CIRCULAR
DESIGN
ATLAS

REPUBLICA AMSTERDAM

Architect(s):
Marc Koehler Architects

Year:
2023

Location:
Amsterdam, Netherlands

More info:
https://marckoehler.com/project/republica/

Scales:
Buildings, Neighbourhoods

Resources:
Reclaimed Materials, Water, Energy

Design Approaches:
Design for Adaptability

R-Strategies:
Reuse

Aspects:
Design, Resource Flows, Technology, Management, Economy, Stakeholders

TU Delft
BK Bouwkunde

Credits | Design: Marc Koehler Architects | Photo: Sebastian van Damme, Maikel Samuels

A “city in the city” is how Marc Koehler Architects describes their transformation in the site in Buiksloterham, a former industrial area in Amsterdam North.
The Republica project focuses on a circular economy within a mixed-use district consisting of an ensemble of six volumes. The complex has state-of-the-art recycling and utilizes sustainable energy. Each building is distinguished by a characteristic material that reflects the industrial past and the rawness of the environment. Also, the circular materials, such as timber, recycled concrete, and reclaimed bricks were chosen.
This Circular Design Atlas will focus on the Small Girl building, the building that sits by the main entrance to the complex on Papaverweg. Yet, because the overall strategy of the complex closely links six buildings together, sections like ‘The NEW Nexus’ and ‘Stakeholders & Value Chain’ will discuss the overall complex.

Layers of Change and Lifecycle Duration

Site:
While a site in itself is eternal, steps can be taken to improve the overall safety and well-being of those who inhabit it. In the case of Republica, 17000 m^3 of contaminated soil were removed from the area of former heavy industry, reclaiming it for civic use.

Skin:
Reclaimed Brick
Brick as a material has the potential to last centuries depending on its quality, the maintenance it receives, and the materials used for the connection. In the case of reclaimed bricks, the former duration of use has to be subtracted from the total lifespan. The 1850s bricks delivered from Belgium and reused for the facade consequently would have a shorter life span than a new product.

Structure:
Reinforced Concrete
While some older types of reinforced concrete have a lifespan of over a hundred years, the estimate for modern reinforced concrete is about 80 years. This is below the life expectancy of more traditional structural materials such as brick and timber.

Services:
Ground-coupled Heat Exchanger
Heat pumps generally do well in terms of life expectancy in comparison to other heating systems. Ground source heat pumps have a longer lifespan than most combustion-based heating systems.
A carefully maintained system of quality can last up to 50 years. The ground heat exchanger element of the heat pump even has a life expectancy of over 100 years.

Space plan:
Dry Wall
While the plan is conceived as open-plan, the tenants (e.g. cafe, office) might opt for interior walls afterward. Dry wall is the most common type of interior wall, with a lifespan of 50 years.

Stuff:
Wooden Furniture in the Cafe
The approximate lifespan of wooden interiors in the hospitality sector is about 15 years, depending on the quality.

Conclusion:
The biggest discrepancy lies between the potential lifespan of the skin and the structure. The structure layer is crucial in determining the overall building lifespan. The use of reinforced concrete for the structure layer limits the potential longer use of other layers, such as bricks for the skin and heat pump for the services.

Site
Eternal

Photo: Marc Koehler Architects

Skin
ca. 100 years

Photo: Marc Koehler Architects

Structure
80 years

Photo: Vinkbouw.nl

Services
50 years

Photo: J S Wright M&E Services

Space plan
50 years

Photo: VPales / Shutterstock

Stuff
15 years

Photo: Ninkipen

Carbon Footprint of Materials

The facade of the Small Girl building is distinguished by a combination of two materials of contrasting texture and color. A wide horizontal band made of brick is strategically designed to conceal the connection between the two. In order to have an representative analysis of the overall facade, the chosen scope of 1m^3 intentionally includes both materials.

Reclaimed Bricks
The use of reclaimed bricks was an environmentally conscious choice, as it does not produce extra carbon footprint that comes with producing new materials for a new construction. Also, instead of sourcing identical types of bricks, the architect embraced various types that are readily available in the market, which in the end added to Small Girl's strong materialistic identity.

