

URBAN METABOLISM AND CIRCULAR ECONOMY

in the Brussels Region



TOGETHER WE
MAKE TOMORROW
MORE BEAUTIFUL

OVAM

.FABRIC

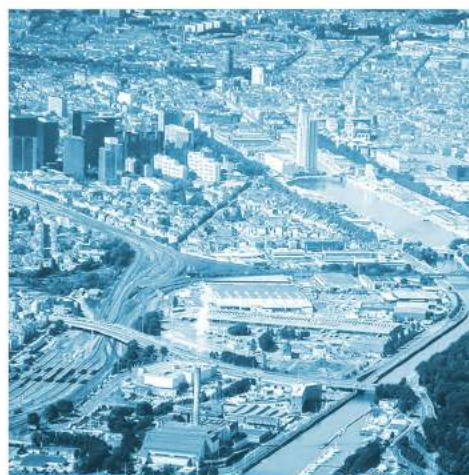
ULB

C **CIRCLE
ECONOMY**

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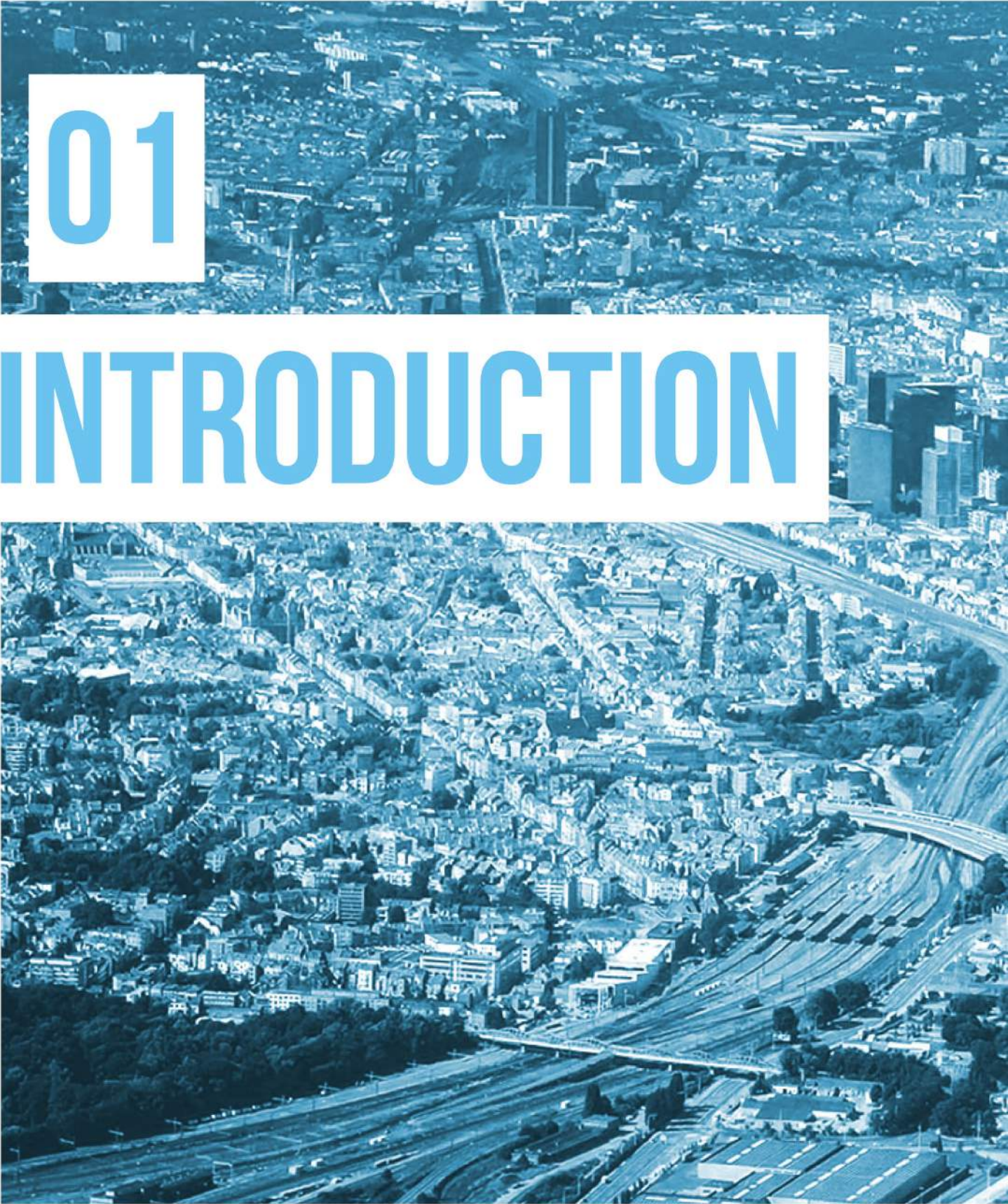
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An aerial photograph of Brussels, Belgium, showing a dense urban landscape with numerous buildings, streets, and green spaces. The image is monochromatic, rendered in shades of blue and white. A large white square with the number '01' is overlaid on the left side of the image.

