CIRCULAR
DESIGN
ATLAS

FLOATING OFFICE ROTTERDAM

Architect(s):
Powerhouse Company

Year:
2020

Location:
Rotterdam, The Netherlands

More info:
powerhouse-company.com

Scales:
Buildings

Resources:
Biological materials
Energy

Design Approaches:
Design for Disassembly
Modular Design

R-Strategies:
Reduce

Aspects:
Design
Technology

TU Delft
BK Bouwkunde

Credits | Design: Powerhouse Company | Photo: © Mark Seelen

The Floating Office was designed by Powerhouse Company for the Global Centre on Adaptation, a climate centre of the United Nations based in Rotterdam. The floating building can anticipate rising water levels and sets a sustainable example by showcasing various circular design principles.

The main structure of the building is made of wood, consisting of prefabricated modular CLT columns and beams, of which the dry connections are designed for disassembly. The wooden structure is connected to a base of concrete floating pontoons with integrated piping for the climate system, which acts as a heat exchanger through its thermal mass. The water of the river Meuse is used to exchange heat during winter or cold during summer, which saves a lot of energy and significantly contributes to the climate neutrality of the building.

Building Material Categories

Biological materials*

1 Spruce wood
Origin: Northern Europe
Use: CLT elements, laminated columns and beams, facade cladding

2 Belinga wood
Origin: tropical West Africa
Use: outdoor deck

Technical materials*

3 Bauxite
Origin: Guinea
Use: aluminium alloy products (ceiling panels, window frames)

4 Iron
(a)Origin: China/India/Brazil/Australia
(b)Steel production: China (predominantly) & Europe
Use: timber connections, steel cables, stairs, balustrade

