NZC Sustainable Design Brief

Redevco Sustainable Design Brief		**Author:**	**Martijn Horsman**
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V1.0	October 2024	Carbon Pricing added Urban Mining requirements added	
V1.1	January 2025	Revised BIM Protocol Proptech protocol added	
V1.2	April 2025	Mass Timber playbook added New Redevco Branding applied	
V1.3	May 2025	Added Version control Updated Appendix and link BIM protocol	
V1.4	June 2025	Added Appendix 6.11 – What is the story with Module D?	

Contents

1. Introduction

Redevco aims to be a 'force for better' by deliberately future-proofing the assets under its stewardship and demonstrating ESG leadership through inspiring projects in the real estate sector. Redevco's impact framework serves to guide the projects' approach.

Impact Framework

Built environment	Social value
Reduce whole life carbon: **Net ZERO** by 2040	Provide spaces that meet **local needs**
Increase onsite **renewable energy** generation	Contribute to **placemaking**
Implement **climate** adaptation measures	Building strong **relationships** with stakeholders
Natural environment	**Economic value**
Aim for **biodiversity** net gain	Optimise capital **value** development
Responsible **water** management	Optimise **rental growth** development
Responsible **waste** management	Minimise structural **vacancy**

M&D projects contribute to Redevco's Mission 2040: leading the transformation of cities to ensure they are sustainable and liveable. Leadership is displayed by imposing challenging general sustainability requirements.

Every Maintenance & Development (M&D) project may have its unique characteristics, the sustainability goals are equal. By a systems engineering approach the goals are set, the way to reach these goals will vary per project, calling upon creativity and ingenuity of the design teams.

The Mission2040 Design Brief is to frame the system requirements for M&D projects to comply to Redevco's Mission 2040. Serving the three main environments of our impact framework (though interconnected through climate change risks and effects):

- Built Environment
- Natural Environment
- Social Value

Sustainable design and build practices need verification and validation. Generic verification methods of BREEAM and WELL assessments are to be applied, regardless of any actual certification requirements being in place. All design team partners know and understand BREEAM to provide Redevco the necessary data for reporting requirements and benchmarking on all specific data.

1.1. Climate resilience

Climate resilience & Climate change risk mitigation is the connection between the built, the natural, and the social values. Physical effects of climate change are to be assessed and mitigating measures are to be incorporated into the development's design and construction (i.e. carbon emissions, heat island effects, soil sealing effects).

1.2. Net Zero Carbon Champion

The Net Zero Carbon Champion plays a critical role in driving the project towards achieving the mission 2040 interests, by determining the mission2040 project strategy, developing the strategy into a plan and have the plan executed by the development team, delivering stage reports, revising the mission 2040 project plan, and advise the team for next steps at every stage end, focusing on:

- Minimizing the carbon footprint throughout the lifecycle of the development project.
- Maximising positive contribution to the natural environment
- Maximising positive impact on the social value

Stage reports containing the base line, effects of progress of the design and build stages, including registration of all issues and changes that have affected the execution plan, and the impact of these changes on the carbon emissions as the impact on natural and social value related to the project.

1.3. Systems approach

Redevco takes a systems approach for sustainability in all developments, considering all disciplines in real estate developments as interconnected through sustainability. It requires collaboration, will trigger innovation and drive efficiency in the design process and in construction

1.4. Verification & validation

Redevelopments require verification by BREEAM in Use certification (=validation) to excellent level aiming for outstanding level. The assessment is to take place one year after completion of the development.
For new build, and major redevelopments BREEAM excellent is the required level of validation through certification, to ensure a secured sustainability base level.

Redevco is aiming for transparency over completeness, any information lacking, or hard to define, must be clear in the reporting. We need the data to analyse and learn from, and report on, in transparency according (upcoming) regulations and reporting standards.

1.5. Joint responsibility

To secure general acceptance of the joint responsibility for social and fair execution of works, Redevco's Supplier Code of Conduct applies to all assignments for all parties involved.

Our commitment to integrity is set forth in our Business Integrity Principles providing standards for all our business conduct. Our commitment to wider sustainability topics is set forth in our Environmental, Social and Governance Policy. Both policies can be found at Redevco.com.

2. Built Environment:

2.1. Net Zero Carbon Commitment

Redevco has signed the World Green Building Council Net Zero Carbon Buildings Commitment – to have all buildings within direct control to operate at net zero by 2030, achieve maximum reductions of embodied carbon in new developments and major renovations by 2030; and to work towards net zero assets under management by 2040 including scope 3 emissions.

The WGBC's definition of a Net Zero Carbon building:

- A highly energy-efficient building with all remaining operational energy use from renewable energy, preferably on-site but also off-site production, to achieve net zero carbon emissions annually in operation."
- A highly resource efficient building with upfront embodied carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or, as a last resort, offset in order to achieve net zero across the lifecycle."

The commitment comes with disclosure of asset related carbon emissions, plan and execute decarbonisation, and verification and validation of the results by reporting in a continuous plan – do – check – act cycle per project stage.

The project is to appoint a Net Zero Carbon champion to guard and lead the mission2040 interests.

M&D projects are the most significant interventions in decarbonising assets for Redevco. Carbon emissions in M&D projects are the product of all Green House Gas (GHG) emissions related to the project. There are two types of carbon emissions: embodied carbon emissions and operational carbon emissions. Embodied carbon emissions being the product of all GHG emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in the project. Operational carbon being the yearly product of all GHGs related to the operation of the asset, predominantly by energy use off handover.

Net Zero is implying a compensation of any residual emissions related to the project. Compensation of carbon emissions by verified and validated (certified) methods implies the introduction of carbon costs in the costs structure of the project:

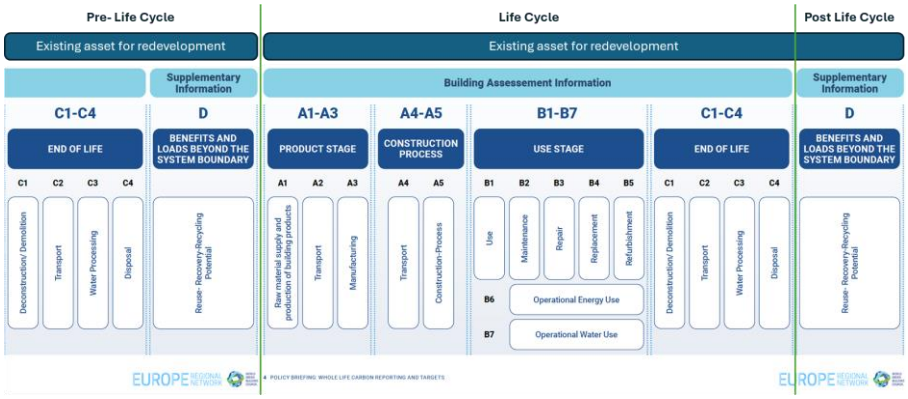
- A non-recurring cost for embodied carbon compensation on the project result.
- A yearly recurring cost for operational carbon emissions compensation during 20 years of operating the asset after completion of the project.

The yearly recurring compensation is considered a risk. Minimisation of operational carbon emissions is the mitigating measure.

2.2. The carbon case

Design choices off early stage define the WLCA of a building, starting with to re-use the existing building structure on site, or to replace it. The carbon case (monetised carbon impact) for all main options considered must be reported, showing the embodied carbon emissions, separated per life cycle stage to €120 per ton CO_2eq as added cost to the development budget per handover (end of development stage). The yearly energy demand to an internal carbon price of €120 per metric ton is an indicator for carbon risk through the operation, until the next intervention.

Life Cycle Modules A, B, C and D: Whole Life Carbon as defined in the EU standard EN 15978. Added: pre Life Cycle modules C and D of onsite existing building – Urban Mining potential.



Breakdown of the WLCA into reporting requirements:

1) Pre life cycle stage embodied carbon emissions for any on site deconstruction works prior to construction separated for:
   a) Module C1-C4
   b) Module D*
2) Life cycle stage separated in:
   a) Upfront embodied carbon emissions Module A1-A5
   b) Embodied carbon emissions use stage Module B1-B5
   c) Operational carbon emissions use stage Module B6 per annum and per life cycle (for in the EU life cycle extents may vary)
   d) On site renewable energy generation in kWp
   e) Operational water use Module B7
   f) On site harvested and regenerated litres of water use per year
   g) End of life stage Module C1-C4
3) Post life cycle stage (next life application) D:
   a) Residuals by kg to landfill or incineration related to all residuals in Module D

*While the general principles for assessing Module D are standardized by EN 15804, the specific application depends on the material, end-of-life scenario, and regional context. The calculation of Module D can vary significantly depending on these factors. Having the data will enable analysis for improving the principles.

2.3. Carbon impact

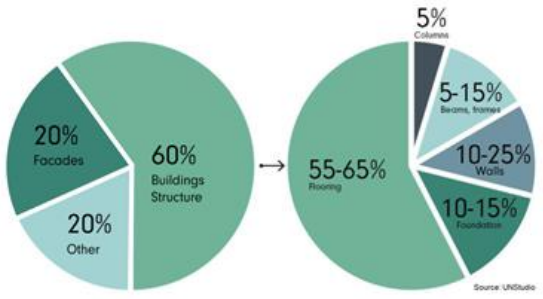
Carbon emissions are embedded in all products through the energy to delve and transport resources, produce and transport products, application and maintenance of products during the life cycle and waste in all process steps, including end of life. During the operation of a building, carbon emissions come from energy consumption, leaking of fluids and gasses, and transport of services and waste. Coolants and refrigerants are known for their major GHG emissions impact, make sure to specify refrigerants with low Global Warming Potential.

Design choices determine the impact from the earliest initial stage up to the end of the life cycle.

2.4. Embodied carbon design choices

Circular design principles apply to all developments, securing design for disassembly with circular and healthy materials, reduction of waste, and enabling next life applications at the end of the life cycle. Carbon emissions need to have served a purpose and must be compensated for in the net zero carbon commitment.

When redeveloping an asset, it's good to know that 60% of the embodied carbon footprint is considered to be in the structure, 20% in the facades, and 20% in MEP, fit out and finishes.