01

INTRODUCTION





PREFACE

Cities and economy are in transition worldwide. The social, environmental and economic challenges that urban areas are facing are enormous. It is clear that many challenges but also opportunities to create momentum for a sustainable and prosperous future of our society are offered in cities. That is why the Public Waste Agency of Flanders (OVAM) issued a call to submit proposals to research these opportunities.

More precisely OVAM posed the question to:

“...investigate urban metabolism as a carrier for a sustainable transition to a circular economy in the Flemish-Brussels metropolitan region.”

The selected proposal of FABRIC, Circle Economy (CE) and LoUISE -

BATir (ULB) to identify and analyze these circular opportunities is based on the ambition to valorize existing knowledge and translate it into a spatial impact, identifying thus opportunities for local stakeholders.

The objective for this research was to investigate how the framework of Urban Metabolism could be used to implement the principles of circular economy in the Brussels Metropolitan Region. The idea was not to limit this study to data collection and analysis exercise but also to see how the metabolic flows at a regional scale could provide some insights at the local scale. In addition, it was important to create a vision and a narrative behind the metabolic flows assessment and the identification and proposal of circular economy strategies for local stakeholders. The whole study took place in the context of the Atelier Brussels Productive Metropolis, one of the ateliers of the International Architecture Biennale Rotterdam 2016 (IABR): The Next Economy. The roots for this atelier go back to 'Metropolitan Landscapes (2016)' a research by design by Architecture Workroom Brussels (AWB). In that study the guiding role of open space in the metropolitan





areas of Brussels was explored and sites for further exploration were identified. To concretely investigate the potentials of these sites Atelier Brussels projected the idea of the productive metropolis over them. The aim was to explore a better match between the changing economy and the organization of space for productive activities in the metropolitan area of the capital. Parallel to the research of FABRIC - ULB - Circle Economy on the Flemish-Brussels metropolitan region, four design teams worked on a Research by Design project focusing on other locations from the Metropolitan Landscapes research. In four Urban Meetings the different teams met with local stakeholders and experts to inspire each other and exchange knowledge. The results of this whole process of research, design and exchange of knowledge was presented at the IABR 2016.

This report brings all work done by the team FABRIC – ULB – Circle Economy together. It gives an overview of the analyses, and results achieved. It is a document 'in progress' that serves as the central document where new elements and additional material can always be added and linked

to.

After completing the research, a series of three masterclasses was organized by OVAM, FABRIC and ULB, centering around the theme of 'designing with flows'. The aim of these masterclasses was twofold. First goal was to use the knowledge found in the research to reach out to a broader public. Second goal was to invite a mix of local and international experts to start help building a metabolic agenda for Belgium. The recordings of these masterclasses can be reviewed at:

http://www.architectureworkroom.eu/en/work/atelier_brussels_masterclasses/







URBAN METABOLISM: AN INTRODUCTION

After the devastating Tohoku earthquake and tsunami, Japanese architect Toyo Ito wrote:

"I can't help sensing a fundamental disruption between our norm and the reality. I think we design things in a mechanical manner as a 'complete machine' complying with nature defined in quantities or abstract definitions; we do not engage with the natural environment as something constantly affected by the varying forces of ground, sea, or wind."

In other words, Ito, who started his career working for one of

the founders of the Japanese metabolism movement - Kiyonori Kikutake - observes that there is a huge gap between architecture, urban planning and landscape design on the one hand, and the environmental challenges that face us on the other.

In Urban Metabolism, the urban landscape is considered as a complex, extensive and interactive system that continuously works to meet the needs of its residents and economy. Flows of materials, energy and water have a major impact on the functioning of our cities, and thereby on our environment, our health, welfare and economic resilience. From this perspective - the city as an ecosystem - planning is no longer just about the design of places, but also about the understanding of flows and how they influence the performance of our cities. Depending on the scale at which we look, flows can change behavior and substance. It is therefore important to understand these flows at different levels: the scale of the region, the scale of the city and even the scale of the street.

In recent metabolic researches, we can distinguish two different schools: an environmental school in the tradition of industrial ecology





Miyako City, Japan 8.9 magnitude earthquake, 2011,
photo credit: Kordian

and a sociological school focusing on how the constituent parts fit together.

Both schools have produced remarkable insights on every changing flows. However, material flows are not something only worth to be observed by scientists. Furthermore, a good understanding of what flow runs from where to where in the city and why, is not enough. In order to allow users of the city to think about other opportunities and to mobilize them to create new links and use resources smarter it is necessary to link spatial urgencies and interests to flows. More and more flows have a direct effect on our daily lives. Waste management for example is one of the main cost items of municipalities around the world.

Yet, as landscape architect Pierre Bélanger puts it:

"We know so little about what it really takes, how urbanization actually works".

Perhaps as a consequence we have not been able to create prosperity without adversely affecting our living environment (Kennedy, C., 2011).

