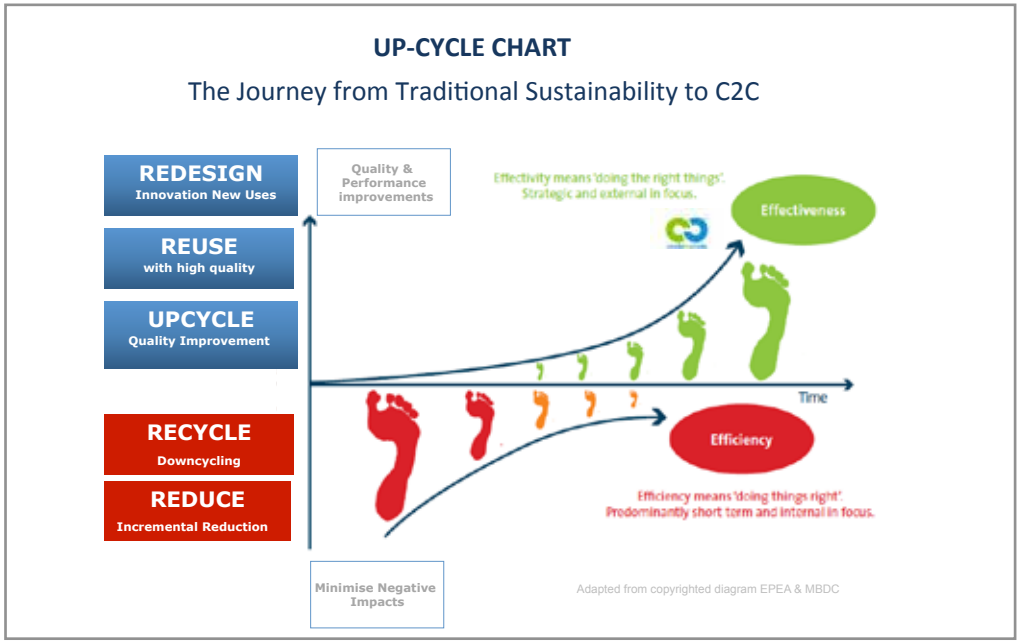


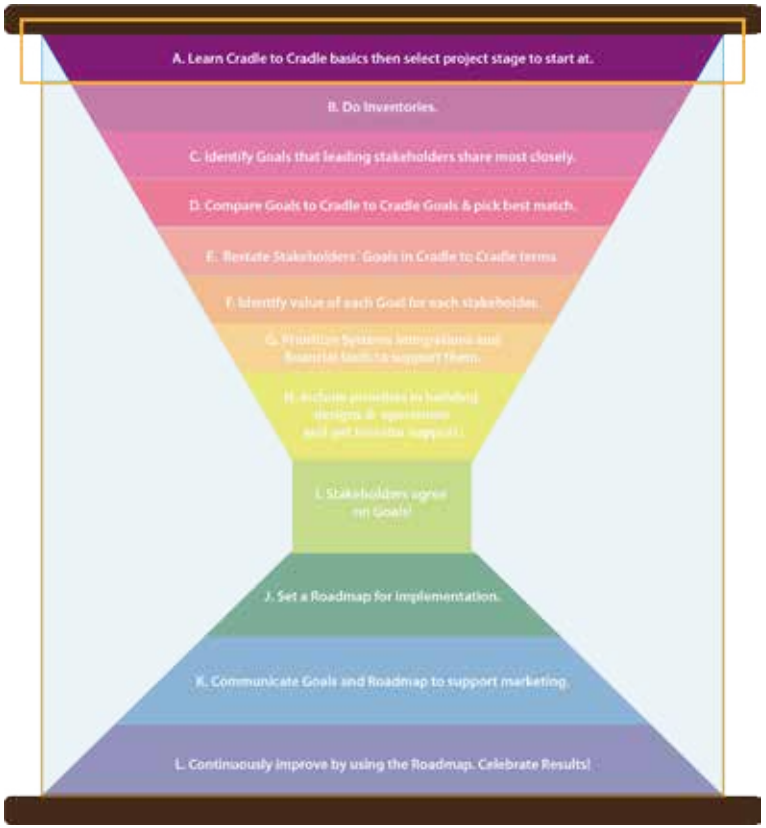
Figure 1: The Journey from traditional sustainability to C2C-inspired circularity. Source EPEA.

1.5 Circular Planning Process

The 'hourglass' approach is a well-known management tool adaptable to your own process. It starts with a broad approach then narrows to agreeing on goals, then broadens out again to implementation across the building project. This resembles the shape of an hourglass. Connected to each planning stage is a set of tools to be used for implementation (Figure 2).

Figure 2: Hourglass goal-setting procedure for achieving positive impacts

2. Planning Stage A.
Cradle to Cradle Basic & Where To Start



2.1 Cradle to Cradle Basic

Philosophy, Principles & Tools

If you are a Cradle to Cradle (C2C) practitioner you know it is often seen as an inspirational philosophy, but it is far more than that. The C2C Design Protocol operates at these diverse levels;

Philosophy

Inspirational guidance describing the positive role of human beings.

Principles

Framework for defining C2C quality and applying tools.

Tools

Innovation and application tools for achieving quality measurably.

Innovation Tools are the focus of this Guide. Philosophy and Principles are described in other publications such as the *C2C Criteria for the Built Environment*. See also educational tools in the following section.

The basis for materials flows in buildings are products designed as biological nutrients for the Biosphere, and as technical nutrients for the Technosphere (Figure 3 & Figure 4).

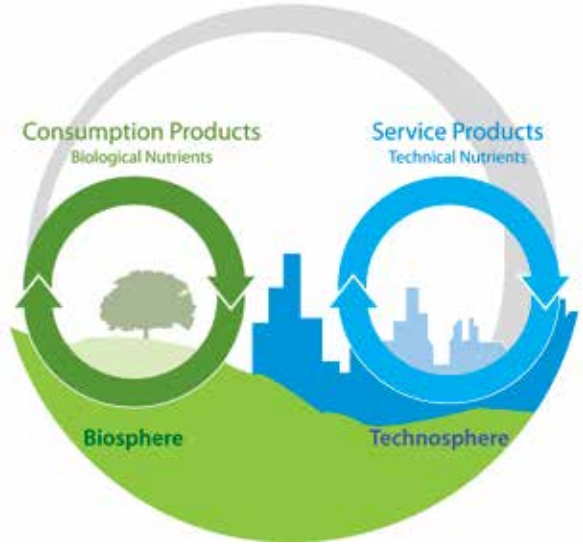


Figure 3: The basis for materials flows in buildings. Products designed as biological nutrients for the Biosphere, and as technical nutrients for the Technosphere. Diagram ©EPEA.

2.1.1 Educational Resources

Because many books are written about C2C in so many languages, it can be hard to decide what to use. Here is a quick guide.

The booklet *Cradle to Cradle Criteria for the Built Environment* gives a brief introduction to C2C Principles & Roadmaps for buildings. As well, many video introductions to C2C inspired products are on Youtube. The most informative ones with practical examples are listed in Table 1.

Overviews	Manufacturing
Cradle to Cradle What is That? *http://www.youtube.com/watch?v=4jORau0V62c* Business Value *http://www.youtube.com/watch?v=AwBkc_2HuXg* The Cradle to Cradle Concept in Detail *http://www.youtube.com/watch?v=HM20zk8WvoM* Ellen Macarthur C2C Tour *https://www.youtube.com/watch?v=zEyF-aq4F94*	DSM C2C Plastics *http://www.youtube.com/watch?v=NFfu5GHW-5U* Vanderlande conveyor systems. *http://www.youtube.com/watch?v=pVbGhrng8co* SunPower solar panels *https://www.youtube.com/watch?v=Sg2NbHKRlmw*
Buildings & Products In Buildings	**Buildings & Products In Buildings**
Buildings as materials banks *https://www.youtube.com/watch?v=fRLOGYX-B4Q* Venlo City Hall *https://www.youtube.com/watch?v=a8dsIBwdiLM* Nexus House *https://www.youtube.com/watch?v=rlLfLLV_WTU* Desso Airmaster *https://www.youtube.com/watch?v=Ic-rFqL9CRE* Tarkett flooring *http://www.youtube.com/watch?v=cTp_sSp_z1k* Schuco Window systems (german language) *https://www.youtube.com/watch?v=n48a5IH4IFc* Hycrete waterproofing for concrete *http://www.youtube.com/watch?v=zk-T-Avm774* Gyproc *https://www.youtube.com/watch?v=54lZYtoCJQ0*	Carbon cure concrete *https://www.youtube.com/watch?v=sNA6sJGj16k* Method Cleaners *https://www.youtube.com/watch?v=l9C9uFUZILY* Velda Resleep *https://www.youtube.com/watch?v=G-jOwq-sxdE* Mosa ceramic tiles *https://player.vimeo.com/video/232972629* Graphenstone wall paints *https://www.youtube.com/watch?v=JHKdUri-uVM* CS (Acrovyn) wall protection: *https://www.youtube.com/watch?v=ZLNmYE9exzE* Reversible Experience Modules *https://www.youtube.com/watch?v=fRLOGYX-B4Q* Orangebox chair *http://www.youtube.com/watch?v=nn-S8ansoOw*

Table 1: Practical examples of C2C-inspired products

2.1.1.1 Practical Websites

Buildings with a beneficial footprint! For examples of C2C approaches in buildings see *www.beneficialfootprint.net*. This is the website for an exhibit at the Biennale in Venice. The Biennale is considered the Olympics of architecture.

Regenerative communities. ReGen Villages is a new model for the development of off-grid, integrated and resilient eco-villages that can power and feed self-reliant families around the world *https://www.effekt.dk/regenvillages*.

Reversible Experience Modules (REMs). Built to be rebuilt. *http://www.epea.nl/rems*. The Reversible Experience Modules exhibition is built from more than 70 products and systems designed for reuse, recovery and recycling, and available on the market today. Together, they form an exhibition showcasing how to realize adaptable, modular and circular buildings. A manual guide for the REMs is available online *http://www.epea.nl/rems* - go to bottom of page.

Reversible building design *https://www.bamb2020.eu/topics/reversible-building-design/*. For effective recovery and reuse of components, products or materials, buildings need to be easily reversible. The Horizon2020 Buildings as Materials Banks project *www.BAMB2020.eu* has an extensive section devoted to reversible building design.

Tracking products and their materials. One of the biggest challenges in the Circular Economy is keeping track of products and materials as they move through the cycle from manufacturing to use to reuse and recycling. While tracking and tracing is nothing new – shipping services do it every day – the capacity to link a detailed description of product characteristics that are relevant to circularity is new. Examples of leaders in their field include: EVRYTHNG, a dedicated platform that allows companies to track their consumer products *https://evrythng.com*. Mindful Materials focuses on building products *http://www.mindfulmaterials.com.* Various other platforms are in the marketplace and are found by searching for the term "tracking circular products".

2.1.1.2 The Circular Economy And Cradle To Cradle

If the Circular Economy is the new vehicle for improving our built environment, then Cradle to Cradle is the steering wheel and guidance system.

The term Circular Economy has been used in China for decades and are part of environmental legislation. The Circular Economy became popular elsewhere when in 2011 and 2012 the Ellen MacArthur Foundation and the management consultancy McKinsey & Partners, with editorial support from EPEA, published *Towards the Circular Economy*, Editions I & II at the World Economic Forum in Davos Switzerland. A third report was published by the World Economic Forum in 2014, and many more followed. Those reports are driving an international movement to adopt the Circular Economy in business.

What is the link between Circular Economy and C2C?

There are more than 100 definitions of the Circular Economy, and as a result the term is understood in different ways by different groups. A general description is; "A Circular Economy is one that is restorative and regenerative by design."

However, when it comes to practical principles & methods to implement that general description, Cradle to Cradle provides a defined set of principles and practices. The C2C materials cycles are the basis for materials value chains in the Circular Economy (Figure 3 and Figure 4).

In *Towards the Circular Economy II*, the Ellen Macarthur Foundation and McKinsey & Partners describe the Cradle to Cradle cycles as follows:

> *…The Circular Economy requires careful management of material flows, which are of two types. These are characterised by McDonough and Braungart in Cradle to Cradle: Remaking the Way We Make Things as biological nutrient and technical nutrients…*
>
> *Biological 'nutrients' are designed to re-enter the biosphere safely for decomposition to become valuable feedstock for a new cycle.*
>
> *Technical 'nutrients' are materials that either do not degrade easily or cause contamination within the biological nutrient flow. These are designed by intention to retain embedded quality and energy.*
>
> Towards the Circular Economy II, Ellen Macarthur Foundation & McKinsey & Partners

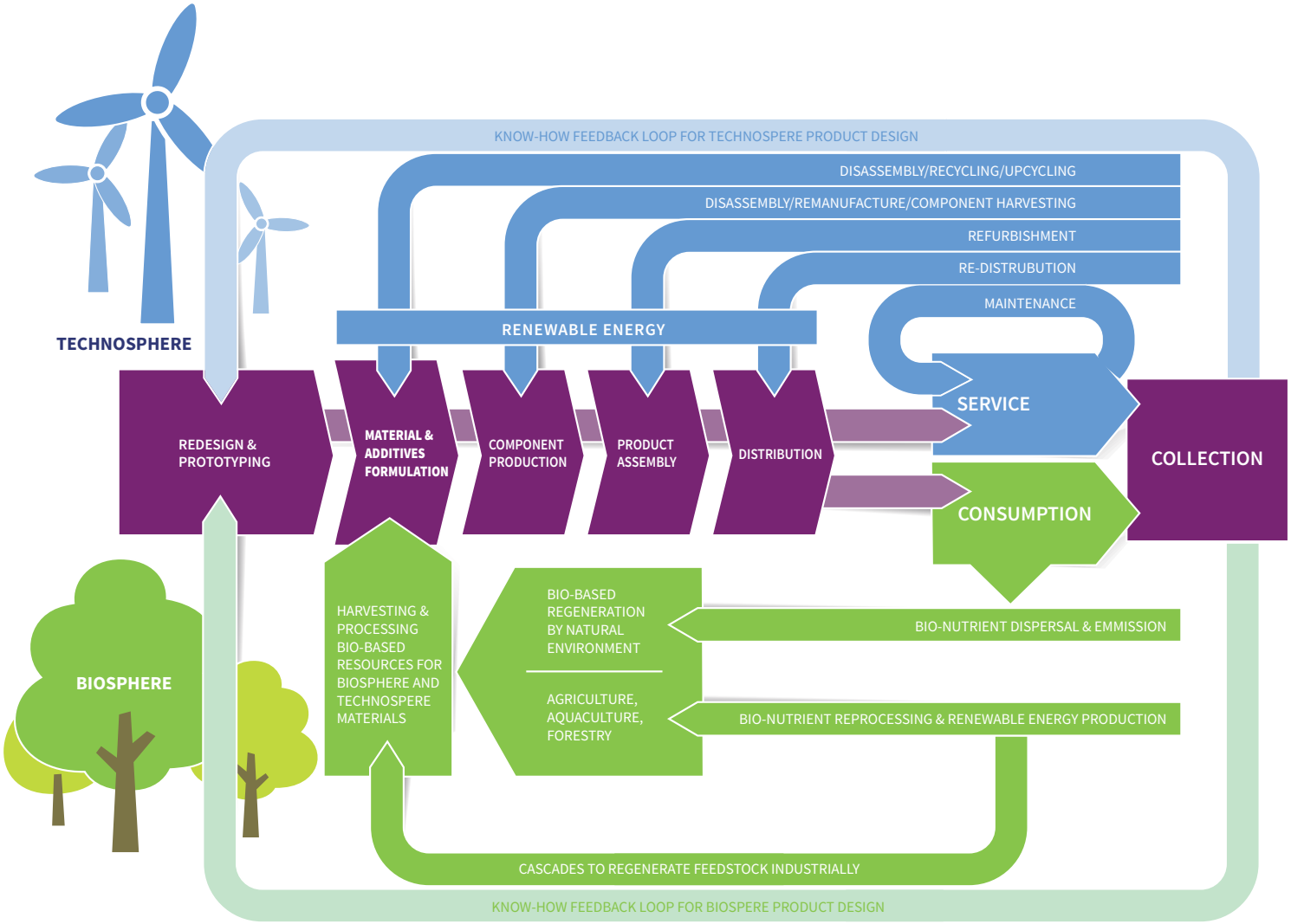


Figure 4: C2C biological & technical cycles for the Circular Economy. Source EPEA, ReturnityPartners, +Impakt.

2.1.1.3 Comparing Linear And Circular Processes

Circular methods alter the relationship between suppliers and customers. A single product could have hundreds of suppliers, and one building could involve thousands of suppliers. Although development processes differ in each region, it is still possible to have an overview of how linear and circular development processes differ.

Figure 5 shows a simple comparison of the linear versus the circular process.

Transforming The Role Of Suppliers To Improve Circular Value

The main challenge is to involve suppliers at the front end to drive circular innovation and generate savings. This involves a paradigm shift in the way customers work with suppliers.

Suppliers are usually involved at the back end of the development process, which results in;

- low incentive for suppliers to use circular methods
- minimal involvement in systems optimisation
- low quality and high failure rates for products.

More effective ways to include suppliers in the circular development process were pioneered in developments like Venlo City Hall and Park 20|20 in The Netherlands, and Ronneby municipality schools in Sweden. They include the private and public sectors.

Table 2 is a comparison between supplier involvement in the linear and circular building processes, to demonstrate potential for improving quality in a Circular Economy.

While the process described here is easier to implement in the private sector, it is also possible to adapt it to the public procurement process. For more information on how this approach fits into the public procurement and tendering process, see section 4.1 on Roadmaps.

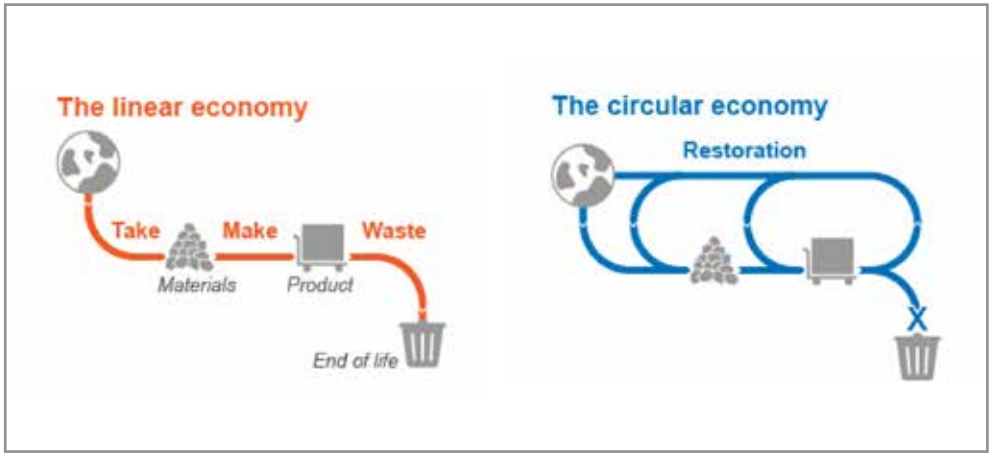


Figure 5: Linear versus Circular Economy. Source Desso.

Linear Downcycle

START HERE

In the linear model there is no feedback by suppliers into early designs.