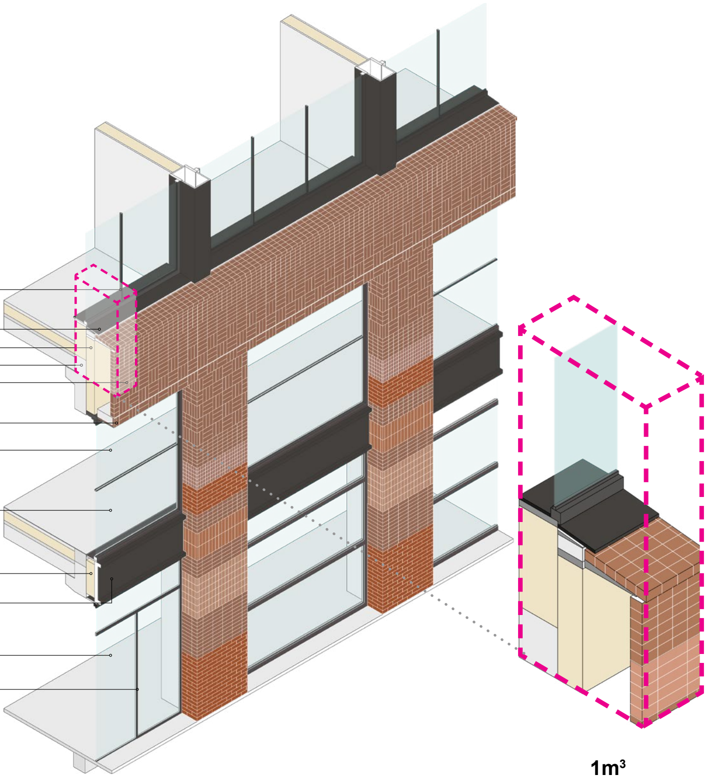
Glass Wool
Behind the brick band, there is 350mm of airspace and glass wool insulation board, which is considered to be more sustainable alternative - this will be discussed in more details in the 'R-strategies' section.

Black Bamboo
The family hotel volume sitting on top of the brick volume has a black bamboo cladding. Black bamboo is a species native to Taiwan and China - no extra process is needed to achieve its unique color. Products made of bamboo have a low carbon footprint of 14.89 kg/m^3 and are considered environmentally friendly.

Aluminum
The waterproof sill plate and window frame are made out of aluminum. The window frames are powder coated to prevent rusting, which will be beneficial in terms of future maintenance. Also, powder coating systems were proven to be a coating system with a relatively low carbon footprint.

Double Glazed Glass
Glass production is known to have a high carbon footprint. However, compared to single-glazed windows, double-glazed windows can efficiently reduce heat loss or gain by up to 30%.

Since the outermost skin of the facade is the only layer visible from the outside, it may disguise the system behind it. In this case, although reclaimed bricks seem to be the most prominent material, the volume does not account for the largest percentage. Thus, in order to counteract waste and reduce the carbon footprint of the whole project, we should also commit to materials 'hidden' in the facade as well.



FACADE MATERIALS CARBON FOOTPRINT

	m^3	kg CO2 eq
glass pane (double-glazed)	0.023	6.12
aluminum window frame	0.024	28.14
aluminum plate	0.004	112.97
glass wool insulation	0.143	15.75
aerated concrete	0.040	7.2
reclaimed brick	0.043	0

209.55 kg CO2 eq / $1m^3$

Credits | Design: Marc Koehler Architects | Diagram: Eun Bin Boo

Building Material Origin

When considering a material's sustainability, not only transport routes but also potential supply risks have to be taken into account. Especially, “critical” materials have limited resources, thus their use should be avoided if possible.

The origins of the materials from the chosen 1m³ facade were based on approximation and predominant mining locations.

