

# THE STACK

A  
VERTICAL  
CIRCULAR  
INDUSTRIAL  
BUILDING  
FOR THE  
MANUFACTURING  
ECONOMY

# 01 A vertical circular industrial building for the manufacturing economy

## SCARCITY

The demand for space for business and industry continues to grow in Flanders. At the same time, we face the challenge of not breaking new ground in open space. At present, 15.4 per cent of the territory of Flanders is either built up or paved. This is the source of many problems: increased risk of flooding, lowered groundwater table and loss of ecosystems. A stacked industrial building can provide an answer to this structural shortage of space. If we succeed in stacking a business park vertically, we will have to encroach on less open space, we will pave less, and we will create opportunities for landscape development, biodiversity and robust water systems.

Not only space, but other 'raw materials' such as water, building materials, metals and energy are becoming increasingly scarce and increasingly costly. To address this scarcity, we drew on the principles of circularity. The circular economy aims to keep everything of value valuable. There is no such thing as waste any more, only (new) raw materials. That is why, in the design of The Stack (in Dutch, De Stapel), we used reusable, renewable and recyclable materials as much as possible.

## PILOT PROJECT

How can you vertically organize a business park? In the Interreg project Circ-NSR, the Intermunicipal Association Leiedal and its partners are looking for concrete answers. The 'transdisciplinary' design research – encompassing a broad team of architects, engineers, lawyers, entrepreneurs, policymakers, developers and academics – is putting forward the design of The Stack on the Evolis business park in Kortrijk as a concrete case that can be tested in terms of architecture, use of materials, energy concept, water management, fire safety, financing and so on. With



this thought exercise, we want to expose the difficulties and opportunities of stacked and circular industry. Realizing The Stack in its current form and at its current location may be a little too optimistic today, but we still believe that the design of The Stack can inspire stacked industrial buildings in the near future, whether in Kortrijk or elsewhere in Flanders.

## WHO IS THE STACK FOR?

The task is to come up with a circular and stacked industrial building for the manufacturing industry. The Stack focuses mainly on medium-sized (> 500 m<sup>2</sup>) and small enterprises (< 300 m<sup>2</sup>). Large industries (> 2,000 m<sup>2</sup>) are more cautious on account of technical requirements; we consider them to a lesser extent to be the target audience for The Stack. As The Stack wishes to set an example in the transition to circular construction and the circular economy, it mainly targets the environmentally friendly, future-oriented and circular manufacturing economy.

# 02 Transition to a circular building culture

The construction sector plays a role in climate change that is not to be underestimated. It is responsible for more than a third of waste, pollution and raw material consumption in Europe. Buildings are moreover responsible for 25 per cent of greenhouse emissions and 40 per cent of energy consumption in Europe. The construction sector is the most polluting sector and so reforming it will have a significant ecological impact. The transition to a circular economy requires fundamentally rethinking a deeply established building culture. A broad collection of habits, standards and norms must, across construction professions and sub-sectors, evolve or be broken through.

## WHAT IS CIRCULAR CONSTRUCTION?

### › Non-building and repurposing

First, we should strive to avoid new construction. From a circular viewpoint, non-building and renovation are better than new construction. A regional analysis should lead to a better matching of demand (current and future business needs) and supply (vacant industrial premises). As a new construction project, The Stack obviously does not score well in terms of non-building. On the other hand, as a stacked business it occupies a smaller part of valuable open space.

### › Conscious choice of materials

Sustainable building materials are materials whose extraction, production and end-of-life cycle cause as little harm as possible to the environment and climate. So give preference – in that order – to reused or reusable components and materials, renewable or biodegradable materials, and finally recycled or recyclable materials.