- Site planning & design & approvals are done without suppliers or building contractor
- Individual buildings planning & designs done without suppliers
- Contractor selection is done on a tender or selective bid basis.
- Contractor sends tenders to suppliers based on designs done without suppliers
- Suppliers submit bids to contractor but owner does not see those
- Contractor pushes suppliers to lower price then selects cheapest supplier
- Suppliers lower price then order products at the last minute

End Results

- Suppliers normally do not communicate with each other on systems integration
- Developer and owner have poor control over which products they receive
- Leading to low quality & high failure rates which add costs later for owner

Circular Up-Cycle

- Improved quality & lower failure rates add value
- Owner & operator receive transparent view of products, systems integration & pricing

End Results

- Suppliers order products based on systems knowledge & known profit margins
- Suppliers still compete but on the basis of highest quality for a known price
- Contractor sends tenders to suppliers to provide best quality at a known price
- Developer, contractor & suppliers co-create budgets for selected systems & products
- Developer/owner contacts potential suppliers for selected systems & products
- Planning & designs including consultation with potential suppliers & users
- Developer/owner works with suppliers to integrate holistic quality by briefing them on circularity goals.

Building Design Approvals

In the circular model, planning & design include potential suppliers & contractors

START HERE

Table 2: Transforming the Downcycle to an Upcycle by involving suppliers early in the building process

2.1.2 Modular Design Tools

Modularity is not a new concept, but it is an important tool for circularity. Modular design allows the creation of spaces, infrastructures, buildings, systems, components and products that can be easily assembled and disassembled, are multi-functional, accessible for repair and composed of defined materials. Modular design improves quality and economic performance, residual value of components & materials, and facilitates their reuse or reintegration into technological or biological cycles. It also allows rapid adaptation to innovations in manufacturing and equipment.

A summary of benefits is in Table 3.

Construction	Quicker, easier construction due to designs focused on rapid installation and assembly.
Operations & Maintenance	Improving recovery value of materials by making their extraction quicker and easier.
Sale & Disposal	Quantifying recovery value potential from materials.
Modular Assembly	Modular assembly speeds construction by splitting systems into modules, which are pre-assembled then delivered to the assembly location.
Multifunctionality	Fewer tools required and manufacturing assembly costs are reduced if one connector type performs multiple functions. Costs are reduced if one part is used in multiple systems.
Reliable Contents/ Ingredients	Defined content improves recycling quality and value of component materials as well as avoiding liability from hazardous substances.
Accessibility	Accessibility for convenient on-location cleaning & maintenance. Quick extractability of parts from products or components so they can be reused, refurbished, or recycled at high quality and repairs are easier.
Value Chain Integration	Integrating Design for Disassembly (DfD) along the value chain can generate savings for the entire chain, from concept through to dismantling. For example, modular designs make assembly quicker, maintenance easier, reduce disruptions to building operations, and make recovery of components and recycling more economical.

Table 3: Benefits of modular designs

These modular concepts can be accelerated by databases and design software, thus adding the advantage of ICT and data analysis, through automated recognition and correction of errors, as well as transparency between actors in the value chain and accurate tracing of components and materials. (Source of section courtesy +Impakt)

Reversibility Tools

The term "reversible" is applied to buildings in diverse ways. These each improve residual and operating value. For example;

Re-purposable buildings

A re-purposable building is easily modified to suit different functions and users. Today, especially the interiors of buildings are being repurposed at a much faster rate due to the rapid turnover of occupants. For example, Luxembourg's Kirchberg development experienced large-scale construction of buildings some years ago, and today many of the tenants of those buildings are turning over, long before the buildings' useful function is over. Costs of repurposing those spaces could be significant. These turnovers are happening across Europe and globally.

Reversible buildings

A reversible building is one that comes apart easily at the end of its useful function, but also for renovation. Reversibility supports repurposing.

Reversible products

Products that go into buildings are sometimes already designed for reversibility in order to improve their repair as well as extraction from a building. Pumps are an example. In this case reversibility includes the following levels;

- Extractability from the building and ease of re-purposing or re-installation e.g. how easily the product disconnects and can be re-connected. Types of connectors are a key aspect of this (see Figure 24).
- Disassembly of components. How easily the components could be removed for rapid repair and refurbishment.
- Reusability of components. Which components are easily re-used in the same product or other products.
- Separation of materials. This is a more challenging part of reversibility; separating the parts into their component materials for recycling or next use. Increasingly, composites as well as complex combinations of materials are challenging the capacity to effectively access component materials. However, advances like chemical disassembly are being introduced to meet the challenges of composites.

For a simple yet effective guide to designing reversible products by Stanford University lecturer Jeremy Faludi watch his youtube presentation *https://www.youtube.com/watch?v=vcFRvuOnWQ8*.

Examples

BAMB Pilot Projects and Reversible Experience Modules

As part of the BAMB project, a number of pilot projects for reversibility were initiated and are described at *https://www.bamb2020.eu/topics/pilot-cases-in-bamb/*.

One of those projects is the Reversible Experience Modules (REMs). These modules were designed as a travelling exhibit to show how products and elements in buildings can be defined for their content as well as their connection to a building. See *http://www.epea.nl/rems*.

Adapted from the REMs website;

Instead of being immovable mountains of materials, buildings become improvable and re-useable with lasting value. Built for changing people, in changing environments, and for being used over and over again. The Reversible Experience Modules exhibition shows how to build such collections of reuseable products and materials, and how Materials Passports are the key tool to organize the building and re-building (Figure 6).

The REMs exhibition consists of more than 70 building materials and -products, all optimized for healthy use and reuse. Together they form a space that resembles parts of actual buildings, with a hallway, an office area, a home area and an outside area. Visitors use the Materials Passports to dismantle and rebuild parts of the exhibition themselves. They experience the benefits of building for reuse, and see what Materials Passports make possible.

Figure 6: Reversible Experience Modules. Image EPEA.

How to design-in reversibility?

A range of books and pilot projects describe how to design reversibility into buildings and products, but the methodology is still in its infancy compared to its potential. The main challenge is to include it in the goal-setting phase of the project and be certain that contractors and suppliers are aware of this.

The University of Twente is one of those at the forefront of reversible building design and has published a series of papers on the topic arising from a conference held there in 2017. The publications are found here *https://ris.utwente.nl/ws/portalfiles/portal/24832151/Conference_Proceedings_3rd_Green_Design_Conference_web.pdf*.

These methodologies are extensive and still in development. For example, Twente has developed for the BAMB project a typology for connection types describing ways in which products and elements are connected to a building or each other. At the time of writing the methodoly was still in development and an example is described in Table 4.

For up-to-date information on reversibility in buildings, simply perform a web search for 'design for disassembly built environment'. The number of books and guides on the topic is multiplying rapidly, so do a search periodically.

Connection Types	Description
Type I	› Direct chemical connection. Two materials are permanently fixed by chemical connection (no reuse or upcycling).
Type II	› Indirect connection with irreversible chemical connection, which is stronger than the connected elements/ materials/products.
Type III	› Direct connection with reversible chemical connection. Two elements are connected with softer chemical substances, which can be removed or delaminated (reuse by refurbishment is possible).
Type IV	› Direct insert connection. Two elements are connected by upland insertion of accessories into the element (element is weaken after disassembly).
Type V	› Direct connection with mechanical fixing devises. Two elements are connected with mechanical connection, which can be removed without damaging the elements (reuse and reconfiguration/adaptability is possible).
Type VI	› Indirect connection via dependent third component. Two elements are separated with third element/component, but they have dependence in assembly (reuse is partly possible).
Type VII	› Interlock connection. Two elements are connected without being damaged by fixing devises (direct reuse and reconfiguration/adaptability possible).
Type VIII	› Intermediary connection. Two elements are connected by third element using dry/ mechanical connections. Disassembly of one element does not affect the other (direct reuse and reconfiguration/adaptability possible).
Type XI	› Gravity. Two elements are connected only by gravity force.

Table 4: Connection Types. Typology developed by E. Durmisevic Twente University BAMB Project.

2.1.3 Tools To Integrate Modular Designs With Healthy Materials

The following examples show how to integrate modular design with healthy materials.

The Steelcase Think chair (Figure 7) comes apart in seconds for profitable recovery of parts and materials for reuse & same-quality recycling. It also reduces assembly time and costs as well as improving the resale value and makes repair quicker and less expensive.

Likewise, the Herman Miller Mirra chair (not shown here) based on similar principles also proved that modular designs can be beautiful. The chair is featured in the Museum of Modern Art in New York. Building designs can take many lessons from the Herman Miller Chair. Before Herman Miller applied those principles to its product, it already applied them to its factory with William McDonough Architects, resulting in improved productivity. Studies on Herman Miller designs are published by Harvard Business School and the Journal of Industrial Ecology.

Figure 7: Steelcase Think chair comes apart in seconds for profitable recovery of parts and materials for reuse & same-quality recycling. Images Steelcase.

BB-Lightconcepts developed Lightpipes® (Figure 8), which generate consistent high quality flicker-free lighting designed for easy installation and maintenance.

BB-Lightconcepts used C2C design and leasing concepts to achieve savings on manufacturing, use, energy, and disassembly. For more information see *https://bblightpipe.com/*.

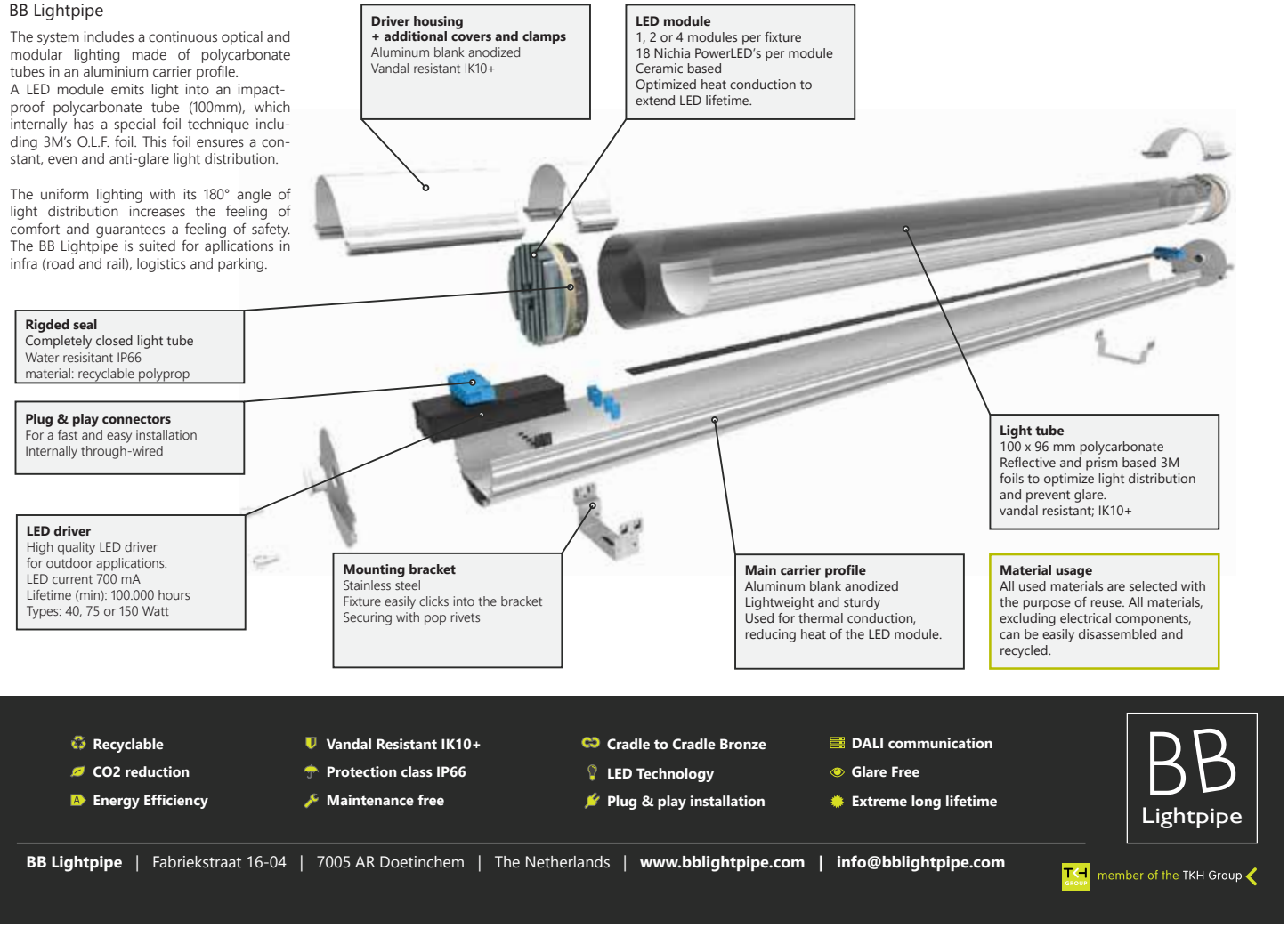


Figure 8: Lightpipes® by BB-Lightconcepts. Image BB-Lightconcepts.

2.1.3.1 Materials Chemistry Tools

Everything in buildings is made from materials. Every material consists of chemicals. However, chemistry is not part of architectural training and most architects are not familiar with materials chemistry in the buildings they design.

It is important for architects and designers to learn more about the materials they specify because there are important value propositions connected to the chemistry of buildings including;

- Healthy air quality in buildings depends on healthy materials.
- Innovative energy generation and savings depend on chemistry.
- Surfaces safe for human contact are based on safe chemicals.

The EPEA ABC-X assessment system (Figure 9) was designed for assessing healthy ingredients in products. Chemistry is the basis. For more information please refer to *https://www.epea.com/scientific-foundation/*.

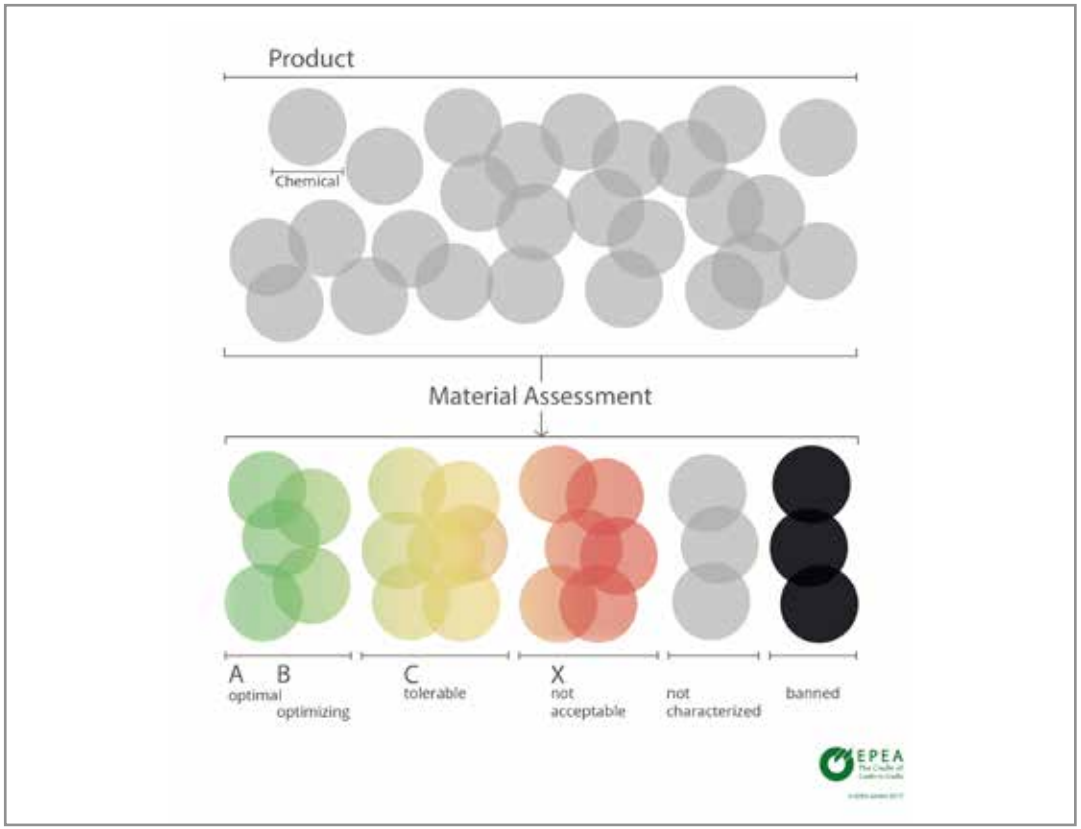


Figure 9: The EPEA ABC-X assessment system for healthy ingredients in products. Diagram EPEA.

Using the right materials also saves energy

There is a strong focus on energy savings in buildings. However, energy savings often come from materials choices. For example, the conveyor system company Vanderlande saved more than 50% energy consumption in a prototype conveyor system when it changed the materials in its rollers from PVC to a C2C certified™ plastic. The improvement came because the replacement plastic required less tension on rollers (see Figure 10).

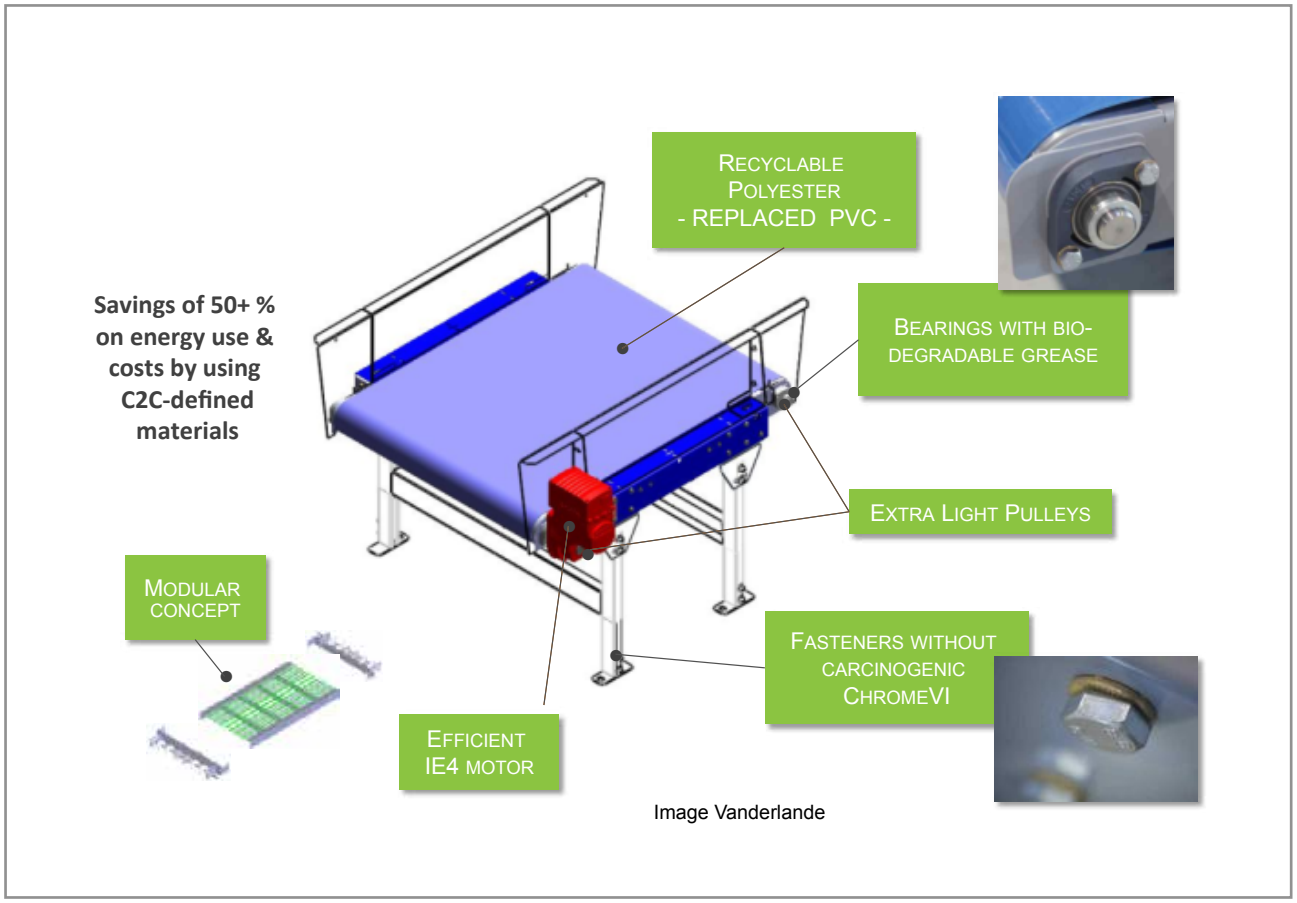


Figure 10: Using the right materials to improve energy performance and quality in a conveyor system. Image Vanderlande.