Credits | Map: https://geoawesomeness.com/best-map-p

Technical Materials

1. Iron
Origin: China/Brazil/Australia
Use: Re-bar for Reinforced Concrete

2. Sand
Origin: Netherlands
Use: Concrete, Mortar, Glass

3. Oil
Origin: Russia/Middle East/USA
Use: Waterproofing Layers

4. Cement
Origin: China/USA/Indonesia
Use: Mortar

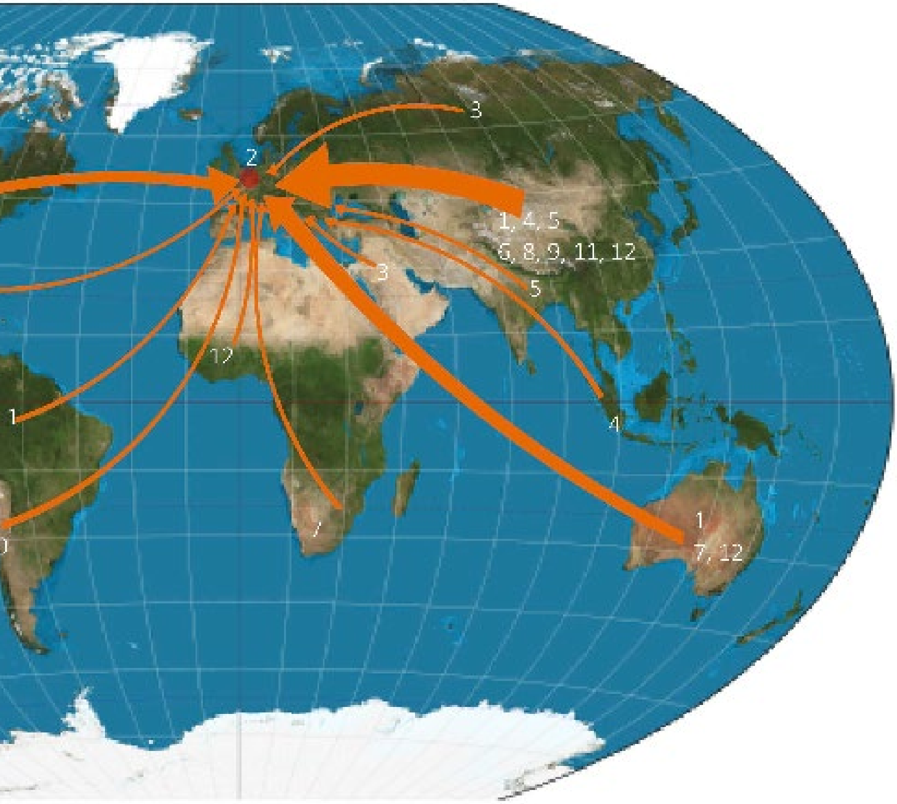
5. Lime
Origin: China/USA/India
Use: Mortar

Critical Materials

6. Magnesium
Origin: China
Use: Aluminum Alloy (window frame)

7. Manganese
Origin: South Africa, Australia
Use: Aluminum Alloy (window frame)

8. Fluorspar
Origin: China, Mexico
Use: Steel and Mortar production



projection | Graphic: Leonie Straub

9. Silicon metal
Origin: China
Use: Aluminum Alloy (window frame)

10. Copper
Origin: Chile
Use: Aluminum Alloy (window frame)

11. Graphite
Origin: China, Mexico, Canada
Use: Heating Component in Steel Production

12. Bauxite
Origin: Australia, Guinea, China
Use: Aluminum Alloy (window frame)

R-Strategies

R-strategies often focus on ensuring a future life for various building elements. The circular values of Republica lie more within its reuse of materials as demonstrated with reclaimed brick in the Small Girl building or recycled concrete in the Skinny Lad building.
Concerning the facade fragments of Small Girl and its different materials, the following R-strategies could be identified:

SMARTER USE & MANUFACTURING

Reduce:
Glass Wool Insulation
Reclaimed Brick

The architects use reclaimed bricks instead of a new product for the facade, choosing low-energy production (only assembly).
For the facade insulation, glass wool was used. Glass wool is an alternative to insulation made from fossil resources. It is nonflammable and waterproof, which provides very good heat insulation that puts it above biological materials. It is made from glass waste and its production is low on energy consumption.
Unfortunately, glass wool cannot be recycled and will be disposed to a landfill, placing it at the end of the product lifecycle.

