METABOLIC

City of Amsterdam

Copper8

The environmental impact of building materials: ECI and EPB

The circular tool box

Content

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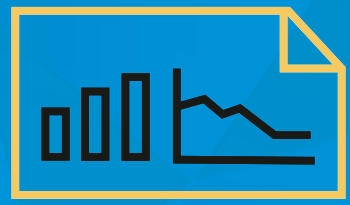


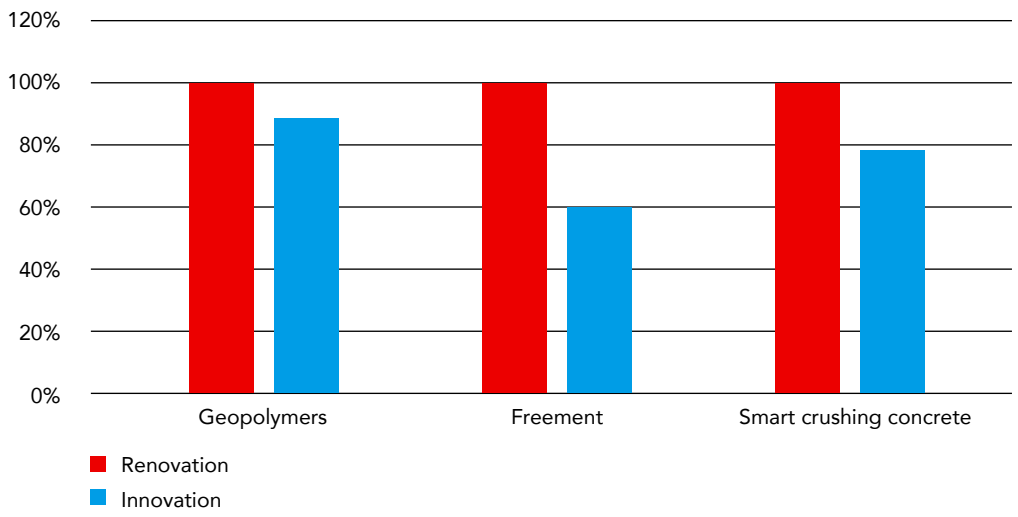
- → Understand how the ECI and EPB arose and what they measure
- → Gain tools to lower the ECI and EPB at the project level
- → Understand the limitations and implications of both methods

Summary

Reducing the negative environmental impact caused by building processes and materials is an important element of circular construction. Sustainable construction applies to both public spaces (as it pertains to civil and hydraulic engineering) and the built environment (the construction of residential and nonresidential buildings).
The Environmental Cost Indicator (ECI) is an instrument that expresses this environmental impact within a civil engineering framework; the Environmental Performance of Buildings (EPB) is a set of standards that calculates the overall environmental performance of buildings.

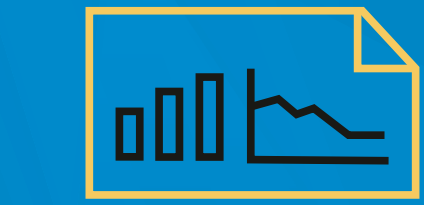
As a first step, any construction project for public spaces and the built environment must start with good design choices that significantly reduce environmental impact. The next step is to research and choose materials with the lowest possible environmental impact. For example, the impact of three types of concrete (seen in Figure 1) is calculated with data from the Dutch National Environmental Database (NMD).

Figure 1: Illustration of the environmental impact of three different types of concrete compared to their traditional reference (in %), which can be used for works in public spaces. Source: NIBE[1]



Recommendations

- Make choices during the design phase that will significantly reduce the project's environmental impact.
- Aim to reduce the environmental impact at a project's structural level by applying the ECI (for public spaces) and the EPB (for buildings), for example, as a control instrument in tenders and for making variant studies in design teams.
- When requesting an ECI or EPB in a tender, always ask for further substantiation of the choices made within the context of the sustainable use of materials. This prevents receiving a tender with unrealistically low ECI or EPB values.
- In projects, make it a requirement that producers contribute their product data to the national equivalent of the NMD database, to help ensure the database is continuously updated.
- Always weigh the reduction of the environmental impact against other sustainability objectives, such as the potential reuse of detachable materials at the end of life or the stimulation of biodiversity.