Operational carbon will be determined by situation and orientation of the building, the physical capacities of the shell (e.g. insulation, heat resistance, airtightness) the asset use types, existing energy supply to the site and renewable energy generation options up and to the building and its site. The main impact on carbon footprint in operation is the Global Warming Potential (GWP) of the refrigerants in the HVAC systems. The F-gas Regulation (EU) 2024/573 (applied per 11 March 2024) regulates GWP of refrigerants and coolants in Europe. Some examples of low GWP refrigerants:

R-1234ze (GWP ~ 6), R-290 (Propane) (GWP ~ 3), CO_2 (R-744) (GWP = 1)

In strategic definition of the development project choices depend on whether there's a greenfield or a brownfield site. The majority of Redevco's developments would be brownfield, meaning the site is occupied by a building. First design choice in this stage is whether to replace, or to retrofit - re-use the existing building structure. Full demolition (WLCA modules C1-4) generates carbon emissions through waste of refrigerants and coolants, incineration of materials, landfill, contractors' equipment, transportation, temporary measures, etc. By performing an Urban Mining Scan before taking that decision a considerable amount of products and materials could be harvested for re-use and recycling, avoiding waste and carbon emissions (WLCA module D). The program, volume and orientation of the building will be chosen in this stage, having its effects on the operational carbon e.g. through solar radiation, shading, wind effects.

In concept design, or sketch design new build situation -replacement- part of the embodied carbon budget has been spent on demolition. This is limiting the design options to the extent of the impact of WLCA module D. Therefor our policy is retrofit first. In case of functional or physical barriers for retrofit, by structure strength, or contamination with toxic sprayed asbestos, Chrome-6 or alike, health and safety will dominate decision making, still minimising carbon emissions with recycling and re-use in mind. In this stage of design choices are made around the structure of the building, joints, materialisation, re-use options, static scheme, prefabricates. This is where 60% of the embodied carbon gets defined.

At the same stage, the choice for Passivhaus technology, or alike should be made, for it will influence the choices for MEP in a later stage. If not taken, a choice for genuine MEP climate control will be inevitable a no return path, leaving options to save on energy consumption untaken.

Every design stage, the design gets more detailed, leaving less space for interventions. In the technical design stage, around tender stage, the budget almost always appears to be too tight, forcing the design team to cut cost and make changes to the design. This is a stage where choices will be made on financial reasons and that's where the carbon pricing is a tool to not lose too many of the sustainability ambitions.

The effect of a low embodied carbon circular design will lead to low embodied carbon maintenance, renovations and redevelopments and in the end it will result in low carbon deconstruction and highly re-usable elements and products to harvest for next life high quality applications.

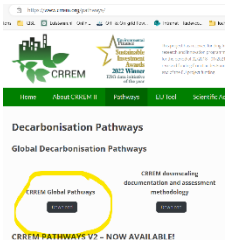
2.5. Carbon storage in long lasting products

The European Commission has issued regulations on Carbon Removals and Carbon Farming in April 2024 by adopting the provisional agreement on the Carbon Removals and Carbon Farming (CRCF) Regulation. The regulation is set to create an EU-wide voluntary framework for certifying carbon removals, carbon farming and carbon storage in products. Carbon storage in long lasting building elements e.g. superstructure, and insulation materials creates carbon sinks of buildings. By the 2024 EPBD (Energy Performance of Buildings Directive) building owners are allowed to declare their structures' carbon storage capacity on their EPC.

Registering all carbon storage capacity in timber, biogenic insulation materials and other long lasting (35+ years) building elements is required for all (re)developments for the purpose of declaring storage to the EPC of the asset at completion.

2.6. Operational carbon design choices

Operational carbon emissions come from energy consumption by operating the building in use. Redevco requires all developments to comply to the specific asset use type, country related CRREM targets for the year 2040. (ctrl+click picture for link).



CRREM 2040 targets ensure us the asset will be future proof at least until the first intervention by redevelopment. The design choices for core and shell buildings must be made with the general use per asset type by a tenant in mind, in a way the tenant can use the energy needed for operating their business or their home, within the operational carbon limits defined by CRREM.

Onsite renewable energy generation (wind or solar, roof or façade or canopy) provided by either Redevco or tenant. Energy storage is to be considered integrating. In any case at least to be prepared for future application.

2.7. Proptech

Proptech enables real time monitoring and automated registration of asset performance, and offers control options for systems to optimise performance. And it can support verification and validation for certification schemes.

When it comes to thinking about PropTech, "the sooner the better" is the best approach. Depending on what PropTech choices made, budget may vary, as installation timeframes. Upon commencement of a (re)development project, consult Redevco's Innovation manager, for support along the PropTech journey, following the Proptech Protocol (available on request).

2.8. Climate adaptation

There is an interconnection between natural environment and built environment. Nature based solutions and renewable resources have a positive impact on the built environment regarding lowering the embodied carbon in developments. Or by using natural renewable energy resources and physics to generate cooling, heating and ventilation.

Urban built environment is poorly equipped for maintaining or even growing of natural ecosystems. And humans are part of nature as well, as we suffer from climate change effects, insects, animals and plants do too. Not to mention the social aspects being enhanced by nature.

A development project offers the occasion to be prepare for future increasing climate change effects as the risk on extreme weather events, like heavy rain falls, strong winds, heat waves, drought, rising water levels of seas, lakes and rivers. The development team must assess the climate change risks associated with the assets location and take mitigating measures to cope with extreme weather conditions to prevent the asset for damage by climate change effects. For example water storage for heavy rains, as drain capacity and robust roof structure. Flood barriers, elevated equipment rooms, water resistant structure up to a safe level. As shelter for sun and extreme heat, wildfires and drought. The ability to capture and hold water in extreme rains relieves drainage systems, and provides a water buffer for cooling, watering etc. Like a battery in a renewable energy solution, to destress energy supply.

2.9. The Reduce - Renewable – Increase efficiency - Triangle

The trias energetica principles can be projected on water use and material use as well. The impact reduction is managed by the principles to reduce demand of resources (water, energy, materials) in the first place, secondly maximise the use of renewable resources (energy, water and materials), and thirdly increase efficiency of the use of any residual non-renewable resources (energy, water and materials).

Trias Energetica – Trias ‘Aquatica’ – Trias Materialica

“Trias Energetica”:

1. Reduce energy demand: The first step is to minimize the energy required by optimizing the design of the building, improving insulation, and using passive design strategies like natural ventilation, daylighting, and thermal mass.
2. Use Renewable Energy: After reducing the energy demand, the next step is to meet the remaining energy needs using renewable energy sources like solar panels, wind turbines, or geothermal energy.
3. Use Fossil Fuels Efficiently: If the energy demand cannot be entirely met by renewable sources, the third step is to use fossil fuels in the most efficient way possible, ensuring that their impact on the environment is minimized.

"Trias Aquatica" as the water management equivalent of Trias Energetica:

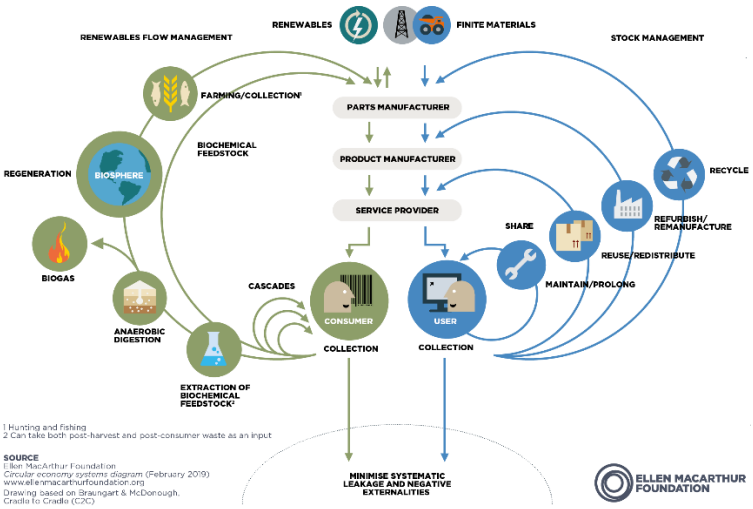
1. Reduce water demand: Implementing conservation practices and promoting water-efficient technologies to minimize overall water usage through simple fixes like water saving sanitary appliances, demanding management through policies, and technologies to control water demand and to detect leakage.
2. Use renewable water sources: such as rainwater harvesting, recycling water, and sustainable groundwater management by installing the necessary infrastructure and processes.
3. Increase water efficiency: by using real-time data and advanced technologies to control water usage and responsible resource management.

“Trias Materialica” as the materials management equivalent of Trias Energetica:

1. Reduce Material Use: optimizing the design, using fewer resources, and preferring strong, durable, and lightweight materials, avoiding waste.
2. Use Renewable resources for materials: renewable materials, re-use or recycling materials, reducing the environmental impact of material extraction and processing.
3. Use Non-renewable Materials Efficiently: materials that are non-renewable or cannot be easily recycled, must be used as efficient as possible, minimizing waste and ensuring a long lifespan in the building or beyond.

2.10. Circular Economy

The circular economy principles are well explained by The Ellen McArthur Foundation, Built environment and the circular economy (ellenmacarthurfoundation.org).



Redevco has a net zero carbon circular design guide to explain circular design principles based on specific building elements' life cycles and materials choices, to be found in the appendices.

2.11. Urban Mining

Urban Mining refers to the process of recovering valuable materials from the built environment, considering existing buildings as stock for re-use, either direct or through recycling as meant with Module D in the WLCA. By extracting and recycling these materials, urban mining reduces the demand for raw materials, conserving natural resources and minimizing the environmental impact of traditional mining.

This process not only diverts waste from landfills but also contributes to the circular economy by turning urban waste into a resource. Additionally, urban mining supports sustainable development, helping Redevco reduce their carbon footprint, cut construction costs, and enhance resource efficiency in the long-term.

For most effective next life application of Urban Mining Potential, the generally required specifications of all elements, materials and residuals are categorised in:

- Object material specifications and characteristics
- Functional and technical information
- Sourcing information
- Logistical information

A breakdown of required data and information is listed in the appendix.