› **Wood where possible, concrete or steel where necessary**

Concrete, steel and wood are the three main building materials for the load-bearing structure of a building. In stacked industrial buildings, concrete and steel are difficult to avoid, as they offer the ability to create large spans and carry heavy loads. A major drawback is their ecological impact. The production of cement and steel releases a lot of greenhouse gases. In addition, once poured, concrete is difficult to recycle. Steel, however, is better suited for recycling as bolted joints are used. The big advantage of wood is its favourable carbon footprint. Wood is a renewable resource and even has negative carbon dioxide emissions, since using wood in a building is a form of carbon storage. On the other hand, wood is a relatively soft material that does not tolerate high loads and large spans. Wood is also highly sensitive to fire. Wood therefore seems a less appropriate material for the realization of a stacked building for manufacturing activities. Nevertheless, it can be of use in places where loads are considerably less important, such as in roof structures, mezzanine floors and office volumes.

› **Building an intelligent ruin**

To limit the long-term climate impact of a stacked industrial building, it is important that the built structure (usually in steel and concrete) can last for a long time and is adaptable to different situations, including those that might not be conceivable today. A rational structure, with maximum spans and large clear heights, is preferred. The structure of the building is best designed as an ‘intelligent ruin’: it defies the centuries and can systematically be given new uses. The building shell of the structure, the furnishings, the interior and the techniques thus become the temporary features of a less temporary support.

› **Building in layers**

The different ‘layers’ of a building – structure, façade, indoor work, techniques – each have different lifespans and therefore different maintenance, renovation and replacement cycles. Circular construction involves separating the building layers in the design to allow for easy maintenance, renovation, replacement and repurposing in the future.

› **Dismountable construction**

Reversible or dismountable construction means that the connections between materials and components can be undone. As a result, renovation cycles involve less demolition and more dismounting. Components are made available again for other projects. Among other things, this means maximum use of dry connections. Dismountable construction supports layered construction.

› **A building is a materials bank**

A building whose various parts and components can easily be dismantled and reused can be regarded as a materials bank. Unlike in a linear building process (where materials end their life as waste after demolition), the materials retain their market value. A prerequisite for the later ‘harvesting’ of materials and components is that the various materials and individual components are mapped in detail in a materials passport and preserved sustainably for future generations.

› **New business models**

In recent years, a number of new business models have emerged that respond to the task of circular construction. Some manufacturers of building materials are betting on take-back programmes: at the end of the life cycle of the building or building component, the manufacturer takes back the materials or components to put them back on the market or to recycle them. Other manufacturers are making the shift from the sale of a product to the provision of a service (as-a-service). Examples in use today include lighting, vertical circulation (lift) and daylight.

› **Sharing spaces and services**

The different businesses that set up shop in a stacked industrial building can share a number of spaces. Think of the reception area, the cafeteria, meeting rooms, showrooms, storage areas, and so on. Sharing spaces is a very simple way to build less, use fewer materials and take up less land.

### › Linking flows and closing cycles

The inputs and outputs of businesses can be linked, both within the stacked industrial building and in the wider urban environment. One company's waste or residual heat can serve as a raw material or energy source for another company, or even, by extension, for the surrounding neighbourhood. If we manage to coordinate the various flows of energy, heat, water, materials and raw materials and close them as much as possible, we can create an 'urban metabolism', so to speak, in which as little energy and as few raw materials as possible get lost.

## 03 The Stack

### CAMPUS MODEL

The vertical circular industrial building The Stack is located on the sustainable business park Evolis in Kortrijk. The site is close to the E17 motorway at the Kortrijk-Oost exit. Various cycle routes connect the area with the surroundings. As much space as possible has been freed up for nature and water on the business park. Four wind turbines provide green electricity. The Stack was designed as a campus model. Five different typologies are arranged side by side in a publicly accessible park. The five sub-buildings each have their own system, structure and division so as to accommodate the widest possible range of businesses. Thanks to its principled architecture, The Stack is a showcase for the businesses that set up shop there. The beating heart of the city gains in visibility.