5 Chalk (concrete)
Origin: France/Germany/Belgium/Netherlands
Use: concrete pontoons

6 Sand (concrete)
Origin: Netherlands
Use: concrete pontoons, glass

7 Oil
Origin: Middle East/Russia/Canada
Use: XPS insulation, waterproofing layers

Critical materials

Magnesium
Use: aluminium alloy products

Antimony
Use: fire retardant materials

Gallium
Use: LED lighting

Indium
Use: LED lighting

Fluorite
Use: glass and steel production

Graphite
Use: steel

*this data is based on approximation and predominant mining locations

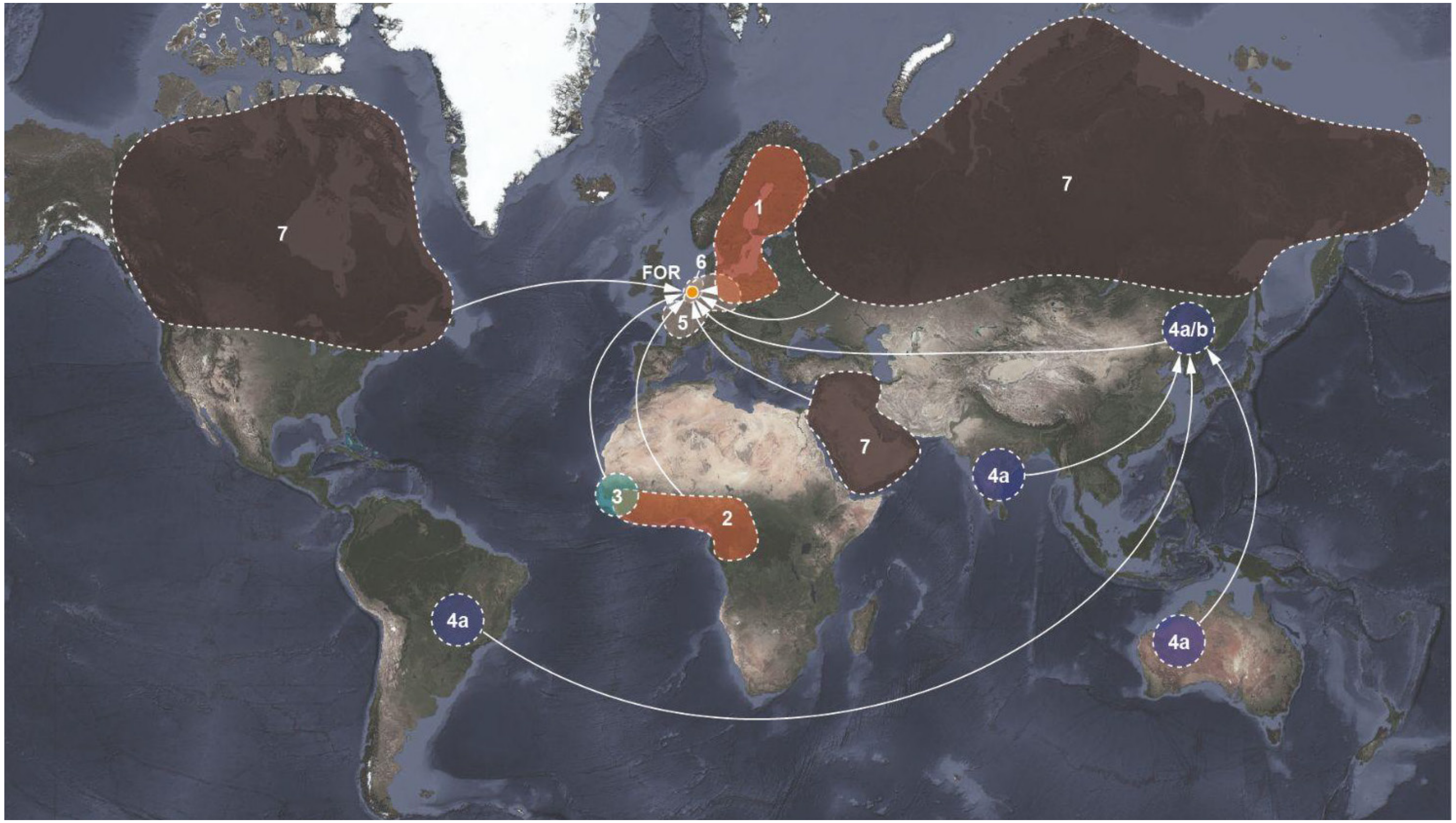


Diagram: Jelte van den Berg, Elise Bos, Tim ter Heide, Nynke Stam

R-Strategies

It was noticed that some of the R-strategies are mainly focussed on future possibilities. In the future many of the materials in this building can be repaired and reused. However, no reused or recycled materials have been used in this project. All concrete and wood that has been implemented in the building, seems to have been newly produced and transported to the site.

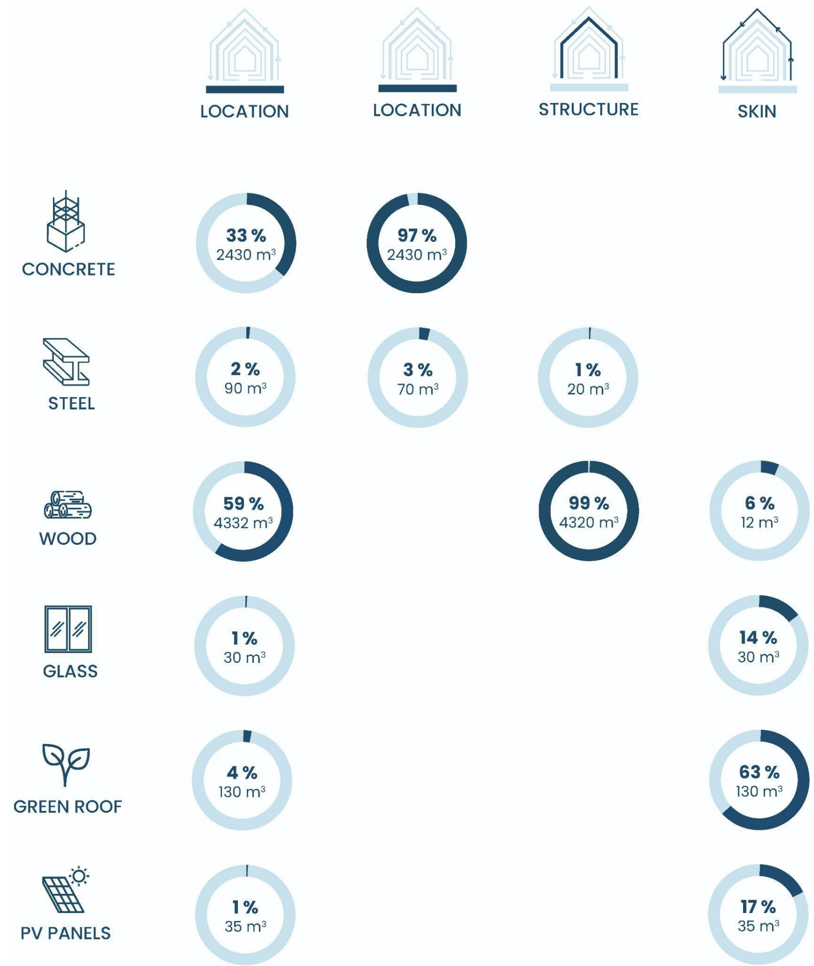
Reduce: due to maximum dimensions regarding the transport of the concrete base (since it was transported over water and needed to pass certain narrow waterways and bridges) the footprint of the buildings' foundation is limited. This also caused restrictions for the upper floors of the building. Because the building has to float, it had to be as light as possible. This translated in using lightweight materials and a lightweight column construction.