2.1.3.2 Use Materials Passports As Tools To Improve Holistic Quality

In 2013, the European Union Resource Efficiency Platform recommended creating Product or Materials Passports to facilitate recovery and re-use of materials in products used throughout the economy. The call for Passports was a response to materials scarcity and price volatility especially in Europe because Europe has fewer natural resources than other parts of the world.

In 2015, the EU Horizon2020 Buildings as Materials Banks (BAMB) project was launched with one of its goals being to establish and optimize Materials Passports *www.BAMB2020.eu*. Following that, a number of other passport platforms were created for products and for buildings.

Why are passports important for building owners?

Surprisingly, most building owners do not know what is in their buildings. The information usually stays with the contractor in a complex web of invoices and purchase orders. Product choices are often made after the contract is awarded, based on low cost rather than added value for the owner.

One result is; While the value of material commodities historically rises, it drops in buildings because the materials are not designed for recovery. As well, materials prices have been rising and falling suddenly over the past years, and this volatility is a problem for suppliers because its leaves them uncertain about future supply costs. Combined with that are challenges of knowing the materials content of products to achieve healthy buildings and product choices. Materials Passports are designed to fill that gap, and they cover more than materials content;

What are they?

A Material(s) Passport is a set of data describing defined characteristics of materials in products that give them added value for their present use as well as recovery and reuse.

Passports are a marketplace mechanism to encourage product designs, material recovery systems, and chain of possession partnerships that improve the quality, value, and security of supply for materials so they can be reused in continuous loops or closed loops or beneficially returned to biological systems.

Materials Passports are distinct from, but can be used to support Environmental Product Declarations (EPDs) reporting on the environmental impact of materials or assemblies. See Figure 11 for an example of a Materials Passport, describing the basic function of the product, which circularity aspects it was assessed for, and where it fits into technical and biological cycles for re-use. This output results from data input by suppliers, which is then processed into usable information. Other examples of Materials Passports are found in the *Reversible Experience Modules Manual Guide* developed for the BAMB project *http://www.epea.nl/rems/*.

Figure 12 gives examples for the structure of a passport platform. In order for passports to be implemented, three core stages are required; Data input, data storage & processing, and passport output. The passport shown in Figure 11 represents the final output stage. Passport platforms are also developed to include products in the context of buildings (Figure 13). Examples of Materials Passport-type platforms as well as the challenges associated with them are found in a *State-of-Art Synthesis Report* published as part of the BAMB project *https://www.bamb2020.eu/wp-content/uploads/2016/03/D1_Synthesis-report-on-State-of-the-art_20161129_FINAL.pdf*.

Figure 14 compares Building Passports and Materials Passports. For example, the engineering company Drees & Sommer co-developed the Building Material Scout, a service that provides information about healthy building materials *https://www.building-material-scout.com/en-us/index*. Drees & Sommer designed a revolutionary building in Essen Germany that is piloting a system of Building Passports *https://www.bamb2020.eu/topics/pilot-cases-in-bamb/new-office-building/*. Another example of building-level platforms is Madaster, which is designed as a public, online library of materials in the built environment. It facilitates registration, organization, storage and exchange of data *https://www.madaster.com/en*.

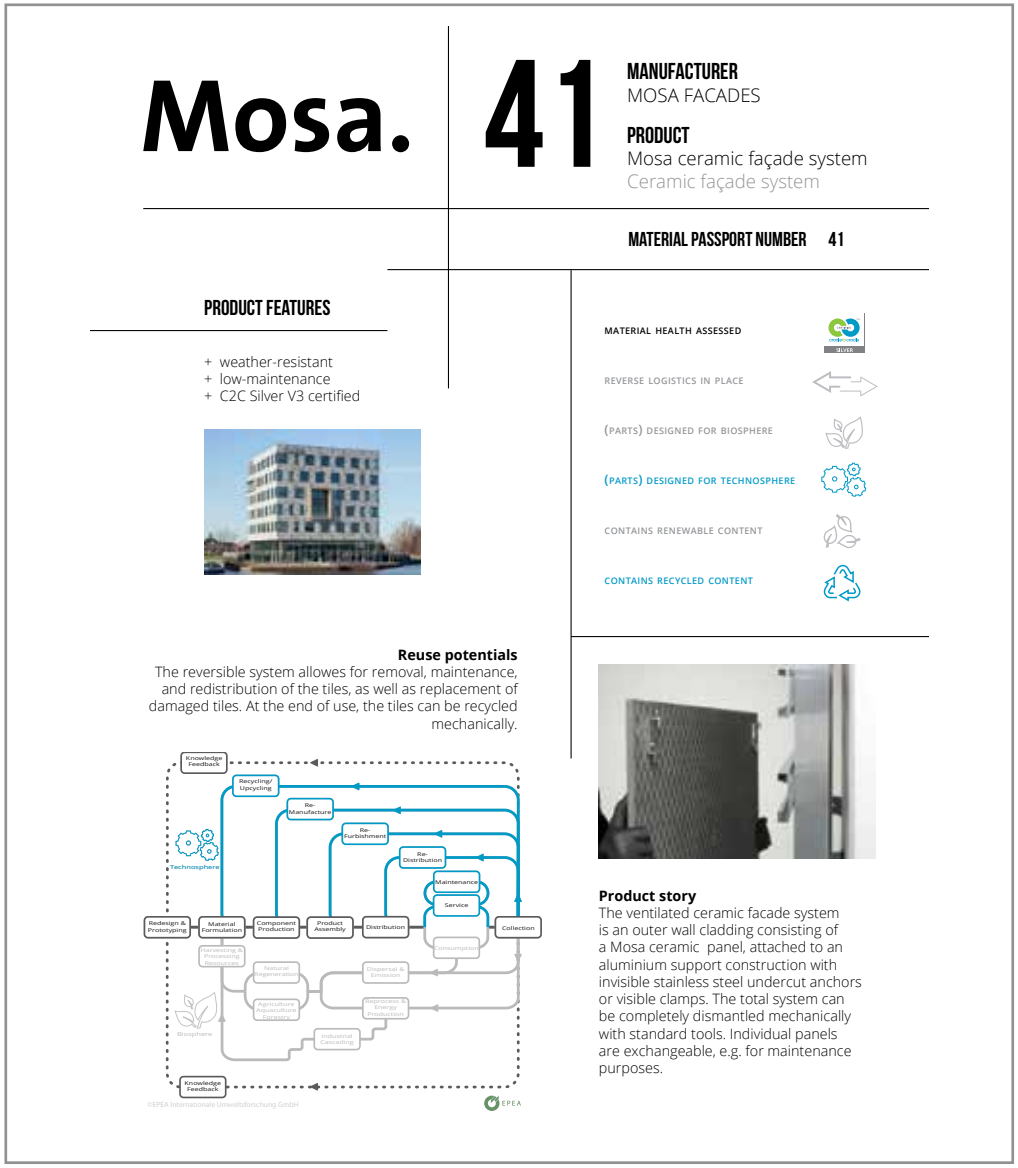


Figure 11: Example of Materials Passport output. Excerpted from Reversible Experience Modules manual *http://www.epea.nl/workspace/uploads/imagefolder/180911_manualguide_v4-secure-.pdf*.

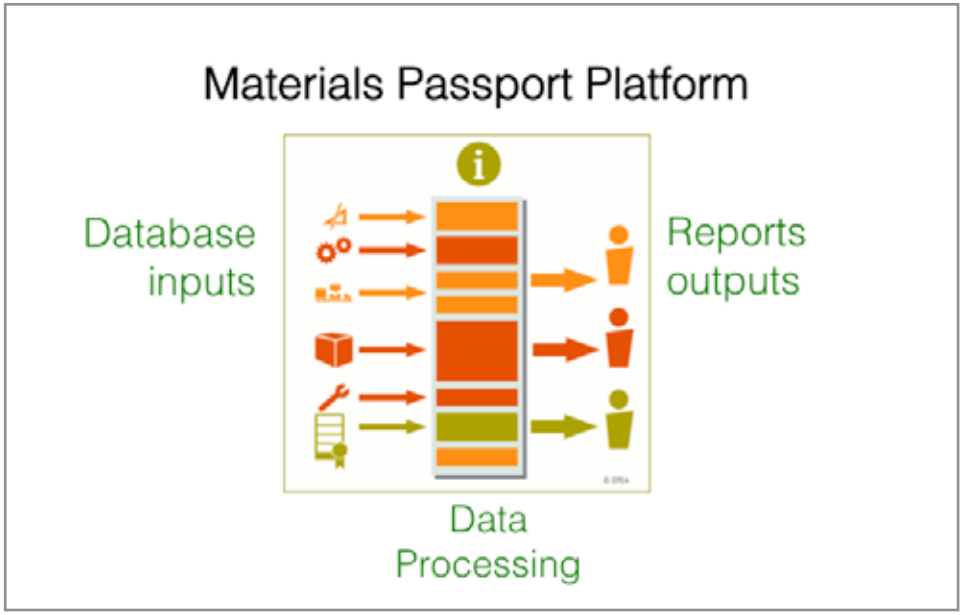


Figure 12: Structure of a passport platform

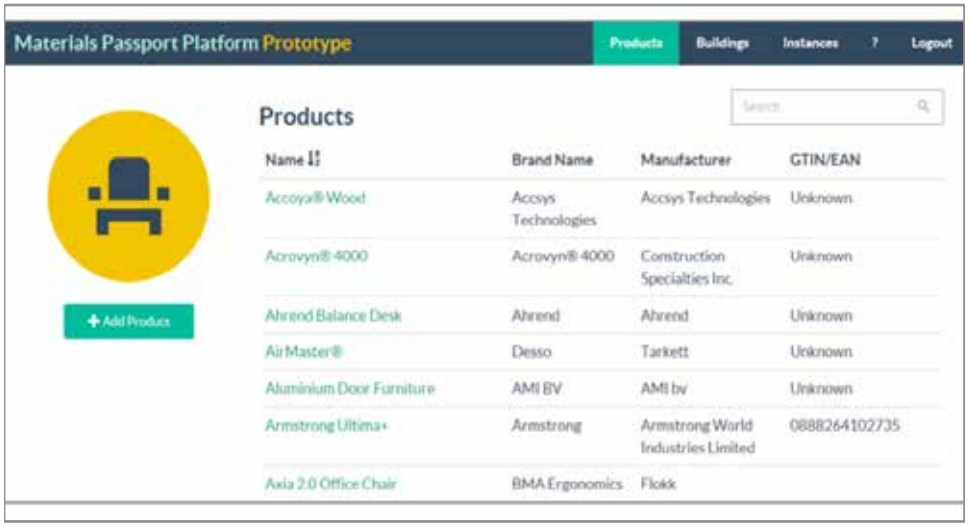
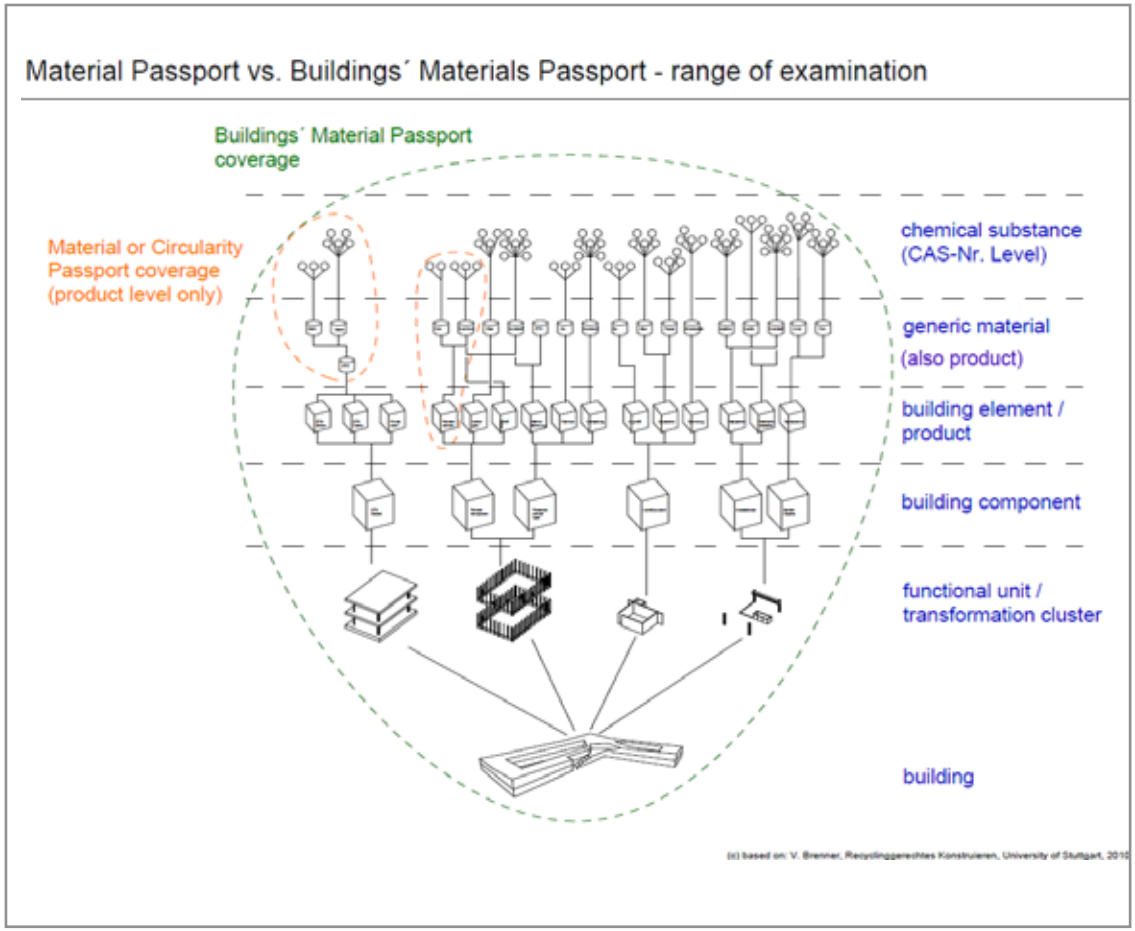


Figure 13: Passport platforms are also developed to include products in the context of buildings. Here is a snapshot depicting that type of platform.



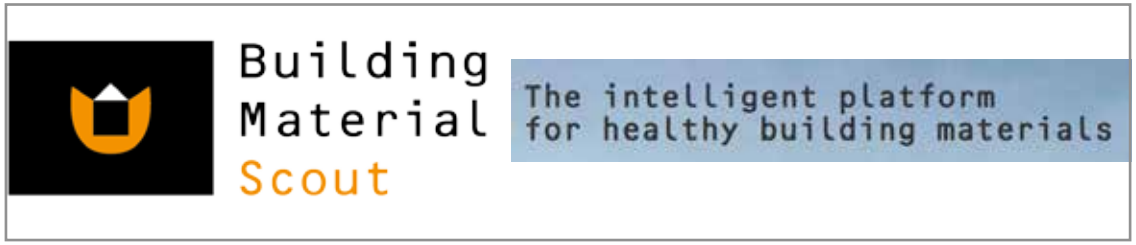


Figure 14: Materials Passport vs. Buildings' Materials Passports. Source (upper diagram): Based on V. Brenner *Recyclinggerechtes Konstruieren*, University of Stuttgart, 2010. The Building Material Scout then used a similar approach in a platform for healthy building materials & products, also organised into building projects. Source: www.building-material-scout.com

2.2 Selecting Project Stage To Start

2.2.1 Which Stage Do You Want To Start At?

The process can be started during building planning, construction or operations;

- In many cases Stakeholders only learn about C2C when they are part-way through the building development process, so it is important to identify at which stage you are starting and where the approach can be used.
- The focus will differ depending on when you start.

2.2.1.1 Identify Project Stage

Start your inventory after you know which stage of the development you plan to start with. For example; if site services are already installed there is no point spending time and money on design criteria for those services.

2.2.1.2 Determine Your Starting Point Before Choosing Goals And Tools

Different stages e.g. planning, tendering, or operations have different focuses.

For example at the planning stage, goals inspired by the Cradle to Cradle Building Manifesto presented at Biennale in Venice 2016 offer the broadest possibilities, *www.beneficial-footprint.net* (Figure 15).

At the planning phase of a residential building, many features can be implemented. Here are examples being implemented by one of the future residents of a private multi-unit residential development in Utrecht (Developer CPO Goeman Borgesiuslaan). These are far less expensive to include at the beginning than to retrofit.

- All electric heating and cooking with an air-to-water heat pump system including enlarged boiler to buffer heat during the day.
- Thirteen 300wp solar panels on the roof for renewable energy generation.
- Sedum-green roof integrated with the solar panels to reduce thermal stress on the panels, and increase their performance, increase cooling in the summer, support biodiversity, finedust capture and air purification.
- Central open "light & air column" from a roof-window all the way down to the ground floor connecting all floors to increase daylight everywhere.
- The roof-window can be opened to increase natural ventilation in the summer through the same central column.
- White south-façade to reflect sun in the summer and passively prevent overheating.
- Shutters for the windows on the south façade to prevent overheating.
- Pergola in front of south façade with seasonal vegetation overgrown in the summer to block sun, and open in the winter to let sun in.
- Clay stucco on the inside walls for material health, acoustics, humidity regulation and heat buffering.
- Natural stone floor for optimal floor heating efficiency and heat buffering.
- Acoustic ceiling, which also improves humidity regulation.

Figure 15: Cradle to Cradle Building Manifesto presented at Biennale 2016. Every line in the poster represents a potential goal for a building. Source Braungart et al.

Starting Later?

If you start later in the development process, it is important to leverage existing features in your building.

Example of leveraging existing features; If a water recycling system is already designed into the building, it might make sense to negotiate tax breaks or extra building space with water authorities to take advantage of infrastructure savings from the building recycling its own water. This was implemented as a prototype in the Covent Garden building in Brussels (Figure 16). In that case you can use an existing asset to generate circular added value.

If the building is already in construction and the structure is in place, there is no point to focus on optimizing structural materials. Focus on something else. SolarWind developed by IDL at Ecoparc Windhof in Luxembourg began before Stakeholders learned about C2C. However, due to its many innovations the developers were able to retroactively identify C2C–Inspired Highlights and identify new added value. New interior Highlights were also included late in the construction. For example, Thoma Holz C2C certified™ wood was installed in the top floor meeting room *www.thoma.at* (Figure 17).