Substantive deepening

Calculating the environmental impact

In the Netherlands, the NMD foundation manages the method for calculating the environmental impact of construction. This organization establishes the Determination Method, the standard for environmental impact calculations, which is based on the European standard EN 15804 (Figure 2). From January 1, 2021, the NMD adopted version EN 15804:A2. This version expanded the mandatory impact categories from seven to 13 and thus changed how environmental data is maintained. Companies and different sectors generate their environmental data with the results of a Life Cycle Assessment (LCA), which are then expressed in an Environmental Product Declaration (EPD). Recognized experts verify and approve this data before it is included in the NMD database.

Such data is divided into three categories:

- Category 1: tested, product-specific data
- Category 2: tested, industry-average data
- Category 3: untested, generic data

When this EPD is in the NMD database, it can be used for ECI or EPB calculations using one of the NMD tools, including DuboCalc, MPGCalc, One Click LCA, and GPR. Those tools designed for civil and hydraulic engineers create the ECI values, and those for residential and non-residential buildings generate an EPB value. An EPB value is simply an ECI value expressed per square meter of a building's surface. Promote circularity within that part. The six layers must be divided between functionality and functional lifespan in order to develop each separately.

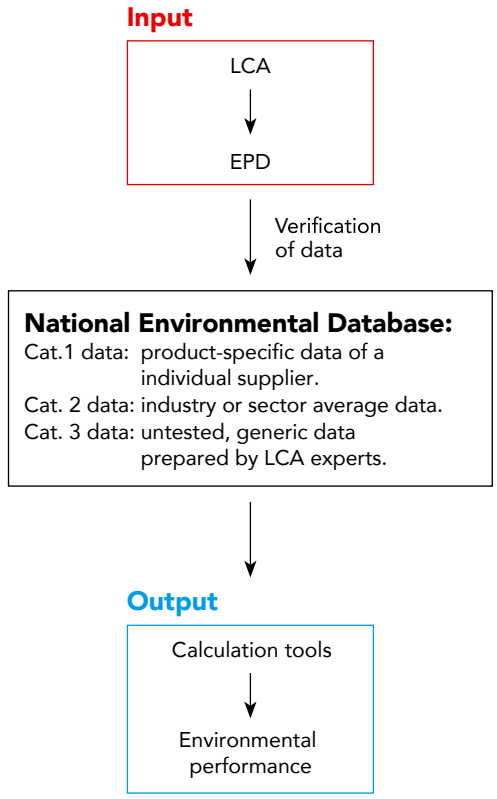
Principles and tips for reducing environmental impact

Several principles can help reduce the environmental impact in both public spaces and buildings:

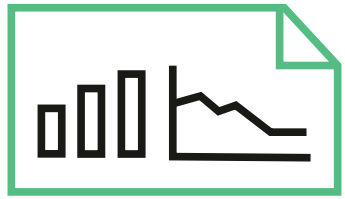
- Provide sufficient space when it comes to the possible material composition of products, so that (innovative) sustainable applications can be used as well. Therefore, do not record too much in terms of requirements if this is not vital for the end product.
- Where possible, choose materials of a low environmental impact, based on the following considerations:
  - Choose lightweight products: this saves materials.
  - Use recycled materials or products with high recycled content: this has a much lower environmental impact, as the impact can be spread over several years of life and it avoids the need to produce a new product.
  - Opt for bio-based materials: these often have a lower ECI and EPB than "regular" alternatives.

In addition, aiming for a low environmental impact as it concerns transport is particularly important in public spaces. Due to the usually large volumes of materials that are required, a lot of environmental benefits can be achieved here as well. Examples include the use of local products (becoming available), the choice of regional manufacturers, and the electrification of equipment to be used.