2.12. Responsible and sustainable construction practice

Compliance to the Breeam Management credit for sustainable, social, healthy and safe working conditions at the construction site. MAN03 is mandatory. The credit will be part of the Breeam verification and validation applying for a Breeam certificate, or can be used as a performance verification method for use of legal and sustainable timber, ISO 14001 Environmental Management System, formal agreement on related performance targets, and monitoring the targets during construction. In the Netherlands contractors can apply to join an industry standard promoting responsible and sustainable construction practices, particularly in areas like safety, environmental management, and communication with the local community, called Bewuste Bouwers, by which compliance to the Breeam building management credit MAN03 gets verified. (See appendix).

To comply with CSRD the value chain must be assessed on sustainable, responsible, healthy and safe working conditions for all subcontractors and suppliers. In all tenders for construction works this must be addressed in the selection criteria (Supplier Code of Conduct applies). ISO14001 is a recommended selecting criterium.

2.13. Banned chemicals

In accordance with EU REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulation banned or severely restricted hazardous chemicals must not be contained by any product applied in the development. The European Chemicals Agency (ECHA) is displaying the regulations and the list of banned chemicals on their website. As ECHA is responsive to EU legislation, focusing on restricting chemicals scientifically assessed for risks within the EU, future liabilities by not yet assessed chemicals on a candidate list are not being banned.

The Cradle to Cradle Products Innovation Institute (a certification program that promotes circular economy principles, sustainable product design, and material health) is pushing for innovations that eliminate hazardous substances before they are officially banned or restricted by regulatory bodies like ECHA and has a particular emphasis on the elimination of toxic chemicals and the use

of safe, renewable, and recyclable materials throughout a product's life cycle. The institute displays Cradle to Cradle Certified products on the website.

Cradle to Cradle products' assessments cover the safety, circularity and responsibility across five categories:

- Material Health
- Product Circularity
- Clean Air & Climate Protection
- Water & Soil Stewardship
- Social Fairness

The chemicals like halogenated fire retardants, PFAS/PFOS, Lead, Cadmium, Mercury, relate to health & safety and environmental sustainability issues such as being carcinogenic, mutagenic, or toxic to reproduction (CMRs), persistent bio-accumulative and toxic (PBT), or endocrine-disrupting, to all users and all workers in the value chain. Circularity gets threatened by these chemicals, for the very likely risk of hazardous chemicals getting spread through society by re-use, repurposing, or recycling. Obvious chemicals would be asbestos or chrome-6, less obvious could be glues, adhesives, fire retardants, finishes or even mineral fibers (glass wool or stone wool).

All release of Volatile Organic Compounds (VOC) from among others adhesives, paints, sealants and coatings are to be avoided in Redevco (re)developments, verification by compliance with the *Well standard*, specifically the materials section credits X05, X06, X07 (Standard | WELL V2).

Redevco refers to the Cradle to Cradle Products Innovation Institute list of banned chemicals to avoid risks and to secure health & safety in the circular economy.

3. Natural Environment

As loss of nature is a result of depletion of the earth's resources and destruction of ecosystems, resulting in climate change effects and risks, restoration and reinstalment of ecosystems should mitigate climate change risks and impact its effects.

In the light of sustainable and liveable cities, the Cradle to Cradle principles water stewardship, soil stewardship, clean air and climate change protection touch upon Redevco's drivers for Natural Environment:

- Biodiversity net gain
- Responsible water management
- Responsible waste management

3.1. Biodiversity

Biodiversity enhancement requires reduction of heat stress and water management. Vegetation reduces heat stress, only locally conventional vegetation to be applied, avoiding invasive species. Heavy rains require rain water buffering, which can be used to water vegetation and cooling the area by natural evaporation, which has a cooling effect.

The vegetation is the living area of birds and insects. Birds and insects need stepping stones within their respective reach to connect various habitats in the area. The project must support local vegetation and wild life (rewilding initiatives) by minimizing air and light pollution and creating safe shelters for birds and insects, thus serving biodiversity net gain. BREEAM new construction and renovation standard's chapter Land use and Ecology will guide the project.

Soil stewardship in urban and built environments is essential for ecological balance, biodiversity and water management. Pointless pavement must be avoided.

If properly managed, the soil will filter pollutants, protecting groundwater and rivers. As it will contribute to climate change mitigation, storing and distributing water, storing carbon, growing vegetation and mitigating urban heat island effects.

Soil provides habitat for biodiversity in support of overall ecosystem health, contributing to human health and well-being. Visual and physical access to green spaces contributes to mental and physical health, by providing room for recreation and improved air quality.

Next to water and soil stewardship, clean air is an important influencer of human wellbeing, as part of the ecological system that benefits from these. This is where direct and indirect emissions meet

water and soil conditions. Creating a healthier and safer habitat will influence climate change and mitigate climate change risks.

3.2. Responsible water management

Water stewardship is about making water systems more sustainable, resilient, and equitable. Responsible water management reduces pollution and enhances water quality for ecosystems. Drinking water supply is under pressure and some countries as Belgium already have regulations in place to store rain water. Re-use of water and use of rain water systems in the built environment will increase efficiency, and secure availability over longer term. Water management will enhance climate resilience, in both droughts and increased rainfall. As it will contribute to public health and biodiversity.

Water consumption covers operational use for households, workplace and leisure, as water used in the production of materials and products in construction stage, in factories and on site, even for operating the sites amenities.

3.3. Responsible waste management

The circular economy is designing out waste towards residuals, to serve as resources for new products. As well for products in the built environment as for products in business operations in buildings. Circular Economy in the Built Environment is described in chapter 2.

Facilitating separation of residuals demands placemaking and commodity. The facility must be clear and easy to use, to accommodate the desired behavior and get the residuals sorted in bespoke high valued residual streams for resources. The operations programmed in the development require assessment to understand the sorting of residuals, the timing and the handling to design the facility with the flexibility to make adjustments for varying operations, or changes in products, for example when the circular economy is getting more successful in changing to biogenic resources.

4. Social value

To ensure a liveable and sustainable living environment, Redevco's developments must provide equal rights, equal treatment, independent living and full participation in society, by giving access to all public amenities, including buildings and infrastructure.

Redevco focuses on the following social values:

- Local needs
- Placemaking
- Stakeholder relationships

4.1. Local needs

Local needs are bespoke and vary per area, that's why a local needs assessment must be carried out by the development team to deliver the key local needs the development can contribute to. "Before delivering any Social Value, it's integral to build a deeper understanding of the economic, social and environmental needs of a local community." - *Tessa Alcorn, Head of Planning and Local Needs Analysis, Social Value Portal*.

A local needs delivery plan for the deliveries on placemaking and stakeholder relationships must be supplied for monitoring progress on Social Values.

4.2. Placemaking

Placemaking is creating public spaces enhancing social interaction and cultural exchange. Social interaction demands the space to be accessible for all, a safe and secure environment, providing comfort and wellbeing.

Improved connectivity for everyone by public transport, safe walking and cycling must be considered in urban development plans, and the development must include amenities to accommodate these ways of travel.
The EU standard EN 17210, 'Accessibility and usability of the built environment' sets out functional requirements the built environment - including urban areas - needs to fulfil to be considered accessible and usable. Local regulations and requirements might contain more specific requirements, but should be in line with the EN 17210. Be aware that accessibility & inclusivity also applies to people with all kinds of disabilities, (cognitive) disorders, and simply to all ages, cultures and socioeconomic backgrounds. Check local organisations, NGO's, for support in the design stage.

Apart from emergency escape routes and their visibility and accessibility, safety and security is about avoiding dark areas, dead angles, about proper lighting, sightlines and wayfinding in public

areas, and in communal areas. Publicly available sources can provide insights in the local crime rates, population and trends, to determine focal points for the design team. Check local policies, standards and directives, often displayed in local BREEAM HEA health criteria in new build and renovation certification guidelines.
The European Standardization of Security Measures (CEN/TS 14383-2) specifies the assessment of risk of crime problems (crime and/or feelings of insecurity) and the framework, process, measures and procedures aimed at reducing these risks in a specific new to build or existing environment.

Heat stress, rain and wind cause discomfort in urban areas. Nature by vegetation can provide comfort by giving shelter and purifying air. Discomfort by wind caused by buildings' aerodynamics must be avoided. Also acoustics must be assessed in planning, to avoid resonating noises bouncing of hardened surfaces.

#health&safety, #comfort&wellbeing, #accessibility&inclusivity

4.3. Stakeholder relationships

Urban developments must provide spaces for social interaction, in a way that avoids crowd effects, giving a safe and secure environment. Amenities like sports or playgrounds, public services, leisure activities or communal spaces like libraries and cafes encourage interactions. The spaces must be designed to welcome and stay, to connect and meet.

The plan must support local community by enhancing the network of local entrepreneurs, working with local contractors and suppliers. For example by having entrepreneurs involved with innovative business development in and around the asset. Exploring community local needs prior to development is key to (re)integrate the development in the local community.

5. Requirements for developments

The requirements for compliance to the Net Zero Carbon Sustainable Design Brief are collected in an Excel file containing different tabs for Built Environment, Natural Environment, and Social Value.

All requirements must be verified and motivated per requirement. Traffic sign signalling progress. Proof by reports, certificates, plans or other means must be logged and on delivered on demand for responsible reporting purposes.