Determining the stage of your project will also let you manage expectations by determining which C2C added values are realistic to achieve.

For example, if you start at the post-design stage, structural aspects will already be fixed, so it makes sense to focus instead on C2C-Inspired Systems Integrations for interiors, landscaping and operations.

See Table 11 Examples Of C2C-Inspired Focus At Each Phase Of Building Development.

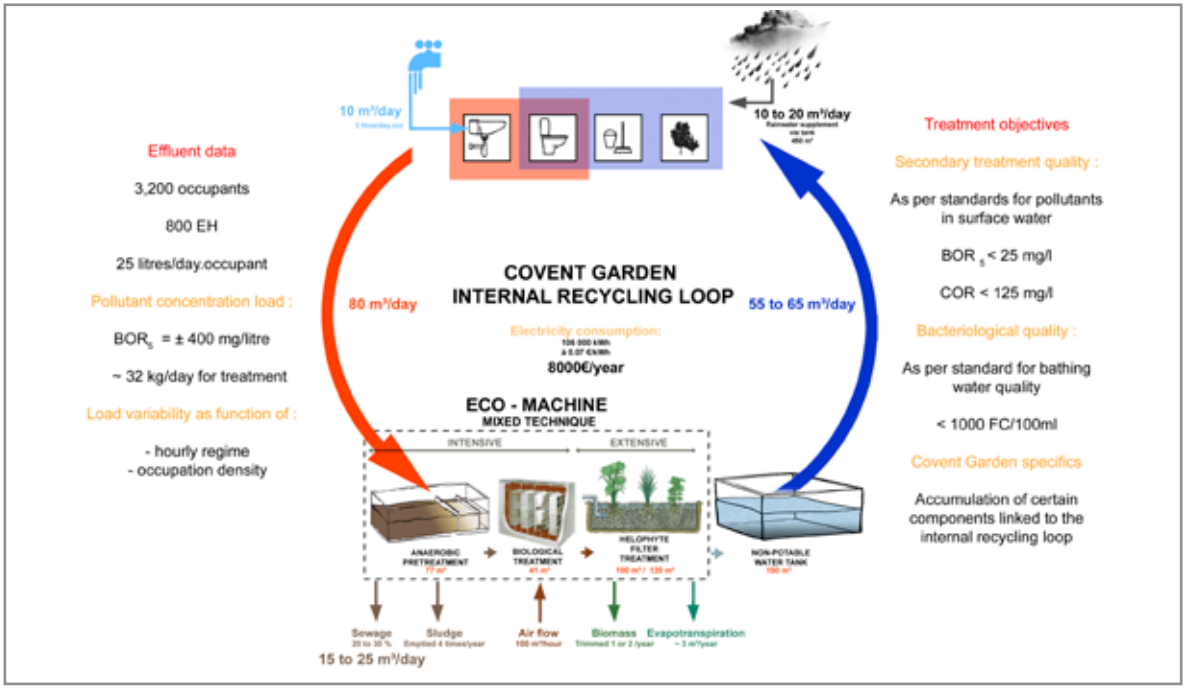
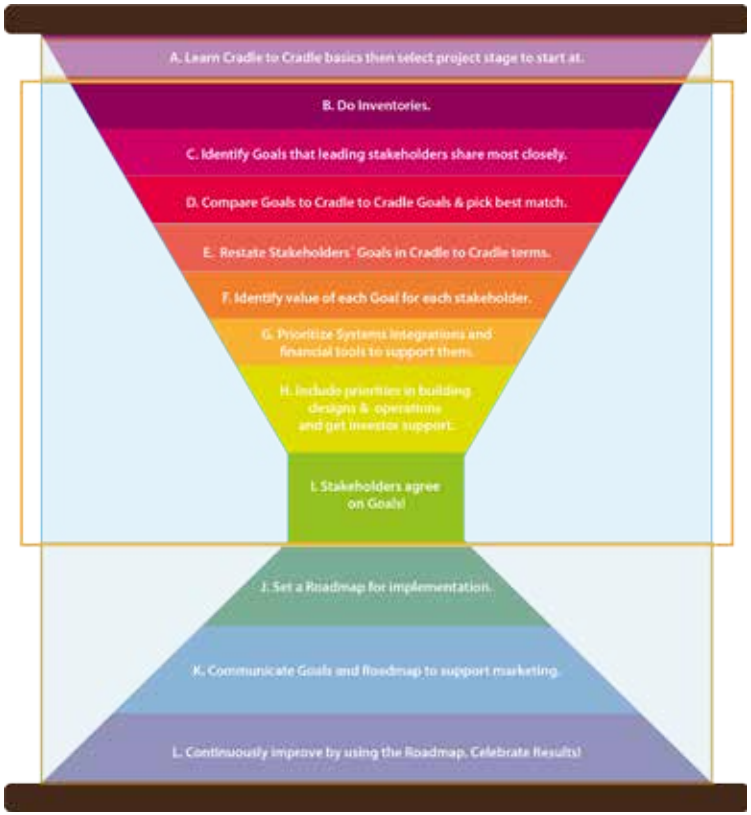


Figure 16: Water Recycling, Covent Garden Brussels. Source Art & Build.

Figure 17: Starting later? SolarWind developed by IDL at Ecoparc Windhof in Luxembourg - the developers were able to retroactively identify C2C–inspired Highlights and identify new added value. Image Solarwind. For example, Thoma Holz Cradle to Cradle certified™ wood like example at top right was installed in the top floor meeting room. Image Thoma Holz GmbH.

3. Planning Stages B. To I. Inventory & Goal Setting



3.1 Planning Stage B. Inventory What You Have And Need

3.1.1 What Is An Inventory?

The term 'inventory' is used here to describe a list of available resources. The challenge with inventories is to minimize the time and money spent on them. To do this, consider an inventory as a "quick-scan". In this respect, C2C inventories take less time than Life Cycle Assessment inventories.

Here are tools to optimize your inventory process;

3.1.1.1 Identify Ways To Get Resources For Planning

A main cause of mistakes in building developments is too few resources for planning. An effective planning process has a very low cost compared to the costs of fixing mistakes later. To achieve this;

- Consider capitalizing investment for planning to spread the cost over years instead of treating it as a short-term operating expense.
- Consider applying for innovation subsidies to optimise C2C-Inspired Integrations in your development.

3.1.1.2 Identify Tools To Finance Integration

Every building development has a financial framework, which offers potential for C2C-Inspired added value. Use Table 6 to identify those opportunities. Organize a special workshop to focus on those tools.

3.1.1.3 Identify Economic Stakeholders

In C2C, Stakeholders become partners for getting financial resources as well as benefitting from added value. See Table 8 Examples of Stakeholders. It is surprising how often planners do not inventory Stakeholders, with the result that Stakeholders create barriers. For example, local residents can block a development if they feel threatened by it or not consulted. So, know who your Stakeholders are.

3.1.1.4 Organisational Culture Tools - Learn What Stakeholders Actually Want

Intentions & Goals can best be achieved if Stakeholders perceive they are formulating them as their own.

It is important to align C2C Intentions and Goals with Stakeholders' own perception so they work together positively.

Experience shows success comes when Stakeholders voice their Intentions and Goals and adopt them instead of being told what the Goals are.

> *Facts are facts but perception is reality!*
>
> - Albert Einstein

3.1.1.5 Learn The Business And Organizational Culture Of The Main Stakeholders

The culture of the organization plays an important role in defining Intentions and Goals, then implementing them.

Example of organizational culture questions to investigate;

- Is the organization known as a frontrunner or as conservative?
- Is the organization proactive or reacting to outside pressure for changes, e.g. new regulations or public pressure?

- Does the organization encourage input from outsiders or does it rely more on its own designers?
- Might part of the owner's business be tied to development or operation of the building to involve them directly, e.g. monitoring systems, construction materials, management systems?

3.1.1.6 Quick-Scan Site Features

If the site has already been selected, identify special challenges or positive features where C2C value-added Goals might be developed.

Examples of Site-Specific Qualities;

- For a renovation; existing feature e.g. atrium. Describe integrated water, air, nutrient and biodiversity benefits of the atrium so you know what it does now as a basis for optimizing. See Table 10 Example Of C2C Integration.
- Innovative product manufactured in the building or area.
- Protected nature reserve on or near the site.

3.1.1.7 Inventory Systems To Focus On For Integration

You can combine building systems to generate added value by using C2C-Inspired Integration.

Example; Atria can be used to integrate the benefits of HVAC, landscaping, and mechanical systems. See Table 10 Example Of C2C Integration.

3.1.1.8 Do Baseline Analysis. Identify What You Are Already Doing Right!

Identify what you are already doing that might be on the way to C2C. Analyse site qualities with circular potential, especially existing structures and natural assets. Check traditional inventories to identify circular potential.

Example; Check energy contracts, environmental impact statements, zoning submissions to regulatory authorities. For example, perhaps you already developed a power-purchase agreement for on-site renewable energy.

Example; The Ministry of Infrastructure and Environment in The Netherlands commissioned a baseline study to identify C2C-Inspired Integrations for renovation of its headquarters in The Hague. The study found diverse Integrations in the building already on the way to circularity. A sample table of contents showing main aspects of the study is available on request to the authors.

3.2 Planning Stage C. to G. Setting Intentions & Goals

Timeframe

Goal-setting can occur over a few days, weeks or months depending on complexity of the development and diversity of Stakeholders.

Who Does It

Project Developer or Operator working with Stakeholders. Support from an outside facilitator is advised.

3.2.1 Planning Stage C. Identify Stakeholders Goals For The Development

Do You Know Where You Are Going?

The purpose of setting intentions and Goals is so Stakeholders know where you are going and can join you. It is surprising how many building developments start without a clear description or common understanding by Stakeholders of Goals. It leads to big cost overruns later, so it is best to get it right from the start!

Understanding Stakeholder Goals or lack of Goals is important so you can;

- Learn Stakeholder expectations and perspective.
- See if Stakeholders already have Goals that can generate added value.
- Describe circular added value of those Goals.

3.2.1.1 Integrate Innovators With Adopters

In every group of Stakeholders there are usually two types of participants, Innovators and Adopters;

- **Innovators** prefer taking risks with new approaches.
- **Adopters** prefer "tell me what to do and I will make it work."

Innovators and Adopters are each contribute to making C2C-inspired approaches successful. It is important to give them each tools for their particular skills. For example;

- Innovators might want a menu of inspirations while Adopters want a systematic formula for doing the work.
- Adopters in the finance department might want defined "hard" values to calculate C2C benefits. For this, you can refer them to hard values described in Table 5 Examples of C2C-inspired Added Value for Stakeholders.

3.2.1.2 Integrate Tradition, Transition And Transformation

Buildings often have problems due to conflicting aims of Stakeholders; especially conflicts between Innovators and Adopters.

To solve this, you can channel the personal skills and aspirations of Innovators and Adopters into areas of the building where they can innovate or be more traditional.

Therefore it is important to learn aspiration levels of each Stakeholder. For example:

Tradition

Optimize traditional "less bad" sustainability but also learn more about what might be beneficial in your buildings.

Transition

Use an incrementally beneficial approach.

Transformation

Use innovative beneficial approaches to be a frontrunner.

Tradition, Transition & Transformation Can Co-Exist

Stakeholders might want to be traditional in some areas and revolutionary in others. Local technologies or regulations might dictate how aggressive they can be in some areas. You can identify those areas and prioritise them.

For example, the builder might want to be conservative with structural concrete, but the occupants want to be frontrunners with innovative lighting systems and leasing that save operating costs. Perhaps a local company is offering leasing systems that make it easier to implement leasing concepts.

Be sure you understand the reasoning by Stakeholders for their differing innovation levels.

After that develop a table showing innovation intentions for your development. The table is an important tool for managing expectations, describing your intentions to municipal officials, and for marketing your development.

3.2.1.3 Upgrade From Minimizing Damage To Maximising Benefits

Stakeholders working with traditional sustainability can easily confuse being less bad with being good. One of the greatest challenges of implementing C2C is to show Stakeholders the difference.

Being Beneficial

Stakeholders often have functional aims, e.g. providing space for a given number of occupants. Those can be used as platforms to introduce benefits like improving the air and materials quality in workspaces. Table 9 Examples Of Value-Added C2C Quality Dimensions & Goals For Stakeholders describes actively beneficial Intentions & Goals.

The smallest footprint is a building that doesn't exist! Traditional sustainability tries to reduce the footprint of a building, but buildings don't have small footprints. Instead, C2C-Inspiration aims for a big beneficial footprint. Air-and-water-cleaning moss rooftops are an example for that. See summary of benefits in highlighted column at right. The integrated moss roof (Figure 18) was developed from 20 years of research by Wolfgang Behrens' team.

Moss mats have multiple positive impacts. They:

- *are universal biological protective coatings. They are versatile, robust, economical, easy to clean and therefore widely applicable.*
- *are humidifiers. They release water vapor slowly into the air.*
- *produce oxygen.*
- *clean rain water. They filter air pollutants from the rain water, which in consequence no longer seep into the soil.*
- *soften water. They remove carbonates from the water and therefore lower its pH-value. Ideal irrigation water is created again and again.*
- *bind fine particles. Their big, finely structured and positively charged surface holds on to the particles.*
- *convert fine particles into biomass. The ammonia salts are transformed by the moss mats themselves, the organic fine particles by the bacteria that live on the mosses.*
- *take up air pollutants. Gaseous air pollutants, above all nitrogen compounds which are dissolved in water are absorbed.*
- *bind heavy metals. They can remove various toxic and harmful substances from water.*
- *are antimicrobial. Above all in interiors they are cleaning the air from germs like bacteria and fungi.*

Ten Functions of Moss Mats,
excerpted from *The Cradle to Cradle Creative Boxes Booklet*

Figure 18: Being Beneficial with Big Healthy Footprints. Water retention via thin-layer extensive roof on retailer building. Image NIRA GmbH & Co. KG.

Minimizing Impacts

Stakeholders often have traditional sustainability aims, e.g. reduce CO_2. Sustainability often focuses on minimizing impacts instead of being actively beneficial.

The Connection

Sometimes minimization can be translated into beneficial, e.g. instead of minimizing CO_2, maximize CO_2 capture and reuse by plants. Distinguish between minimizing energy and using beneficial energy with technical methods such as "breakthrough efficiency" & "threshold efficiency". For more information on those terms contact *epea@epea.com*

3.2.1.4 Imagineering Tool

Conduct an "Imagineering" session where Stakeholders formulate their own positive Goals based on their own technical and economic strengths. The main purpose is to use Stakeholders imaginations to identify new opportunities. You might seek support from a C2C-trained facilitator.

Desso imagineered a new type of carpet that removes up to 8 times more harmful particulates than bare floors (Figure 19). The Airmaster® is also designed for recycling and uses defined recycled materials. Desso's best-selling product was one of the reasons why the company was acquired by Tarkett, which also specializes in C2C certified™ flooring products.

Is your office or factory suitable for your children to play in? The question was asked at the Ford Motor factory, Ecopark Windhof, Park 20|20 and other developments. In the end the answer was yes. Highlights like water and recreational space can lead to new value-added perspectives for Stakeholders (Figure 20). At Park 20|20 onsite greenhouses grow food that is served in the restaurant.

Especially consider the role of disruptive technologies in generating savings. For examples see the World Economic Forum report *Shaping the Future of Construction* *http://www3.weforum.org/docs/Future_Scenarios_Implications_Industry_report_2018.pdf*.

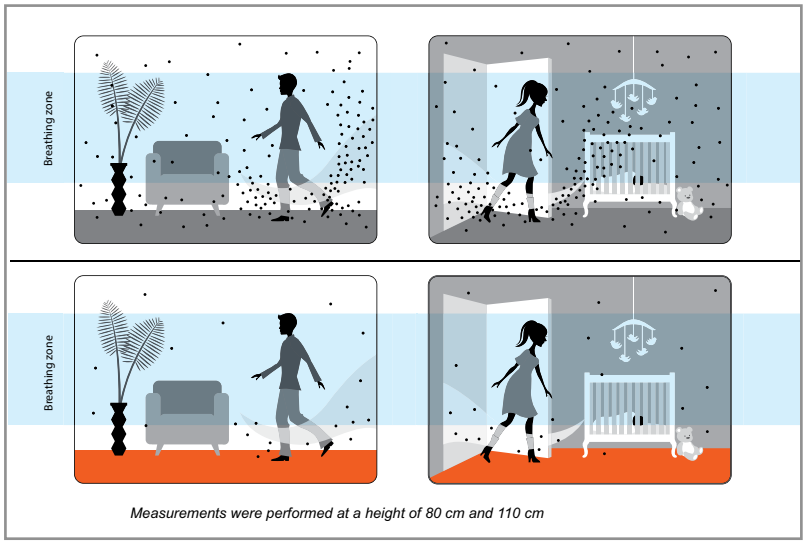


Figure 19: Who Would Imagine? Carpets that clean the air! Desso imagineered a new type of carpet that removes up to 8 times more harmful particulates (lower image) than bare floors (upper image). Image Desso.

Figure 20: Enjoy! Adding new value-added perspectives for Stakeholders. The pond depicted here safely filters water while improving aesthetics. Photograph Sander van Torren, courtesy Delta Development Group.

3.2.1.5 Agree Definitions Of Intentions & Goals With Stakeholders

Diverse Stakeholders have diverse Intentions & Goals. They might call those "Objectives" or "Vision" or "Ambition". It is important to divide those into Qualitative Intentions and Quantitative Goals. This is important because Stakeholders often mix qualitative and quantitative.

For example, C2C Intentions and Goals are distinguished this way;

- Intention. Quality dimension. The focus is quality rather than quantity. Intentions are also referred to as Aspirations or Ambitions but in practice they are the same. Example of C2C-Inspired Intention or Aspiration; *"Every material used in the building will be healthy for occupants and the environment"*.
- Goal. Quantitative target to measurably achieve the intention by a defined date. Example of C2C-Inspired Goal; *"Every material used to maintain the building is defined to 100ppm by year 3 of operation."*

3.2.2 Planning Stage D. Compare Stakeholders Goals To Examples Of C2C Goals

3.2.2.1 Organise Goals By Type

Aligning Stakeholders Intentions & Goals with C2C Goals can be a challenge. However, if done effectively it adds value by getting everybody moving in the same direction.

There are different types of Goals so it is important to spend time identifying those. Examples;

- Stakeholders own goals before they learned about C2C
- C2C-Inspired Goals specific to your building site
- C2C-inspired Goals used at other building developments

3.2.2.2 Consider Examples Of Value-Added C2C-Inspired Intentions & Goals

After Stakeholders draft their Goals, consider existing examples of circular features to complement those. See Table 9 Examples Of Value-Added C2C Quality Dimensions & Goals For Stakeholders.

3.2.3 Planning Stage E. Add Value By Integrating Stakeholder Goals With C2C-Inspired Goals

Timeframe

Prior to drafting tenders at the construction, operations or renovations stage.

Who Does It

Principal Stakeholders together. Outside facilitator.

In this stage, Stakeholder Goals are integrated with C2C-Inspired Goals then Stakeholders take ownership of them. It is preferable to do this stage in a focused workshop with a qualified facilitator.

Be clear what Stakeholders want, then start to adapt C2C Goals to those priorities. It is one of the most challenging stages because sometimes what Stakeholders want seems different from C2C approaches. However, usually it is possible to put the two together.

