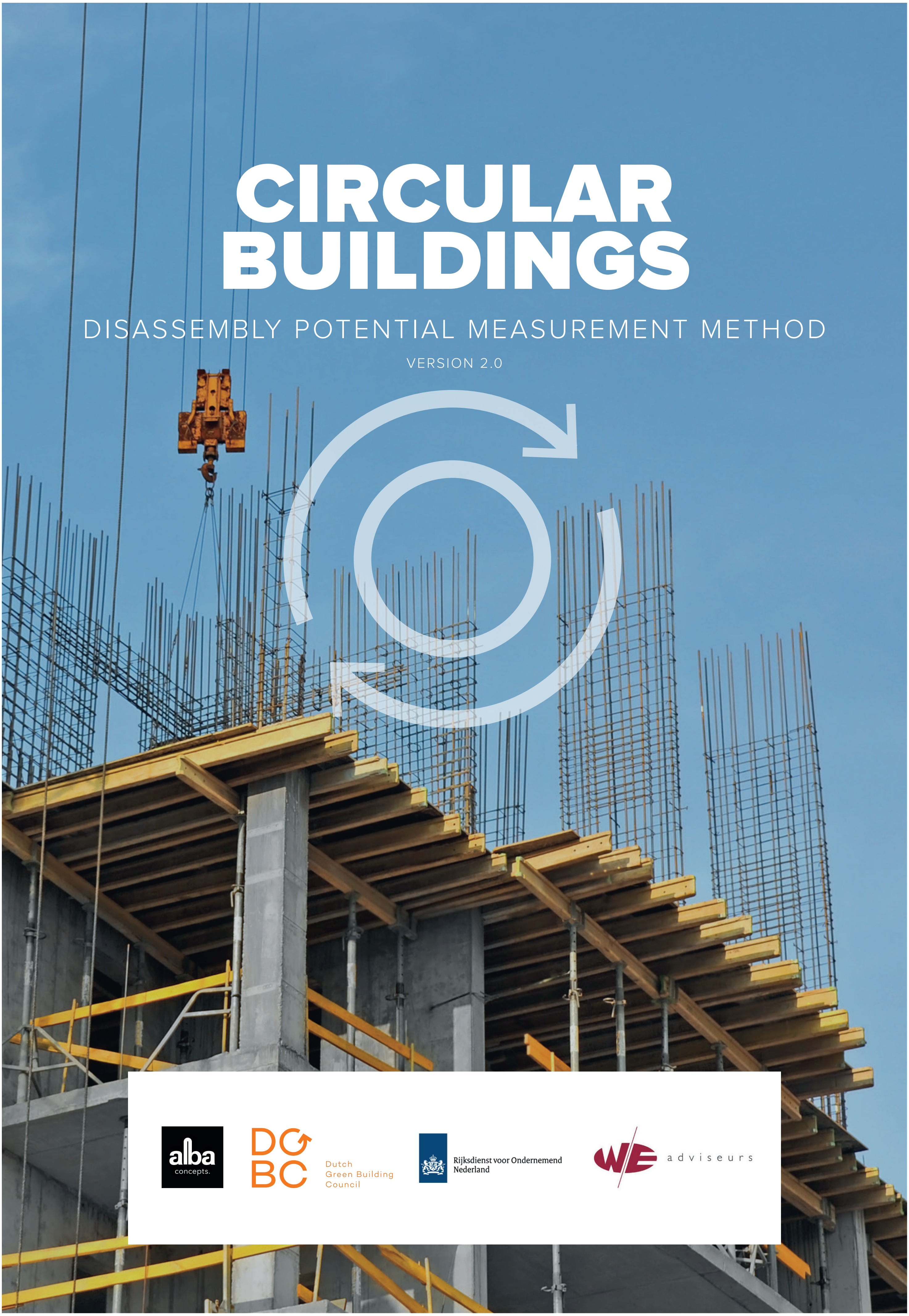

CIRCULAR BUILDINGS

DISASSEMBLY POTENTIAL MEASUREMENT METHOD

VERSION 2.0

alba concepts.

DGBC Dutch Green Building Council

Rijksdienst voor Ondernemend Nederland

WE adviseurs

DGBC

Colophon

The report 'Circular Buildings - a measurement method for disassembly potential 2.0' is part of a series of publications with indicators for circularity, which are being worked out concretely within the DGBC circularity program.

The elaboration of the indicators follows the report 'A Framework for Circular Buildings: Indicators for possible inclusion in BREEAM'. This report describes a new strategic framework that clarifies the conditions a circular building can meet. In the process, we investigated which circular indicators could be added to the BREEAM sustainability label to make a circular building more measurable.

The Disassembly Potential Measurement method was developed and assessed by a consortium of Alba Concepts, Dutch Green Building Council, Netherlands Enterprise Agency and W/E Adviseurs on behalf of the Ministry of the Interior and the Circular Building Economy Transition Agenda.

Auteurs

Mike van Vliet, Alba Concepts
Jip van Grinsven, Alba Concepts
Jim Teunizen, Alba Concepts

Executed by:

alba concepts. — DGBC Dutch Green Building Council — Rijksdienst voor Ondernemend Nederland — W/E adviseurs

The DGBC Circularity program is supported by:

ABN·AMRO — alba concepts. — AM — ASSA ABLOY — inbo — Deerns — Kuijpers — ROCKWOOL — DE VRIES EN VERBURG

The translation of this report was established as part of BuildingLife and Life Level(s)

World Green Building Council JOIN #BUILDINGLIFE — LIFE Level(s) — Life

Indemnification

The publisher and authors declare that this publication has been compiled with care and to the best of their knowledge. However, the publisher and authors can in no way guarantee the accuracy or completeness of the information. The publisher and authors therefore do not accept any liability for damage of any kind.

Publication date

May 2021

PREFACE

Disassembly potential is developing into one of the keys in the circular building economy, alongside concepts such as adaptivity, toxicity, value development and environmental cost indication. Disassembly potential may be the key to releasing what is fixed for (re) use, preferably as high quality as possible. With that, disassembly potential does not have an independent value, but depends on the past -what exactly was attached in what way-, and the future, -what can you do with it when the material is released-?

The Dutch transition team Circular Construction Economy (CCE) uses the series Signalling > Research > Instrument development > Practice trials > Evaluation > Signalling #2 in fulfilling its agenda. On the second signalling, the question is: stop, another round or proceed to implementation? In that implementation, a legal path may be chosen. The topic of disassembly potential is currently going through a second round. In it, the results and experiences from the first round are used, in order to come up with an improved instrument. This can then be tested in practice again.

Disassembly potential 2.0 has been achieved thanks to an intensive collaboration between Alba Concepts, W/E Adviseurs and the DGBC. The result is directly applicable in both BREEAM-NL and GPR Gebouw [sustainability digital tool]. This immediately creates a bridge to the next development step: testing in practice. Given the importance and urgency of more circular construction, your understanding, judgment and use is of the utmost importance.
Your findings are welcome by the CCE transition team.

Hans Korbee
Netherlands Enterprise Agency (RVO)

TABLE OF CONTENTS

INTRODUCTION

This research was commissioned by the Netherlands Enterprise Agency, conducted by Alba Concepts in collaboration with W/E Adviseurs and Dutch Green Building Council. The purpose of this revised version of the report 'Circular Buildings - a measurement methodology for disassembly potential' is to introduce a uniform measurement method for disassembly potential in construction.

The first report in September 2019 established the foundation for the measurement method and then challenged the market to apply the measurement method in practice. In the first report, the disassembly potential for five realized pilot projects was calculated. The results were analyzed in terms of feasibility, definitions used, disassembly potential factors, operation of the measurement methodology and other aspects. With this, feedback was collected and recommendations were formulated.

In addition to the feedback from the pilot projects, a public call to the market to provide feedback on the measurement method was issued in November 2020. Both forms of feedback were analyzed, resulting in several insights to improve the measurement method for disassembly potential. Where necessary, it is also clarified. This report describes the revised version of the measurement method for disassembly potential.

In this measurement method, the definitions, preconditions and starting points for determining the disassembly potential are explained. The scope of the measurement method has been adjusted. It is now fully connected to the measurement method for the Environmental Performance of Buildings (MPG). The formula for determining the product's disassembly potential has been changed, so that from now on you can only compensate low scores with high scores to a limited extent. As an additional, insightful, intermediate step, the disassembly potential as per the Layers of Brand was created. This has no consequences for the formula for the disassembly potential of a building.

Disassembly potential in itself is not an indication of circularity. Practical experience shows that disassembly potential is at the heart of several circular building principles. Consider high-quality reuse of building products, adaptive construction, circular management and maintenance, and the possible application of circular revenue models. The measurement method should be applied in relation to other circular principles.