6. Appendices

- Requirements Built Environment
- Requirements Natural Environment
- Requirements Social Value
- Net Zero Carbon Circular Design Guide
- Redevco BIM protocol
- PropTech Protocol.pdf
- Mass Timber Insurance Playbook
- Urban Mining data requirements
- BREEAM country specific social value credits
- Responsible Contractors

6.1. - Requirements Built Environment

Requirement ID	Requirement Description	Verification Method				Comments
BE01	The project must set up a sustainability action plan to manage targets set per sustainability requirement and update the plan at each development stage change.	Baseline report and end stage reports containing status updates per requirements including due changes to the sustainability action plan for review by Redevco's sustainable development manager				The sustainability action plan concerns all sustainability actions for all impact framework topics. The baseline is the economic, built, natural and social environmental program at initiation of the development. The development is monitored through proper issue and change management reflecting to the baseline. All interventions are equally assessed and scored to all topics, delivering tranparency, learnings, and data to analyse and report.
BE02	The project must assess climate risk and set mitigation measures using the climate risk tool outcomes from the Asset Business Planning process	Material topics (score 6 or more) are projected in investment decision paper, and mitigation measures				
BE03	The project is to assess Redevco specific CSRD compliance and reporting requirements.	All requirements in the Sustainable Design Brief must be adressed with argumentation.				The Mission 2040 Design Brief is meant to cover all CSRD reporting requirements. A check at initiating the development

						will mitigate risk of non-compliance.
BE04	The project is at least to be certified BREEAM Excellent (new build and renovation) to comply to investors' requirements.	Breeam assessment by a certified advisor. Validation by a 3rd party certified assessor.				Breeam construction certifications is a validation of the quality standard of the development.
BE05	The project must assess the options and do a feasibility check to be certified BREEAM Outstanding (new build and renovation)	Breeam assessment by a certified advisor. Validation by a 3rd party certified assessor.				
BE06	The project must include BREEAM in Use certification one year after completion, accomplishing Excellent level.	Breeam assessment by a certified advisor. Validation by a 3rd party certified assessor.				Breeam in use is the validation of compliance to investors' requirements.
BE07	The project will apply BIM in accordance with the Redevco BIM protocol.	Redevco BIM protocol 3.10 Model Validation and Quality Control - reporting requirement				
BE08	The project will deliver an as built building materials passport in accordance with the Madaster model, as per the Redevco BIM protocol.	Part of BIM protocol reporting requirement. Madaster templates for property sets, validation through Madaster Material Passports or equivalent, full passport including technical annex showing materials, Circularity, and environmental information as per the BIM protocol.				

BE09	The project must report the calculated carbon impact by WLCA according the EN 15978 EU standard's life cycle stages, following the breakdown as mentioned in the paragraph ' The carbon Case' in the Mission 2040 Design Brief	Report to Redevco's sustainable development manager the project's actual expected tonnes of upfront embodied carbon and annual operational carbon to the internal carbon price (currently €120,- per ton CO2e) per design stage and development stage, related to initial targets set.				
BE10	The Project must perform a n Urban Mining Scan (UMS) to register non hazardous obsolete elements and materials on site and present a strategy to have all obsolete residuals offered to the market for at least recycling, preferred upcycling or re-use.	The scan and strategy are reported to Redevco's sustainable development manager.				Most acknowledged consultants on sustainability will know how to perform a UMS and to report the carbon impact.
BE11	The project must report the outcomes of the executed UMS strategy for the project.	At actual execution of the plan, the contractor is to provide reporting of the actual results compared to the baseline of the initial urban mining scan. The report is to follow requirements as stated in the Mission 2040 Design Brief paragraph 'Urban Mining', and to display Embodied Carbon emissions in kg CO2e, categorised per material or element deconstructed. To be reported to Redevco's sustainable development manager.				
BE12	The development’s upfront embodied carbon intensity is limited to a maximum of 200kg/m2, including deconstruction activities to the original building - a retrofit first approach.	The embodied carbon impact calculated for EN 15978 stages A1-A5, plus stages C1-C4 and D regarding the existing asset on site to prepare for the project. To be				

		reported to Redevco's sustainable development manager.				
BE13	A new build NZC development's upfront embodied carbon intensity is limited to 450kg/m2, including deconstruction on site to prepare for the new build.	The embodied carbon impact calculated for EN 15978 stages A1-A5, plus stages C1-C4 and D regarding existing assets to be removed for the development on site to prepare for the project. To be reported to Redevco's sustainable development manager.				
BE14	The project design team is committed to assess options to get beyond the set embodied carbon targets by at least 10% at initial design stage.	Choices might have a financial impact for later development stages. The initial stage, before a preliminary design has been made, is the only stage to do meaningfull trade offs on carbon and capex through the carbon cases for various options.				
BE15	The project design team must register all carbon storage capacity in timber, biogenic insulation materials and other long lasting (35+ years) building elements.	Verification by reporting of the carbon sink assessment according to the Energy Performance of Buildings Directive (EPBD).				
BE16	A NZC development's operational carbon intensity is bound to stay within the CRREM 1.5o pathway for at least 15 years off handover without investing extra capex. Therefor the energy use intensity is also limited to the country and asset use type specific CRREM 1.5o pathway targets.	The annual operational energy intensity as expected in case of regular use of the asset is calculated based on the equipent configuration in the design, including average use of occupiers, split in landlord's share (common areas) and tenant's share.				

		To be reported to Redevco's sustainable development manager				
BE17	Refrigerants must comply to low Global Warming Potential (i.e. <10) standard. Best practice heading towards GWP of 1. Refrigerants are labelled hazardous waste.	Verification by using the POL and ENE credits of Breeam new construction assessment methods, using specifications in technical design and contractor's specifications.				
BE18	A NZC development's primary energy supply is fossil free. Emergency generators for fire safety equipment are allowed under restrictions of regulations, preferred fuel is synthetic or bio-fuel – HVO100, GTL, or alike).	Report to Redevco's sustainable development manager the specifications of any fosill fueled equipment needed.				
BE19	In case a project is bound to use of fossil fuelled energy supply, the conversion to non-fossil energy use will be shown in time per the maintenance planning, as will the financial implications (Capex and Opex) be shown in the project's business case.	Verification per business case implications and maintenance planning.				
BE20	Onsite renewable energy generation is to be provided by the project. Energy storage is to be considered integrated. In any case at least to be prepared for future application within 3 years after completion (included in the	Verification per business case implications and maintenance planning. Assessing feasibility for available roof - and façade area available. regarding balanced risks and benefits.				

	Opex/Capex structure of the business case).					
BE21	Every project is to be handed over including Building Management System and smart metered grid connections for all energy grid connections, including water - both consumption water as regenerated water use.	Verification assessment according BREEAM new construction ENE Energy Monitoring credit.				
BE22	The project must perform a Proptech scan with help of Redevco's innovation manager. Criteria: • Does it improve the experience of the tenant? • Does it drive sustainability of the asset (and give us useful data or help toward our 2040 ambition)? • Does it drive down operational building costs? • Does it increase the value of the asset? • Does it assist us with regulatory compliance? • Does it help or hinder liquidity (depending on our choices)?	The proptech strategy for the project is reported to the innovation manager				

BE23	The project is committed to zero waste and zero emissions by presenting a management plan to avoid waste and emissions, applying circular design practices, diverting any waste from landfill or incineration. This includes waste and emissions during construction and during operation.	Presenting a zero waste and zero emissions management plan to the Sustainable Development Manager.				See Natural Environment requirements for Redevco's waste criteria reporting obligations. All residuals categorised by sort. Mono streams keeping most value. Prefab just-in-time delivery diverts residuals from the construction site, managing product specific residuals at the production facilities.
BE24	As part of the zero waste plan the development must comply to the list of banned chemicals by the Cradle to Cradle Products Innovation Institute to avoid risks and to secure health & safety in the circular economy.	Verification by presenting the Cradle to Cradle certificates or equal validated proof of compliance.				Cradle to Cradle certificates vary from Bronze to Platinum based on five focus areas: Material Health, Product Circularity, Clean Air & Climate Protection, Water & Soil Stewardship, and Social Fairness. The lowest level for the five areas determines the overall level. Banned chemicals are a main part of the material health section.
BE25	To protect occupiers' and users' health during the operation of the asset, the project will prove compliance with Well- X05, X06, X07 for limitation of VOC.	Verification by sustainability advisor, applying Well X05, X06, X07 credits.				Consultants should be familiar with Well. Cradle to Cradle certified products and materials will simplify the Well assessment.

BE26	The project will apply the responsible construction practices for all construction companies / contractors in the construction agreements / contracts, complying with Breeam new construction MAN03 criteria as verification method.	Verification by sustainability advisor, applying Breeam new construction MAN 03 credits.				Responsible construction practices appeal to health and safety, waste, environment, communication and site neighbors. It's part of the conditions in the construction contracts, and must be combined with zero waste and zero emissions construction.

6.2. - Requirements Natural Environment

Requirement ID	Requirement Description	Verification Method				Comments
NE01	The project must deliver a sustainability action plan to manage targets set per sustainability requirement and update the plan at each development stage change.	The plan describes biodiversity targets to be met, including a timeline to measure the outcomes of the interventions in time. Touching upon all BREEAM Land Use and Ecology (LE) credits, for New build and Renovations. Including local species assessment and connecting nearby habitats, creating of stepping stones for birds and insects and other topics referred to in chapter 3.1, as it includes how to maintain, improve, measure and report on the KPIs for the duration of the asset life cycle. Baseline report and end stage reports containing status updates per requirements including due changes to the sustainability action plan for review by Redevco's sustainable development manager				The sustainability action plan concerns all sustainability actions for all impact framework topics. The baseline is the economic, built, natural and social environmental program at initiation of the development. The development is monitored through proper issue and change management reflecting to the baseline. All interventions are equally assessed and scored to all topics, delivering tranparency, learnings, and data to analyse and report.

NE02	The project must apply an ecologist's advise how to enhance biodiversity within the project, and set material and relevant targets.	An ecological report describing the natural habitat at the development site, including a review of the current state of the habitat, and actions including costs and benefits to enhance biodiversity by strengthening the habitat by setting material and smart KPIs.				Non material KPIs raise risk of being critisized for greenwashing. A proper report by an ecologist will deliver transperancy on materiality. actions could be as small as adding a stepping stone on RHS assets for birds and insects to feed and rest, to implementing landscaping in RWP assets or area developments.
NE03	The project must assess and justify application of vegetation on roofs, at facades, and at ground level for support of biodiversity enhancement, and urban heat stress releaf.	The baseline consists of the existing asset before redevelopment: - plot area, - % non paved plot area; - total existing rooftop area, and - % green roof of rooftop area; The redevelopment's impact on the baseline showing the - alterations to plot area, - paved plot area; - rooftop area and - green roofs at rooftop area.				By calculating the areas upfront, the capacity for harvesting and retaining rainwater, releasing sewage systems and flood risk damage control can be integrated in the redevelopment plans. If there is no green space at street level (Retail High Street) rooftop and façade are to be explored for green contribution, bringing relief in urban heat stress and improving air quality.