Figure 1: Calculating of environmental impact



Determination method based on EN15804(A2)



Implications of current ECI or EPB calculations

Although the ECI and EPB are a reliable means of gaining insight into environmental impact, this system also has its limitations. The NMD does not yet include all innovative products, and the limited extent to which CO2 storage is currently included in the application of bio-based materials is a topic of discussion.

Therefore, when aiming for a low ECI or EPB, consider the following four points:

- Every calculation relies on accurate data. However, data is not yet available in the NMD for many sustainable innovations. Consequently, it is often only possible to make calculations for traditional products already included in the NMD. This makes it more difficult to tender with innovative materials for tenders where an ECI or EPB is mandatory, because, for example, an LCA still has to be submitted (at additional costs) or Category-3 data has to be used in the calculation instead (which increases the ECI or EPB). So check carefully whether the form in which the ECI or EPB is requested leaves room for the sustainable use of materials.

- Much of the data in the NMD database is still untested, generic, Category-3 data. This makes an EPB calculation less accurate compared to using tested, factory-specific, Category-1 data. Demand the use of Category-1 data as much as possible.

- Weighting factors (also known as environmental prices) are used to convert the environmental impact into a single ECI or EPB figure. This is how the price of €0.50 per kilogram of CO2 equivalent is charged for CO2. But because such weighting factors are becoming outdated, updated weighting factors based on new scientific insights will be investigated in 2022. This update is likely to have an increasing effect on ECI and EPB, which could incentivize the more sustainable use of materials.

- Because ECI and EPB provide a static picture when tendering for a contract, consider them as potential measurements based on given preconditions. After awarding the tender, always explore other possibilities of reducing their values further. During contract management, aim to accomplish the minimum values presented.

Coherence among the ECI, EPB, and circularity

The ECI and EPB indicate the direct environmental impact of a project upon its completion, but a “discount” on the environmental impact (found in Module D of the ECI and EPB calculations) can be applied when materials can be reused in the future. Other circular objectives, such as the use of recycled materials or the detachability of a building and its components at their end of life, are not included in quantitative ECI or EPB calculations. It may therefore be necessary to also focus on qualitative circular aspects along with the emphasis on a low environmental impact.

Another possibility is that a circular solution can have a higher environmental impact once implemented, by choosing a product of higher quality but with a longer life, for example. Therefore, allow for how these considerations affect each other within a project, for example, by requesting a substantiation of the EPB or by setting additional requirements and/or criteria for circularity.

Case study 1

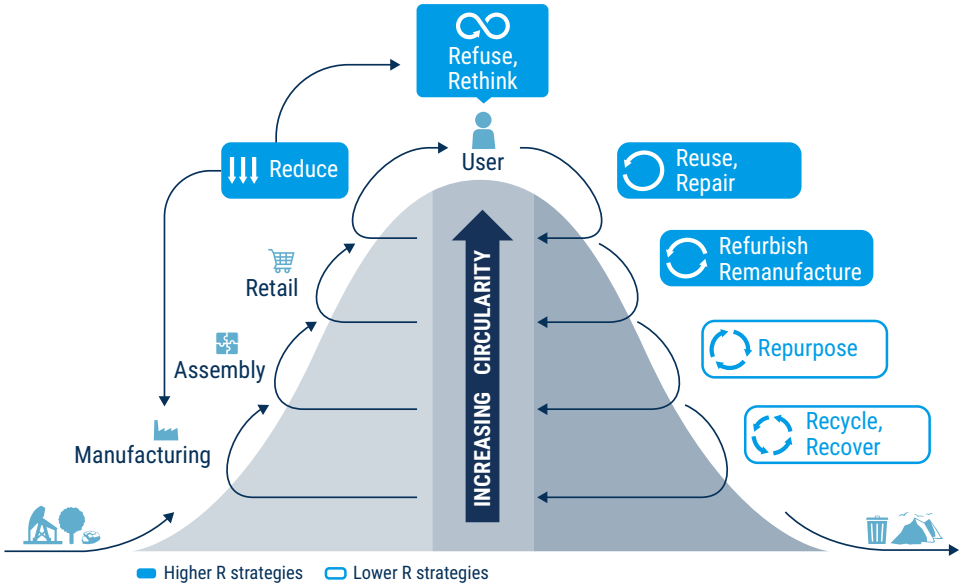
Circl

Circl is the circular pavilion of ABN AMRO bank. However, the first designs were traditional, featuring a concrete structure and a lot of stone and marble. When more circular objectives arose during the process, a new, circular design was implemented on top of the concrete basement already poured.