EXTENDING LIFESPAN OF PRODUCT AND ITS PARTS:

Remanufacture or Repurpose:
Reclaimed brick

While the wet-fixing of the bricks makes their extraction more difficult, the reclaimed bricks that are being used for this project were already claimed from wet-fixed structures before, making a third or fourth return of the bricks as facade elements plausible.

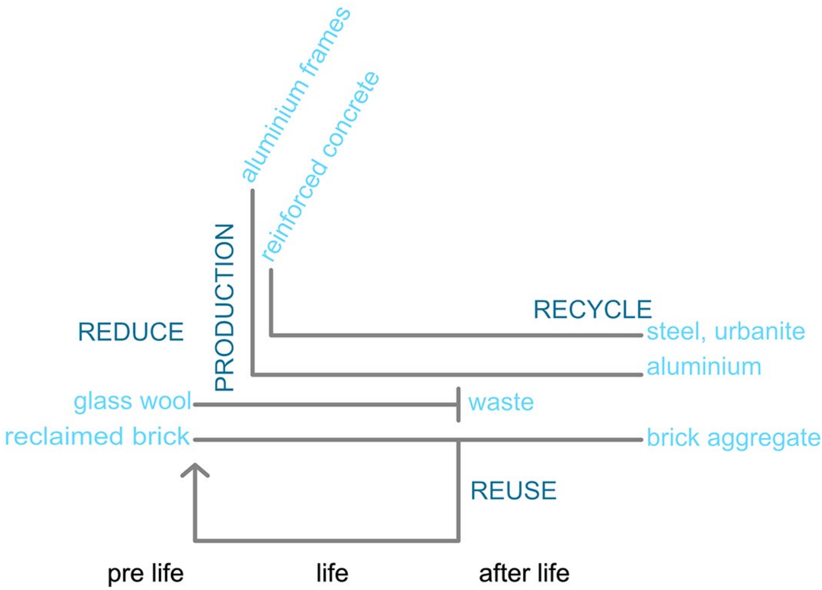
END OF LIFE SCENARIO:

Recycle:
Reclaimed Brick
Reinforced Concrete
Aluminum Window Frame

Bricks have a long lifespan, but even after they are worn down, they can be ground up and re-enter the cycle as a base for new bricks or as aggregate for roads and pathways.
While energy intensive, recycling reinforced concrete is possible. The extracted rebar can be recycled and the concrete rubble can serve as a base for recycled concrete, urbanite.
Auminium may be quite energy-intensive in production and not the best choice in terms of heat conduction in a window frame, but it is almost 100% recyclable. The recycling process itself takes approximately 5% of the original energy needed for production.

Room for improvement:

For the improvement of the elements already present in the facade, the following might be suggested:
In terms of repairing, dry-fixing the facade bricks might facilitate easier maintenance and replacement of singular damaged bricks, while allowing easier access to underlying elements in the facade.