Reuse: the chosen structure is simple and demountable, which is why a 6 meter grid has been chosen. After the lifespan of this building, the structure can be used for a new building. For the structure laminated timber has been applied. It might be necessary in the next life cycle of these construction elements to repair them first.

One element that is difficult to fit into one of the strategies but should be mentioned is the heat-treated pine wood façade material. Because of the heat-treatment the quality of the material increases massively. With this rot and shrinkage is avoided. This way the lifespan of the material is longer and therefore also possibilities appear of recycling or even reusing the material in the future for other buildings.

Material Passport

The visualization below shows that volume wise the main materials used in the floating office are concrete and wood. The concrete makes up a third of the building as it is the main material used to keep the building afloat. The full construction of the building is made out of wood with some steel materials such as bolts to connect the beams. All of these parts are demountable so could be reused in a new building.



Source: https://www.madaster.com/nl

Ecosystem & WEF Nexus Approach

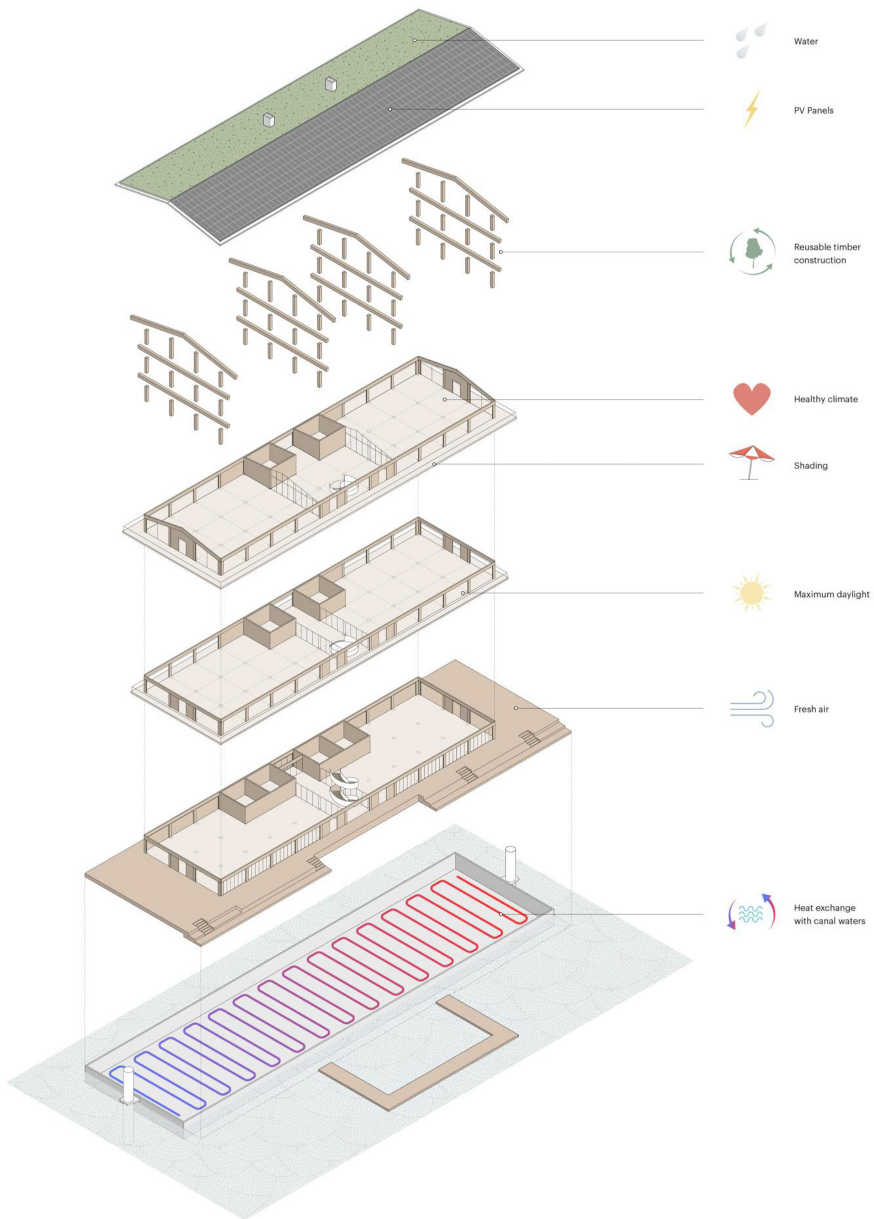
The Floating Office's ecosystem approach is mainly focussed on the usage of the water. The Floating Office makes use of the Rijnhaven water as a heat/cold exchanger. Furthermore the building includes a harbour pool. The building creates a protected section of the Rijnhaven water to swim. The building also makes use of the sun for electricity production and heating through positioning the building towards the south.