This report describes the core measurement method for disassembly potential and how to assess it. It was drafted to integrate the aspect of disassembly potential into the current sustainability tools BREEAM-NL and GPR Gebouw. This report recognizes several areas of application for the measurement method, but is limited to integrating disassembly potential into current sustainability tools. The collaboration between Alba Concepts, DGBC and W/E Adviseurs ensures that the various sustainability tools make this aspect of circularity measurable in a uniform way.

The revised version of the measurement method is a new starting point for the industry to gain knowledge and experience with construction that can be disassembled. New points of discussion and recommendations for follow-up research have also emerged during the preparation of this report. They are included in the last section. We are inviting people to share practical experience with each other in order to further stimulate practice and theory on construction with disassembly potential.

01 THE IMPORTANCE OF DISASSEMBLY POTENTIAL IN A CIRCULAR CONSTRUCTION ECONOMY

At present, the global economy is based on a linear model. This is based on the principle: 'take-make-waste' (mining raw materials, converting them into products, consuming and ultimately destroying them). This linear economy results in the following problems:

- Waste generation by landfilling, resulting in the permanent loss of (scarce) raw materials;
- CO_2 emissions from combustion and the need for manufacturing for replacement products;
- Depletion of the Earth.

A transition to a circular economy is therefore necessary to secure the future of the planet.

The circular economy considers products at the end of their useful life not as waste, but as sources of raw materials that you can reuse. The circular economy consists of three main components.

The economic model, the biological cycle and the technical cycle (see Figure 1). Materials and products are returned after their use through one of these cycles. This prevents the landfilling or incineration of materials and products and encourages reuse.

Figure 1 is a representation of the circular economy model. To activate the two cycles, we have to collect materials. This is not obvious because a building is a fixed object, made up of a quantity of different products and materials attached to each other.

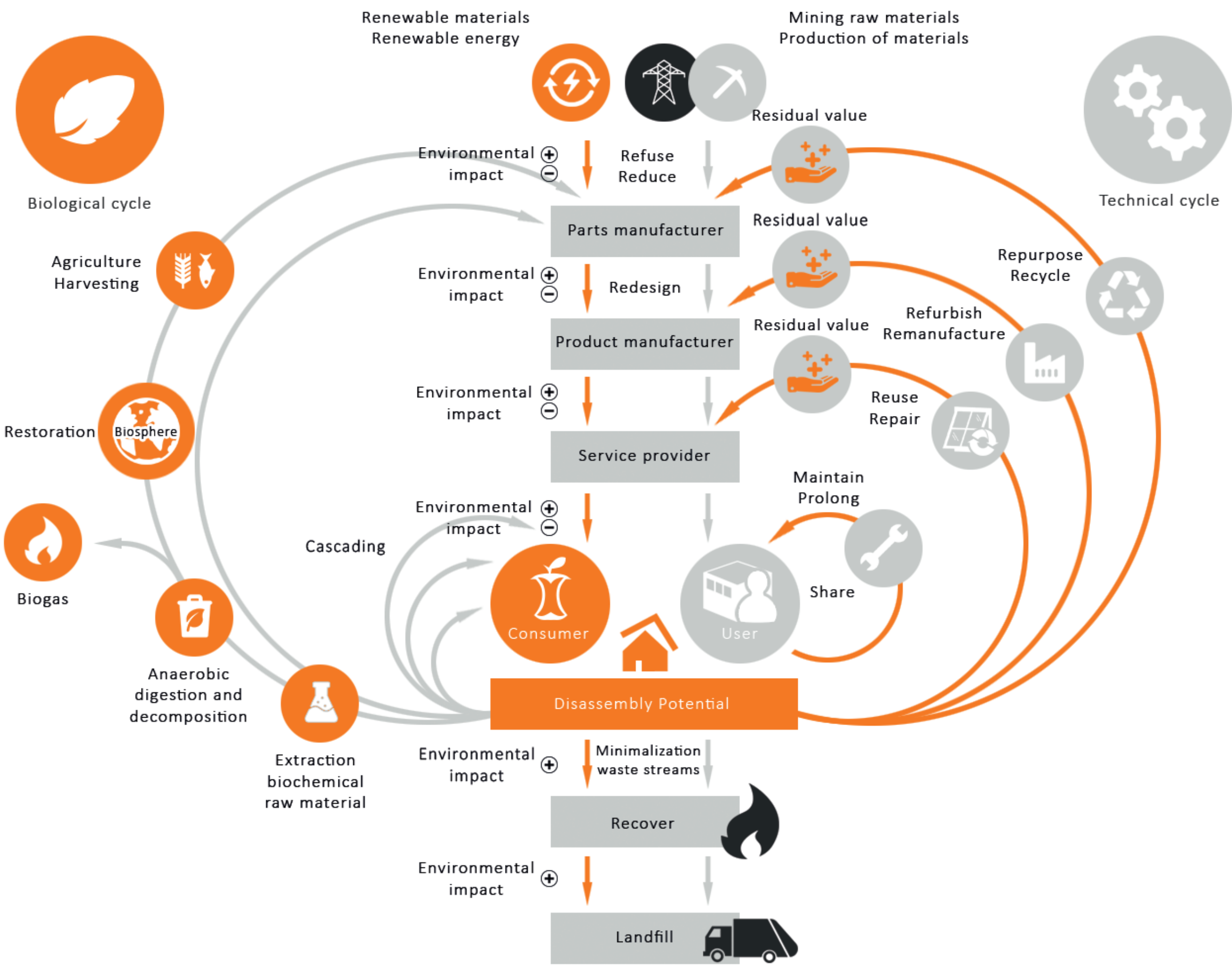

Figure 1: **Disassembly potential as a basis for a circular economy.** Adapted from Towards the Circular Economy by Ellen MacArthur Foundation, 2012.

01.01 Definition of disassembly potential

Buildings are a collection of complex entities made up of various materials, products, and elements that are interconnected. The extent to which these connections can be broken, so that an object can retain its function and high-quality reuse can be realized, determines the degree of disassembly potential.

"The disassembly potential of a building is the degree to which objects can be disassembled at all scales without compromising the function of the object or surrounding objects."

In this, objects are all materials, products, elements, etc., independent of a defined scale level.

01.02 Disassembly potential for the reuse of products

In relation to a building, we have to harvest products. If products are inseparable, then you cannot harvest them, leaving demolition as the only option. The more a building can be disassembled, the easier it is to harvest products and the more obvious this is. Therefore, disassembly potential underlies the enabling of a circular construction economy (Figure 1). Thus, this shows that disassembly potential is not an end, but a means to enable reuse.

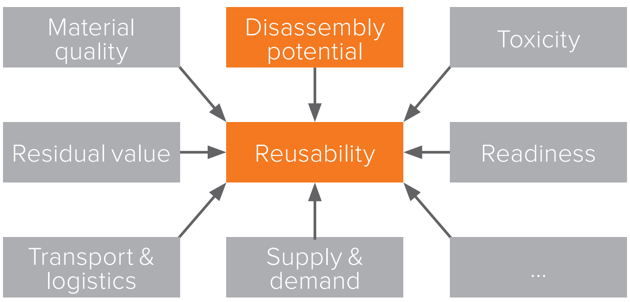

Figure 2: **Disassembly potential as a factor for reusability** from Disassembling the steps towards Building Circularity by van Vliet, M., 2018, Technische Universiteit Eindhoven, Eindhoven

To express high-quality reuse, we are using the 10-R model. This emphasizes the goal of reusing products in their original state as much as possible, resulting in lower energy consumption. The final step is to recycle products into raw materials for a new product.

Figure 3: **10-R model**. Adapted from 'Strategische Verkenning: 'Op weg naar Cirkelregio Utrecht' [Strategic Exploration: Underway to Cirkelregio Utrecht] by Cramer, J., 2015

01.03 Disassembly potential for adaptability

A building and the products in a building have a very long lifespan. The report 'Gebouwen met Toekomstwaarde!' [Buildings with Future Value!] uses the following definition for adaptability:

"The adaptive capacity of a building includes all properties, which allow the building to maintain its functionality in a sustainable and economically viable manner during its technical lifetime, in the face of changing needs and conditions."

A building that is used throughout its life by different types of users, thus meeting a social need, is sustainable and future-proof. If you develop a building that can be disassembled, you can replace (partial) objects more easily in the event of changing needs and circumstances. On the one hand, disassembly potential affects the reusability of the resulting products (as described in 01.02). On the other hand, it ensures the building's future-proofing through adaptive capacity.

01.04 Disassembly potential in management and maintenance

A building is maintained during its lifetime to ensure the quality of the products used - and therefore the building. Products that can be disassembled are easier to maintain, reducing maintenance costs. This has a positive effect on the operating costs of a structure.