NE04	The project must set targets on and deliver a plan how to accomplish water efficiency.	The plan is to touch upon all BREEAM Water (WAT) credits, New construction and Renovations, for verification purposes. Drinking water forecast must comply to Breeam Outstanding specifications. The targets must be material and smart.				Smart metering the water systems is a requirement in the built environment requirements section. Water efficiency is influenced by the kitchen and sanitary fit outs, water quality, and behaviour.
NE05a	The project must assess and justify application of rain water usage for saving drinking water by:	- rain water retention, buffering heavy rain water to release stress on the (rain water) sewage system				
NE05b		- rain water harvesting, collecting rain water for flushing toilets and watering of plants				
NE06	The project will net enhance soil quality, by assessing and justifying all advised by the ecologist.	The Breeam LE - Land use and Ecology - credits for new construction and renovation.				Relative to the asset class type there will be different impacts.
NE07	The asset's roof structure will be designed for bearing a green roof and PV panels together.	The combined load must be mentioned in the design criteria of the structural engineer. If an existing structure can't bear the combined load, it must be explaind.				Green roofs have a cooling effect on PV panels, enhancing the efficiency of the panels.

NE08	Retail parks must contain green areas, pedestrial and cylists zoning for safe trafic to and at the retail park. Bicycle parking areas to be forseen in the design.	Verification by Breeam Transport Criteria (New Construction).				Pedestrian and cyclist friendly (for all types of user regardless of the level of mobility or visual impairment - related to SV04) with the provision of cycle lanes, safe crossing points, direct routes, appropriate tactile surfaces, good lighting and signposting to other amenities, public transport nodes and adjoining off-site pedestrian and cycle routes.
NE09	Pavement at parking zones will be of a permeable kind, combined with rain water storage capacity to run off heavy rain to a buffer.	Verification by reporting of the on site water balancing. All water added: drinking water, rain, snow Retained water by soil, tanks, pavement, wadi/pond Harvested water for re-use Re-used water: watering plants, grey water system Evaporated water Disposal and drainage of waste / rain water				retention capacity mitigates flood risk and reliefs sewage systems in heavy rain showers. The re-use of harvested water saves the intake of fresh drinking water.
NE10	It's not allowed to mix hazardous waste with any residuals at the construction site.	Verification by the Built Environment requirement for a zero waste plan.				All disposed residuals must be logged and reported bu the coordinating contractor to the project manager.

NE10a	The project must report handlings of hazardous waste from construction site:	#kg hazardous waste generated during construction containing one or more of the hazardous properties listed in Annex III of Directive 2008/98/EC of the European Parliament and of the Council17 on waste. Logged data: kilograms collected, collecting site and date by handler, handling company, delivey site, kilograms delivered at delivery site.				Transport companies are obliged to log all transport data and deliver a copy of the bill to the client (in this case the contractor). The contractor should hold a log filing all bills and deliver that log to the PM.
NE10b		#kg hazardous waste directed to incineration				
NE10c		#kg hazardous waste directed to landfill				
NE10d		#kg hazardous waste diverted from disposal for recovery operations (chemical treatment, reprocessing)				Recovery, replacement of otherwise new produced products, saving resources
NE10e		#kg hazardous waste diverted from disposal for preperation for re-use				Cleaning, no significant modification
NE10f		#kg hazardous waste diverted from disposal for preperation for recycling				Recycling / upcycling

NE11a	The project must report handlings of non-hazardous waste from construction site:	#kg non-hazardous waste generated during construction, **not** containing one or more of the hazardous properties listed in Annex III of Directive 2008/98/EC of the European Parliament and of the Council17 on waste. Logged data: kilograms collected, collecting site and date by handler, handling company, delivey site, kilograms delivered at delivery site.				Transport companies are obliged to log all transport data and deliver a copy of the bill to the client (in this case the contractor). The contractor should hold a log filing all bills and deliver that log to the PM.
NE11b		#kg non-hazardous waste directed to incineration				
NE11c		#kg non-hazardous waste directed to landfill				
NE11d		#kg non-hazardous waste diverted from disposal for recovery operations (chemical treatment, reprocessing)				Recovery, replacement of otherwise new produced products, saving resources
NE11e		#kg non-hazardous waste diverted from disposal for preperation for re-use				Cleaning, no significant modification
NE11f		#kg non-hazardous waste diverted from disposal for preperation for recycling				Recycling / upcycling

NE12	The project must assess residual streams to be expected from operating the development and design a facility for residual streams selection to create the best circumstances for becoming resources in any production process.	The plan contains a residuals ('waste') handling site optimised for collecting separate streams for: - pallets, wood/timber - plastic foils - plastic products and containers - styro foams - cardboard - glass - paper - metals - organic (specific f&b monostreams: orange peels and coffee grounds) - chemical / hazardous (NB: specific legislation)				Depending on the operational program. Cardboard is a valuable stream, as are metals and paper and plastics. Styro foams are not plastic and must be hold separate from. in larger quantities coffee grounds and orange peels represent value as well in circular industries.

6.3. - Requirements Social Value

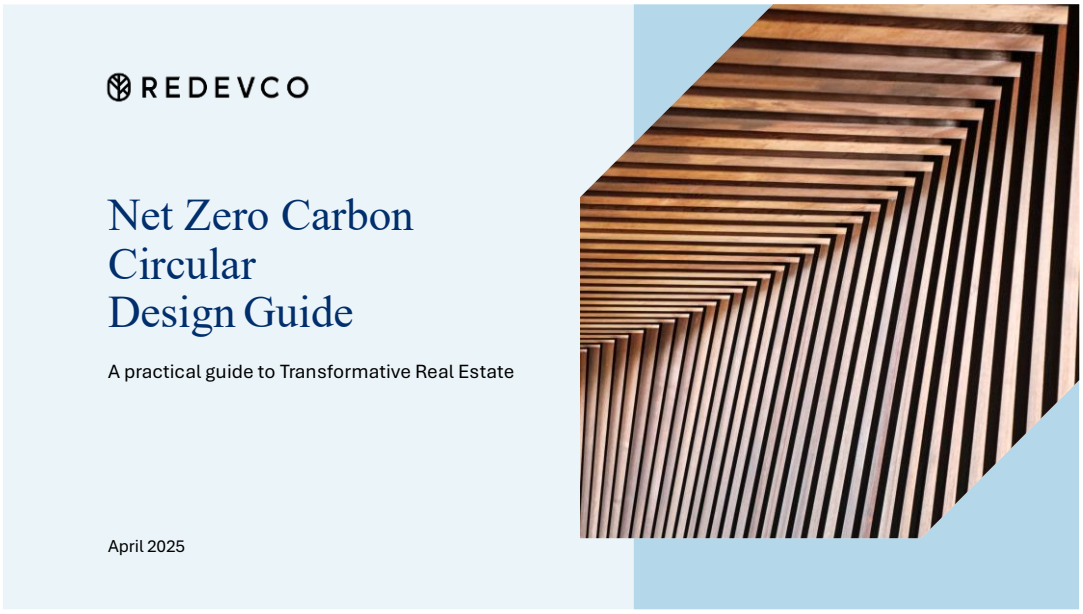
Requirement ID	Requirement Description	Verification Method				Comments
SV01	Local Needs: The project must provide a Local Needs Delivery Plan for monitoring progress on Social Values in the context of the project and its local setting and to report on issues and recommendations to be implemented in the development.	Reporting based on a SWAT analysis on local needs related to health, safety, wellbeing and inclusivity, based on publicly available sources for local economy, population, crime rates, and trends.				
SV02	Local Needs: The project must assess safety and security risks for the site and the asset. Crime risk mitigation, applying The European Standardization of Security Measures (CEN/TS 14383-2)	Verification according BRE HE06: "Through consultation with a suitably qualified security specialist (SQSS), site-specific recommendations can be made to improve the security of the site. This creates a safer and more secure environment that reduces the fear of and risk of crime. This supports the physical and mental wellbeing of building users, and the protection of property and business."				

SV03	Placemaking: The project guarantees accessibility for all abilities and user groups. Demanding technical, functional and spatial requirements, including signage and wayfinding.	Functional requirements for the built environment according the EU standard EN 17210, 'Accessibility and usability of the built environment'. Use country specific BREEAM credits (appendices) for verification and validation. Engage with local organisations to assess local needs and requirements, exceed local regulations where possible. Local legislation UK: DDA, Disability Discrimination Act.				
SV04	Placemaking: The project must assess how to contribute to improved connectivity for everyone by public transport, safe walking and cycling and implement measures in the development.	Verification by compliance to SV03 and NE08. NE08 refers to verification by Breeam Transport Criteria (New Construction).				
SV05	Placemaking: The project must include services and amenities in support of enhancing social interaction, comfort and wellbeing in the context of the project and its local setting to contribute to safe and secure social interaction by the project and apply measures for improving / offering social interaction in the development. Spaces must be designed to welcome and stay, to connect and meet.	Verification by reporting the follow up of the local needs plan (SV01) per category identified in the plan. The plan must provide maximum coverage of GRESB targets TC1- tenants engagement program, TC2- tenant satisfaction survey and satisfaction improvement program, TC3- ESG related Fit out and Refurbishement program, TC4- ESG specific requirements in standard lease contracts, TC5- H&WB program and improvement measures, TC6- Community engagement program, and monitoring its impact on community.				Reference: Boulevard St Catharine. In residential projects social interaction of residents must build community feeling. Common areas providing space for social activities, community management and interaction with local organisations, artwork and so on.