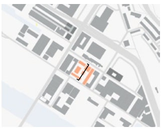


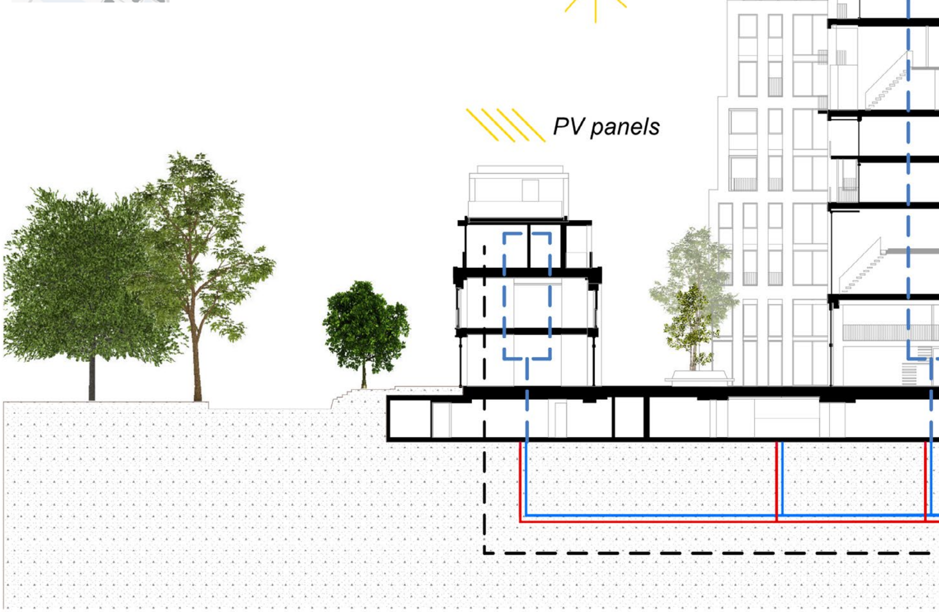
Credits | Diagram: Leonie Straub

The NEW Nexus

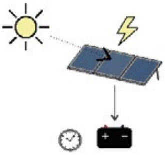
Republica responds to the NEW nexus mostly on the level of energy generation, as an energy self-sufficient complex.

A ground-coupled heat exchanger pulls energy from the groundwater and PV panels generate solar energy - both are stored in the district battery and shared via a smart grid to ensure the best possible distribution. Peak shaving optimizes this process. Additionally, winter gardens along the facade enable passive climate control.
In terms of nutrients, a biorefinery turns the apartment's and hospitality facilities' food waste and wastewater into biogas.
Additional water components are represented by the use of grey water and water retention system in the shape of infiltration crates, sedum roofs, and plentiful greenery across the complex.





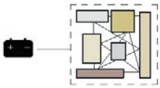
Credits | Design: Marc Koehler Architects | Drawing: Leonie Straub