02 AREA OF APPLICATION OF THE MEASUREMENT METHOD

Disassembly potential is a precondition for making circular construction possible. An inseparable object cannot be harvested and therefore cannot be reused. But disassembly potential is not the only aspect that is important for circular construction: a detachable object is not necessarily reused, and buildings that can be disassembled are not always transformed. The measurement method we are describing in this paper was developed to quantify the disassembly potential of objects. It is therefore not a measurement method for circularity, several aspects play a role in this.

We identify different areas of application for the measurement method for disassembly potential:

- The measurement method as a design tool to develop connections that can be disassembled;
- The measurement method as part of a material passport, securing information on demountable objects;
- The measurement method by which you test products and product development for disassembly potential;
- The measurement method by which you assess the aspect of disassembly potential in sustainability tools.)

This report helps to integrate disassembly potential in a uniform way into the current sustainability tools BREEAM-NL and GPR Gebouw.

"We encourage and promote the use of the measurement method in the other application areas, but this is beyond the scope of this report (for now). In this report, we will not discuss the consequences of using the measurement method for other purposes."

03 SCOPE OF THE MEASUREMENT METHOD

If you want to integrate the measurement method into existing sustainability tools, then the disassembly potential must be a benchmark by which you determine the disassembly potential of a building as a whole.

Therefore, the following principles were established for applying the measurement method:

- The disassembly potential reflects all products used in a building;
- The disassembly potential can be applied to all building functions;
- You can apply the disassembly potential to new construction, remodelling and renovation projects;
- The disassembly potential can be tested during or after the design process;
- You can assess the disassembly potential after the completion of the building.

03.01 Building levels

A building consists of several parts: separate entities and self-contained complex systems. Consider the difference between a brick and a complete installation system. This affects how you assess disassembly potential of a building.

1. **Product**: A component that arrives at the construction site and is further processed into a building.
2. **Element**: A component that consists of several products, that arrives at the construction site as one composite whole.
3. **Sealing materials**: A material or product that provides the seal between different products or elements.
4. **Fasteners**: A material or product that provides the (structural) connection between different products or elements.

“This means that you assess the disassembly potential of a component as it arrives on the construction site and is processed. If a part consists of several (prefabricated) products, for example an HSB element including frame, you can consider this as one element.”

You determine the disassembly potential of all products and elements in a building, and not of the sealing or fastening materials in a building. In which, incidentally, fasteners are part of the measurement method.

From this point in the report, we refer to products or elements, rather than objects.

"It is possible that an assessor may assess the disassembly potential differently or in more detail than prescribed. This is outside the scope of the area of application of sustainability instruments."

03.02 Products and elements to be assessed

The Environmental Performance of Buildings (MPG) measurement method is directly linked to the measurement method for disassembly potential in the following way:

- To determine the disassembly potential of a building, you must identify each product or element in a building. This must also be done before determining the MPG;
- The Environmental Cost Indicator (ECI) of a product is the weighing factor to determine the disassembly potential of a building.

The disassembly potential assessor shall determine a disassembly potential of each product or element in a building, as realized in the "as-built" situation. For this purpose, the assessor may use the bill of materials from an MPG calculation, as long as it is representative of how the products have been applied in a building.

If the same product or element is manufactured in different ways, the assessor must differentiate between them to determine the disassembly potential. For example, if you place a frame in a façade in different ways. Then, as an assessor, use the following rule of thumb:
The rating of a product should be representative of all products in the building, with some exceptions allowed. The disassembly potential assessment must be representative of at least 95% of the quantity of products or elements.

The disassembly potential is not relevant to all products in a building. To delineate the elements to be assessed, we apply the 'Layers of Brand'. The 'Layers of Brand' distinguishes various building layers with specific functions.

Figure 4: **Disassembly potential within the Layers of Brand**.
Adapted from 'How building learn' by Brand, S., 1994.

The layers 'Structure', 'Skin', 'Services' and 'Space plan' fall under the products and elements to be assessed in a building. 'Site' and 'Stuff' are therefore excluded from the assessment. In the measurement method, a distinction is made between the products from the different Layers of Brand.

"One of the characteristics of the Layers of Brand is that products have different life spans. Structural products (products under the 'Structure' layer) are usually retained throughout the life of a building, while finishes are replaced several times. Products with a shorter lifespan than that of the building in which they are used are particularly interesting in terms of being produced for disassembly."

03.03 Remodelling and renovation

Construction includes new construction and existing buildings. Determining the disassembly potential for both existing and new products in a building is possible. This report does not prescribe a delineation for the inclusion of products when assessing the disassembly potential of remodelling or renovation projects. It is the responsibility of sustainability tools to clearly indicate which products fall within the scope of the assessment.

04 THE MEASUREMENT METHOD

A measurement method for disassembly potential should give an indication of to which extent a building and the products in this building can be disassembled. The design of buildings has the most influence on disassembly. The development of a circular building must be guaranteed in terms of process and finance. In this report, we are making a distinction between the technical, process-based and financial aspects of disassembly potential (see Figure 5).

Technical aspects: the design determines whether products and/or elements can be physically dismantled;
Process-related aspects: during the design and construction process of buildings, you can control the process on the basis of these aspects, so that you guarantee the potential for disassembly at the end of the life;
Financial aspects: the financial feasibility of both developing a dismantlable building and carrying out end-of-life disassembly influence the choice of disassembly over demolition. This means that the value of a product or element must be greater than the disassembly costs.

This report focuses on determining the technical disassembly potential. How products and/or elements can be physically disassembled.

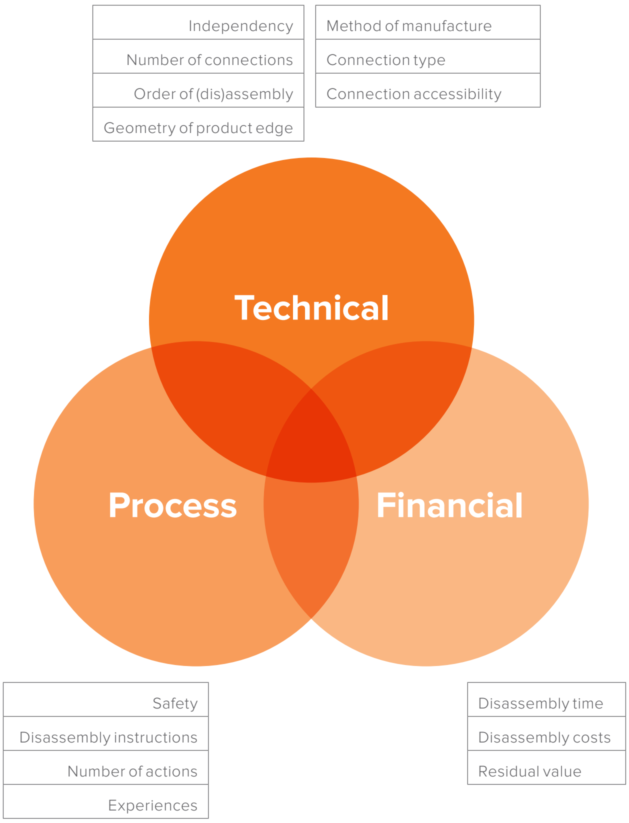

Figure 5: **Overview of aspects of disassembly potential** taken from Disassembling the steps towards Building Circularity by van Vliet, M., 2018, Technische Universiteit Eindhoven, Eindhoven.

A total of 25 factors have been identified, divided into technical, financial and process-related aspects. All factors influence to which extent an object can be disassembled. This has been reduced to the 14 most important factors, 7 of which are technical in nature. This is in line with the results of a study in which the most important factors were identified in a survey with a total of 122 respondents.

The disassembly potential of the connection (DPc) represents the ability to disassemble a product or element at the end of its building life. Thus, the disassembly potential of the connection reflects the inverse order of construction.
The following factors are part of the disassembly potential of the connection:

- Connection type;
- Accessibility of the connection.

For type of connection, the “load-bearing connection” is the normative connection. For the accessibility of the connection, the disassembly order applies, which is usually equal to the reverse order of construction.

Compositional disassembly potential represents how easily a product can be disassembled in the interim. For example, in renovation and remodelling or in repairs and replacements, if a product has to be unexpectedly disassembled from the existing situation anyway. Thus, the factors of independency and the geometry of product edge must be evaluated in the situation where surrounding products or elements are preserved. The following factors are part of the disassembly potential of the composition:

- Independency;
- Geometry of product edge.

Each product or element within the scope of the measurement method (section 03) is given a disassembly potential (DP). This is done on the basis of the disassembly potential of the connection (DPc) and the disassembly potential of the composition (DPcp). This is a total score and represents to which extent a product or element in a building can be disassembled.

"The other factors do affect the disassembly potential of a building, but are not assessed (for now) in the measurement method because they are not essential to ensure disassembly potential. It is possible that the measurement method will be expanded by more factors in the future."

An (optional) intermediate step is to determine the disassembly potential per Layer of Brand. Different types of products in a building are characterized by being easier or harder to disassemble. There is also a different emphasis for each layer. For the shell, adaptive capacity is more often the issue, while for the systems (lease agreement), maintenance is more often the issue.