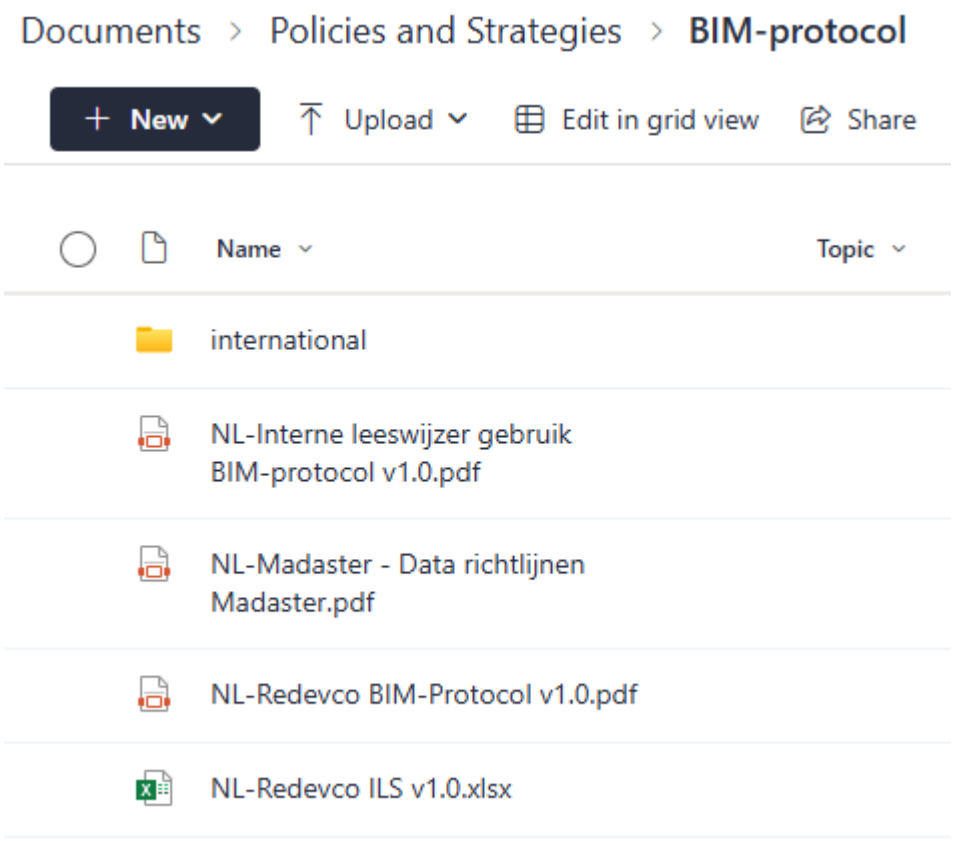
SV06	Stakeholder relationships: The project must support local community by enhancing the network of local entrepreneurs, working with local contractors and suppliers	Verification by providing a suppliers list with business locations, referencing local as being based in the city or region of the asset.				Consultants and development team members aren't nessecarily local.
SV07	Stakeholder relationships: The project must implement local climate change resilience needs	Verification by mitigating measures to relief the assets' surroundings from heat, drought, flood, et cetera as identified as material risks in requirement BE02.				This requirement is to show the relations with Built and Natural environments
SV08	Stakeholder relationships: The project must engage with local community in case of developing local renewable energy production for participation	In general Aqua Thermal Energy Storage, or district heating like services can only be profitable on a larger scale. Verification by proof of a survey and the results of the survey, or a signed contract / agreement.				This could be as small as offering a surplus of generated solar or wind energy, recovered heat or cold to a neighbor.

REDEVCO

6.4. Net Zero Carbon Circular Design Guide

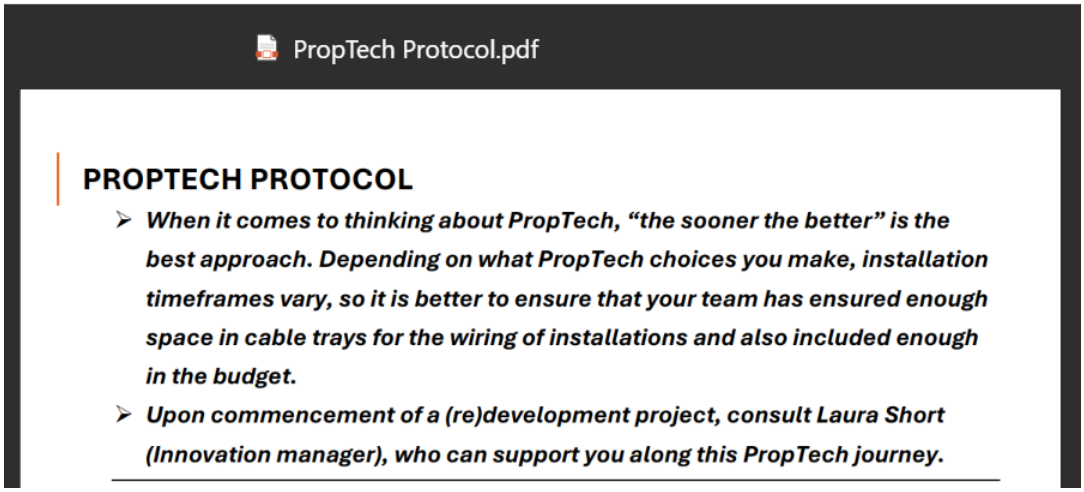


6.5. Redevco BIM protocol



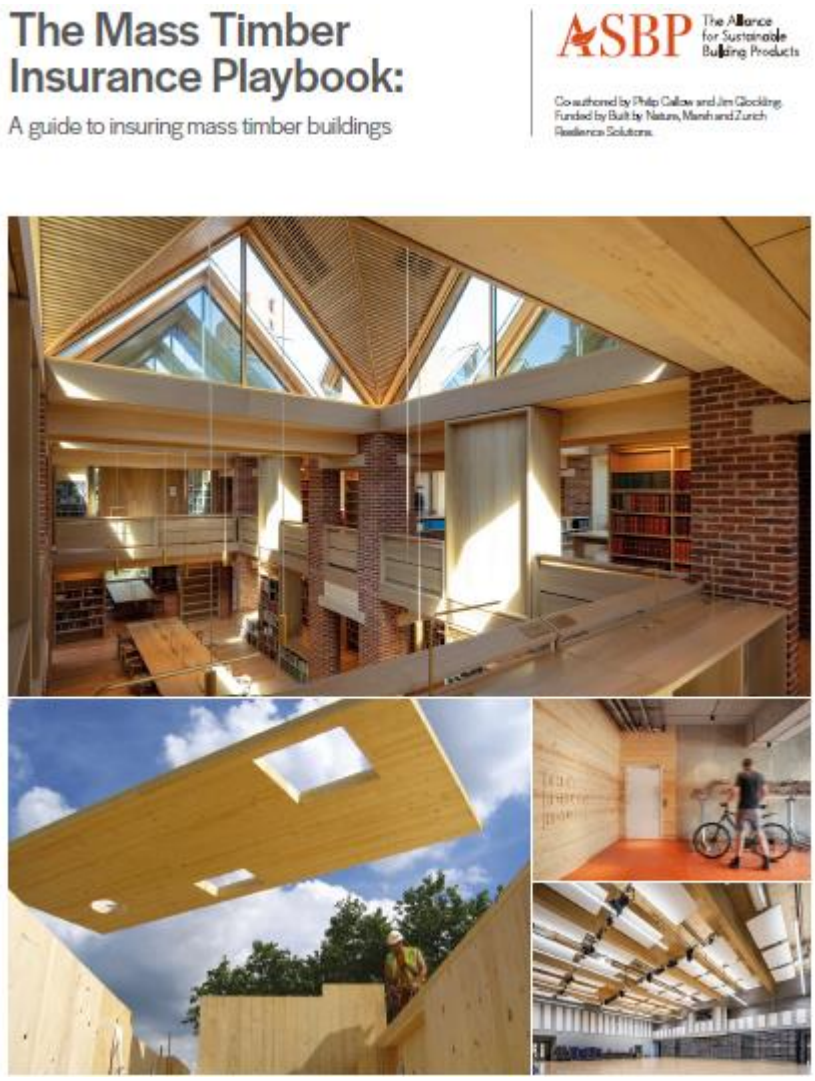
6.6. Proptech Protocol

The PropTech Protocol.pdf can be downloaded from the Innovation Sharepoint page.



6.7. Mass Timber Insurance Playbook

“The Mass Timber Insurance Playbook provides us with a real opportunity to address all parties’ needs and deliver sustainable buildings that are considered best in class for building safety and property protection both, during construction and operation.”



6.8. Urban Mining data requirements

Object:	
Urban mining location, address, asset use classification	
List of available as built documentation	document title, producer, version and date
Building permits history, including conditions and documentation, legal restrictions	
Object decomposition	Explanation of the object's chemical and physical properties as in composites, alloys etc.
Dimensions and weight	M, kg
Object meronomy	Aggregation representing the relationship between an object (as a whole) containing components (as parts).
Object's functional information	Structural, thermal performance, fire resistance
Object's functional unit	Pcs, m^1, m^2, m^3, kg
Object location in the structure	
Materials Passport (when applicable)	ID's
Joint types	Clicked, screw, nail, bolt, glue, slide, weld, hook, clamp
Number of joints per type	#
Crossings	i.e. for ducts and pipes
Containments	i.e. cast in
Condition	Visual non-destructive systematic evaluation of the condition, defects, and materials
Circularity, re-use level	Re-use, refurbish, repurpose, recycle, waste
Technical data:	
Density	Kg/m^3
Adaptability	Explanation

Standard product	Y/N
Maintenance instructions	Pdf
Cleaning instructions	Pdf
Maintenance log	Pdf
Assembly instructions	Pdf
Disassembly instructions	Pdf
Technical drawings and calculations	Document IDs (as built, incl status)
Product specification sheet	Pdf
Product EPD	Pdf
CE/KOMO/etc. certificates	Pdf
Product LCA	Pdf
Sourcing information:	
Original manufacturer, supplier	
Year of manufacturing and installation	
Use history, alterations	Log
Warranties	Status and conditions
Supply chain history	Legal ownership(s)
Availability	Per date
Transport conditions	
Pricing	

6.9. BREEAM country specific social value credits

BREEAM NL	HEA 06 – Veilige toegang en toegankelijkheid
BREEAM BE	HEA 06 – Veiligheid en Beveiliging
	POL 06 – Social Safety
BREEAM FR	HEA 04 – Accessibilité,
	HEA 10 – Sécurité des Usagers
	POL 06 – Conception Sécurisée
BREEAM DE	1.2.5 – Sicherheitskonzept
	HEA 10 – Visuelle und Physische Sicherheit
BREEAM ES	HEA 01 – Salud y Bienestar
	HEA 10 – Seguridad y Protección
BREEAM UK	HEA 06 – Accessibility
	POL 06 – Safe and Secure Design
	MAN 04 – Inclusive Design

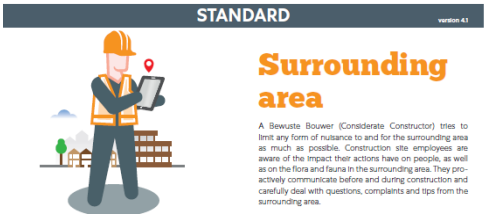
6.10. Responsible Contractors

Compliance to the Breeam Management credit for sustainable, social, healthy and safe working conditions at the construction site. MAN03 is mandatory - BREEAM | Sustainable Building Certification.

