FutureBuilt criteria for circular buildings

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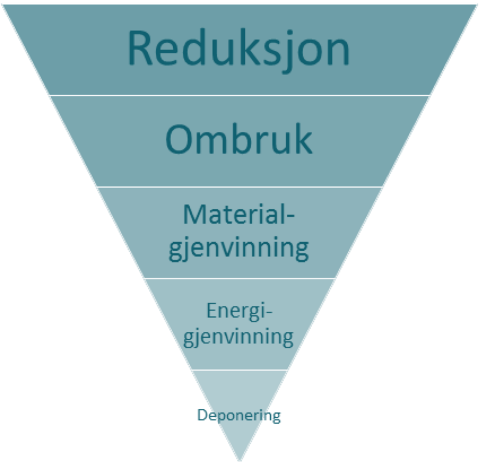
This document contains the *Criteria for circular buildings in FutureBuilt*. The first version of the criteria was published in January 2019, and were based on discussions between FutureBuilt, Asplan Viak and SINTEF Byggforsk. Version 2.0 is a revised edition, following feedback from a number of parties in an innvoation workshop held on the 21st of November 2019 and a follow up feedback meeting on the 6th of January 2020. This document has been authored by Anne Sigrid Nordby, Asplan Viak.

FutureBuilt intend these criteria to build awareness and to be easy to use. It is also a goal to align the criteria with established Norwegian standards and guidelines. The purpose is to motivate to reuse and circular principles in rehabilitation, demolition and new build, and to establish a standard for the level of ambition expected for a circular building.

1. INTRODUCTION

The goal of circular economy principles is to keep products, components and materials at their optimal use-case and highest value at all times, by closing material- and energy cycles, reducing the rate of circulation and improving the efficiency of resource consumption (freely adapted from the Ellen MacArthur Foundation).

The *Waste Pyramid* illustrates the priorities in Norwegian waste policy and the EUs Framework Directive on Waste. *Reduction* is the highest priority, followed by direct *Reuse*, which is prioritised above *Material Recycling*. At the bottom of the pyramid are *Energy Recycling* and *Disposal*. A sizeable proportion of building waste is already sorted in Norway, and most of the waste goes to material and energy recycling. The EU have set a target of 70% reuse and material recycling by 2020 (The Norwegian Environment Agency 2019).



The principles in the pyramid can be translated to buildings at several levels;

Reduction entails planning av building in such a way as to reduce resource use and the creation of waste. Reduced resource use can be achieved by building for area efficiency and increased intensity of use, for instance by several functions sharing the same space. Reduced waste creation can be achieved by ensuring that the building, and its components and materials, have a long lifespan. Two strategies for a long lifespan are to design for adaptability (whole building level) and for reusability (component level). Regular maintenance is also a form of waste reduction, as the long term need for more dramatic interventions is reduced.

Reuse can mean retaining or rehabilitating a building instead of demolishing it or reusing used components. A decision to demolish a building should be based on a thorough assessment of the total resource consumption. The most sustainable form of reuse is usually to retain, repair, rehabilitate or transform the building in such a way that as many of the original components as possible are retained with their original position and function. This form of reuse will in the following be designated as *rehabilitation*, and include all measures from simple maintenance/ repair to a full transformation of the building, for example by stripping it down to the load-bearing structure.

If components are dismantled, they can be reused in the same building or in other projects and functions. One form of reuse is to give used components a new value through processing and product development – so called upcycling.