3.2.3.1 Describe Potential C2C Goals & Set A Timeline

Using information from Goal-setting sections of this guide, develop with Stakeholders potential C2C Goals by integrating their own Goals with generic C2C Goals and site-specific Goals. For examples use Table 10 and Table 11 as guidelines.

3.2.3.2 Convert Stakeholder Goals Into C2C Value-Added Potential

Examples of converting Stakeholder Goals into C2C value-added potential;

- The owner might want to maximize returns by maximizing floor space, but there are other ways of maximizing value without occupying the whole site footprint. See Examples of C2C-inspired Added Value for Stakeholders.
- The employees' representatives might want good working conditions and can be introduced to benefits of greenhouses and air-cleaning vegetation for the working environment.
- The Corporate Social Responsibility department might want a transparent GRI-measurable process for involving Stakeholders and can be introduced to C2C-Inspired continuous improvement Roadmaps as a way of improving transparency.

3.2.4 Planning Stage F. Identify Added Value Of Each Goal For Each Stakeholder

Here is how circular value can be added with diverse tools.

3.2.4.1 Describe Examples Of C2C-Inspired Added Value

Probably the most important step in your financial planning. Added value takes many forms, and can benefit many Stakeholders. It can improve the value of capital assets, generate savings or revenues, or improve security.

Added value can be described in hard and soft terms, where a hard value fits into a financial balance sheet, and soft value is a quality, which makes the development more attractive to occupants but might not have a defined financial value.

See Examples of C2C-inspired Added Value for Stakeholders. It is strongly recommended to hold a dedicated workshop with the main Stakeholders to identify C2C-Inspired added values with them.

3.2.4.2 Maximize C2C Value By Collectively Defining The Site

If site definition for an area development is part of the feasibility analysis, reorganize the process to support C2C-inspired innovation and get more for your money.

Traditionally when competing architects are asked to give site definition input they do not contribute their best concepts due to fear of losing them to competitors. As well, good ideas are often lost when one concept "wins" over the others.

Experience suggests it is more effective to pay a small number of architects to collectively define the site.

After that is done, use the resulting platform as a level playing field to invite competing building designs later. It is more cost-effective for the owner & architects because it integrates the best concepts.

3.2.4.3 Describe Priority For Attracting Occupants

If the building is designed for leasing, does the owner prefer occupants with good credit ratings, or getting the highest rent? A high-rated occupant can improve the capital value of a property. A low-rated occupant might pay higher rent but their lower rating might downgrade capital value by increasing uncertainty. High-rated occupants are more likely to want qualities that improve working and living conditions. Lower-rated occupants might focus on shorter-term considerations.

3.2.4.4 Identify Potential Quick Wins

Quick wins are important tools to demonstrate the value of C2C. Where can you generate immediate results to demonstrate added value of the C2C-Inspired approach? For example, design for quick assembly, light leasing systems, or C2C-workwear can generate instant benefits.

3.2.4.5 Examples Of Innovative Products & Processes To Add Value

Here are examples of innovative products and processes to add value to any project.

The Healthy Printing Alliance. Everybody uses printed materials. Packaging for products used in the built environment can be optimised & certified so it is safe to be recycled in a continuous cascade of products. Examples of C2C-inspired printing are found at *www.HealthyPrinting.eu*. More than 40 organisations are members of the Healthy Printing Alliance (Figure 21).

Figure 21: Join The Healthy Printing Alliance!

Support biodiversity by providing a home for bees anytime from site acquisition, through operation to demolition! For example, this modular street divider for a parking lot was designed as wood bee habitat to add value with aesthetics & biodiversity. Companies like Carlsberg support the CityBee project in Copenhagen for urban honey-making. The EPEA headquarters in Hamburg has a bee colony on its roof. Features like this are quickly assembled and disassembled for use at other sites (Figure 22).

Figure 22: Be(e) Smart With A Bee Parking Lot! Photo Douglas Mulhall.

Textile air ducts facilitate high air quality by cleaning air as it moves through a building. They are removable and washable. This avoids build-up, which commonly occurs in metal-duct systems, as well as reducing energy costs. The air ducts can also be easily adapted after renovations (Figure 23).

Mounting systems support quick assembly & disassembly. Partner with product suppliers to develop a roadmap for continuous improvement for features like mounting systems with rails, brackets, assembly pieces and clamps (Figure 24).

Figure 23: Cradle to Cradle certified™ Cradlevent® textile air ducts for continuously high air quality & easy repurposing for renovations. Photo KE Fibertec.

Figure 24: Support Quick Assembly & Disassembly - wall mounting systems allow quick installation & removal of products fixed to walls. Photo Würth, Künzelsau.

3.2.4.6 Examples Of C2C-Inspired Added Value For Stakeholders

Table 5 shows examples of added value for different Stakeholders. Use it as a checklist.

VALUE-ADDED CATEGORY	VALUE ADDED TYPE Hard Value = Value can be calculated using standard accounting methods. Soft Value = Requires subjective estimation of value to Stakeholders.	STAKEHOLDER WHO BENEFITS
Revenue	**Hard Value** › **Selling C2C-defined renewable energy** into the grid or to other buildings. › **Storing C2C-defined energy** to improve returns on renewables investment by releasing energy when it is required. › **Revenues from diversifying spatial use** during different parts of the day, e.g. using foyers as event spaces after work hours, or sharing meeting space between buildings. › **Carbon credits** from reusing CO_2 as a resource. › **Urban farming revenues** from leasing rooftop, walls, or atrium space & growing food for building occupants or restaurants/cafeterias.	Owner Leaseholder Occupants
Capital Value	**Hard Value** › **Materials banking** to improve residual value instead of incurring demolition & removal costs throughout the building cycle. › **Innovative functional landscaping** can improve the capital value & aethetics of a building, e.g. water & hedges as barriers instead of fences. **Soft Value** › **Improved internal environment**. Capital value of the development increases due to perception that C2C-Inspired improvements make the building a desirable place to work or live. › **Lease value.** For tenants the added perceived value might improve the value of the lease if the tenants are considering sub-leasing. › **Municipality improves its own attractiveness** through high-value properties and avoiding derelict properties that harm taxes and attractiveness of the area.	Developer Owner Investors Leaseholder Municipality

VALUE-ADDED CATEGORY	VALUE ADDED TYPE Hard Value = Value can be calculated using standard accounting methods. Soft Value = Requires subjective estimation of value to Stakeholders.	STAKEHOLDER WHO BENEFITS
Financial & Supply Chain Security	**Hard Value** › **Reliable energy & water costs** into the future. Energy and water costs are increasing in real and inflationary terms. Energy autonomy can be used to reliably calculate energy costs and revenues for the building into the future. › **Decoupling from materials price & supply volatility** by being able to recover materials from buildings. **Soft Value** › **Energy security** from self-generated and stored power. › **Water security** from capturing & recycling water.	Owner Leaseholder
Capital & Cash Flow Savings	**Hard Value** › **Improving value of available space per m^2** by including productive functions in under-utilized areas, e.g. rooftop greenhouses & green walls. › **Increase investment available per m^2** through diverse use of the same space, which reduces floor space required, allowing more investment into a smaller physical footprint. › **Improve capital value from high credit-rated tenants.** Capital value is often determined by the quality of tenants' credit rating instead of how much rent they pay. A healthy building can attract more reliable tenants. › **Service and leasing** to save capital costs or cash flow on systems & equipment, e.g. leasing office interiors, energy generating systems & lighting systems. › **Improve energy investment payback times** with building integrated elements, e.g. building-integrated photovoltaics (BIPV). › **Water cost savings** from capturing & recycling water. Also reduces stress on municipal water systems and reduces requirements to build new infrastructure to service new buildings. An important consideration for municipal authorities when negotiating zoning for the building. › **Renovation & next phase savings** with disassembly & reassembly. (a) Recover materials as assets instead of demolition liabilities (b) Improve redemption value of land. (c) Make later renovations or additions less expensive.	Developer Owner Supplier Water Agencies Municipality

VALUE-ADDED CATEGORY	VALUE ADDED TYPE Hard Value = Value can be calculated using standard accounting methods. Soft Value = Requires subjective estimation of value to Stakeholders.	STAKEHOLDER WHO BENEFITS
Capital & Cash Flow Savings (continued)	› **Collective purchasing savings** e.g. of C2C energy in deregulated markets, C2C paper with customers acting as suppliers of feedstock for recyclers in a continuous loop. › **Insurance savings** by defining safe materials & improving security, e.g. tenants in an area development can pool resources to improve security. Insurers sometimes offer premium reductions for these features. › **Landscape maintenance savings** by reusing nutrients from e.g. wastewater by recycling them for fertilizer. **Soft Value** › Use resource pooling to improve marketing & productivity, e.g. clean-air pre-school at a business site, allowing parents to save time and money.	Developer Owner Supplier Water Agencies Municipality
Productivity Improvements	**Hard Value** › **Improve spatial productivity** of rooftop and walls, as well as diverse after-hours uses. **Soft Value** › **Improve occupant productivity** via healthy air & comfort. This feature is relatively new in the marketplace, but supported by studies on the negative impacts of sick building syndrome as well as studies on the positive impacts of healthy buildings on occupant performance, satisfaction and absentee rates.	Developer Owner Leaseholder Occupants Municipality
Risk Management Benefits	**Hard Value** › **Use modular heating and cooling** instead of fixed systems to be more adaptable to future heating and cooling requirements and allow variable uses of the building. Buildings are often too hot or cold when their uses change and the number of occupants or heat-generating equipment exceed design specifications. **Soft Value** › **Improve risk management with trusted materials.** Regulations alone will not protect you from liability. C2C can provide added security. For example, water valves in buildings can met specifications but poison the water and be expensive to remediate. *https://vtnews.vt.edu/articles/2010/11/111710-engineering-edwardsunc.html* › **Renewable heating and cooling systems** allow reliable forecasts of energy costs into the future and improve energy security.	Owner Architect Builder Lease holder Occupants

VALUE-ADDED CATEGORY	VALUE ADDED TYPE Hard Value = Value can be calculated using standard accounting methods. Soft Value = Requires subjective estimation of value to Stakeholders.	STAKEHOLDER WHO BENEFITS
Leverage Intellectual Property	**Hard/Soft Value** › **License new innovations,** e.g. work with universities and private managers to develop new ways of measuring air quality. These methods might be licensable. The RESET standard is an example of this: *https://www.reset.build/*.	Owner Builder
Supplementary Financing	**Hard Value** › **Subsidies & grant funding for innovation.** R&D funding agencies are ready to finance innovations for improving air, water & other qualities in buildings.	Architect Owner Builder
Marketing C2C Characteristics	**Hard Value** › **Attracting high quality tenants** with high bond rating improves the value and credit worthiness of the building. **Soft Value** › **Positive image** from improved perception by various Stakeholders. › **Frontrunner image.** Suppliers and contractors who meet the requirements can use the know-how to position themselves as frontrunners in a competitive marketplace.	Owner Municipality Contractors
Improving Occupants' Business	**Soft Value** › **Occupants add value to their own business** by learning about C2C benefits or participating in C2C aspects of building design, construction or operations, e.g. an instrumentation company provides sensing systems to improve C2C building performance. A furniture company adapts modular building design principles to its products, just as Herman Miller did by adapting its factory designs to its furniture. › This added value can also support the developer to market the building to occupants. Normally, this is not included in a conventional value approach to building developments, but in the case of C2C it can be an important financial consideration, also for marketing and competitiveness.	Developer Occupant

Table 5: Examples of C2C-inspired Added Value for Stakeholders

3.2.4.7 Example Of Economic Tool To Add Value

Organise Buildings As Materials Banks To Add Value

Buildings are like banks but instead of banking money they bank materials and unlike many banks you always know where your assets are! As with banks, assets are deposited then removed from a building during its use due to maintenance and renovation.

However materials often lose much of their value after they go into buildings because there is no way to get them back at the same level of quality. The good news; products and buildings are being redesigned so materials in buildings are assets instead of liabilities. Initiatives like the previously described Buildings as Materials Banks BAMB project are pushing this forward.

Materials Innovation At Every Stage

The quality of materials for re-use can be improved at every stage; planning, construction, maintenance, and for products moving through buildings during operations & maintenance.

The diagram in Figure 25 describes the velocity of materials moving through buildings in a human lifetime. The structure might be replaced once, but during its operation, products like furniture, carpet, filters, topsoil & plants cycle more quickly, providing more innovation opportunities as generations are replaced.

The approach can be an attractive value proposition also for municipalities because when materials are profitably recoverable, the local government is not stuck with empty or abandoned buildings.

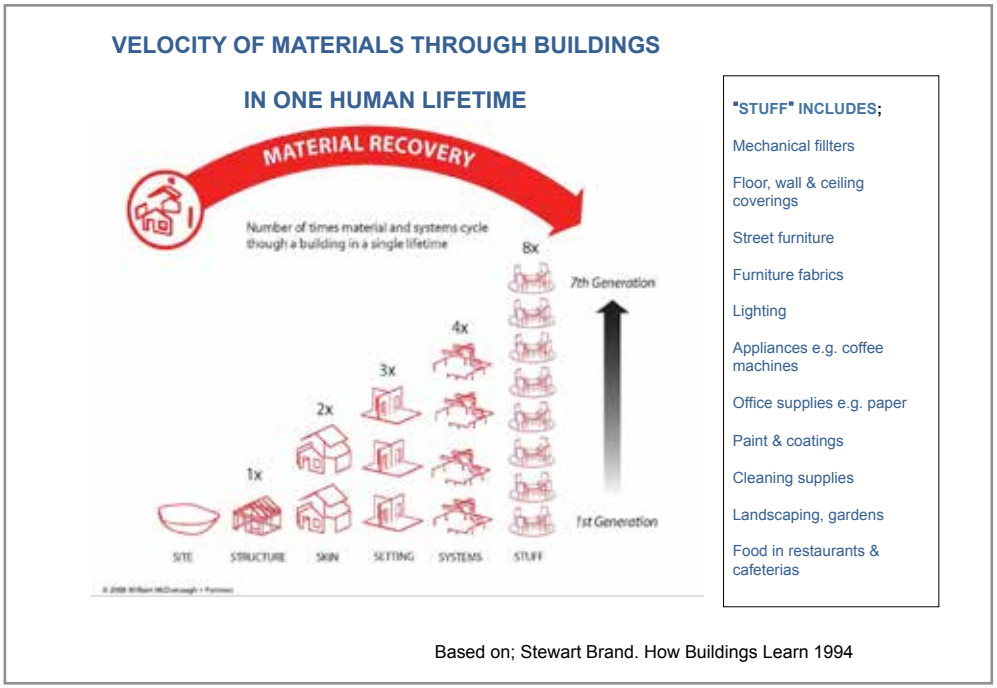


Figure 25: Diagram by William McDonough & Partners is an adaptation of the original concept developed by Stewart Brand in his 1994 book *How Buildings Learn*.

3.2.5 Planning Stage G. Stakeholders Select C2C-Inspired Systems Integration

When systems function together, their synergies are more effective than each component functioning alone.

In biology, those synergies are referred to as symbiosis, where the interaction of biological systems is beneficial. Symbiosis can also occur between technological systems.

Building developments are based on electrical, air handling, data network, and other systems. Those systems are becoming more complex as buildings provide services like intranets and smart grids.

A major barrier to synergy in buildings, and a leading cause of cost overruns, is too much focus on low price for individual components and not enough on systems integration. To solve this, C2C-Inspired Systems Integrations are used to achieve synergy between systems and add value for Stakeholders. Integrations are described further in this section.

Business parks like Park 20|20 in The Netherlands by Delta Development Group, designed by William McDonough & Partners, contain many examples of holistic quality, ranging from a renewable energy system for the whole development to ponds and biofilters that clean grey water on site, and green roofs and walls that purify the air and generate clean air (Figure 26).

Figure 26: Business park Park 20|20 in The Netherlands by Delta Development Group, designed by William McDonough & Partners, containing many examples of holistic quality. Photographs Sander van Torren, courtesy Delta Development Group.

Award winning preschools in Ronneby, Sweden designed with quiet acoustics, safe materials and extensive air quality monitoring (Figure 27). Chronic noise normally interferes with teaching and learning in schools, but Ronneby solved that with a holistic approach with acoustic flooring and strategically placed wall panels. Everything from wall and floor coverings to furniture and children's toys was assessed for healthy materials. Kitchen staff were trained by Cradle to Cradle inspired chefs in preparing meals with fresh food. Planners participated early in C2C training and set goals as part of a multi-year roadmap.

Safe materials

Air quality monitor

Figure 27: Award winning preschools in Ronneby, Sweden designed with quiet acoustics, safe materials and extensive air quality monitoring. Images William Lavesson, Laura Vidje & Martina Lindgren, courtesy Municipality of Ronneby.

3.2.5.1 Integrating Systems To Achieve Circularity

Holistic quality does not mean doing everything at once. It is also acceptable to do a few things well, to start.

Integrations are outstanding features that combine C2C principles with Stakeholder goals to achieve holistic quality through a systems approach.

There are various advantages to Integrations;

- There are more than one billion buildings on Earth but only a few thousand are certified under green certifications. It is important to speed the introduction of beneficial functions into buildings, and Integrations provide one mechanism because they are often easily replicated.
- Do a few things well. It is not necessary or realistic for your whole development to be circular to start. Instead you can focus on a few aspects that integrate your Goals to maximise their effectiveness.

Integrate your Goals by selecting five Cradle to Cradle-inspired Systems Integrations. Consider how they each tell a story. For marketing and education they can tell a story about being beneficial, while their use gets support from regulatory authorities, investors and other Stakeholders.

Describe C2C-Inspired Integrations to Stakeholders

For examples of Integrations see the following pages as well as Table 10 Example Of C2C Integration. These accelerate introduction of circularity without expensive and lengthy certification processes.

As well, small Integrations can add value to a building by showing the potential in entertaining ways.

Examples Of Integration

Integrations go beyond the traditional green approach of reducing negative impacts in categories like water, air, and energy. They provide iconic examples, which integrate, e.g. healthy water, healthy air, and diversity.

See Table 10 Example Of C2C Integration for an example of how Systems Integration combines C2C-Inspired Intentions and Goals.

Atria like the one in Figure 28 in The Hague, Netherlands integrate C2C-inspired value-added features, e.g. enjoyment, natural light, bio-diversity, and energy savings. Atria can also actively demonstrate how your building is meeting diverse goals such as recycling 100% of grey water, and providing natural light to every occupant's workspace. Atria offer many possibilities for continuous improvement over the years to add value e.g. by improving the species of plants, which clean the air and water.

Figure 28: Atrium. Atria like this one in The Hague, Netherlands integrate diverse C2C-inspired value-added features. Photo Douglas Mulhall.

Added value of Integrations will vary depending on the geographic and climate zone your development is in. The same Integration generates different added value depending on location. For example, the rooftop garden shown in Figure 29 on a restaurant provides tropical fruits, sunshade and other benefits year-round due to high solar intensity in the tropics. However, a green roof in temperate climates might provide heating insulation in winter and sunshade in summer (see also Figure 18).

Another example of design for climate resilience is the Nexus House (see video link in Table 1) developed by Technical University of Munich and University of Texas at Austin for the Solar Decathalon. Designed for living in the climate of the southwestern U.S., it uses solar energy generated on site, and captures and reuses rainwater as well as its greywater to grow plants in and around the house. It is reconfigurable, disassemblable and designed for transport *https://www.tum.de/en/about-tum/news/press-releases/detail/article/32286/*.