Table 4.1 Responsible construction management items

Ref.	Criteria	Required for one credit
Risk evaluation and implementation		
The principal contractor evaluates the risks (on site and off site), plans and implements actions to minimise the identified risks, covering the following, where appropriate:		
Vehicle movement		
a	Manage the construction site entrance to minimise the impacts (e.g. safety, disruption) arising from vehicles approaching and leaving the development footprint.	✓
b	Ensure the development footprint is accessible for delivery vehicles fitted with safety features (e.g. side under run protection) to remove or limit the need for on-street loading or unloading. Where on-street loading is unavoidable, this should be appropriately managed.	
c	Identify access routes to the development footprint, including for heavy vehicles to minimise traffic disruption and safety risks to others.	
Pollution management		
d	Minimise the risks of air, land and water pollution.	✓
e	Minimise the risks of nuisance from vibration, light and noise pollution.	
Tidiness		
f	Practices ensure the development footprint is safe, clean and organised at all times. This includes, but is not limited to, facilities, materials and waste storage.	✓
g	Ensure clear and safe access in and around the buildings at the point of handover.	✓
Health and wellbeing		
h	Provide processes and equipment required to respond to medical emergencies.	✓
i	The principal contractor identifies and implements initiatives to promote and maintain the health and wellbeing of all site operatives within the development footprint. This can be via site facilities, site management arrangements, staff policies etc.	
j	Establish management practices and facilities encouraging equality, fair treatment and respect of all site operatives.	✓
k	Provide secure, clean and organised facilities (e.g. changing and storage facilities) for site operatives within the development footprint.	
Security processes		
l	Minimise risks of the site becoming a focus for antisocial behaviour in the local community (e.g. robust perimeter fencing, CCTV, avoid creating dark corners etc.).	
Training, awareness and feedback		
See Definitions on page 55. The principal contractor is responsible for ensuring:		
m	Aspects of the construction process that might impact the community are communicated regularly, ensuring that nuisance and intrusion are minimised.	
n	Ensure ongoing training is provided, and up to date, for personnel and visitors (covering items a to l, as appropriate.)	✓
o	The principal contractor ensures that site operatives are trained for the tasks they are undertaking (including any site-specific considerations).	✓
p	The fleet operators (see Definitions on page 55), undertakes driver training and awareness to promote safety within the development footprint and off site.	
Monitoring and reporting		
The principal contractor ensures:		
q	The fleet operators, captures and investigates any road accidents, incidents and near misses and reports them back to the principal contractor. The principal contractor analyses these items.	
r	All visitor, workforce and community accidents, incidents and near misses are recorded and action is taken to reduce the likelihood of them reoccurring.	✓
s	Processes are in place to facilitate collecting and recording feedback from the community and to address any concerns related to the development footprint.	

Standard for responsible construction management by contractors in the Netherlands, committed to 'Bewuste Bouwers'.



6.11. What is the story with Module D?

← New Product LCA Network for the UK

What is the story with Module D?

Posted on May 6, 2025 by constructionlca

Summary

This article provides an overview of Module D provided in construction production EPD. It describes the background to Module D, supplementary information in the EPD which aims to provide transparency on the environmental benefits resulting from reusable products, recycled materials and recovered energy leaving a product system, However, the paper identifies and explains a number of serious limitations with Module D and its use listed below. These limitations highlight the importance of careful consideration when using Module D in environmental assessments and comparisons, and this paper provides guidance on the appropriate use of Module D.

Inconsistency with Other Modules:

- Module D should never be aggregated with Modules A-C, due to different system boundaries and allocation approaches, leading to inconsistencies in methodology.
- If Module D was aggregated with Modules A-C, it would result in no difference between the impact of a primary product and a recycled product which are both recycled at end of life, failing to recognise the benefits of a circular economy.

***Overestimation of Future Benefits**:*

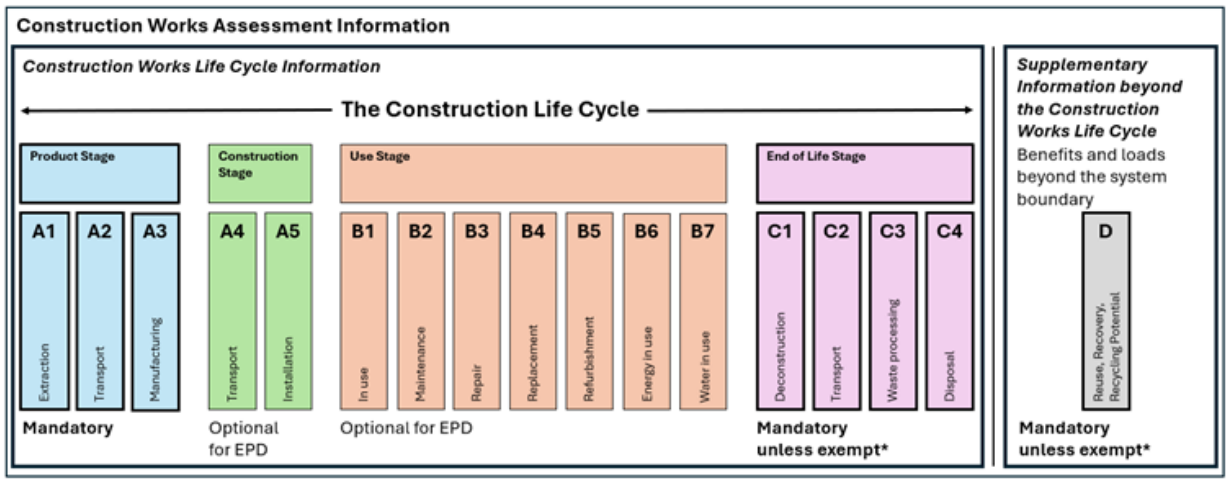
- Module D uses current impacts to assess the avoided impacts of primary production, which may significantly overestimate benefits due to expected decarbonization of industrial processes by 2050.

***Limited Recognition of Circular Economy**:*

- Module D only recognises the benefits of recovering primary material. It does not reflect the benefits of recycling already recycled materials, or reusing reused materials, both of which will be crucial for a circular economy.
- For recycled materials which are reused, Module D may not show any benefits at all.

Introduction

If you look at a construction product Environmental Product Declaration (an EPD for short), then you will see that the environmental impacts are broken down into life cycle stages and modules, as in Figure 1 below.



*An exemption exists for construction products that are physically integrated with other products during installation so they cannot be physically separated from them at end of life, and are no longer identifiable at end of life as a result of a physical or chemical transformation process, so long as they do not contain biogenic carbon. Examples would include cement and timber preservatives.

Figure 1 The Life Cycle Stages and Modules used for construction product EPD

According to the standards for construction product EPD, EN 15804 and ISO 21930, the construction life cycle covers the Product Stage (A1-A3), the Construction Stage (A4-A5), the Use Stage (B1-B7) and the End-of-Life Stage (C1-C4). In addition, most construction product EPD must also report **Module D**, but what does this module report and what can it tell us about a construction product?
Module D is supplementary to the information provided about the product's life cycle and reports the "Benefits and loads beyond the system boundary". Defining a system boundary is one of the requirements when using life cycle assessment (LCA) – the science which underpins EPD. It is used so that you know when to start measuring impacts and when to stop measuring them, and it needs to be defined consistently for all the different resource, material and emission flows within the product system. The system boundary needs to be defined both with nature, and with other product systems, as shown in Figure 2 below.

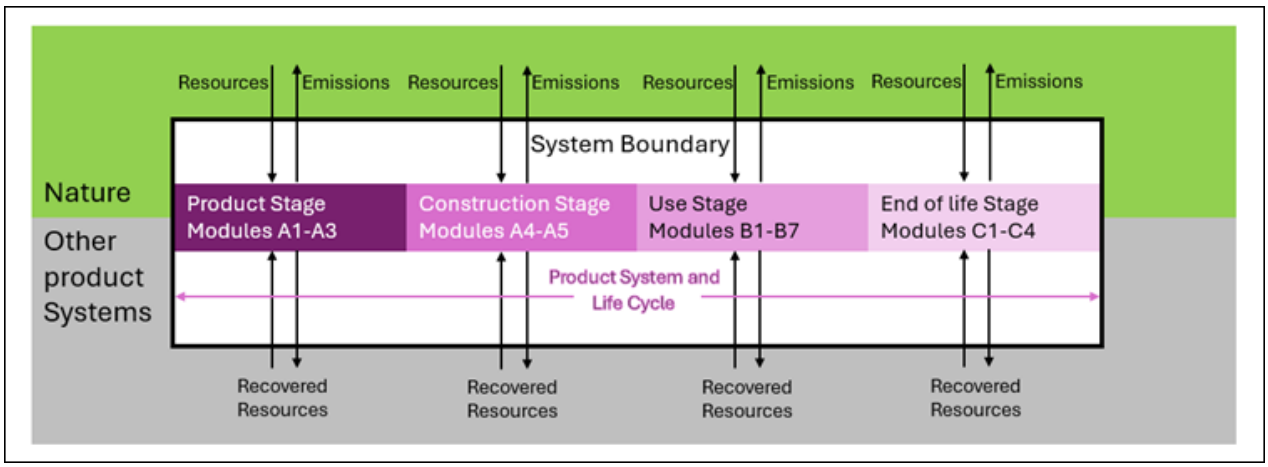


Figure 2 Diagram illustrating the system boundary to nature and to other product systems

In construction product EPD, we account for all the human related processes starting from the extraction of resources from nature such as the biomass, renewable energy, fossil fuels, minerals, or water used to make products, maintain them, or dispose of them; we also track any the emissions which are released to nature, such as CO_2 emitted to air,

pollutants released into rivers or the sea, or wastes which are deposited on land, as shown in the top half of Figure 2.
We also need to define the system boundary to other product systems. This system boundary applies when we use recovered resources within the product system, such as recycled or reused materials, secondary fuels or recovered energy, or when we recover wastes that we have produced, such as when we generate recycled or reused materials, secondary fuels or recovered energy within the product system, as shown in the bottom half of Figure 2.