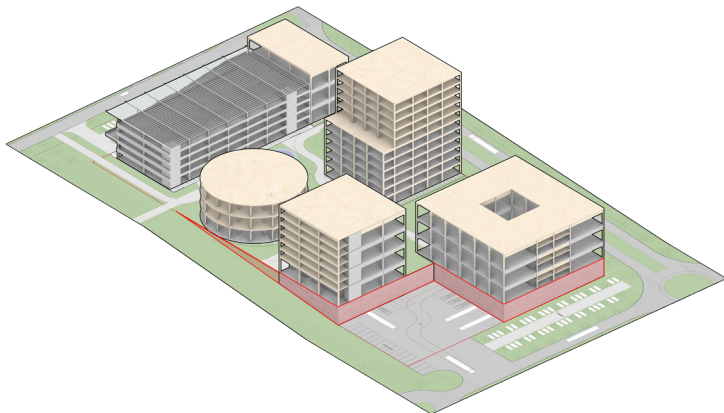


The Stack encourages the sharing of spaces, programmes and services. Shared spaces include catering facilities, leisure and sports facilities, and showrooms. Logistics and storage areas can also be shared where possible. The Stack also offers numerous services – think of logistics tasks, a shared technician, IT service or waste collection – so that staff can fully concentrate on their core activities. Besides services, group purchases of raw materials or machinery, for example, can also be considered in order to reduce costs.



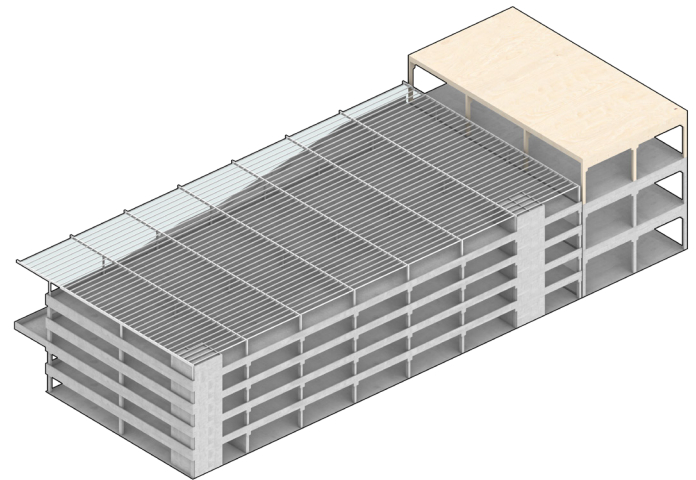
## PUBLIC PARK AND LOGISTICS PLINTH

The design proposal makes clever use of the height difference on the site by creating two separate zones at different heights: the raised ground level and the logistics court. The raised ground level is a safe, green zone between the buildings. It is designed as the public park of the campus, with space for water infiltration, water treatment, sports infrastructure and leisure. The logistics court to the south of the site provides the gates and loading platforms of the logistics plinth, which is located below the raised ground level and which connects to the Mast, Automaton and Stack House. Thanks to this intervention, the raised ground level between the buildings remains free of motorized traffic.



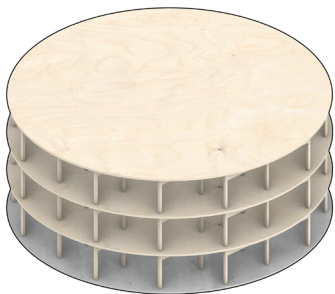
## TRANSPORT HUB

The Transport Hub is a hybrid building consisting of two different structures: a parking building and stacked SME units (SME: small to medium-sized enterprise). The parking building is conceived as a bare, dismantlable concrete structure. The substantial floor heights allow the building to be repurposed as offices or studios in the future. The stacked SME units (ranging in size from 250 to 750 m<sup>2</sup>) are placed next to the parking building as a quasi-independent structure and are all accessible, via the ramp of the parking building, by small van. A goods lift is provided next to the ramp, ensuring the vertical transport of goods delivered by a heavier truck. The Transport Hub is also an 'energy hub'. Solar panels on the roof and façades generate renewable energy. Electrification of the vehicle fleet will allow the building to act as a battery for The Stack in the future.