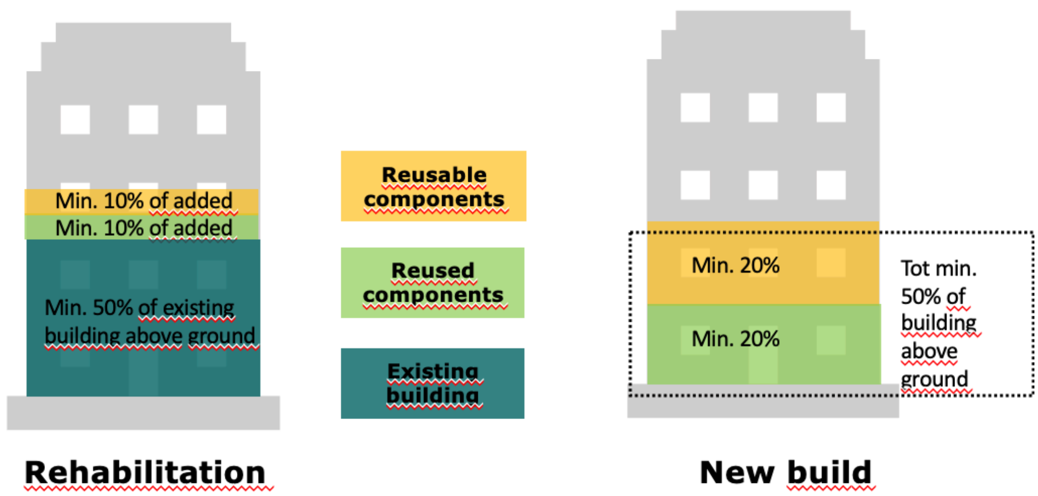
Building components based on materials that represent a large environmental investment (energy use, emissions etc.) in production, materials from limited and non-renewable resources as well as components which typically have a high frequency of replacement should be prioritised. For more information on the environmental consequences of the manufacture of materials, see the “Grønn Materialguide” (GBA and Context 2017).

2. CRITERIA

A circular building shall facilitate resource utilization at the highest possible level and consist of a minimum of 50 percent reused and reusable components.
The criteria are elaborated in five points:

1. Environmentally reasoned decision on rehabilitation or demolition
2. Resource consumption in the demolition and building phases
3. Reuse of components
4. Reusability
5. Adaptibility

Points 2, 3, 4 and 5 must be addressed in all projects. Point 1 must also be addressed if there are existing buildings on the site.



The figure illustrates quantitative criteria for reuse and reusability for circular buildings (see sections 2.3 and 2.4).

2.1. Environmentally reasoned decision on rehabilitation or demolition

Criteria

- *Where there are existing buildings on site, a thorough assessment must be performed to ascertain the environmentally best scenario; continued maintenance and repair, rehabilitation or demolition.*
- *The assessment must be carried out by a multi-disciplinary team of consultants and construction professionals, so that all advantages and disadvantages of the alternative scenarios are considered.*

Required documentation

- *The project must document how the issue of rehabilitation or demolition has been assessed and concluded.*

Purpose and strategies

Retainment or rehabilitation of buildings usually has lower environmental consequences than demolition and new build. There must therefore be weighty arguments in order to choose demolition. A thorough assessment prior to this decision is intended to motivate projects to choose retainment and rehabilitation where possible, and to build awareness of the environmental advantages and disadvantages of the alternatives.

Several factors will influence which is the environmentally best solution in any given situation. The need for an energy efficient building may compromise the ability to retain components in the climate shell, and area efficiency may be poor when reusing a building which is planned for a completely different function. The efficient use of a site and its location is another overarching issue that may have an effect on transport related emissions in the use phase. These factors should be assessed in a holistic manner. Parts of this assessment can be performed using life cycle analysis (LCA).

For more information on considerations concerning rehabilitation and demolition, see the guideline "Tenk deg om før du river" (GBA 2019).