Building Services

The services of a building play a role in the management of the operational resources, such as water, energy and nutrients. They are very much related to technical and environmental requirements and comfort standards of a specific period, which changes rapidly over time.

Before adding installations to a building, design choices can affect the extent to which they are needed. Much can be achieved through passive climate design. The floating office does this for example by orienting itself towards the south.

The whole building is heated via underfloor heating which is a very adaptable system when changing the layout. The cooling is done via a cooling ceiling, which has the same adaptability as underfloor heating. Above this cooling ceiling is room for installations. The timber beams have drilled holes that allow the installations to run through the building. The suspended ceiling ensures even more flexibility.

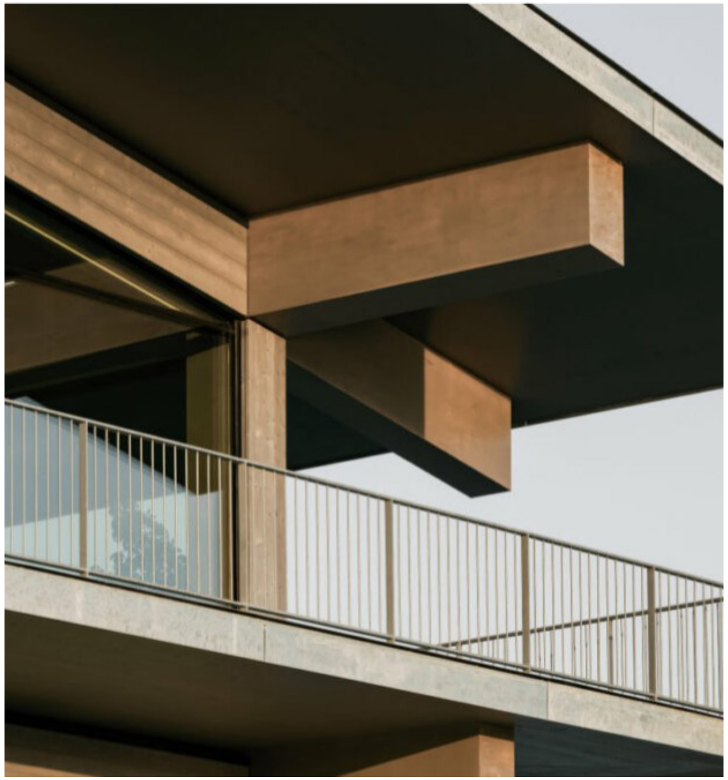


Source: https://www.detail.de/en/de_en/floating-office-rotterdam-von-powerhouse-company