Differentiating between the average disassembly potential of the different layers gives the user of the measurement method more insight.

The purpose of the measurement method is to integrate the principle of disassembly potential into sustainability tools. A building-level score is needed so you can compare different buildings for disassembly potential.
This is determined by the disassembly potential of the building (LI).

Determining the disassembly potential of a building follows the following step-by-step plan:

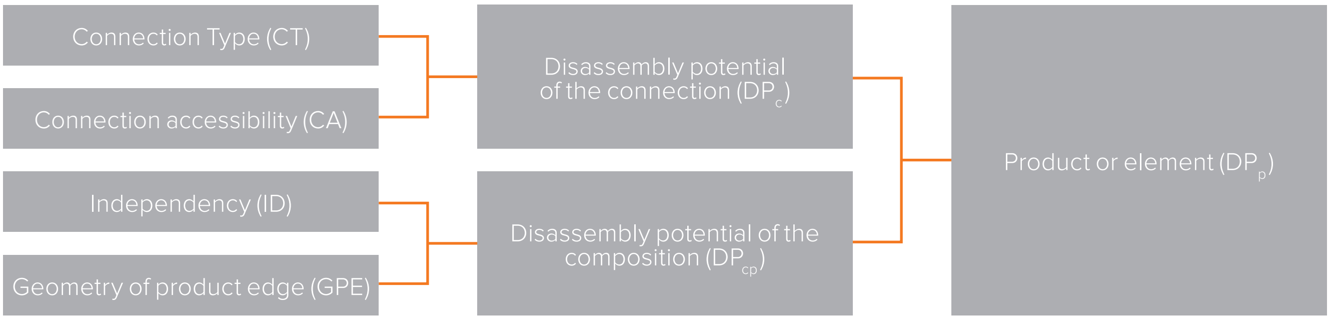

Figure 6: **Step-by-step plan for assessing the disassembly potential of a product or element.**

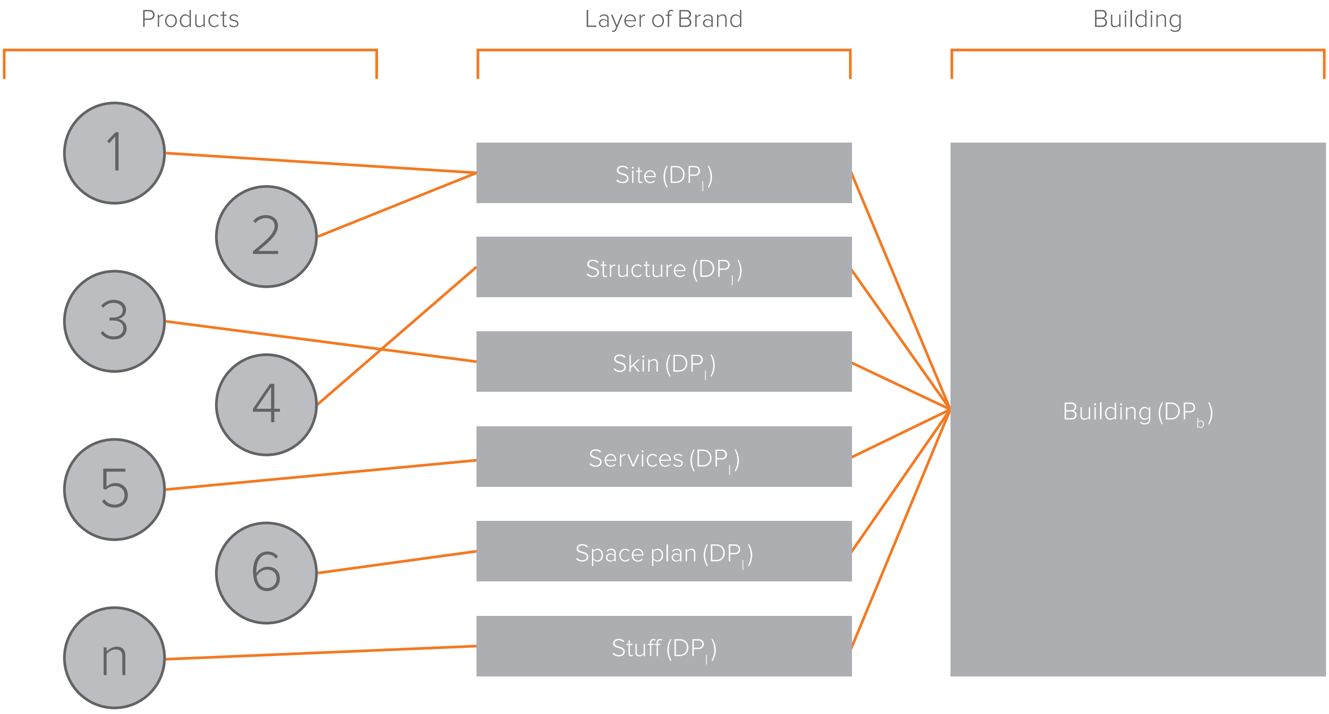

Figure 7: **Step-by-step plan for assessing the disassembly potential of a building.**

04.01 Connections types (CT)

Objects are connected by various types of connections. In disassembly potential, dry connections, connections with added elements and direct integral connections are preferred, rather than soft and hard chemical connections. In Table 1, these categories are expanded to include the most common fasteners used in the construction industry.

Connection type (CT)		Score
Dry connection	Loose (no fastening material)	1,00
	Click connection	
	Velcro connection	
	Magnetic connection	1.00
Connection with added elements*	Bolt and nut connection	0,80
	Spring connection	
	Corner connections	
	Screw connection	
	Connections with added connection elements**	
Direct integral connection	Pin connections***	0,60***
	Nail connection	
Soft chemical connection	Caulking connection	0,20
	Foam connection (PUR)	
Hard chemical connection	Adhesive connection	0,10
	Dump connection	
	Weld connection	
	Cementitious connection	
	Chemical anchors	
	Hard chemical connection	

Table 1: **Connection type valuation**. Adapted and taken from 'Transformable Building Structures' by Durmisevic, E., 2006, Delft University of Technology, Delft.

* Added connecting elements must be made in materials that are insensitive to degradation due to weather and/or use conditions (e.g. stainless steel).

** For example, a façade hanging system

*** For example, a non-connection

04.01.01 Connection type assessment guidelines

A building consists of many products and elements that are interconnected. Some products are connected in multiple ways or with multiple products. Determining every type of connection of every product takes a lot of time. To determine the disassembly potential, you only need to assess one connection. That is the connection that has a load-bearing function for the product in question. If more than one connection is functionally load bearing, then rate the worst scoring connection according to Table 1.

Table 1 is a representation of common connection typologies and their score. If a connection is not included or is not well represented by the relevant typology, then you can evaluate the connection differently from Table 1, according to an equivalence principle. In this situation, the assessor must demonstrate that a connection can be disassembled equivalently.

"A type of hard chemical connection that can be disassembled just as well as a dry connection through (innovative) techniques may be rated as good as a dry connection in accordance with this equivalence principle, provided you substantiate it."

04.01.02 Calculation example

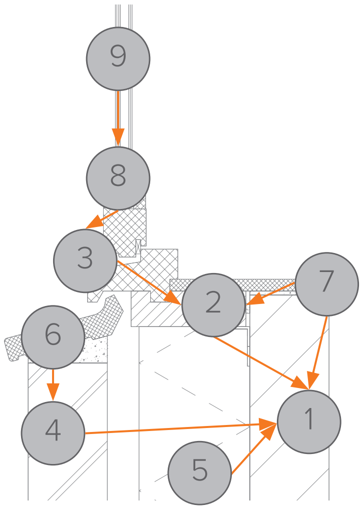

Figure 8: **Vertical detail of a window frame (below) with numbered products and connections**. This is a fictional calculation example. The assumption is that this detail is representative of 95% of the products used.

ID	Product	Load-bearing connection	Layer	Score CT
1	Sand-lime	(level) floor	Structure	0.1
2	Frame set	Sand-lime	Skin	0.8
3	**Frame**	Casement frame	Skin	0.1
4	**Masonry**	Sand-lime	Skin	0.1
5	Insulation	Sand-lime	Skin	0.8
6	Window sill	Sand-lime	Space plan	0.2
8	Window frame	Sand-lime	Skin	0.8
9	Glazing	Window frame	Skin	0.2

Table 2: **Assessment of the connection type factor in the calculation example (Figure 8).**

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example.
The masonry (4) is connected to the inner cavity leaf (1) and the window ledge (6). The load-bearing connection is the connection with the inner cavity leaf. Of these, you determine the type of connection. The cavity anchors are completely bricked in. This is not a "connection with added connection element (0.80)" but a "hard chemical connection (0.10)".
The frame (3) is connected to the casement frame (2) through an "adhesive connection (0.10)". If the frame and the casement frame form an element, then the connection between the casement frame (2) and the inner cavity leaf (1) is representative. In that case, it is connected with a corner connection (0.80)"

04.02 Connection Accessibility (CA)

Can you (physically) get to the connecting elements, and to what extent does damage occur to the surrounding objects? That is the core of the "accessibility of the connection" factor. If the accessibility is good, i.e. you can easily reach the connecting element without causing damage to the surrounding building parts, then this has a positive effect on the disassembly potential of a product (Table 3). The accessibility to connection can be determined in the same way as the type of connection.