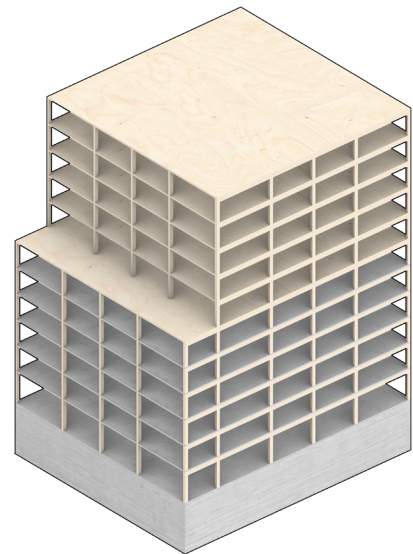
## KIOSK

The Kiosk is an atypical building on the site because no production takes place there. Instead, it provides catering, entertainment and a showroom. Because of the relatively light loads, the Kiosk can be constructed almost entirely out of wood. The building owes its name to its round design, which has a connecting and appealing effect within the green campus. The Kiosk is a public building where staff, clients and visitors meet. Companies can display their products in the spacious showroom on the first floor.



## MAST

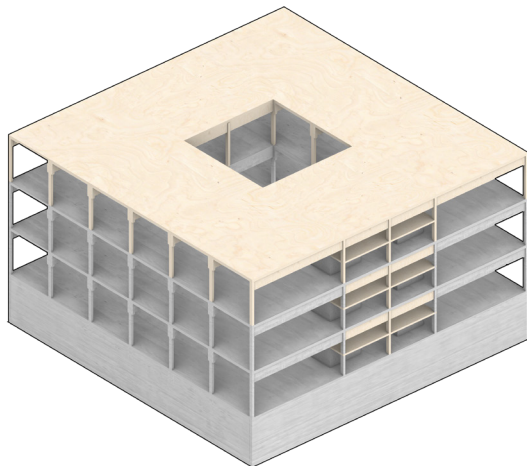
With its eleven storeys, the Mast towers high above the other buildings on the campus. The building combines offices with workshops for light craft production and prototyping. The Mast provides an answer to the growing demand for spaces where activities can take place that are rather artisanal in nature and that cannot really take place within an office environment (think of companies that use machines such as laser cutters or 3D printers), but also do not need large and heavy structures. Due to the limited floor load, the high-rise is mainly constructed of wood and CLT. Only the central core is made of concrete. That core houses six lifts, four of which are small goods lifts with a load capacity of 2,000 kg. Besides offices and studios, the Mast is home to showrooms on the ground floor and a cafeteria with a large city balcony on the fifth floor. The building is designed in such a way that it can be repurposed as housing in the future.