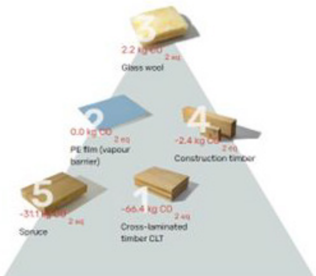
Carbon Footprint

Taking 1m² of a homogenous part of the facade (excluding window frames) an approximate CO_2 footprint was calculated. This was done using the calculator of the Construction Material Pyramid / Materialepyramiden developed by the Danish Centre for Industrialised Architecture (CINARK) at the Royal Danish Academy.

The large use of biobased materials such as timber means that the materials have a negative emission value. This is because of carbon sequestration during the growth of the trees used in the structure. There is however not enough information available to calculate how the footprint is affected by production and transport processes. These are important factors, which means we are only seeing part of the picture.



Images: www.powerhouse-company.com/floating-office-rotterdam



| kg $CO_{2\,eq}$
| module A1-A3

Your pyramid: -97.8 kg $CO_{2\,eq}$

show result in pyramid ↑	reset calculation	type project name	m 2				
	material	group	impact / m3	volume [m3]	area [m2]	thickness [mm]	result
1	Cross-laminated timber CLT	tree	-664.0 kg CO2eq/m3	0.10 m3	1 m2	100 etc	-66.4 kg $CO_{2\,eq}$
2	PE film (vapour barrier)	plastic	266.3 kg CO2eq/m3	0.00 m3	1 m2	0.08 etc	0.0 kg $CO_{2\,eq}$
3	Glass wool	mineral	12.8 kg CO2eq/m3	0.17 m3	0.94 m2	180 etc	2.2 kg $CO_{2\,eq}$
4	Construction timber	tree	-680.0 kg CO2eq/m3	0.00 m3	0.06 m2	60 etc	-2.4 kg $CO_{2\,eq}$
5	Spruce	tree	-777.5 kg CO2eq/m3	0.04 m3	1 m2	40 etc	-31.1 kg $CO_{2\,eq}$

Screenshot of Construction Material Pyramid, CINARK. Done by Jelte van den Berg, Elise Bos, Tim ter Heide, Nynke Stam

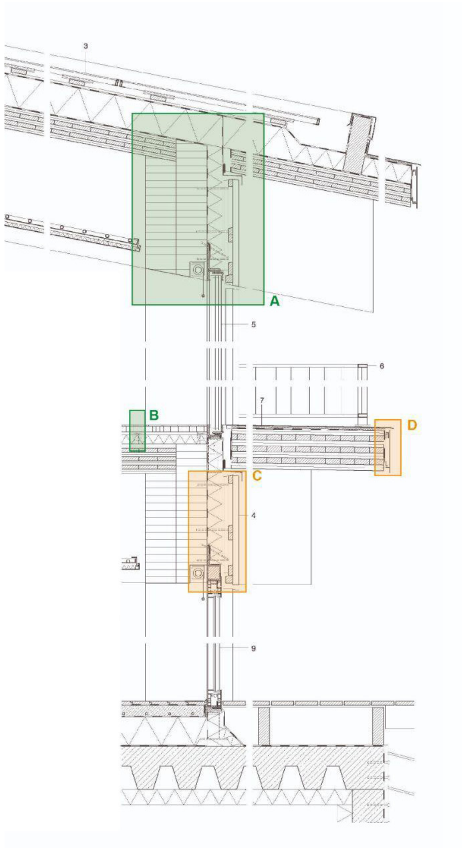
Design Approaches

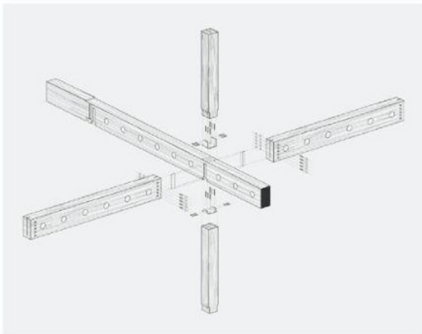
The structure is made out of laminated timber columns and beams. It is designed to be demountable (A), which can be considered as a circular solution. The interior skin consists of prefabricated timber frame elements and is therefore also demountable.