Connection accessibility (CA)	Score
Freely accessible without additional actions	1.00
Accessible with additional actions that do not cause damage	0.80
Accessible with additional actions with fully repairable damage	0.60
Accessible with additional actions with partially repairable damage	0.40
Not accessible - irreparable damage to the product or surrounding products	0.10

Table 3: **Connection accessibility valuation**. Adapted and taken from 'Transformable Building Structures' by Durmisevic, E., 2006, Delft University of Technology, Delft.

04.02.01 Guidelines for assessing connection accessibility

The accessibility to connection is determined from the reverse construction sequence, at the end of the life of the product or element:
For products or elements that last as long as the building, this means the reverse construction sequence when the building is dismantled.
For products or elements with a shorter lifespan than the building, this means the reverse construction order for replacement work.

04.02.02 Calculation example

ID	Product	Layer	Score CA
1	Sand-lime	Structure	0.4
2	Casement frame	Skin	0.6
3	**Frame**	Skin	0.6
4	**Masonry**	Skin	0.4
5	Insulation	Skin	1.0
6	Window sill	Space plan	0.6
8	Window frame	Skin	1.0
9	Glazing	Skin	1.0

Table 4: **Assessment of the connection accessibility factor in the calculation example (Figure 8)**.

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example.
The masonry (4) is connected to the inner cavity leaf (1) and the window ledge (6). The masonry (4) lasts the entire life of the building. The reverse construction order is the removal of the window ledge (6) and then the removal of the masonry (4). This causes partially repairable damage to the masonry (4) and possibly to surrounding products or elements (0.4).
The frame (3) is connected to the casement frame (2). The reverse construction order is the removal of window ledge (6), the masonry (4), the insulation (5) and the frame (3). The starting point is that the frame (3) must be replaced earlier than the masonry (4). Additional actions are therefore required to remove the window ledge (6) and the masonry (4). In addition, the frame (3) must be detached from the casement frame (3). This is "repairable damage (0.60)".

04.03 Disassembly potential of the connection (DPc)

The formula for determining the disassembly potential of the connection is:

$$DPc_n = \frac{2}{\frac{1}{CT_n} + \frac{1}{CA_n}}$$

Where:
DPc_n = disassembly potential of the connection of n product or element *n*:
CT_n = type of connection of product or element *n*;
CA_n = accessibility connection of product or element *n*.

04.03.01 Calculation example

ID	Product	Layer	Score DPc
1	Sand-lime	Structure	0.16
2	Casement frame	Skin	0.69
3	**Frame**	Skin	0.17
4	**Masonry**	Skin	0.16
5	Insulation	Skin	0.89
6	Window sill	Space plan	0.30
8	Window frame	Skin	0.89
9	Glazing	Skin	0.30

Table 5: **Determination of the disassembly potential of the connection in the calculation example** (Figure 8).

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example.
The masonry (4) has a connection type of 0.10 and connection accessibility of 0.40.

$$DPc_{masonry} = \frac{2}{\frac{1}{0,1} + \frac{1}{0,4}} = 0,17$$

The frame (3) has a connection type of 0.10 and connection accessibility of 0.60.

$$DPc_{frame} = \frac{2}{\frac{1}{0,1} + \frac{1}{0,6}} = 0,16$$

04.04 Independency (ID)

The term "independency" means that products or elements are intermingled or even integrated with each other in their entirety. As a result, you need more actions to disassemble a product or element at the end of its life. Especially when the lifetimes of the relevant products differ, you need to replace them in the interim and surrounding products or elements need to be preserved.

Independency (ID)	Score
No independency - modular zoning of products or elements from different layers.	1.00
Occasional independency of products or elements from different layers.	0.40
Full integration of products or elements from different layers.	0.10

Table 6: **Valuation of independency**. Adapted and taken from 'Transformable Building Structures' by Durmisevic, E., 2006, Delft University of Technology, Delft.

Since independency mainly hinder the (interim) replacement of products or elements once they have different life spans, this is part of the assessment. Characteristic of the Layers of Brand (see Figure 4 on page 10) are the varying life spans. Ideally, they should therefore remain separate from each other. An independency is assessed only as such if products from another layer (physically) traverse each other.

04.04.01 Guidelines for the assessment of independency

The assessment of independency works both ways. The product or element that causes the independency and the product or element that is traversed are given the same rating.

If you are dealing with multiple independencies or interlacings, then the lowest scoring rating will be normative for the relevant product or element.

04.04.02 Calculation example

ID	Product	Layer	Score ID
1	Sand-lime	Structure	0.1
2	Casement frame	Skin	1.0
3	**Frame**	Skin	1.0
4	**Masonry**	Skin	1.0
5	Insulation	Skin	1.0
6	Window sill	Space plan	0.4
8	Window frame	Skin	1.0
9	Glazing	Skin	1.0

Table 7: **Assessment of the factor independency in the calculation example** (figure 8).

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example. The masonry (4) falls under the layer "skin". Provided that no more than 5% of the masonry is crossed by a product from another layer, the masonry scores "no independency (1.00)".

04.05 Geometry of product edge (GPE)

With the geometry of product edge factor, you assess how products are placed in a composition and whether this is open or closed. As the name suggests, this has to do with the physical "edges" of the product or element. If a product is situated in such a way that it is "locked up" by surrounding products, then we are referring to product edge geometry. This makes it impossible to disassemble a product other than in the reverse construction order. The product edge geometry factor is relevant in two situations: 1) for single products enclosed by the composition and 2) for serial products enclosing each other.

Geometry of product edge (GPE)	Score
Open, no obstacle to the (interim) removal of products or elements.	1.00
Overlapping, partial obstruction to the (interim) removal of products or elements.	0.40
Closed, complete obstruction to the (interim) removal of products or elements.	0.10

Table 8: **Geometry of product edge valuation**. Adapted and taken from 'Transformable Building Structures' by Durmisevic, E., 2006, Delft University of Technology, Delft.

04.05.01 Guidelines for the assessment of the geometry of product edge

Products are not enclosed by surrounding products, see Figure 9. The edges are open in relation to each other. You can completely disassemble a product out of the composition from at least one accessible side.

Figure 9: **Open, no obstacle to the (interim) removal of products or elements.**

Products, see Figure 10, are partially enclosed by surrounding products. As a result, there is overlapping on one edge at least. To disassemble products (in the interim) from a composition, you must first disassemble other products.

Figure 10: **Overlapping, partial obstruction to the (interim) removal of products or elements.**

Products, see Figure 11, are fully enclosed by surrounding products. As a result, there is containment on at least two edges. To disassemble products (in the interim) from a composition, you must first disassemble other products. The following situations also fall under "closed":

- Serial products interconnected with a hard chemical compound;
- Products fully formed on site (monolithic and poured).

Figure 11: **Closed, complete obstruction to the (interim) removal of products or elements.**

04.05.02 Calculation example

ID	Product	Layer	Score GPE
1	Sand-lime	Structure	1.0
2	Casement frame	Skin	0.4
3	**Frame**	Skin	0.4
4	**Masonry**	Skin	0.1
5	Insulation	Skin	1.0
6	Window sill	Space plan	1.0
8	Window frame	Skin	1.0
9	Glazing	Skin	1.0

Table 9: **Assessment of the geometry of product edge factor in the calculation example (Figure 8).**

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example. Masonry (4) is a serial product with interlocking masonry mortar. The masonry mortar (and any grout) impedes interim disassembly. This counts as a hard chemical connection. This is a closed assembly shape (0.10). The frame (3) is enclosed by the casement frame (2). The frame is enclosed by the casement frame and thereby gets scored as "closed (0.10)".

04.06 Disassembly potential of the composition (DPcp)

The formula for determining the disassembly potential of the connection is:

$$DPcp_n = \frac{2}{\frac{1}{ID_n} + \frac{1}{GPE_n}}$$

Where:

$DPcp_n$ = disassembly potential of the composition of element *n*:

ID_n = independency of product or element *n*;

GPE_n = product edge geometry of product or element *n*.