These circular objectives minimized the use of new materials and led to a design featuring maximum detachability, so the materials and components used can be reused at the end of life. This has led to the following choices toward reducing environmental impact:

- According to the "Reduce" principle of the "10 Rs" model, much was left out when designing the interior; there are no ceilings, and the pipework is visible. The concrete basement, which had already been laid before the decision to build a circular pavilion, has no flooring other than the finished concrete. Many parts of Circl had a past life. For example, the floors consist of recycled wood with used pavement tiles as dampening material, and the window frames are made of recycled material. Other raw materials can be reused in the future, from wood used in the structure to the aluminium in wall panels.

Figure 2: Adapted from 'Circle Economy - Master Circular Business with the Value Hill (2016).[3]



- Circl has low-impact materials, such as a wooden structure instead of the traditional concrete. This is because the production of concrete releases a relatively large amount of CO2 and it is not easy to reuse.

- The project applied detachability principles, such as screwing together beams made of larch wood. Those beams are even slightly longer than was necessary in order to facilitate reuse; only the part where the beams are screwed together need to be sawn off to make reuse possible.

Case study 2

Port of Amsterdam cycle path

The Port of Amsterdam's objective was to create a sustainable bicycle path with the lowest possible environmental impact. The tender included a strong emphasis on the lowest possible ECI. Schagen Infra implemented this by applying a few practical principles to both the use of materials and the design of the cycle path.

The design is based on circular principles:

- The cycle path consists of monolithic concrete that, where necessary, can be sawn into modular blocks. When the path needs to be dug up, the cut concrete block can be removed, put back, and secured again.

The use of material is also partly circular:

- The coarse aggregate, which normally consists of gravel, has been completely replaced by recycled concrete granulate. In addition to this coarse portion of the concrete mixture, 70% of the cement has been replaced by recycled cement, which consists of granulated blast furnace slag.
- Conventional iron ore pigment was replaced by natural iron oxide-based pigment, directly extracted from nature instead of being created in an energy-intensive production process. The same applies to the road markings.
- The reinforcement is partially comprised of synthetic fibres. The choice allowed for omitting steel reinforcement, which has a high ECI. The fibre reinforcement makes it possible to reduce overall thickness and easier transport of the modular elements.
- The dimensions of the structure are as slim as possible, to minimize the use of primary raw materials. At the end of life, this material is also 100% recyclable.

Another positive contribution is the promotion of biodiversity in this project. For example, "insect hotels" were installed during construction and the adjacent banks are nature-friendly by design, making them more accessible to amphibians and bank vegetation.

More Information

These publications offer additional background on reducing the environmental impact of building materials:

- **EPB procurement guide (NMD Foundation): a guide providing in-depth background information and a step-by-step plan to effectively manage the EPB**
- **Circular Innovations in civil and hydraulic engineering (NIBE): a document containing 11 innovations that can significantly reduce the environmental impact and primary material consumption in civil and hydraulic engineering**
- **Guide to Climate Neutral and Circular Procurement Asphalt and Concrete (Amsterdam Metropolitan Area): a guide providing information about concrete and asphalt and a step-by-step plan for EPB-based purchasing**

Footnotes

1 https://puc.overheid.nl/rijkswaterstaat/doc/PUC_160745_31/ .Pagina 29-31

2 https://milieudatabase.nl/gevolgen-van-de-gewijzigde-en-15804-voor-de-bepalingsmethode-milieuprestatie/

3 https://ecochain.com/nl/knowledge-nl/levenscyclusanalyse-life-cycle-assessment-lca-complete-beginners-guide/