Moreover the flooring of the first and second floor are raised (B) to allow for easy removal.

The skin of the building is made out of of wooden slats that are screwed onto the construction (C). This allows for demountability, however degrades the original materials.

This is also the case with the galvanized steel sheets covering the cantilevered balconies (D). The building has a consistently implemented grid structure of 6x6m for the floorplan. This allows for a lot of flexibility. The service core of the building is located in the middle which divides the building into 6 spaces that can be leased separately or combined. This central core also makes sure the rest of the space is free to be used as desired. Furthermore the netto floor height of 3m creates spacious floors.

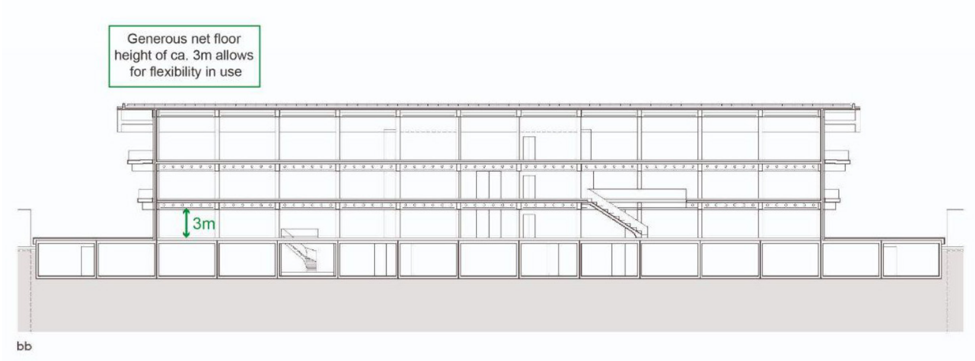


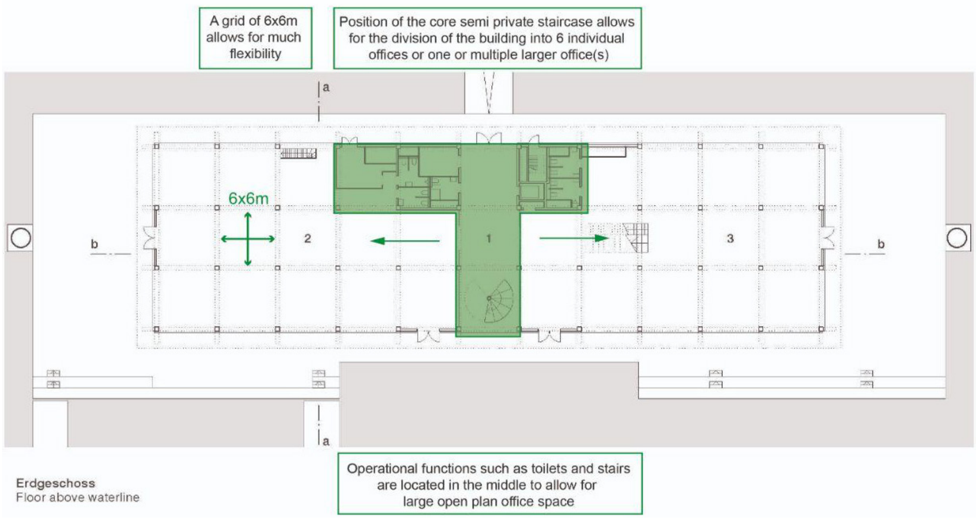


A) 3D exploded view the connection of columns and beams and demountability of these elements.