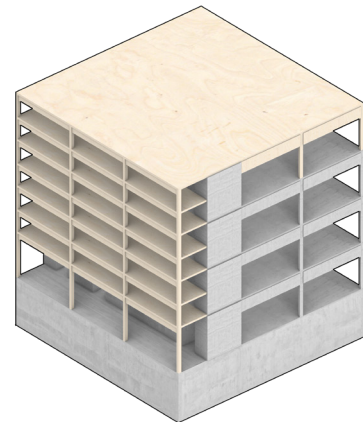
## AUTOMATON

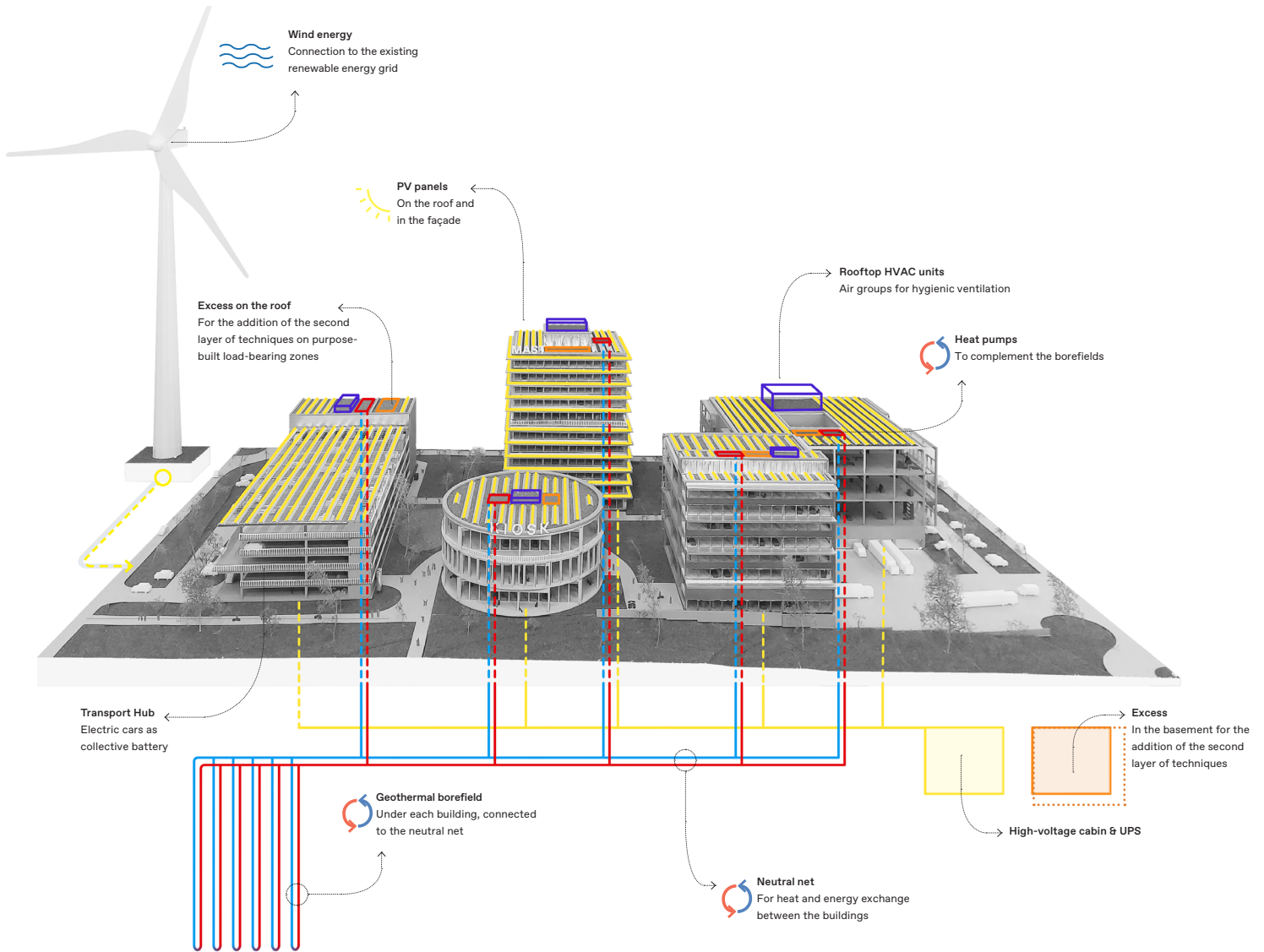
The Automaton is a flexible and hybrid structure that can accommodate one large company on the ground floor and smaller SMEs on the upper floors. The building gets its name from its centrally located, automated storage system. It consists of self-driven pallet shuttles that transport pallets within a large rack structure. It is a fully automated 3D grid with unloading and loading points on the storeys adjacent to the production halls. In addition to this system, two large goods lifts (with a cabin size of  $3 \times 6$  m and a lifting capacity of 5,000 kg) are also provided to transport long goods and 'ugly' goods. The Automaton is a building with medium-sized units and floors capable of supporting heavy loads. The 18 m span from core to façade gives ample space for the placement of machines and robots. The top floor is constructed entirely of wood. Future repurposing into offices is possible by deduplicating the floors and removing the storage system, creating a void that brings daylight deep into the centre of the building.