04.06.01 Calculation example

ID	Product	Layer	DPcp
1	Sand-lime	Structure	0.18
2	Casement frame	Skin	0.57
3	**Frame**	Skin	0.57
4	**Masonry**	Skin	0.18
5	Insulation	Skin	1.00
6	Window sill	Space plan	0.57
8	Window frame	Skin	1.00
9	Glazing	Skin	1.00

Table 10: **Determination of the disassembly potential of the composition in the calculation example (Figure 8).**

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example. The masonry (4) has an independency of 1.00 and product edge geometry of 0.10.

$$DPcp_{masonry} = \frac{2}{\frac{1}{1{,}00_n} + \frac{1}{0{,}10}} = 0{,}18$$

The frame (4) has an independency of 1.00 and product edge geometry of 0.40.

$$DPcp_{frame} = \frac{2}{\frac{1}{1{,}00} + \frac{1}{0{,}40}} = 0{,}57$$

04.07 Disassembly potential of the product or element (DPp)

The formula for determining the disassembly potential of the product or element is:

$$DPp_n = \frac{2}{\frac{1}{DPc_n} + \frac{1}{DPcp_n}}$$

Where:

DPp_n = disassembly potential of product or element *n*.

DPc_n = disassembly potential of the connection of product or element *n*.

$DPcp_n$ = disassembly potential of the composition of product or element *n*.

Or:

$$DPp_n = \frac{4}{\frac{1}{CT_n} + \frac{1}{CA_n} + \frac{1}{ID_n} + \frac{1}{GPE_n}}$$

Where:

DPp_n = disassembly potential of product or element *n*.

CT_n = type of connection of product or element *n*.

CA_n = accessibility of the connection of product or element *n*.

ID_n = independency of product or element *n*.

GPE_n = edge geometry of product or element *n*.

Annex 1 explains the establishment of this revised formula for the disassembly potential of the product or element. Both formulas lead to the same result for the disassembly potential of the product.

04.07.01 Calculation example

ID	Product	Layer	DPp
1	Sand-lime	Structure	0.17
2	Casement frame	Skin	0.62
3	**Frame**	Skin	0.26
4	**Masonry**	Skin	0.17
5	Insulation	Skin	0.94
6	Window sill	Space plan	0.39
8	Window frame	Skin	0.94
9	Glazing	Skin	0.46

Table 11 : **Determination of the disassembly potential of the product in the calculation example (Figure 8).**

The following is an explanation of the "**masonry**" and "**frame**" components in the calculation example. The masonry (4) has a connection type score of 0.1, a connection accessibility score of 0.4, an independency score of 1.0, and a product edge geometry score of 0.1. This results in a disassembly potential score of 0.17.

$$DPp_{masonry} = \frac{4}{\frac{1}{0{,}1} + \frac{1}{0{,}4} + \frac{1}{1{,}0} + \frac{1}{0{,}1}} = 0{,}17$$

The frame (3) has a connection type score of 0.1, a connection accessibility score of 0.6, an independency score of 1.0, and a product edge geometry score of 0.4. This results in a disassembly potential score of 0.26.

$$DPp_{frame} = \frac{4}{\frac{1}{0,1} + \frac{1}{0,6} + \frac{1}{1,0} + \frac{1}{0,4}} = 0,26$$

04.08 Disassembly potential of the Layers of Brand (DPI)

As described in Section 03, all products and elements in a building must be assessed using the disassembly potential measurement method. It gives every product a score. The disassembly potential of all products together, leads to one building-level score with the weighing factor Environmental Cost Indicator (ECI). Each product or element has a certain impact on the building's disassembly potential: the higher the product's overall ECI, the more impact the product has.

An (optional) intermediate step is to determine the disassembly potential per Layer of Brand. Different types of products in a building are characterized by being easier or harder to disassemble. By distinguishing between the average disassembly potential Where: you as a user of the measurement method gain more insight into the different layers.

In addition, a weighing factor for the different Layers of Brand can be determined. This allows you to factor a certain type of product more or less into the building's disassembly potential. This report does not propose the ratio of weighing factors for different layers. The measurement method is integrated into the sustainability instruments without a weighing factor. Follow-up research should indicate whether a weighing factor should be applied.

"PV panels are common products in buildings and essential for the energy performance of a building. PV panels are characterized by a high environmental impact and a high disassembly potential. This positively influences the disassembly potential of a building, so that it (often) scores higher than expected. This is caused by the fact that the measurement method for disassembly potential uses the ECI as a weighing factor. Moderating the impact of certain product groups by their ECI falls outside the scope of this measurement method."

The formula for determining the disassembly potential of a Layer of Brand is:

$$DPl_n = \frac{1}{\sum_{i=1}^{l} ECI_n} \cdot \sum_{i=1}^{l} ECI_n \cdot DPp_n$$

Where:

DPl_n = disassembly potential of a Layer of Brand *n*;

DPp_n = disassembly potential of product or element *n*;

ECI_n = Environmental Cost Indicator of product or element *n*.

04.08.01 Calculation example

ID	Product	Layer	ECI	Disassembly Potential
	Skin		131.56	0.42
2	Frame set	Skin	0.26	0.62
3	Frame	Skin	2.64	0.26
4	Masonry	Skin	34.18	0.17
5	Insulation	Skin	7.65	0.94
8	Window frame	Skin	4.06	0.94
9	Glazing	Skin	82.77	0.46
	Space plan		21.28	0.39
6	Window sill	Space plan	21.28	0.39
	Structure		16.59	0.17
1	Sand-lime	Structure	16.59	0.17

Table 12: **Determination of the disassembly potential of the Layer in the calculation example (Figure 8).**

The layer "skin" consists of 6 products with a total ECI of 131.56. The disassembly potential of the layer "skin" is

$$DPl_n = \frac{1}{131,56} \cdot ((0,26 * 0,62) + (2,64 * 0.26) + (ECI_n * DP_n) + \dots) = 0,42$$

04.09 Disassembly potential of the building (DPb)

The disassembly potential provides a building-level score based on all products used in the building. It is a weighted average based on the ECI. As described in 04.08, the measurement method does not apply a weighting factor for the Layers of Brand. This allows you to compare the formula for determining the disassembly potential with the formula for determining the disassembly potential of a Layer of Brand.

The formula for determining the disassembly potential of a building is:

$$DPb_n = \frac{1}{\sum_{i=1}^{i} ECI_n} \cdot \sum_{i=1}^{n} ECI_n \cdot DPp_n$$

Where:

DPb_n = disassembly potential of building n;

DPp_n = disassembly potential of product or element n;

ECI_n = Environmental Cost Indicator of product or element n.

04.09.01 Rekenvoorbeeld

ID	Product	Layer	ECI	Disassembly Potential
	Project		**169.43**	**0.40**
	Skin		131.56	0.42
2	Casement frame	Skin	0.26	0.62
3	Frame	Skin	2.64	0.26
4	Masonry	Skin	34.18	0.17
5	Insulation	Skin	7.65	0.94
8	Window frame	Skin	4.06	0.94
9	Glazing	Skin	82.77	0.46
	Space plan		21.28	0.39
6	Window sill	Space plan	21.28	0.39
	Structure		16.59	0.17
1	Sand-lime	Structure	16.59	0.17

Table 13: **Determination of the disassembly potential of the building in the calculation example (Figure 8).**

The project consists of three layers with a total ECI of 169.43. The disassembly potential of the layer "skin" is 0.42, the layer "space plan" is 0.39 and the layer "structure" is 0.17. This results in an average disassembly potential score of 0.40.

$$DPb_n = \frac{1}{169,43} \cdot ((131,56 * 0,42) + (21,28 * 0.39) + (ECI_n * DP_n) + \dots) = 0,40$$

05 DISCUSSION AND FOLLOW-UP

The measurement methodology for disassembly potential has been modified and improved from version 1.1 published in September 2019. A public call to the market to provide feedback on the measurement method was issued in November 2020. Several insights were gained from this to improve, and where necessary clarify, the measurement method for disassembly potential.

The starting point of this research was to integrate the measurement method for disassembly potential into the current sustainability tools BREEAM-NL and GPR Gebouw. Through the cooperation between the sustainability instruments and the RVO, a diversity of measurement methods for disassembly potential is avoided.

The development of the measurement method for disassembly potential is not written in stone. With the implementation of the measurement method in the sustainability tools, the market will gain more experience with disassembly potential in construction projects. This practical experience may lead to new insights and a new iteration of the measurement method.

During the preparation of this report, the following aspects have already been discussed but not yet explored further. The elaboration of this requires follow-up research.

1. Disassembly potential is not only essential for (high-quality) reuse of products, but also for other circular aspects such as adaptability, the possibility of (sustainable) upgrading of building parts and circular management and maintenance.
2. It is possible to compile the detachability by Layer of Brand. This allows the user to see which types of products have a high or low disassembly potential. In addition, this allows the user to apply weighting to different Layers of Brand.
3. Disassembly potential can be applied broadly: in new construction projects, but also in remodelling and renovation projects. The sustainability instruments BREEAM-NL and GPR Gebouw have their own guideline for the use of the instruments in remodelling and renovation projects. This should demonstrate how this affects the assessment for disassembly potential.
4. Disassembly potential is also relevant in terms of product development. The measurement method only takes products and elements into consideration. Practical experience shows that disassembly potential between different components of a product is relevant for product reuse.