2.2. Resource consumption in the demolition and building phases

Criteria

<u>Demolition phase</u>

- *The project must document how resource utilisation in the demolition phase has been planned and conducted.*
- *Reusable components must be assessed in the early design stage with regards to their potential for reuse, so that the resource value is apparent to the design team.*
- *Reusable components that are not reused in the project, shall be made available for external parties or returned to the manufacturer, if possible.*
- *Sufficient time must be ensured to allow for selective demolition/ dismantling, and the required demolition method must be designated in the tender documents and contracts. Dismantling and securing of components for reuse must be specified in the tender documents, and references and a description confirming understanding of the task must be required prior to the contract being awarded.*

Building phase

- *The project must document how resource utilisation in the demolition phase has been planned and conducted.*
- *Building waste must be minimized. Offcuts, wastage and packaging as well as incorrectly ordered and surplus products must be limited as much as possible. In cases where these still arise, strategies must be implemented to utilise these resources.*
- *New products (incorrect orders and surpluses) are not to be disposed of, but either returned to the dealer or manufacturer, or made available for internal and external parties.*

Required documentation

- *The documentation must comply with BREEAM NOR issue Wst 01, criteria 7.*

Purpose and strategies

The purpose is to preserve as many material resources as possible intact and at the highest possible level according to the waste pyramid in both the demolition and building phases. For a more detailed description of the strategies, see (NGBC 2017) and (WRAP 2009).

2.3. Reuse of building components

Criteria

- *In total at least 50 % of components in the project (calculated by weight, excluding siteworks and foundations) must be reused or reusable in accordance with points 2.3 and 2.4. The project may freely define its approach and the proportion of reused and reusable components.*
- *In new construction at least 20 % of components (calculated by weight, excluding siteworks and foundations) must be reused, and reuse must be implemented within minimum 10 component types, defined as different building elements at the 2-digit level according to the Norwegian building element table (bygningsdelstabellen).*
- *In rehabilitation projects at least 50 % of existing building mass must be retained (calculated by weight, excluding siteworks and foundations). Retention of existing building mass qualifies as reuse when quantifying reuse percentages. In addition, at least 10 % of components added to the building must be reused, and reuse must be implemented within minimum 5 component types, defined as different building elements at the 2-digit level according to the Norwegian building element table (bygningsdelstabellen).*
- *Local recycling of masses is in addition to the above criteria.*

Required documentation

- *Reused quantities and type of components must be reported by weight and percentage of the buildings weight.*
- *Quantification must, as far as possible, be based on the specific weight of components including technical installations.*
- *Procedures for quality assurance and material documentation must be described. Qualities and properties must be documented in such a way that the components fulfil the requirements of the Norwegian planning and building law (TEK) and the construction products directive (DOK).*

Purpose and strategies

Planning rehabilitation and new build projects with reused components generally results in a considerable reduction in GHG-emissions in the project. In addition, the extraction of virgin resources and waste generation is minimised. Reuse can also be justified in the conservation of historically valuable buildings and elements. Innovative reuse or upcycling can also signal a new, sustainable way of thinking.

Used components can be sourced from one's own building in the case of rehabilitation, from other buildings (primarily local), or from a third-party supplier. Components that are to be reused should be in good condition (ie. a sufficiently long remaining lifespan to justify reuse).

Components containing substances which are hazardous to health and the environment should generally not be reused but removed from circulation. This must be handled through a (legally required) depollution of the building before rehabilitation/ demolition.

For examples and further descriptions of strategies and prerequisites, see (Sintef 2014), (NHP 2018), (Widenoja et al. 2018) and (Team Resirqel 2019).

2.4. Reusability

Criteria

- *At least 50 % of all components in the project must be reused or reusable according to points 2.3 and 2.4. The project may freely define its approach and the proportion of reused and reusable components.*
- *In new construction at least 20 % of components (calculated by weight, excluding siteworks and foundations) must be reusable. Reusable components must be included within minimum 10 component types, defined as different building elements at the 2-digit level according to the Norwegian building element table (bygningsdelstabellen).*
- *In rehabilitation projects at least 10 % of components added to the building (calculated by weight, excluding siteworks and foundations) must be reusable. Reusable components must be included within minimum 5 component types, defined as different building elements at the 2-digit level according to the Norwegian building element table (bygningsdelstabellen).*