## STACK HOUSE

Large enterprises are sometimes less inclined to set up shop in a mixed-use, stacked building due to their inherent business culture. The nature of the activities also often makes it difficult to realize them in a stacked manner. The Stack House aims to provide an answer to this: it is a production building in which one large enterprise is stacked over several floors. The building combines a concrete structure (the production floor) with four double-height storeys and a timber structure (the office floors) with a functional strip in-between containing all vertical circulation, service areas and shafts. Vertical circulation is ensured by two large goods lifts with a cabin size of  $3 \times 6$  m and a load capacity of up to 5,000 kg. In addition, the design provides for a storage lift that stores and transports small goods and tools across the floors. Thanks to the clever placement of the core, the flows of goods and people are separated, ensuring safety.





## **ENERGY EXCHANGE**

A building for manufacturing activities usually consumes a lot of energy, not only for heating or cooling the large volumes but also and especially for the production processes. The energy needs vary greatly from company to company. Some industry sectors need more energy than others. Some companies require heating while others require cooling. To meet the as yet unknown energy demands, we propose a solution that provides two layers. The first layer meets the basic needs of the 'average' company and provides comfort cooling and heating, electricity for normal use and hygienic ventilation. The first layer is permanently provided in the building and is part of the shared infrastructure. The second layer is a modular layer that can respond to specific process demands, e.g. compressors for compressed air, a hydrogen boiler for the production of high water temperatures or the cooling of a data centre. The second layer is not a strictly separate system, but rather an extension that communicates with the first layer. To allow maximum use of residual flows within The Stack, the buildings are connected by a heat and smart grid that allows the exchange of heat and energy.

## **PRODUCTION OF RENEWABLE ENERGY**

The Stack is fully committed to the production of renewable energy. This is generated locally (solar panels on roofs and façades, heat pumps) or comes from a connection to regional systems (adjacent wind turbines, heat networks). Basic heating is provided in The Stack by individual geothermal borefields established under each building and which are interconnected and supplemented by air-water heat pumps.

## **WATER TREATMENT**

The water consumed in The Stack will be purified and reused on site as much as possible. We have opted for a helophyte or marsh filter in combination with a wastewater pretreatment system based on the principle of coagulation/flocculation. This process consumes little energy and requires little maintenance.

## **FIRE SAFETY**

Fire safety is a thorny issue when it comes to stacked industrial buildings. On top of that, the end users of The Stack are not yet known. To maintain the long-term flexibility of The Stack, the building meets the strictest fire standards (Class C). We opted for a building with an ESFR sprinkler system (designed to actively fight fire rather than control a fire). This eliminates the obligation to install a Smoke and Heat Extraction (SHE) system so that bulky shafts throughout the building are avoided.

# 04 Circular finance

## STACKED AND CIRCULAR CONSTRUCTION IS MORE EXPENSIVE

The building cost of The Stack – estimated in 2023 at around €100 million for a surface area of 60,000 m<sup>2</sup> (€1700/m<sup>2</sup>) – is substantially higher than that of a classic industrial warehouse (around €950/m<sup>2</sup>). There are three reasons for the higher construction cost. First, stacked construction for the manufacturing industry needs heavier foundations, lifts and circulation spaces. Second, the carbon dioxide emissions of building materials and the local impact of the building on the environment are not considered when building a conventional warehouse. Third, a classic industrial hall pays less attention to architecture and human well-being. On the other hand, a stacked industrial building takes up less land. Although land prices for industrial plots have risen sharply in recent years, they need to triple to become a major trigger for stacked construction. Today, this means that stacked industry needs to be promoted by means of regulation or government participation.

## LIFE CYCLE COSTING

The duration of projects should be rethought: not only the initial construction process, but also the further life cycle of the building should be taken into account. By introducing material passports and using circular building materials, the value of a building and its components can be retained for longer instead of being depreciated degressively. The building retains some value during renovation cycles and end-of-life cycles. Life Cycle Costing calculates the cost of a building over a longer period than the initial construction cost. Besides design and construction, maintenance and renovation cycles are also included in the costing. Here lies an important key to ‘circular financing’: an initially more expensive solution can be the cheaper solution in the long run.