In the market, several developments are leading to a broader adaptation of the disassembly potential measurement method:

1. This publication is written for the non-residential construction (B&U) sector, at the same time a study is underway into the application of this measurement method in the civil engineering (GWW) sector.
2. Circular reference details are being developed where the disassembly potential is an indicator of the degree of circularity.
3. The guideline Measuring Circularity Version 2.0 of Platform CB'23 refers to the measurement method for disassembly potential, for assessing the aspect of flexibility.

06 REFERENCES

Cramer, J. (2015). Strategische Verkenning: ‘Op weg naar Cirkelregio Utrecht’.
[Strategic Exploration: ‘Underway to Cirkelregio Utrecht’] Utrecht Sustainability Institute.

Brand, S. (1994). How building learn, New York.

Van Vliet, M. (2018). Disassembling the steps towards building circularity. Technische Universiteit Eindhoven, Eindhoven.

Durmisevic, E. (2006). Transformable building structures. Technische Universiteit Delft, Delft.

Hermans, J. et al. (2014). Gebouwen met Toekomstwaarde! [Buildings with Future Value!]

ANNEX 1: ESTABLISHMENT OF THE FORMULA

The formula for determining the disassembly potential of a product or element has been revised (paragraph 04.07). The following steps led to the creation of the revised formula for the disassembly potential. The measurement method for detachability is based on the study "Disassembling the steps towards Building Circularity". In this study, an attempt was made to define a weighting between the different disassembly potential factors. Based on a survey of 122 respondents, no difference was demonstrated. The average between the four factors defines the disassembly potential.

By applying the measurement method in the five pilot projects (see Annex 2) and collecting feedback, the conclusion was drawn that in the existing formula, the disassembly potential factors offset each other.
If one disassembly potential scores low, it is still possible for the product to have a high disassembly potential due to high scores on the other factors. In practice, a completely collapsed product can still achieve a disassembly potential of > 0.70.
This behaviour does not correspond to the reality in disassembly potential, where the 'weakest link' is decisive.

Several options were explored that would allow better modelling of the behaviour. Such as multiplying the scores on the factors or weighting the factors. These options did not prove to produce the desired results. The solution was finally found in a revised formula, which determines the 'harmonic mean' of the four factors of disassembly potential. The behaviour of this formula is that low scores for one or more disassembly potential factors ('the weak links') weigh more heavily in the disassembly potential.

ANNEX 2: DISASSEMBLY POTENTIAL MEASUREMENT METHOD ASSESSMENT PILOT PROJECTS

The measurement methodology for looseness, as described in Section 03, is the first step toward paying more attention to detailing and construction technology in design. In order to validate the measurement methodology and gain more knowledge and expertise, five pilot projects were executed:

- The Green House in Utrecht by alba concepts;
- Circl in Amsterdam by TRAJECT;
- the Temporary District Court in Amsterdam by Cepezed;
- House of tomorrow today (hoTT) by W/E Adviseurs;
- Galileo Reference Center in Noordwijk by the Architekten Cie.

The pilot projects examined in detail the four aspects of the disassembly potential of an element, namely the type of connection, the accessibility of the connection, independency of the element, and the shape inclusion of the element.

The Green House

Function:	meeting building/ restaurant	Builder:	Ballast Nedam, Strukton and Albron
Floor area:	680 m²		
Architect:	Cepezed	Completion date (opening):	April 2018
Client:	Central Government Real Estate Agency	Building certification:	none

The disassembly potential of The Green House is **0.79** (scale: 0.00 - 1.00). The dominant elements that determine the basis and level of the disassembly potential are:

- reused mirror glass façade panels (35% share in MPG);
- glazing HR++ curtain wall (15% share in MPG);
- Legioblocks (9% share in MPG);
- slope insulation (6% share in MPG).

Example detail of floor structure, ground floor (at element level)

The Green House has a ground floor structure, as shown in Figure 17, with the foundations (stelcon slabs with Legioblocks) also designed as detachable elements. The floor structure has a disassembly potential at the element level of 0.85, with the following explanation applying to the four aspects of disassembly potential:

- **geometry of product edge**: no obstacle by surrounding elements (score: 1.00);
- **Independency**: one independency of the main supporting structure (columns) by the floor structure. No impact on the sand pack, but does affect the fiber cement panels and insulation (score 0.40);
- **Connection type**: completely dry and loose floor structure (score 1.00);
- **Connection accessibility**: the elements from the floor structure are removed one by one.

This does not require any additional actions (score 1.00).

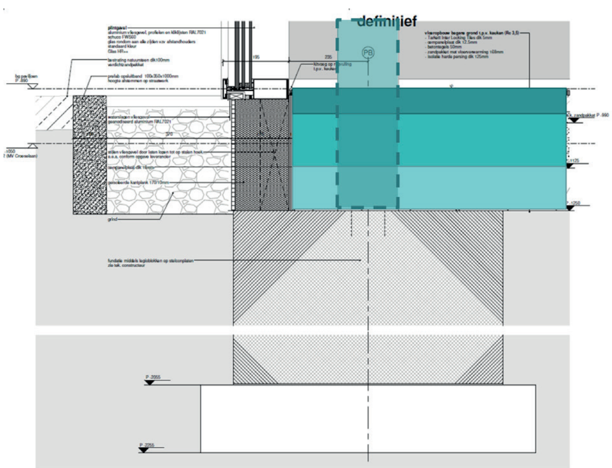

Figure 12 **Floor structure The Green House**

Circl

Function:	meeting building	Builder:	BAM Bouw & Techniek
Floor area:	3,390 m2 GFA	Completion date (opening):	September 2017
Architect:	De Architekten Cie.	Building certification:	BREEAM-NL Outstanding

The disassembly potential of Circl is **0.52** (scale: 0.00- 1.00). The dominant elements that determine the basis and level of the disassembly potential are:

- PV panels (19% share in MPG);
- concrete retaining walls prefab basement (14% share in MPG);
- concrete pile foundation (10% share in MPG);
- basement floor screed (8% share in MPG).

Example detail CLT- with PCM floor element (at element level)

Circl has a cross-laminated timber (CLT) floor on the ground floor with phase-changing materials (PCM), as shown in Figures 18 and 19. The underside of the floor is equipped with sound-absorbing plates, because the meeting center is located on level -1. The floor structure has a disassembly potential at the element level of 0.90, with the following explanation applying to the four aspects of disassembly potential:

- **Geometry of product edge**: no obstacles by surrounding elements (score: 1.00);
- **Independency**: no independency by other elements (score 1.00);
- **Connection Type**: connection between CLT and construction is completely dry and loose floor structure by means of screw connections (score 0.80);
- **Connection accessibility**: possible to access the connections after removing various elements. No damage anticipated with these actions (score 0.80).

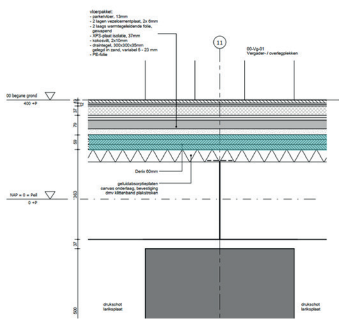

Figure 13: **Floor construction ground floor Circl**

Figure 14: **Photo floor construction**

Temporary District Court of Amsterdam

Function:	district court	Builder:	
Floor area:		Completion date (opening):	September 2017
Architect:	Cepezed	Building certification:	none

The disassembly potential of Temporary District Court is **0.88** (scale: 0.00- 1.00). The dominant elements that determine the basis and level of the disassembly potential are:

- prefabricated HSB elements (11% share in MPG);
- demountable hollow-core floor, type 1 (35% share in MPG);
- demountable hollow-core floor, type 2 (35% share in MPG).

Example detail hollow-core floor, story floor (at element level)

The Temporary District Court consists of remountable hollow-core slab floors as floor slabs, as shown in Figures 20 and 21. The floor structure has a disassembly potential at the element level of 0.85, with the following explanation applying to the four aspects of disassembly potential:

- **Geometry of product edge**: no shape inclusion by surrounding elements (score: 1.00);
- **Independency**: no independency by other elements (score 1.00);
- **Connection type**: added connection between hollow-core slab floor and steel beam by bolted connection (score 0.80);
- **Connection accessibility**: the connection is accessible with additional actions with repairable damage (score 0.60).