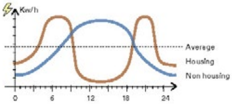
solar energy

water retention

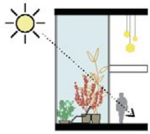
ground-coupled heat exchanger



smart grid



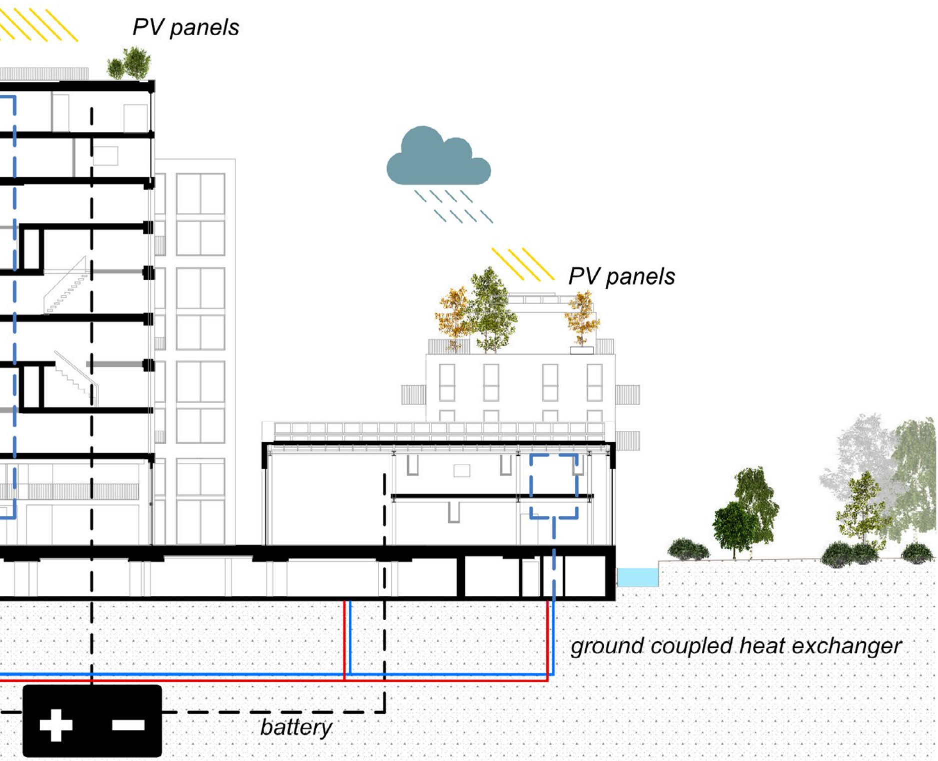
peak shaving



passive heating

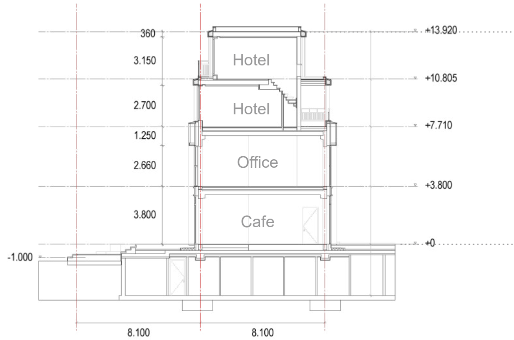
grey water reuse

Credits | Pictograms: Marc Koehler Architects

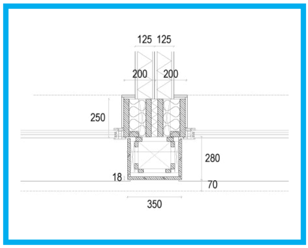


Design Approaches

As discussed in the 'Carbon Footprint of Materials' section, Small Girl is comprised of two volumes on top of one another, visibly distinguishable by the skin layer material. The reclaimed brick volume will be rented out as a cafe on the G/F and an office on the 1/F, while the black bamboo volume houses a two-storey family hotel. Here, different approaches in the structure layer adopted for each volume enable interior space planning strategies according to the program.

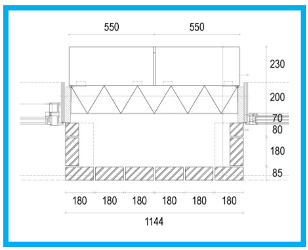


Reclaimed Brick Volume
The structural system of the first two floors consists of a prefab concrete column and a transversal beam structure, which frees up the interior space. This is beneficial for adaptability in the future - the occupants will have the freedom to define the internal layout with furniture.



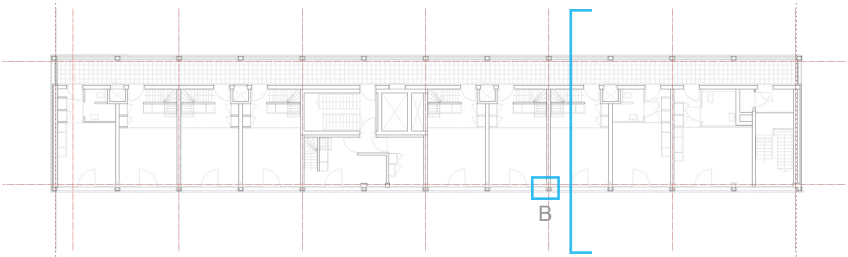
Detail B: 2F Facade Connection

Black Bamboo Volume
On the other hand, the upper two floors are completed with a cross wall system, which is ideal for the hospitality program where spatial division is predetermined. This system allows lightweight cladding like bamboo on top of concrete perimeter walls.

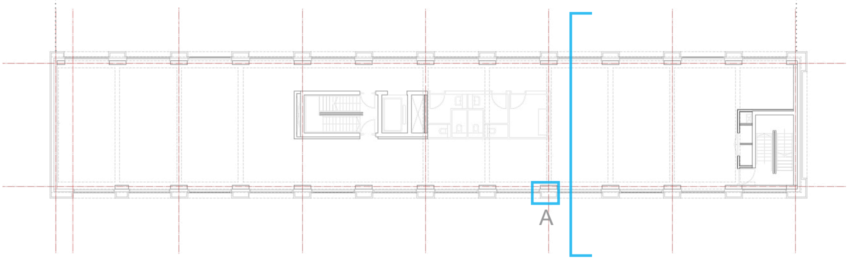


Detail A: 1F Facade Connection

Furthermore, two sets of core that run through the entire building add the lateral stability.