At the infrastructure level, climate-resilient facilities designed for recycling of nutrients from wastewater are taking hold around the world, and an early example of this is the Bionutrient Recycling Project developed in China and Brazil by Hamburg Environmental Institute. Scaleable and climate-adaptable, these types of facilities are being built in Europe, America, India and China. For a Guide to developing the facilities see *http://www.c2c-centre.com/project/biomass-nutrient-recycling*. The BIGH facility described in Figure 32 is a variation on this theme in an urban environment.

Figure 29: Climate-Adaptable Integrations. Added value of C2C-inspired Integrations will vary depending on the geographic and climate zone your development is in. The rooftop garden shown here on a restaurant provides tropical fruits, sunshade and other benefits year-round due to high solar intensity in the tropics. Photo Douglas Mulhall.

C2C-Inspired Highlights

A C2C-Inspired Highlight is a symbolic feature in a building, which shows occupants the potential of being beneficial, with a focus on one or more C2C principles as well as Stakeholder goals.

See Figure 30 for an example of using Highlights. The headquarters of Bionorica, a leading natural pharmaceuticals company, were partway through construction when C2C-inspired Highlights were added.

The Highlights included beneficially defined materials like concrete additives (with Heidelberg), healthy furniture and flooring materials (Herman Miller furniture, Backhausen fabrics, Desso carpets), and air cleaning plants.

As well a leasing concept for solar-powered windows was described to reduce capital expenditures and encourage manufacturers to take back their products to recover the materials.

C2C-Inspired Highlights let you use holistic quality without having to be perfect. They can be introduced throughout the design and operation of a building. For example, study how to integrate nutrient recycling with energy generation and use from wastewater purification systems (see also Figure 16).

The revolving door in Figure 31 generates electricity with kinetic energy of users. On its own it doesn't produce much, but kinetic energy is being used these days to power systems for disassembly of buildings by using the weight of the structure to power hydraulic jacks, as with the Grand Prince Hotel Akasaka building in Tokyo (watch Utube *https://www.youtube.com/watch?v=WbzVfLWQNkA*).

Highlights are best done at the planning stage but can also be done at the renovation and operations stages.

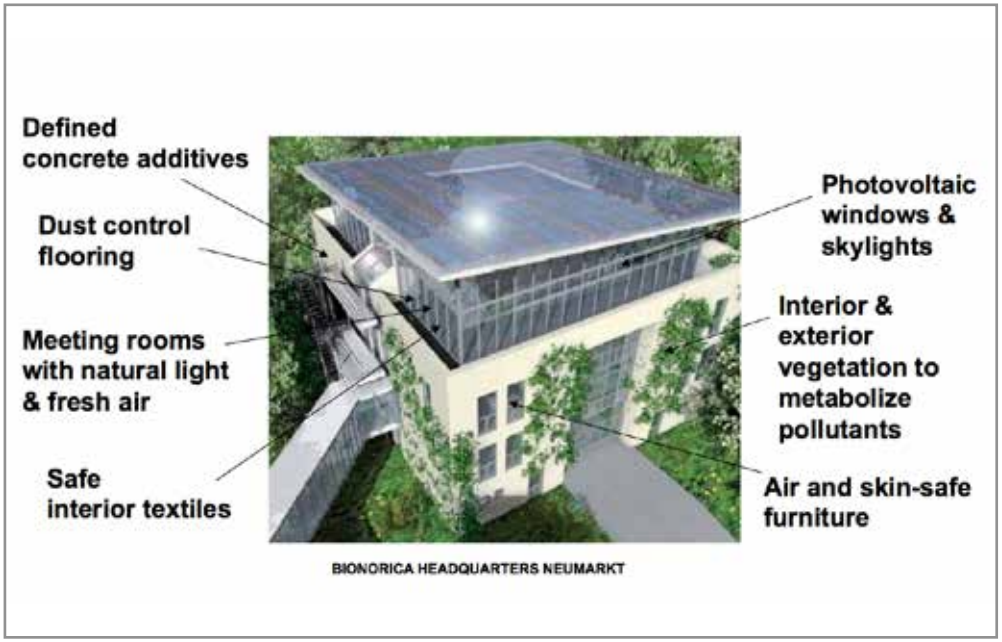


Figure 30: Bionorica headquarters. Composite image EPEA.

Figure 31: Kinetic Energy: An Unusual Highlight—energy-generating revolving door at Natuurcafé La Port, The Netherlands (left) and detail of kinetic mechanism (right). Photos Boon Edam.

3.2.5.2 Use Financial Tools To Support Systems Integration

Financial innovation has two main aims here;

- Generate added value for Stakeholders
- Generate investment funding for C2C features in buildings

It is important to establish the right financial conditions to maximize benefits. Refer to:

- Table 5 Examples of C2C-inspired Added Value for Stakeholders
- Table 6 Tools for Calculating Financial Innovation Potential
- Table 9 Examples Of Value-Added C2C Quality Dimensions & Goals For Stakeholders
- Table 10 Example Of C2C Integration to identify those conditions.

Example of the value of financial platforms for innovation;

As early as the 1990s, the solar industry was revolutionized when Power Purchase Agreements (PPA) used by traditional energy providers were adapted to solar power. PPA replaced high up-front capital costs with low monthly payments. The innovation put solar on a level playing field with traditional energy and contributed to solar being competitive in most parts of the world. By combining technological advances with PPA, most regions of the world today have solar energy that is cheaper than conventional energy.

Financial innovation can also save costs associated with traditional sustainability or 'green' methods. Reducing negative impacts is often seen as a cost rather than a benefit, because there is no added value for Stakeholders. By contrast, C2C-inspired approaches frequently generate early savings and revenues instead of costs. These can come at every stage, from planning through to operations and decommissioning. The biggest benefits are generated at the planning stage.

3.2.5.3 Use Financial Tools To Sharpen Your Focus

The financial tools and added value potential of your development play a big role in determining which focus is realistic. The financial framework can improve your chances of achieving your Goals, or in other cases might restrict them.

Use Table 6 as the starting point to generate your own table. Throughout the planning process, refer back to your financial tools and added value potential to see how they can support your Goals and to make sure the resources are available to achieve them.

FINANCIAL INNOVATION TOOLS	INFORMATION TO INVENTORY	VALUE-ADDED POTENTIAL
Identify Stakeholders & Each Of Their Economic Goals	See Table 8 for Examples of Stakeholders, then describe each of their economic Goals.	The main Stakeholders each have an economic stake in the development By identifying that stake you can adapt C2C to it.
Examples Of C2C-Inspired Added Value	See Table 5.	An important way of showing Stakeholders the special contribution of C2C-Inspired Integrations.
Zoning Incentives	Incentives by local zoning authorities for beneficial features, e.g. does zoning allow replacing roofing & cladding with building-integrated PV?	Increase returns with beneficial features. E.g. Improve payback times on solar by replacing capital cost of facades & roof tiles with Building Integrated PV.
Integrate Capital & Operating Costs	Is *Total Cost of Ownership* (TCO) financing possible? Identify if the Design-Build-Finance-Maintain-Operate framework (DBFMO) will be used	Determine if TCO can be used to optimize operating & capital costs together, e.g. investing in C2C capital features that generate operational savings.
Leverage Owner Occupancy	Will owners be the occupants? Do the owners plan to keep the building for a long time or sell it quickly?	Identify if the owner has self-interest in a healthy building and wants to support that with TCO approaches. Designing for rapid renovation adds value for long-term building owners, but also short-term leasing.
Improve Residual Value	Inventory the short and mid-term residual value of interiors and movables. Inventory modular designs that improve residual value. Example; Venlo City Hall.	By improving the modularity and defined content of materials in buildings, it is possible to improve residual value then back-cast this into present day value.

FINANCIAL INNOVATION TOOLS	INFORMATION TO INVENTORY	VALUE-ADDED POTENTIAL
Capital & Operating Costs For Energy Purchasing & Generation	Are energy Power Purchase Agreements (PPA) used in the region? If not, why not? Are third party PPAs used? Are solar cladding substitutions or residual value of energy-generating systems included in payback calculations?	Determine if PPA can be used to save capital costs or generate revenues, and if third party PPA partners might be available.
Breakthrough Efficiency **Also Known As Threshold Efficiency.**	Identify new systems efficiency innovations for renewable energy generation & use. For example, integrating new photovoltaic savings & efficiencies with cost and energy savings from LED lighting so the building can power its own lighting.	Traditional energy efficiency aims to reduce costs by reducing the use of fossil fuels through efficiency. However a next step is to use energy efficiency to make renewable energy financially attractive for a building.
Building Lease Structure	If the building is leased, who holds the lease on the building and for how long? Determine who benefits from payback over what period.	This can be used to identify who will benefit from e.g. renewable energy, and modular designs when it comes time to renovate.
Who Pays Utility Costs	Do the occupants pay for energy and water? Especially important for identifying who might want to support Breakthrough Efficiency described earlier in this table.	Determine who benefits from water and energy recycling, savings & revenues.
Water Infrastructure	Which authority is responsible for drinking and wastewater infrastructure?	Determine who can gain from recycling water, e.g. local water agency, owner, occupants?

FINANCIAL INNOVATION TOOLS	INFORMATION TO INVENTORY	VALUE-ADDED POTENTIAL
Demolition Costing	If an existing structure is scheduled for demolition has recovery of demolition costs been considered?	By defining and separating materials for trading and reuse some demolition costs can be recovered.
Innovation Finance	Are grant funds or subsidies available to let you focus on C2C-Inspired innovations? Check on funding for e.g. water & air quality innovation. In European legislation provisions allow no-bid tenders for pilot innovations. This can save money in tendering and encourage beneficial innovation.	Accelerate innovation while saving development costs.

Table 6: Tools for calculating financial innovation potential

3.2.5.4 Describe Value Propositions As Investments Instead Of Costs

Traditional sustainability is often seen as a cost rather than a financial benefit, so some Stakeholders might mistakenly apply the same perception to C2C-inspired features. Because of this, it is important to describe the investment value of those features to Stakeholders.

Figure 32 shows the Ferme Abbatoir's Building Integrated GreenHouse (BIGH) *www.bigh.farm* in Brussels, which is one of the prime examples of this type of entrepreneurial partnership. Building Integrated Greenhouses are based on integrated value propositions, which combine effective use of existing urban rooftop space with urban agriculture, aquaculture and marketing of products to local restaurants and supermarkets.

Encourage Stakeholders to see the process as an investment that pays back, instead of a cost. Describe to Stakeholders potential added value from the process. For examples also use Table 5 Examples of C2C-inspired Added Value for Stakeholders.

Nutrients from fish tanks are captured and used for fertilizer in the greenhouse.

Figure 32: The Ferme Abbatoir's Building Integrated GreenHouse (BIGH) in Brussels is one of the prime examples for value-added benefits and entrepreneurial partnership. Images courtesy of BIGH.

3.3 Planning Stage H. Reality Check

3.3.1 Re-evaluate Progress

Now that you have done all that work, it's time to step back and evaluate to be certain it is on the right track.

3.3.1.1 Is It On The Way To Healthy Abundance?

In a marketplace where everybody claims to be sustainable, it is important to distinguish your development from the rest of the pack.

To validate whether your Intentions and Goals are just sustainable or on the way to healthy abundance, ask which of these questions seems to match your Goals;

Traditional Sustainability Question:

How much did it cost to minimize the building footprint?

C2C-Inspired Question:

How much value was generated for Stakeholders by improving holistic quality with a healthy footprint?

You can highlight aspects that go beyond traditional sustainability by distinguishing between Goals that minimize impacts and Goals that generate added value through quality and healthy abundance.

3.3.1.2 Re-Evaluate Innovation Level

Do a reality check with Stakeholders if they are comfortable with their innovation level for each part of the building development before finalizing Goals.

After Stakeholders see the added value from this process, are they ready to raise their innovation level or apply it to other parts of the building? Or is the level too ambitious and do they want to lower it?

An important step for matching Goals with Stakeholder perceptions!

3.3.1.3 Is It Enjoyable Or Beautiful?

In the construction business enjoyment and beauty are often left out, but they are an important part of C2C-inspiration, and an important part of marketing your development to Stakeholders. Check if any of your Goals refer to Stakeholder enjoyment and aesthetic improvement.

3.3.1.4 Is It Measurable?

Check if the Goals are measurable in economic, technical or productivity terms. Do they have a defined delivery date? Are there measurable Milestones along the way to get to the goal?

3.3.1.5 Financial Reality Check

Go back to the Financial Innovation section to see how the financial tools support or limit Stakeholder Goals. Especially refer to Table 5 Examples of C2C-inspired Added Value for Stakeholders and Table 6 Tools for Calculating Financial Innovation Potential. Re-check if you took advantage of the tools and added value propositions.

3.3.1.6 External Reality Check

Communicate Goals to government agencies, suppliers and contractors to get feedback on how realistic they are, who might support which Goals, and who might present barriers to achieving them.

3.4 Planning Stage I. Stakeholders Agree Goals

3.4.1 After Reality Check, Finalize Stakeholders Agreement On Goals

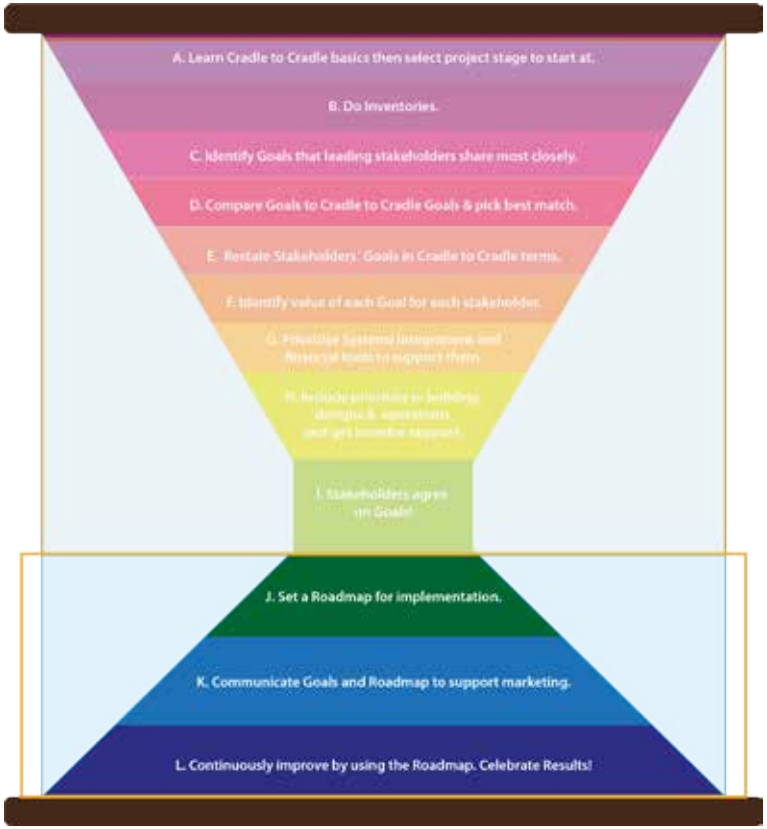
Communicate feedback from external agencies to Stakeholders and consider if the Goals have to be revised.

After that, finalize the timeline for achieving each Goal. See Table 9 Examples Of Value-Added C2C Quality Dimensions & Goals For Stakeholders for examples of timelines.

It is essential that the leading Stakeholders formally agree the goals in order to assure buy-in from participants. The statement of goals can be described in a table similar to the one shown in Table 9. However, it can be adapted to any format suitable for the local Stakeholders.

The important point is that there is one document that everyone agrees with and signs of on so it can be referred back to during the next stages of the project.

4. Planning Stage J. To L. Roadmapping & Marketing



4.1 Planning Stage J.

4.1.1 Roadmap Outline

After Goals and Timeline are finalized you can organize them into a Roadmap with Milestones toward those Goals.

The Roadmap gives Stakeholders a guide for how their Intentions and Goals will develop. It shows how C2C-Inspired Innovations are organized into the following levels of ambition: Tradition, Transition and Transformation (see Figure 34).

To draft the Roadmap outline you can organise your Goals according to the following timeframes;

- Planning until tendering
- Tendering until construction completion
- Operations & Maintenance
- Planned renovations
- Decommissioning and Deconstruction

The timeframes show Stakeholders when they receive added value from each Goal, and when the work is expected to occur.

Some Goals cut across timeframes. For example, if you want your building to be a materials bank, this will cut across site planning, construction, operations, maintenance and decommissioning.

It is not necessary to have a Goal for every timeframe. For example, if you start the process after the planning or construction stage you will want to focus less on structural aspects and more on operations and maintenance.

Roadmaps can take many forms. Figure 33 shows the example of the Desso overall company roadmap for its floor covering products used in buildings ships and aircraft. Categories shown here differ from building roadmaps, but the process is the same. Desso reached its 2008-2020 Goals a few years ahead of time. For more examples of roadmaps see *Cradle to Cradle Criteria for the Built Environment.*

How to start your Roadmap. Using the Tradition, Transition, Transformation approach described in 3.2.1.2, map a preliminary outline of which qualitative goals you want to achieve for each of those levels (Figure 34). In particular, select from the qualitative aspects described in Table 9 Examples Of Value-Added C2C Quality Dimensions & Goals For Stakeholders. A snapshot of the categories is shown in Figure 35.

How to Integrate Roadmaps into the Procurement Process. It makes more sense to have a roadmap if it could be used in the actual tendering process. Figure 36 shows examples of how roadmaps integrate with two types of tendering. There are many more types, and these are for illustration only. These were developed in co-operation with the city of Ronneby, Sweden.

Further information on Roadmaps & Milestones is available in the *Cradle to Cradle Criteria for the Built Environment* and from EPEA.