Required documentation

- *The project must document how reusability strategies have been implemented. In order for a component to be considered reusable, the following requirements must as a minimum be fulfilled:*
    - *Robust and homogenous materials without substances which are hazardous to health and the environment*
    - *Reversible connections between components so that they may be disassembled without damage.*
    - *A layered construction so that components can be disassembled independently of adjacent layers.*
- *For a component to be considered reusable, the following information must be available:*
    - *Operation and maintenance documentation (FDV)*
    - *EPD (where applicable)*
    - *Information about the building system with instructions for disassembly*
    - *An unambiguous labelling of components (where relevant)*
    - *Labelled, visible and accessible fixings (where relevant)*

Purpose and strategies

Designing for reuse entails planning a building in such a way that components can be disassembled and reused when the building is rehabilitated or demolished, either locally in the same building or externally in a new building. This will extend the lifetime of the material resources. A number of strategies and measures can contribute to making a component reusable;

Strategies	Solution / action
Robust material selection	Minimise the number of different materials and components.
	Select homogenous materials (monomaterials), where all constituents consist of the same material.
	Select durable materials and components which can be reused i several generations of building.
	Avoid using materials which contain substances which are hazardous to health and the environment, even if these are within current thresholds, and avoid surface treatment if not necessary to reduce wear and tear or the decomposition of the material.
	Use modular designs, standard dimensions and a low complexity of components and building elements.
Flexible connections	Use reversible connections between components and between building elements, for example screws and bolts. Avoid welding, glue, fillers and sealants/ foams. Use (weak) lime mortar instead of cement mortar for brickwork.
	Minimise the number of different bonding agents, and plan for standard tools.
	Use components and building elements with suitable tolerances for repeated dis- and reassembly.
	Design the structural layers as independent systems and arrange the layers in accordance with the life expectancy of each layer.
Available information	Label materials and component types.
	Label attachment points and ensure that these are visible and accessible.
	Prepare material passports (information about products and materials, eg. EPD, maintenance guidelines and information about the building system with disassembly instructions) as well as declarations of performance (DoP) and other documentation necessary to show compliance with TEK and the construction products directive (DOK), as part of the operation and maintenance documentation (FDV), to be stored accessibly and updated throughout the lifecycle of the building.
	Document the building geometry with open BIM, which should function as a digital twin of the building with appropriate documentation.
Manufacturer contracts etc.	Establish leasing agreements with manufacturers/ suppliers instead of purchasing.
	Establish a returns scheme with manufacturers/ suppliers.
	Temporary use of components prior to regular use (precycling).

Different strategies for reusability can be relevant for different materials and building elements. For further information about strategies and possible measures, see (Nordby 2009), (RIF 2008), (3xN 2016) and (Circle Economy 2018).

2.5. Adaptability

Criteria

- *The project must document how strategies for adaptability have been used.*

Required documentation

- *Description and illustrations as appropriate.*

Purpose and strategies

Designing for adaptability entails planning a building so that its function and use can be changed without major interventions. This will contribute to increasing the useful lifespan the building.

Strategies	Solution / action
Generality	Generalised solutions for access to rooms, for example all rooms accessed from a corridor/ circulation space, ensuring that rooms can be used independently of each other.
	All rooms/ workspaces are supplied with plentiful and even daylight.
Flexibility	Floor plans, structural systems and partition walls are suitable for easy reorganisation of spaces.
	Technical systems are suitable for easy reorganisation of spaces.
Elasticity	Floor plans and structural systems are suitable for being extended horizontally or vertically.
	Floor plans and structural systems are suitable for merging or subdivision of spaces.
	Floor to ceiling heights are suitable for several different functions and can accommodate different ventilation solutions.

Different strategies for adaptability may be relevant for different types of buildings and users. The buildings location, functional requirements and life expectancy are factors that can affect the selection of solutions and measures. For further information about strategies, see (Brand 1994), (Arge og Landstad 2002) and (Madsen et al 2012).

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