2F Floor Plan (Family Hotel)



1F Floor Plan (Office)

Credits | Design: Marc Koehler Architects | Elevation & Floor Plan: Eun Bin Boo

Stakeholders & Value Chain

In this age of scarcity and environmental change, architecture must go hand in hand with a conscious choice of materials and with a circular approach.
- Marc Koehler Architects

The project Republica actively adds value to the society in three different scales, aiming to engage with the relevant stakeholders at each level.

Neighbourhood Scale

First, it creates connections with the adjacent neighbourhood by linking the network of pedestrian spaces and public squares. Six volumes are arranged to create intermediate zones between the buildings on the ground floor, inviting both the occupants and the pedestrians to freely occupy the space. Consequently, it mitigates the high density in the area with the human scale public domain.

District Scale

The project also engages with a number of stakeholders outside the site area by taking part in the neighbourhood-wide energy strategy. To begin with, the project site is located within the EU-funded ATELIER* ‘Positive Energy Districts’. Also, Buiksloterham district in Amsterdam North has a strong focus on sustainability and smart energy innovation initiatives. This means that “all the existing and upcoming smart microgrids in Buiksloterham will be integrated into an overarching, district-level smart grid which will combine local sustainable energy generation and storage systems into one larger energy community portfolio.” Thus, the architect was encouraged to employ various energy techniques such as smart grid, heat storage, and PV panels from the planning stage. Constant and transparent communication with the municipality and the related parties in ATELIER project would boost the positive impact of the project.

Global Scale

Furthermore, the project indirectly contributes to the global climate by consciously defining materials that helps the project stand for a longer lifespan. The architect has worked upon Trias Energetica, a three-step strategy to create an energy-efficient design. Given that the construction industry consumes more than 50% of the total extracted materials in the European Union, selecting materials that can extend the building life cycle would be crucial.

** ATERLIER:*
AmsTErdam and BiLbao cItizen drivEn smaRt cities (https://smartcity-atelier.eu/)

Credits | Satellite Image: Google Earth | Diagram: Eun Bin Boo

Lessons Learned

Needless to say, circular values of the built environment are projected to become fundamental knowledge for the architects of tomorrow. Yet, merely understanding them is only a quick fix. Taking initiatives to implement them is equally important.

The analysis of the shearing layers has shown that when designing with materials, not only their (sustainable) qualities, but also the relation with other materials and the material's position within the building have to be understood. Only then can the architect make an informed choice of circular materials in their design.

Taking initiatives may require more input, seemingly absent of visible or instant reward, but the Republica project shows that looking beyond the conventional materials can be rather beneficial to the project identity. To be specific, the architect designed the reclaimed brick cladding based on the availablility of items in the market. In the end, having seven types of bricks of different size, color, and condition benefit the making of the image.

Likewise, we should not treat the physical design as the predetermined results. Rather, looking into the production processes out of our hands may give a pleasantly surprising outcome. In that sense, the endeavour to integrate as many R-strategies as possible will give plenty of valuable potentials. This could occur through all-round aspects of the built environment - from extraction, treatment, assembly method or potential disassembly, and even the user's long-term operation.

Of course, critical materials are prevalent in many conventional buildings. Supply bottlenecks can be easily foreseen considering that the bulk of the technical and critical materials are supplied only by a handful of countries. Contemporary design strategies should therefore also consider the economic and political challenges of their times and find workarounds or better yet, alternatives for sparse resources.

The NEW nexus informs us about building technology strategies beyond just the achievement of energy needs. Rather, the user's self-determination lies within his sensibility towards nature - not just consuming but giving back, feeding into a bigger cycle. Republica attempts this on a large scale.

Architects have to understand their role in a larger network of local and serve as global actors to best utilize the abilities and perspectives they bring to the table.

The case study of Republica sets an excellent example of what can be achieved when architects and other stakeholders set their minds on the inclusion of circularity in their building processes even in a larger scale project. The fact that the project showcases energy self-sufficiency on a neighbourhood level is recognizable, as it is a scale that is still in its pioneer phase. Overall, Republica and its publicity make it a prominent advocate for circularity, in hopes that many may follow.

Colophon

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