## BANKABILITY

Our research shows that the bankability of a circular project is currently still one of the major stumbling blocks. At present, banks are rather reluctant to include the residual value of building materials or the Life Cycle Cost in funding the building. For banks, the most important criterion is repayment capacity. Nevertheless, with the introduction of the concept of ESG risk, this can be expected to take hold in the future. ESG stands for Environmental, Social & Governance, and means that factors such as energy consumption, climate, resource availability, health, safety and good corporate governance are taken into account when financing investments.

## NEW EUROPEAN LEGISLATION

The circular economy is one of the pillars of the European Green Deal. New European legislation is being developed that will direct companies and authorities to build in a more circular manner and that will only allow financial institutions to provide financing if the European Sustainable Goals are met. There is also the phasing out of the steel, concrete and brick sector’s exemption regime in the ETS (Emissions Trading System), and the European Commission is working on the introduction of the Green Taxonomy in 2023, which will impose reuse obligations on building materials.

## PUBLIC-PRIVATE PARTNERSHIP

The intention is to realize The Stack through a public-private partnership (PPP), in which a local authority (in this case, Leiedal) seeks out a party to build and/or operate The Stack as part of a public contract. The local government can use its landholding to impose certain requirements on the market, for example in terms of stacked and circular construction or the nature of businesses for who The Stack is intended. The local government can either sell its land (e.g. for a symbolic euro) or contribute the land in the form of a long lease or building right. Research shows that a building right is the simplest and most appropriate method. The law on public procurement explicitly provides

for the possibility of integrating environmental, social and economic criteria into the specifications. Things like the life-cycle cost approach and the cost of maintenance, energy and water consumption can be included as criteria.

## MANAGEMENT MODEL

There are several options for the management model. First, the building can be divided into lots, creating a co-ownership of a multi-tenant business building. The various owners of the multi-tenant business building are given autonomous decision-making rights over their own plot, but in addition, there are also the common parts for which an administrator is appointed. Second, the building owners can come together in a Special Purpose Vehicle (SPV): either a private limited company or a cooperative company, in which they house the building. In an SPV, the shareholders are not only owners but also users and tenants of the project development. A shareholders' agreement mutually regulates the arrangements and use of the various spaces. Thirdly, it is also possible for the various companies to rent from a real estate company. Rental also requires management, for example by a business park manager. Belgian business law was recently overhauled. One of the new legal instruments, which gives stacked and circular building perspectives, is the concept of volume ownership.



# Circ-NSR

Circ-NSR is a transnational cooperation project that is part of the Interreg VB North Sea programme. The aim of Circ-NSR is to promote the circular economy in the North Sea region through the following initiatives:

- › Developing and embedding circular strategies in local policies.
- › Building regional and interregional partnerships in terms of circular economy.
- › Realizing pilot projects.
- › Developing a toolbox aimed at strengthening the management of circular economy projects.

The Stack is one of eight pilot projects within Circ-NSR. Since 2022, the Intermunicipal Association Leiedal has been the Circ-NSR project leader.

[www.northsearegion.eu/circ-nsr](http://www.northsearegion.eu/circ-nsr)

# Colophon

## INITIATOR/CLIENT

Intermunicipal Association Leiedal

## TRANSDISCIPLINARY DESIGN TEAM

Trans Architectuur | Stedenbouw

Fallow

BC Architects and Studies

Arcadis

Rasschaert Advocaten

Connect

## EDITOR

Joeri De Bruyn, Public Space

## TRANSLATION FROM DUTCH

Patrick Lennon

## DESIGN

doublebill.design

## RESPONSIBLE PUBLISHER

Intermunicipal Association Leiedal

President Kennedypark 10, 8500 Kortrijk

[www.leiedal.be](http://www.leiedal.be)

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The comprehensive study report on The Stack is available at [www.leiedal.be/destapel](http://www.leiedal.be/destapel)

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