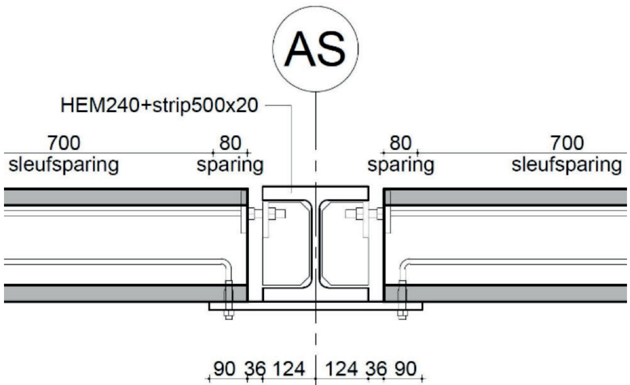

Figure 15: **Floor structure Temporary District Court**

Figure 16: **Floor structure photo** (a) **and type of connection** (b) **Temporary District Court**

House of Tomorrow Today (HoTT)

Function:	residential with practice space	Completion date:	2014
Floor area:	246 m²	Possible certification:	Energy-generating, international (+ level): recognition as an Active House
Architect and builder:	KAW/e Architects built based on Smart building with subcontractors		

The disassembly potential of HoTT is **0.85** (scale: 0.00-1.00) based on an MPG including PV panels of 1.03. When the impact of the PV panels is set to 0 in the MPG, the disassembly potential becomes lower, namely 0.63. The dominant elements that determine the basis and level of the disassembly potential are:

- PV panels (58% share in MPG);
- glazing HR (dry curtain wall (7% share in MPG);
- Sloping roofing (4% share in MPG);
- Foundation beams, concrete, poured on site (4% share in MPG).

Example detail roof structure, sloping, roofing (at product level)

HoTT has a sloping roof that consists of a layer of glued PVC. The roofing has a disassembly potential at the product level of 0.58. The following explanation applies to the four aspects of disassembly potential:

- **Geometry of product edge**: the roofing is closed on one side (score: 0.20);
- **Independency**: no independency by other elements (score 1.00);
- **Connection type**: there is a hard chemical connection (score 0.1);
- **Connection accessibility**: the connection is accessible with requires no additional actions (score 1.00).

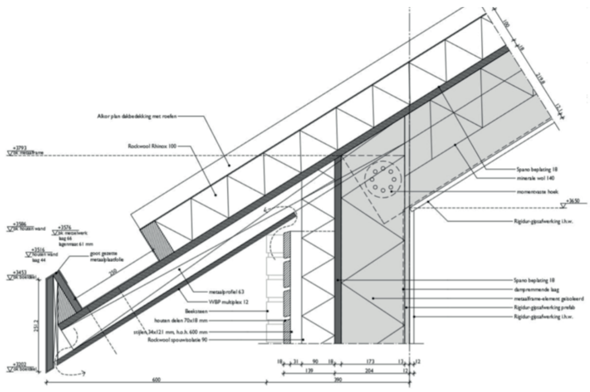

Figure 17: **HoTT roof structure**

Galileo Reference Centre, Noordwijk

Function:	data center, office space	Builder:	Van Rhijnbouw, Katwijk
Floor area:	1500 m²	Completion date:	2017
Architect and builder:	de Architekten Cie. (Pero Pulji, Eric van Noord), Amsterdam;	Building certification:	none

Our intention was to combine the disassembly potential tool with BIM. Unfortunately, due to the lack of an MPG score, Galileo's disassembly potential could not be determined. Nevertheless, the study provided insight. It turns out that a building like Galileo contains many elements, about 26,000. We made a selection and concentrated on the façade, about 900 elements. The disassembly potential data was added manually to the façade elements. Thanks to the added value of BIM, it was relatively quick and easy to do this. All elements of the modular façade have dry screw or click connections, have no independency and are therefore easily detachable.

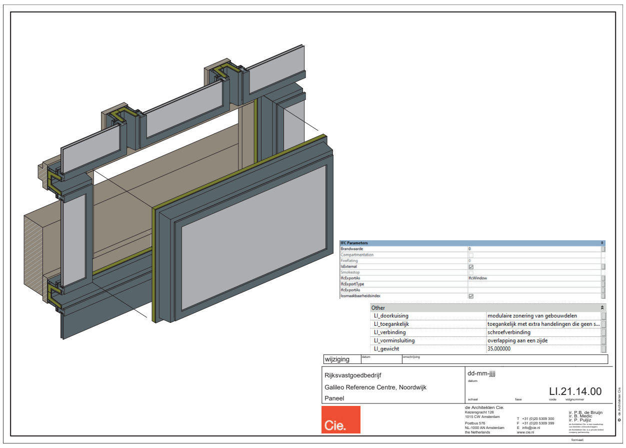

Figure 18: **Panel Galileo Reference Center**

Feedback on the disassembly potential measurement method

All parties have given feedback on a number of aspects on the basis of the disassembly potential measurement method, namely:

- the feasibility of the measurement method;
- the definitions used;
- the choice of disassembly potential factors;
- the measurement methodology;
- other aspects.

The feedback forms the input for improving the measurement methodology detachability and is the starting point to achieve total integration with existing sustainability metrics, such as BREEAM and GPR.

The feasibility of the measurement methodology

The main feedback regarding the feasibility and use of the disassembly potential measurement method is as follows:

- the feasibility of the measurement method depends on the availability of data. Not all parameters can be derived from drawings, so architectural knowledge is required to assess “blind spots”.
- the number of elements to be assessed depends on the project. In complex projects this increases, which means that this takes a lot of time.
- the measurement method should be used as a design tool and not only at the end of the design.
- the tool connects one-to-one with BIM. This makes assessing connection options easier and more objective.

The definitions used

The main feedback regarding the definitions used is as follows:

- there is uncertainty about the definitions of building levels used. This creates a difference in interpretation when assessing the measurement method.
- the factor of form inclusion is not clear enough with the current definition and examples.

The choice of disassembly potential factors

The main feedback regarding the choice of disassembly potential factors is as follows:

- the disassembly potential factor of form inclusion is difficult to assess. This can also be seen as part of the connection accessibility factor.
- It was decided not to adapt the factors life cycle coordination and assembly order in the measurement method. As a result, this is underexposed in the measurement method.
- The application of four disassembly potential factors creates situations where a high score in one factor overrides a low score in another and thus still creates a high disassembly potential.

The measurement methodology

The main feedback regarding the disassembly potential measurement methodology is as follows:

- the building level determines which parts are assessed. The element level is not always sufficient to assess the essential connections.
- the disassembly order is essential in determining the disassembly potential. During the disassembly phase, the factors of accessibility of the connection and shape inclusion are less important, because hindering situations are nullified by the disassembly sequence.
- the MPG determines the weighting of the disassembly potential. It is still unclear how recycling and reuse count in the MPG calculation, which means that certain components have a higher impact on the disassembly potential.
- by using the mpg as a weighing factor, circular products with a low environmental impact have little influence on the disassembly potential. As a result, the application of these products is not rewarded.
- the connection to be tested is the connection at which the element bears the weight (the connection between the object and the underlying object that has a load bearing function). It would be better to test the most difficult to detach detail as the normative connection.

Other aspects

- the complexity of disassembling different types of elements, such as a floor in relation to a solar panel, is not taken into account.
- reuse (value) is not included as a weighing factor for the disassembly potential. As a result, products where disassembly potential is irrelevant are also assessed.
- the measurement methodology must be in line with the latest version of the NMD and NL/SfB.

Alba Concepts

Alba Concepts is a young, sustainable company that focuses on three activities: consultancy, management and project development. Central to all activities is that they act where real estate, sustainability, strategy and finance meet in the early planning stages.

Dutch Green Building Council

Dutch Green Building Council (DGBC) Foundation is the national organization dedicated to making the built environment future-proof at a rapid pace. The independent foundation established in 2008 at the initiative of the market and thas almost 400 participants. They all support DGBC's mission: to make the built environment more sustainable. DGBC connects organizations, lets them collaborate on sustainability and encourages them to be an example to others. In addition, DGBC is the developer and manager of the BREEAM-NL sustainability label.

RVO

The Netherlands Enterprise Agency (RVO.nl) encourages sustainable, agricultural, innovative and international entrepreneurship. With subsidies, finding business partners, knowledge and complying with laws and regulations. RVO.nl carries out assignments on behalf of other ministries, including the Ministries of the Interior and Kingdom Relations and Economic Affairs and Climate. RVO.nl also works on behalf of the European Union.

W/E adviseurs

W/E Adviseurs sustainable building foundation provides advice on sustainability in construction, real estate and area development. Practical tailor-made project advice on (sustainable) energy, building physics, sustainable building or renovation. W/E supports organizations, from vision formation to implementation in daily practice. They also develop knowledge and software (including GPR Gebouw) that makes sustainability transparent and measurable. They also share knowledge through courses.

alba concepts.

DGBC
Dutch
Green Building
Council

Rijksdienst voor Ondernemend
Nederland

W/E adviseurs