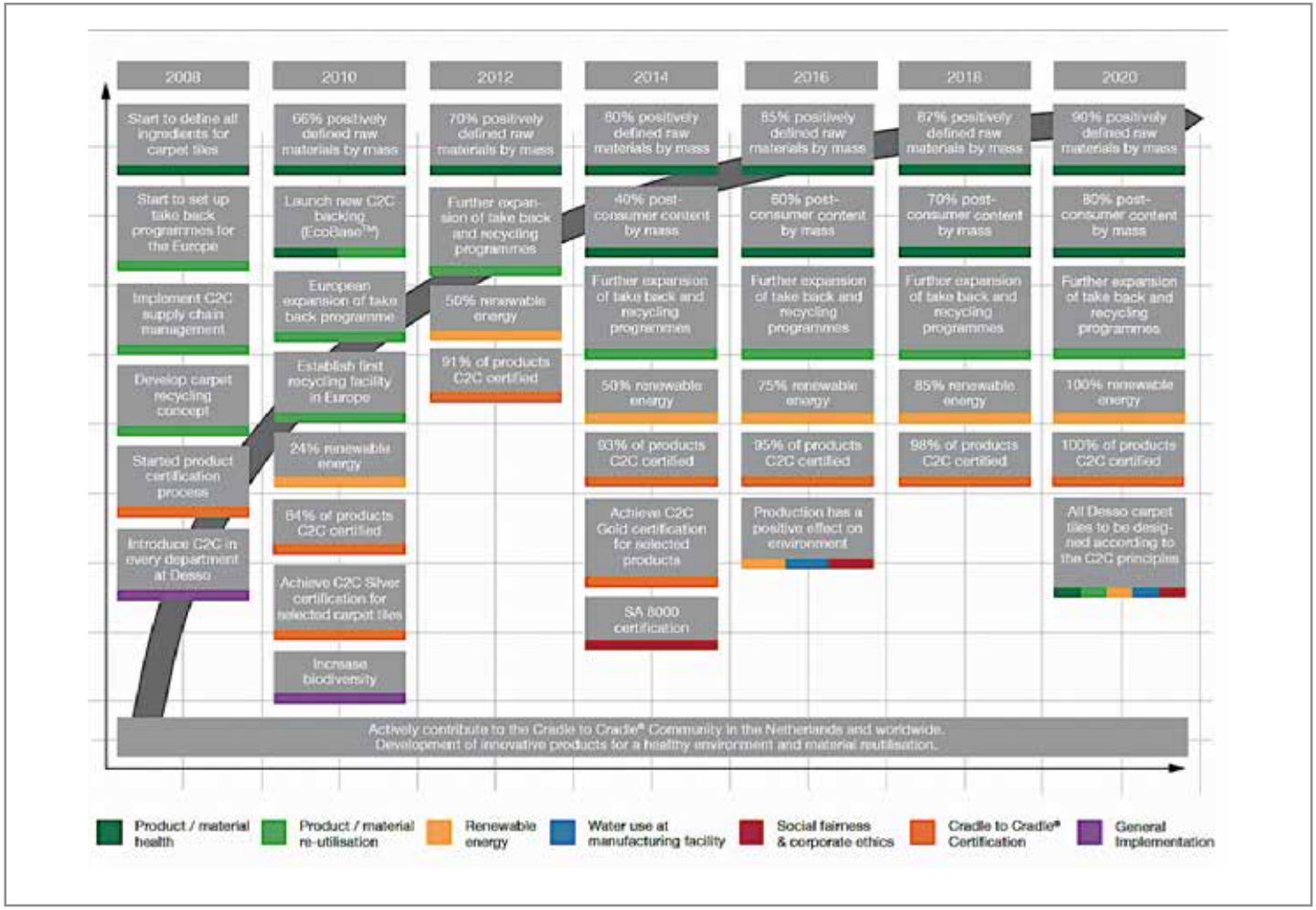


Figure 33: Roadmaps Can Take Many Forms — Example of Desso overall company roadmap for its floor covering products used in buildings ships and aircraft. Image Desso/ Tarkett.

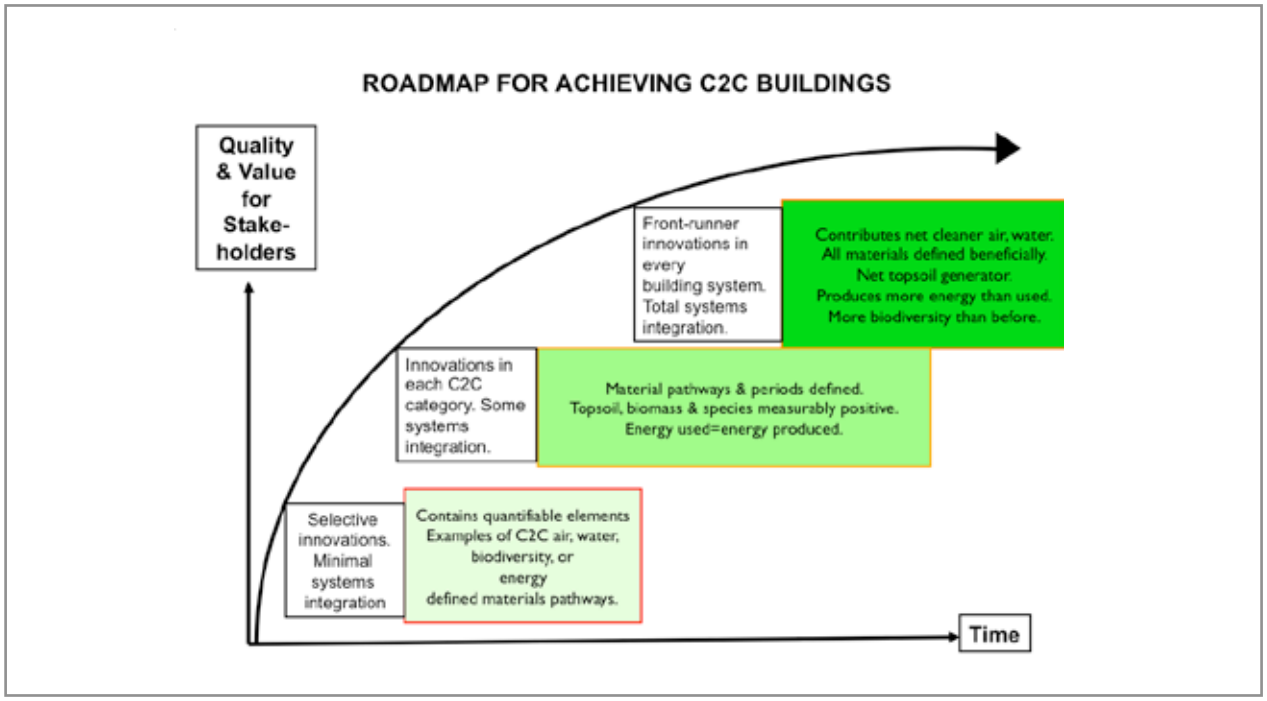
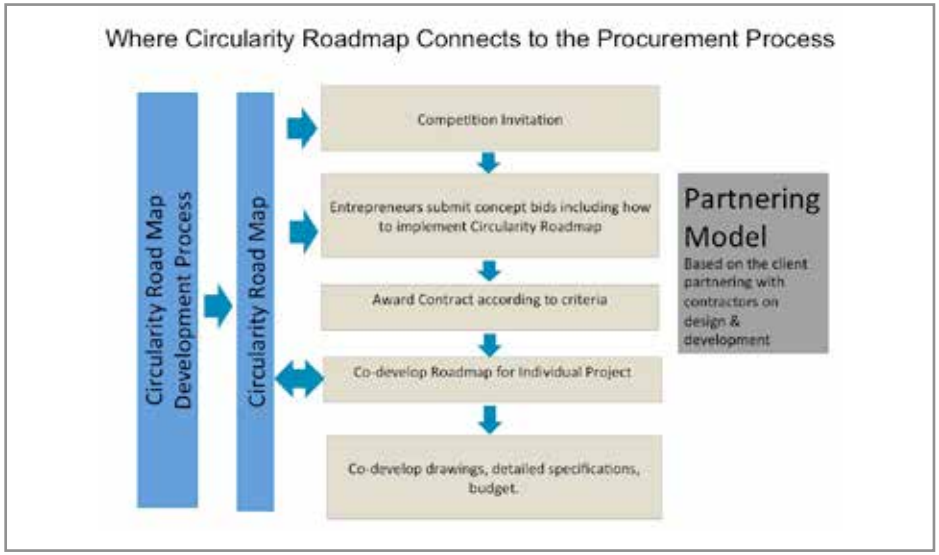


Figure 34: How to start your Roadmap using Tradition, Transition and Transformation.

C2C PRINCIPLES	Everything is a Resource for Something Else. Waste=Food.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C QUALITY Dimension* / STAKEHOLDER	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diver-sity, Healthy Quality of Life, & Multifunction-ality	Other Inten-tion/Ambi-tion For Quality ?
OCCUPANT	TECHNICAL / ECONOMIC GOALS Integrate interior & exterior systems, vegetation, HVAC, p	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	

Figure 35: How to Integrate Roadmaps into the Procurement Process — Examples developed in co-operation with the city of Ronneby, Sweden.



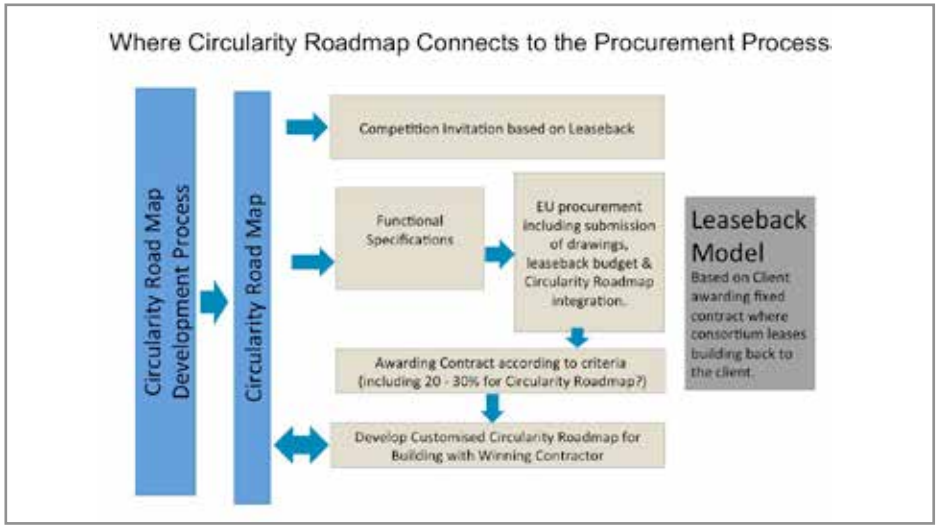


Figure 36: Examples of how roadmaps integrate with two types of tendering.

4.1.1.1 Solving Perceived Barriers Posed By Tendering And Other Factors

There is a popular mis-conception that linear systems like public tendering do not allow introduction of circularity or C2C, and prevent early supplier involvement. It is true that linear systems and regulations often pose barriers. However, tendering procedures often allow involving suppliers at the front end of the process. For example;

- In Venlo, The Netherlands, municipal officials were able to overcome linear barriers to include C2C and circular goals and highlights into the building. The building has won design awards, is praised by its occupants for improving employee working conditions, and is actively cleaning the outdoor air (Figure 37).
- In The Hague, the Netherlands, the planners involved large contractors in a market consultation process before specifications were developed for the tendering on the former VROM headquarters next to the main train station.
- In Sweden, a procurement process involving suppliers near the front end was used by the municipality of Ronneby in constructing its new schools.
- A provision known as the Innovation Provision is included in European as well as national legislation. It allows no-bid or limited-bid procurement, if a special innovation is demonstrated. Many owners are not aware of the provision, but it is used.
- As well, private sector projects including Park 20|20 in The Netherlands and a new office building engineered by Drees & Sommer in Essen, Germany have overcome tendering barriers to successfully include many Cradle to Cradle aspects.

Figure 37: Venlo City Hall is one of the most striking examples where municipal officials were able to overcome linear barriers to include C2C and circular goals and highlights into the building. Image Tom Desar, Courtesy City of Venlo.

Nonetheless, there are definitely barriers, and some of those were identified in a BAMB state-of-art synthesis as described in the following Table 7. Experience demonstrates that especially in multiple building developments but also for individual buildings, the regulatory and permitting process poses significant barriers to circularity.

While these challenges remain considerable, there is an acceleration of C2C-inspired buildings and building products that are overcoming them, through innovative approaches like those described in this publication.

Main Identified Barriers	State	Knowledge	Market	Civil society
› Fragmented policy framework: from EU to communes	✓		✓	✓
› Conflicting Energy and. Environment policy measures	✓		✓	✓
› Lack of robust and standardised data/ information over the entire value chain of the product/building	✓	✓	✓	✓
› Linear construction industry models			✓	✓
› Higher complexity of disassembly compared to demolition		✓	✓	
› General perception that reversible design solutions entail high financial costs			✓	✓
› Lack of certification and quality assurance for reclaimed products and recycled materials	✓		✓	✓
› Lack of a business model framework related to circular and reversible building		✓	✓	✓
› Reversible building is largely unknown to the general public		✓	✓	✓

Table 7: Main identified barriers — Regulatory Permissions. [Source *https://www.bamb2020.eu/wp-content/uploads/2016/03/D1_Synthesis-report-on-State-of-the-art_20161129_FINAL.pdf*]

4.1.1.2 Integrating Co-Creation Into The Regulatory & Permitting Process

In Luxembourg, an analysis of challenges and barriers was performed by +Impakt and a methodology proposed to deal with it. This section provides insight and suggestions for how to leverage that experience.

A modular design process can build on existing regulations by applying circular methods through proactive involvement of Stakeholders.

The added value is a co-creation process, which better involves Stakeholders around circular objectives for each step. It is important to note that the process does not replace the processes required by law but complements them, in order to produce better quality. The deadlines set out in the regulations are not changed, but one can expect to receive fewer complaints and to have more fluid administrative processes, due to good information and involvement of all the Stakeholders.

This is a cross-cutting approach, spanning multiple stages of the regulatory process, which allows for broader Stakeholder participation at an earlier stage. This approach requires investing more resources in collecting information earlier in the process, information that can be used by downstream actors. Legal deadlines also remain unchanged, but time savings can be achieved through overlapping steps.

Major gains in quality and speed can be expected in both cases by better management of information flows and greater involvement of Stakeholders and their interests, regardless of their role in the regulatory process. Finally, this approach can only be implemented in a consistent and effective way if it is first piloted. A pilot will allow local testing, both at the level of a development zone and at the level of individual companies. The involvement of the pilot over the entire phase of the area will improve the management of information.

Benefits

A substantial reduction in the duration of the regulatory process, while maintaining the quality of the process and results, has significant gains at different levels:

- Economic gains through a faster operationalization.
- Increased visibility for promotion activities: a shorter process allows you to engage potential customers early in the process and build loyalty, and to better accommodate their needs.
- Better consideration of the interests of all Stakeholders involved, thus saving time and greater satisfaction for all.

Section adapted from *Circular Economy for Business Sites* *http://positiveimpakt.eu/en/portfolio/circular-economy-for-business-sites/* (courtesy +Impakt).

Figure 38 shows the development of circular objectives and indicators including roadmap for the extension of an existing business site & industrial zone in Northern Luxembourg. The methodology from Mulhall, Braungart & Hansen was adapted by EPEA, Progroup and Royal Haskoning for the Economic Activity Zone Lentzweiler, in close collaboration with the "Syndicat Intercommunal pour la Promotion du Canton de Clervaux (SICLER)" and is being applied to similar projects in Luxembourg.

4.1.2 Complete The Roadmap & Display In A Prominent Place

The Roadmap is the multi-year Guide for Stakeholders. Be sure it is prominently displayed where everybody can see it. Make comments about it; on a website, in your project room, or in the lobby of your existing building.

Communicate it!

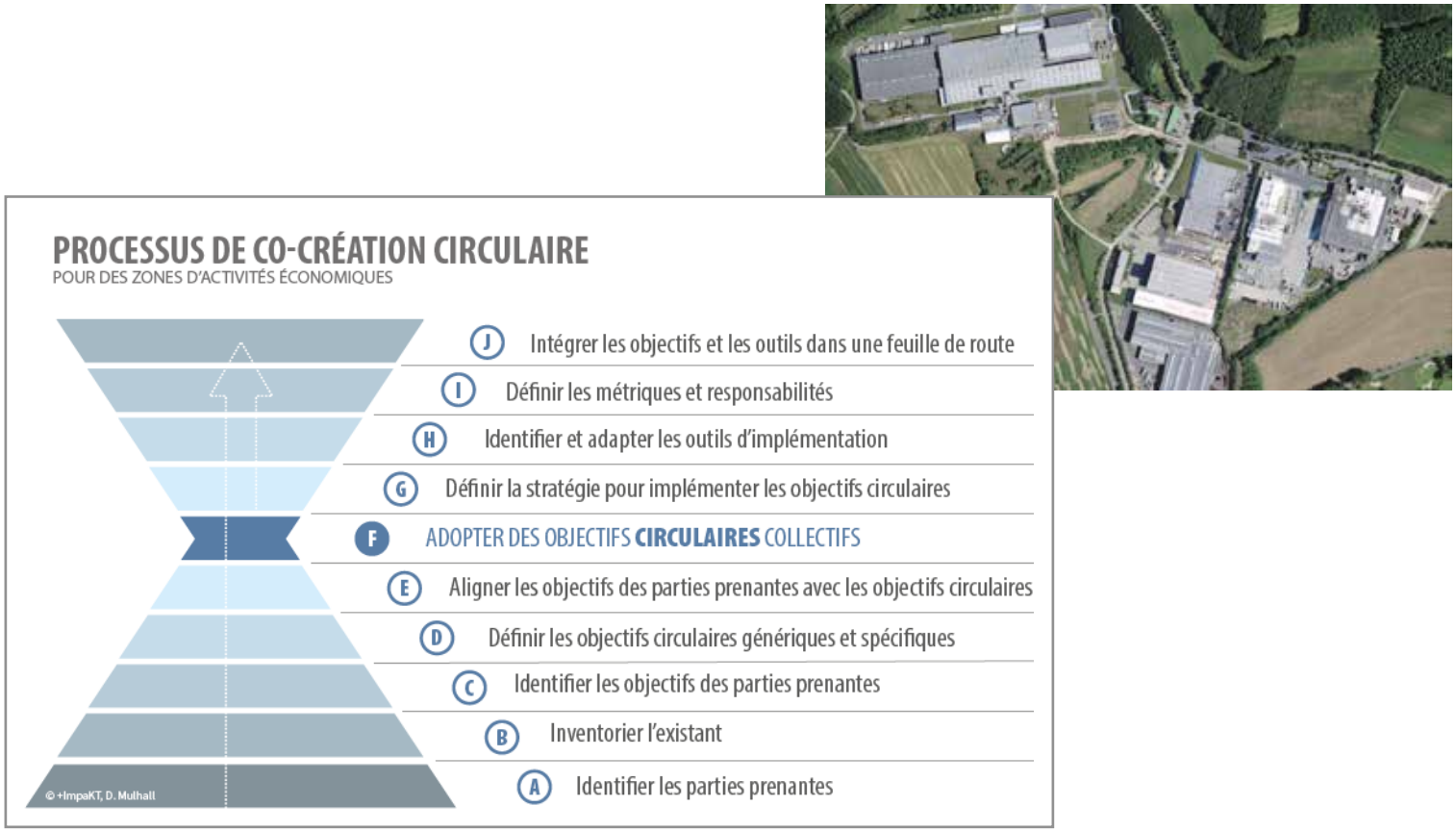


Figure 38: Development of circular objectives and indicators including roadmap for the extension of an existing business site & industrial zone in Northern Luxembourg. Image +Impakt.

4.2 Planning Stage K. Celebrate Achievements With Marketing

4.2.1 Use Integration To Support Marketing

Check C2C-Inspired Integrations & Highlights developed earlier. Describe;

- How each Integration & Highlight supports Stakeholder Goals.
- How each Integration & Highlight generates financial and other added value.
- How Integration & Highlights can be used for marketing to show how Goals translate into reality.

After you complete the process, use those descriptions to begin developing a marketing plan to highlight the added value of Stakeholder Goals, and Integration & Highlights.

4.2.2 Distinguish Yourself In The Marketplace

Goals and added value tools can be used as marketing tools.

The next step is to craft those into a marketing plan to distinguish your development in the marketplace, and show your Stakeholders the added value they generated with the C2C-Inspired process.

- The C2C-Inspired Roadmap with Goals and Milestones is an important tool for this. It becomes your guidance for continuous improvements, which will make your development more attractive. Publish the Roadmap and use it as a marketing and management tool for Stakeholders throughout the building cycle.
- Celebrate your C2C-Inspired Integrations and Highlights by featuring them in your marketing.

4.3 Planning Stage L. Continuous Improvement & Enjoyment

4.3.1 Appoint Individual to Track

The roadmap is designed to guide you through the process of continuously improving the approach.

New technologies and methods will always come along that could be integrated into the roadmap. In order to be certain this happens, it is a good idea to appoint one individual, preferably the project manager and then the property manage, to oversee implementation and updating of the roadmap.