For construction product EPD, the system boundary between products systems is defined when:

- the recovered material, product or fuel is commonly used for specific purposes; AND
- a market or demand, shown, for example by a positive economic value, exists for such a recovered material, product or fuel; AND
- the recovered material, product or fuel fulfils the technical requirements for the specific purposes for which it is used and meets the existing legislation and standards applicable to products or secondary fuels.

EN 15804 also requires that the“use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts”. Waste which has been recovered and meets these conditions has reached the “end-of-waste state”, and due to the identical requirements of the EU Waste Framework Directive, this point is also commonly where waste changes its legal status to that of a product which has to comply with relevant product legislation, for example the REACH Regulation[1].
As an example, if a construction product uses recycled plastic, then the impact associated with the recycled plastic will only be accounted for from the point at which the recycled plastic reaches the end-of-waste state, normally once it has been granulated. And if waste plastic is produced and recovered during the construction product life cycle (for example at end of life), then the impacts will be accounted for until the waste plastic reaches the end-of-waste state, again, once it has been granulated. This means the system boundary for recycled plastic is in the same place whether it is an input or an output to the system, there is no double counting. Similarly, if transferring any impacts from primary production to materials recovered at the end of life – known as allocation – the LCA rules require that the approach must be consistent for the whole system, so that an input and output of the same recovered material would have an identical impact. In EPD for construction products, the “cut-off” approach (also known as the “100-0” or “recycled content” approach) is used. This means that for re-used and recycled materials and secondary fuels that cross the system boundary, for example recovered materials from construction or demolition, no impacts from their original life cycle are allocated or transferred to this later life cycle – they enter the next product system free of burden. This follows the “polluter pays principle”, where those generating waste have all the impacts associated with producing and disposing of it.

What is Module D?

EN 15804 assigns all the impacts associated with producing and treating end-of-life waste to the producer of the waste, and they are not able to allocate or transfer any of the impact of primary production forward to the potentially many recycled product life cycles in the future. Alongside the life cycle impacts of the product system reported in modules

A1-C4, Module D is intended to recognise the benefits of designing for reuse, recycling and recovery, and indicates the potential benefits from the avoided use of primary materials, whilst taking into account the potential loads associated with recycling and recovery processes beyond the system boundary.

From this point of view, Module D mirrors an alternative approach to allocation of primary impacts, where these are allocated from the primary product system to future recycling using an allocation approach called the "avoided burden" approach (also known as the "0-100" or "end-of-life recycling" approach). We have discussed above how LCA studies must use a consistent system boundary and allocation approach for recovered materials. This is provided with the "cut-off" approach used for assessing modules A1-A5, B1-B7 and C1-C4 over the life cycle of the product – if all the life cycle stages and modules have been assessed for the product based on the relevant building context, then the impacts can be aggregated to give the full impact over the life cycle using a consistent system boundary and allocation approach. Sometimes however, we see Module D aggregated with Modules A-C. This is really problematic, as it both expands the system boundary for outputs so that it is not consistent for inputs and outputs, and also means that the "cut-off" approach used for inputs is not consistent with the "avoided burden" approach used for outputs in Module D. For this reason, **the impacts from Modules A to C must never be aggregated with those from Module D.**

An example of the problem with aggregation can be seen if we look at the impact of a plastic product made of primary material which is recycled at end of life, substituting the same primary plastic. The benefit calculated in Module D will be equivalent to the impact of primary production in A1-A3, only deducting the losses from the recovery process. This means that if we aggregate Modules A-C and Module D, that most of the impact of primary production in A1 is cancelled out in Module D, and the only impact for the product is from product processing in Module A3, the impacts in modules A4-C4 and any processing to reach the point of substitution in Module D, plus the primary impact of manufacturing the small amount of material lost through recovery. If we compare this to the impact of the same product made of the same recycled plastic, which is recycled in the same way at the end of life with the same losses, and aggregate the impacts of modules A-C and Module D, these two plastic products will have practically the same impacts aggregated over Modules A-D, despite having very different impacts in reality. **Aggregating Module D with Modules A-C provides no recognition of the circular economy benefits of using recycled materials today, nor of the benefits of circular products which are both made of recycled content and recycled at end of life**.

A further problem with Module D is that for most construction products, their end of life will not be for many years into the future. However, Module D uses current impacts to assess the avoided impacts of primary materials (the benefits) and the impacts of recovery (the loads). As we expect that many industrial processes will be significantly decarbonized by 2050, we can see that the calculation of benefits and loads using current impacts is not conservative, but very likely **Module D over-estimates the benefits that will occur in the future from recycling and recovering primary materials**.

Additionally, Module D only accounts for the benefits and loads associated with "net output flows" of recovered materials. This means that for an output of recovered material from a product system, which will go to substitute future primary production, any input to the product system of the same recovered material must be deducted from the output to arrive at the net output flow (the output minus the input of the same recovered

material), and only this net output flow can be considered in Module D. This means that whilst a product made of primary material that is 100% recycled at end of life can report the benefits in Module D, a product that is made of the same 100% recycled material and is 100% recycled at end of life cannot report any benefit, even though there will be exactly the same benefit in the future in terms of avoided primary production. Module D is sometimes talked of as providing information in EPD in relation to the circular economy, but the fact that it only recognises the benefit of recovering primary material at end of life, and not the benefits of recovering recycled materials (which would be more recognisably circular), means that **Module D is not a good reflection of the circular economy, as recycled products which are themselves recycled show no benefits in Module D**.

Module D for reused products

The examples above have considered recycling, but for reuse, the results in Module D can be even more surprising. For products made of primary material, reusing them at end of life will show big benefits in Module D. However, for a recycled product which is reused at the end of life, some interpretations of EN 15804 would consider the material for reuse is made of the same secondary material used to manufacture the recycled product. If this interpretation is used there would be no net output of secondary material so Module D would show no benefit, failing to recognise the significant benefits of reuse expected within a circular economy. To address this inconsistency, the second version of the RICS Professional Standard for Whole Life Carbon in the Built Environment has stated that when a recycled material is reused, the material for reuse should not be considered as the same secondary material, and the benefit of reuse should be calculated on the net output of material for reuse, which would give a similar result in Module D to the reuse of the same primary product. This approach has also be included in the most recent draft of the revised EN 15978.

How can you compare construction products using EPD?

EN 15804 provides rules for comparing construction products using EPD, which state that the comparison must be based on the product's use in a building and its impact on the building and must consider the complete life cycle. However, EN 15804 also allows for comparisons at the sub-building level, e.g. comparing products directly, perhaps for just one life cycle stage. In such cases the principle that the basis for comparison is the assessment of the whole building over its life cycle, must be followed by ensuring that for any comparison:

- the same functional requirements for the product as defined by legislation or in the client's brief are met, AND
- the environmental performance and technical performance of any excluded assembled systems, components, or products are the same, AND
- the amounts of any excluded material are the same, AND
- excluded processes, modules or life cycle stages are the same; AND
- the influence of the product systems on the operation and impact of the building are considered;
- the elementary flows related to material inherent properties, such as biogenic carbon content, the potential to carbonate or the net calorific value of a material, are considered completely and consistently, as described in EN 15804.

In this way, if you were comparing two floor coverings using EPD, then the products could be compared using the impacts provided in their EPD if:

- Both products can provide the functional performance required by the client, and any relevant legislation – this does not mean they need to provide the same functionality, so long as the required functionality is met.
- The adhesive to fix the flooring could be excluded so long as the amount of adhesive was the same and the environmental and technical performance of the adhesive was the same.
- The life cycle modules for installation (A5), maintenance (B2), repair (B3), replacement (B4) and refurbishment (B5) could be excluded if they would be the same for both products, i.e. if there would be the same amount of wastage, they would be cleaned in the same way, and would last for the same amount of time.
- The module for transport (A4) would need to be included if the products came from different locations with different transport impacts;
- The modules for end of life (C1-C4) would need to be included if the products had different masses per m^2 so had different end of life impacts, or if one product could and would be recycled and the other would be disposed of using energy recovery.
- If for any reason one of the floor coverings would influence the operation of the building differently (for example influencing the availability of thermal mass), then this would need to be accounted for in the comparison.

If the conditions for comparison are met, then the information from the EPD for the relevant processes and information modules could be used for the comparison of the two products. As Module D provides supplementary information beyond the construction works life cycle, it does not have to be considered within any comparison of construction products using EPD. But if Module D is considered as part of any comparison, as explained above, great care should be taken, and certainly it is clear that the impacts in Module D must not be added to the impacts of the remaining modules within the product life cycle. If one the compared products uses recycled inputs, it must be recognised that Module D will not show any benefits of recovering this product, although any recovery will clearly have similar benefits to recovering the product made of primary material. And **if you are looking to recognise the benefits of moving towards a circular economy, remember, Module D only reflects the benefits of the future recovery of primary material. In addition, any benefits reported in Module D are likely to be a significant overestimate of the actual benefits in the future, due to industrial decarbonisation.**

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[1] Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R1907-20240606

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