A) This picture displays the demountable construction elements of the building

Diagrams: Jelte van den Berg, Elise Bos, Tim ter Heide, Nynke Stam





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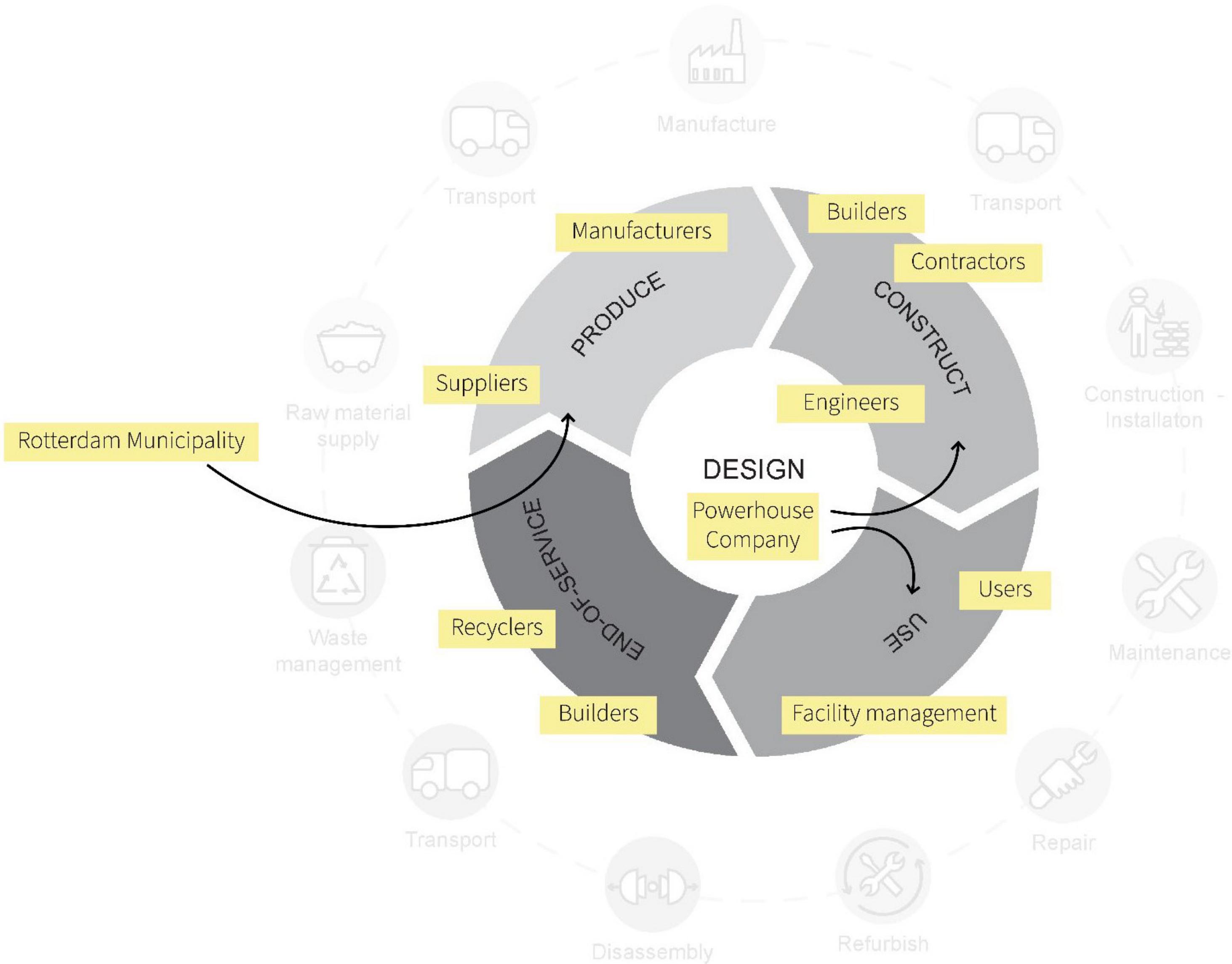
Stakeholders

The Municipality of Rotterdam initiated the Floating Office so they could house the Global Center of Adaptation. Powerhouse Company, a local architecture firm, accepted this challenge and came up with a design which they would also develop themselves. During the production process different material suppliers and manufacturers made sure the right materials were ready for the building before transporting them to the site. During construction the builders and contractors worked together to put everything into place. Also the engineers and architect-designers of Powerhouse were involved in this part of the process. Construction was finished in 2021 and has since housed 3 parties; one being the Global Center of Adaptation and one being Powerhouse Company. So not only did the architecture firm design the building but they are also the main user of the Floating Office. Facility Management supports by maintaining the building interior and exterior. When the current service of the building ends in the future, builders will be able to demount the building structure and other building parts so recyclers can decide how these materials can get a new life in a next building. And so, the circular building design process can start all over again.



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