4.3.2 Celebrate

Always remember to continuously celebrate your results.

For example, developments like Venlo City Hall, Ronneby Preschool and Park20|20 have organized educational visits for tens of thousands of people, thereby distinguishing those projects and allowing them to serve as educational tools to propagate the approach.

Enjoy!

5. ANNEXES

5.1 ANNEX A.
Table 8 — Examples of Stakeholders

The purpose is to identify and prioritise Stakeholders according to their roles, then describe their Goals, or describe who does not yet have Goals.

One Stakeholder might play diverse roles and have diverse Goals, e.g. owner might also be occupier.

Investors	› Developer › Landowner › Banks & Investment Funds
Builders, Users, Operators	› Builder incl. Project Manager & Subcontractors › Architects & Designers › Suppliers for Builders & Operations › Service Providers, e.g. water agencies, energy providers, telecom › Occupants, Users & Tenant association › Customers who use the development but do not occupy it, e.g. store and restaurant customers, parents of students. › Lease holder. If a third party, might be different from occupant. › Property manager › Technical maintenance manager
Government Planning & Regulatory Agencies	› National, Provincial/State, Regional Authorities who give approvals › National & Provincial development authorities › County development & zoning authorities › National & Regional Environment & Safety › Municipal Authorities › City Council › School Boards › Municipal Architect & Planning Dept.

Taxpayers	› Including ratepayers associations, property owners associations.
Non-Government & R&D Organizations	› Chamber of Commerce / Entrepreneur Association › Research funding organizations
Neighbours & Neighbourhood associations	› Might be economic Stakeholders if property value is affected.
Environmental & Public Interest organizations	› Potential to support or oppose the development based on added value they perceive based on their organisational goals.
Media & Marketing	› Local business media › PR departments of participating builders & suppliers › Municipal marketing team

Table 8: Examples of Stakeholders

5.2 ANNEX B.
Table 9 — Examples of value-added C2C Quality Dimensions & Goals for Stakeholders

Guidance

Quality Dimensions and Goals described here are only examples. You are encouraged to develop your own!

For some Stakeholders the goals are left blank so you can identify goals which match the needs of those Stakeholders.

Dark blue row describes C2C Principles. The Principles are positioned over C2C Quality Dimensions they best support in the table. Every Principle applies in some way to every area, so this row is just a guide for the main support areas.

Light blue row describes examples of C2C Quality Dimensions, also known as Intentions, Aspirations or Ambitions.

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C QUALITY Dimension* / STAKEHOLDER	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality	Other Intention/Ambition For Quality ?
OCCUPANT	TECHNICAL / ECONOMIC GOALS Integrate interior & exterior systems, vegetation, HVAC, p	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	

Grey column on the left describes the main Stakeholders who participate in and benefit from each Goal.

Yellow highlighted headings in each Quality Dimension column describe measurable Goals for creating added value for Stakeholders. The highlighting also describes Stakeholders who might share Goals. Important tool for reaching agreement on final Goals!

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C QUALITY Dimension* / STAKEHOLDER	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality	Other Intention/Ambition For Quality ?
OWNER	MEASURABLE GOALS TECHNICAL GOALS Capture and reuse 90% of CO2 & NOx emissions from the building by year 3 of operations. ECONOMIC GOALS Integrate CO_2 recovery with water & nutrient recycling to profitably grow 5 tonnes of vegetables by end of year 1 of operations. Determine if carbon credits can be claimed from this.	MEASURABLE GOALS TECHNICAL GOALS Capture, reuse then purify for discharge into ecosystems 70% of rainwater falling on the site by end of year 1 operations, progressing to 90% by year 3. ECONOMIC GOALS Estimate savings on water fees & processing costs prior to finalizing building plans.	MEASURABLE GOALS TECHNICAL GOALS 35% of high value systems e.g. HVAC, elevators, electronics designed for quick maintenance, removal and disassembly, by end of planning stage. By end of year 5 of operations 100 percent of replacement parts will meet those criteria. ECONOMIC GOALS Generate savings on maintenance & renovations through easier replacement of equipment & parts.	MEASURABLE GOALS TECHNICAL GOALS Integrate modular energy systems to achieve energy-positive status in first five years of operations, e.g. activated concrete, energy storage, BIPV, heat chimneys, ground heat exchange, daylight, photovoltaic windows, stationary wind turbines, kinetic energy. ECONOMIC GOALS Integrate financial instruments to make renewable energy cost-competitive over the use period of the building.	MEASURABLE GOALS TECHNICAL GOALS Provide renewably powered charging and reverse charging stations for 75 electric vehicles at preferred parking locations. Year 1 operations. ECONOMIC GOALS Business model from charging electric vehicles. SOCIAL Kindergarten on site saves parents traveling to pick up their kids.	MEASURABLE GOALS TECHNICAL GOALS Declare 25% of exterior areas and 10% of interior as biodiversity zones by year 1 operations, e.g. fish habitat, roof bee habitat, landscaping soil manufacturing zone. ECONOMIC GOALS Profitable agriculture products for restaurants or occupants. Produce 50 kg honey annually from bee-keeping business.	MEASURABLE GOALS TECHNICAL GOALS Cultural diversity. Integrate water recycling as art in 5 areas. e.g. water walls, fountains etc. year 1 operations Quality of Life & Multi-functionality. Clean-air kindergarten for children of workers in the area. Year 1 operations.	MEASURABLE GOALS TECHNICAL GOALS ECONOMIC GOALS Describe here

* C2C Quality Dimensions are also referred to as intentions, ambitions or aspirations.

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C QUALITY / Dimension* / STAKEHOLDER	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality	Other Intention/Ambition For Quality ?
OWNER	ADDED VALUE TO STAKEHOLDER Use unused space. Carbon credits. Revenues or savings from crops. PR value. OTHER STAKEHOLDERS WHO SHARE GOAL Occupant	ADDED VALUE TO STAKEHOLDER Water security for water fees, processing costs, water for urban agriculture & landscaping. OTHER STAKEHOLDERS WHO SHARE GOAL Water Agencies Occupant	ADDED VALUE TO STAKEHOLDER Savings on waste management costs during maintenance & renovations. Improve end-value of materials & structures. OTHER STAKEHOLDERS WHO SHARE GOAL Occupant Suppliers	ADDED VALUE TO STAKEHOLDER Energy costs security. Energy supply security OTHER STAKEHOLDERS WHO SHARE GOAL Occupants Investors	ADDED VALUE TO STAKEHOLDER Charging stations; Added revenues Kindergarten; Improved productivity. Positive image for marketing. OTHER STAKEHOLDERS WHO SHARE GOAL Occupants Investors	AESTHETIC Establish five beehives for kids to learn about pollination. ADDED VALUE TO STAKEHOLDER Added productivity from unused spaces e.g. rooftops. Marketing claim. OTHER STAKEHOLDERS WHO SHARE GOAL Occupant Environmental Agencies	ECONOMIC GOALS Revenues from integrated use. Enhance lease value with added services for occupants FUN ! Include a waterpark for educational fun for children ADDED VALUE TO STAKEHOLDER Added revenues from same space. OTHER STAKEHOLDERS WHO SHARE GOAL Occupant Investors	

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C QUALITY Dimension* / STAKEHOLDER	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality	Other Intention/Ambition For Quality ?
OCCUPANT	TECHNICAL / ECONOMIC GOALS Integrate interior & exterior systems, vegetation, HVAC, products to support healthy air quality. ADDED VALUE TO STAKEHOLDER Determine if air quality & comfort improve productivity compared to competing buildings in the area or region. OTHER STAKEHOLDERS WHO SHARE GOAL Owner Municipality	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	TECHNICAL / ECONOMIC GOALS Describe here. ADDED VALUE TO STAKEHOLDER Describe here. OTHER STAKEHOLDERS WHO SHARE GOAL Describe here.	
INVESTOR	Describe goals here.							
MUNICIPALITY	Describe goals here.							
To add other stakeholders see: **Table 8 - Examples of Stakeholders**	Describe goals here.							

Table 9: Examples of Value-Added C2C Quality Dimensions & Goals for Stakeholders

5.3 ANNEX C.
Table 10 — Example of C2C Integration

Guidance

Atria integrate diverse value-added features e.g. natural light, biodiversity, energy savings & enjoyment. Atria also offer many possibilities for continuous improvement to add value for Stakeholders.

The Integration, Intentions and Goals described here are only examples.

You are encouraged to develop your own!

Dark blue row describes C2C Principles. The Principles are positioned over C2C Quality Dimensions they best support in the table. Every Principle applies in some way to every area, so this row is just a guide for the main support areas.

Light blue row describes examples of C2C Quality Dimensions, also known as Intentions, Aspirations or Ambitions.

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity		
C2C Quality Dimension* / C2C Integration	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality	Other Intention/Ambition For Quality ?
ATRIUM	TECHNICAL / ECONOMIC GOALS Integrate interior & exterior systems, vegetation, HVAC, p	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	TECHNICAL / ECONOMIC GOALS Describe here.	

Grey column on the left describes the part of the building that integrates C2C features.

Yellow highlighted headings in each Quality Dimension column describe measurable Goals for creating added value for Stakeholders.

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity	
C2C QUALITY Dimension / C2C-INSPIRED INTEGRATION	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality
ATRIUM **Also known as;** **BUILDING INTEGRATED GREENHOUSE** **or** **WINTER-GARDEN**	MEASURABLE GOALS TECHNICAL GOALS Biofilters capture & metabolise 50% of CO2 & particulates from air in the building interior rising to 70% in 3 years, and re-introduce cleaner air to meeting rooms. ECONOMIC GOALS Evaluate savings from using CO2 and compost to profitably grow vegetables and gain carbon credits. Savings on HVAC filter maintenance & replacement costs by using plant based biofilters.	MEASURABLE GOALS TECHNICAL GOALS Capture 70% of rainwater on site for reuse & discharge into ecosystems, rising to 90% over 3 years. ECONOMIC GOALS Quantify savings on water fees & water reprocessing costs. Quantify savings on water for urban agriculture & landscaping.	MEASURABLE GOALS TECHNICAL GOALS Compost 50% of bionutrients used in the building, rising to 90% in 3 years. Nutrients for plants e.g. soil, fertilizer are defined for the whole cycle by year 3. ECONOMIC GOALS Capital savings by disassembling & reassembling old greenhouses. Evaluate savings on maintenance & renovations with easier replacement of equipment & parts designed for disassembly.	MEASURABLE GOALS TECHNICAL GOALS Atrium is a functional part of the heating & cooling system, using solar energy for photosynthesis, supporting heating and cooling of the building. Date; By year 1 of operations. ECONOMIC GOALS Lighting costs savings from integrating more natural light. By moderating temperature extremes, using current solar income, and using excess heat for growth, atrium supports renewable energy cost-effectiveness. Date; Year 1 of operations.	MEASURABLE GOALS TECHNICAL GOALS Improve mobility between buildings in cold or hot climates by moderating temperatures and creating integrated spaces instead of divided ones. Date; By end of construction. ECONOMIC GOALS Business model from charging electric vehicles. Date; By beginning of construction. SOCIAL Use Atria to establish diverse meeting zones.	MEASURABLE GOALS TECHNICAL GOALS Declare Atrium as biodiversity zone e.g; pond as fish habitat, trees as bee habitat, landscaping as topsoil enhancement zone. Date; Year 1 of operations. ECONOMIC GOALS Produce profitable urban agricultural products for restaurants or occupants. Year 1 of operations. Savings on landscaping topsoil by soil manufacturing.	MEASURABLE GOALS TECHNICAL GOALS Cultural diversity. Integrate water recycling as art e.g. water walls, fountains Date; By completion of construction. Quality of Life & Multifunctionality. Atrium is a clean-air pre-school for children of occupants. Date; Year 1 operations. ECONOMIC GOALS Revenues from integrated use. Date; Year 1 of operations. Enhance lease value by offering added services to occupants.

C2C PRINCIPLES	Everything is a Resource for Something Else.			Current Solar Income		Biodiversity, Conceptual Diversity, Cultural Diversity	
C2C QUALITY Dimension / C2C-INSPIRED INTEGRATION	Healthy Air & Climate	Healthy Water & Nutrient Recycling	Healthy Materials	Renewable Energy-Positive	Mobility Enhancement	Biodiversity Enhancement	Cultural Diversity, Healthy Quality of Life, & Multifunctionality
ATRIUM [continued]	ADDED VALUE Capital value appreciation from improved user perception. Evaluate productivity impacts. Use under-utilized rooftop or atrium space profitably. Carbon credits potential from reusing CO2. Savings or revenues from growing fruits & vegetables	ADDED VALUE Financial & supply security for; Future water fees, Wastewater processing costs, Irrigation water for urban agriculture & landscaping.	ADDED VALUE Waste cost saving for maintenance & renovations. Increase materials & structures end value so the building becomes an appreciated asset instead of depreciated demolition expenditure	ADDED VALUE Savings on heating, cooling, ventilation & lighting.	ADDED VALUE Improve mobility in the building for occupants.	AESTHETIC Establish five beehives to keep away wasps from public areas & for occupants to learn about pollination. Year 1 of operation. ADDED VALUE Added productivity from unused spaces e.g. rooftop	FUN GOAL Establish nice places to eat, work, & relax ADDED VALUE Rentable space for diverse uses.

Table 10: Example of C2C Integration

5.4 ANNEX D.
Table 11 — Examples of C2C-inspired focus at each phase of building development

Adapt this table to your local process

The stages here are organized into modules adaptable to your local situation and available planning resources.

It is not necessary to use every tool!

TOOLS	EXAMPLES OF C2C FOCUS FOR EACH STAGE
Early Planning for Financing & Go-Ahead **Focus on added value for Stakeholders to improve chances for regulatory permissions.**	
Publications & Video lists	Introduce C2C added value tools to Stakeholders by providing them with publications & video described in this Guide.
	Identify architects, planners & finance partners familiar with C2C, or at a minimum with reversible designs and value propositions.
Table 6 Financial Tools	Prioritise financial innovation tools for added value.
Table 5 Examples of added value	Organize Stakeholder workshops on C2C-Inspired added value.
Table 6 Financial Tools	Involve the municipality, water agencies and energy suppliers in early planning to explore C2C-Inspired added value, which might facilitate go-ahead decision and permitting.
Inventory	If the site is known, quick-scan site features for C2C potential. If it involves renovation, quick-scan the building to identify positive and problematic C2C areas.
Goals Setting Tools, Organisational Culture Tools	Develop *Statement of Intentions*, *C2C-Inspired Goals & Roadmap*.

TOOLS	EXAMPLES OF C2C FOCUS FOR EACH STAGE
Upgrade from minimizing damage	Distinguish between being beneficial & reducing negative impacts.
Inventory	Inventory Stakeholder and local business new technologies to see which can be integrated into C2C approaches.
Table 5 Examples of added value	Describe the Business Case based on C2C added value.
Feasibility Analysis **Focus on Integration. A leading cause of cost overruns is too much focus on pricing individual systems and too little focus on systems integration.**	
Systems integration. Table 10 Example of systems integration	*Systems engineering* can be combined with *systems integration* for more effective tendering and construction. First, determine which systems you want to integrate . Then ask systems engineers to optimise the designs.
	Maximise benefits by collectively defining the site.
Go/No Go Decision	
Table 5 Examples of added value	Use C2C-Inspired Added Value as criteria for the Go-No-Go decision.
Regulatory Approvals e.g. Site Services & Zoning	
	Consider examples from other municipalities where C2C-Inspired features are applied.
Table 5 Examples of added value	Identify C2C added value that can benefit broader Stakeholders like the municipality or water agencies, e.g. reducing stress on sewage systems.

TOOLS	EXAMPLES OF C2C FOCUS FOR EACH STAGE
Preparing Tendering or Building Contract Selection Criteria **Focus on preparing potential suppliers for C2C approach to specifications & tendering. Use market consultation process to work with them and learn what they can deliver.**	
	Identify suppliers with previous C2C experience and talk to them.
Table 5 Examples of added value	Use consultation meetings with potential suppliers to focus on C2C–Inspired added value.
	Include C2C focus in specifications to support your Goals.
	Include in tendering specifications approaches on design for disassembly to improve separation and recovery of construction residues, which make up to 30% of materials used.
Contact local recyclers	Co-operate with recyclers on specifications for materials separation & recovery.
Contact *epea@epea.com*	Integrate Technical and Biological Metabolisms into specifications.
Site Preparation/Infrastructure	
Inventory	Consider how to recover value from existing structures on site.
Inventory	Study how to preserve topsoil and other ecological features on site.
Modular design	Consider design for disassembly of site services e.g. precast concrete, removable piping.
Construction	
Inventory	Inventory what might already be on the way to C2C.
	If you start C2C at this stage you might focus on interior designs and materials because these contracts are awarded later in the process.

TOOLS	EXAMPLES OF C2C FOCUS FOR EACH STAGE
Operations & Maintenance **Focus on maintenance, supplies and monitoring.**	
	Start a C2C-inspired suppliers network for maintenance. The City of Venlo & Park 20|20 in The Netherlands, and City of Ronneby in Sweden are developing supplier networks.
Inventory	If starting with C2C only at this stage, inventory what might already be on the way to C2C.
Roadmapping	Develop Roadmap for continuous improvement of supplies used during building maintenance & operation. If you are already working with C2C since the planning stage, monitor C2C-inspired performance factors that were set in the process.
https://bigh.farm/	Optimize biosphere flows for CO_2 & nutrient recycling e.g. landscaping, building-integrated greenhouses & cafeteria food waste.
Renovation, Disassembly & Reprocessing **Focus on profitable materials recovery.**	
Various guides on modular design e.g. *www.BAMB2020.eu*	Utilize modularity and designs for disassembly described in this publication.
Developers in your area	Partner with building developments to provide materials from your disassembled building.

Table 11: Examples of C2C-inspired focus for each stage

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A. Learn Cradle to Cradle basics then select project stage to start at.
B. Do Inventories.
C. Identify Goals that leading stakeholders share most closely.
D. Compare Goals to Cradle to Cradle Goals & pick best match.
E. Restate Stakeholders´ Goals in Cradle to Cradle terms.
F. Identify value of each Goal for each stakeholder.
G. Prioritize Systems Integrations & financial tools to support them.
H. Include priorities in building designs & operations and get investor support.
I. Stakeholders agree on Goals!
J. Set a Roadmap for implementation.
K. Communicate Goals & Roadmap to support marketing.
L. Continuously improve by using the Roadmap. Celebrate Results!

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Creating Buildings with Positive Impacts is designed to do what its title says. It is a guide for every property owner, investor, developer, builder, or planner to create a beneficial footprint in the Circular Economy. The guide includes a practical method for setting objectives and gaining economic benefits from the results, with examples at every stage, and combines best practices from the marketplace for new and renovated buildings.

About the Authors

Douglas Mulhall, Michael Braungart and Katja Hansen co-developed many of the methods, which serve as a basis for the award-winning Cradle to Cradle (C2C) Design Framework and the Circular Economy framework. They have been working together since the 1990s through EPEA, an innovation consultancy for C2C, as well as the Hamburg Environmental Institute, and have collaborated at Prof. Braungart's earlier Academic Chair, Cradle to Cradle for Innovation and Quality, Rotterdam School of Management and at Technical University of Munich & Delft University of Technology.

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Mulhall and Hansen participated in developing and implementing the Horizon 2020 Buildings as Materials Banks (BAMB) project.

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