In response curator for the International Rotterdam Architecture Biennale 2014 - Urban by Nature - Dirk Sijmons reasons:

"Since city and nature overlap spatially and interact functionally, it is no longer fruitful to separate man from nature."

As a possible solution for closing the gap that Ito identified, Sijmons poses the question: *'What new terms can we use to talk about cities? And what new problem-solving approaches would come about if we were to try to consider the whole network of flows, of relationships, as opposed to putting either people, things or nature first?'*

Science

Social-cultural

Anthropology/ Philosophy

Architecture

Urban metabolism

Ecology

Biology

Metabolism

Ecology

Systems Ecology

Industrial Ecology

Economical

Industry



WAY OF WORKING

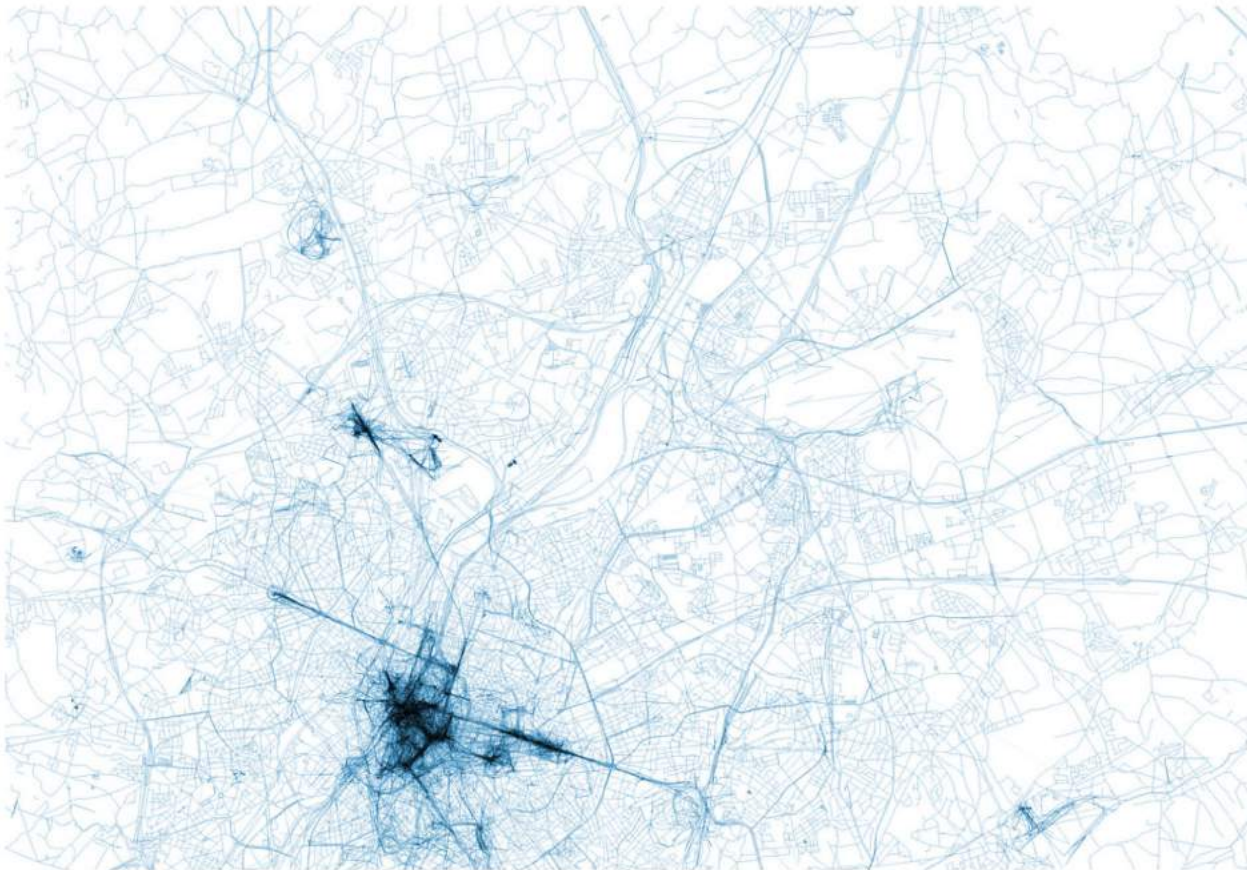
For improving the urban metabolism there are roughly two approaches: one using the geographical proximity of material flows to create synergies. The second approach focuses on a different way of setting up material flows in the production-consumption chains.

Brussels represents a huge jumble of chains that cannot be seen as being separate from each other. To get a comprehensive picture at the different scale levels of the region, the city and the street, many material flows and interdependent systems must be analyzed and understood. Previous research by design projects in Rotterdam, Amsterdam, Barcelona and Albania have shown that understanding a city's metabolism from its constituent metabolic flows (energy, water, materials, ...) is very labor intensive and time consuming. The strict political and geographic barriers between Brussels and Flanders introduced another challenge: a lack of homogeneous information and data. From past experiences in the transition to a circular economy we also know that it makes sense to start by optimizing individual flows using general principles.

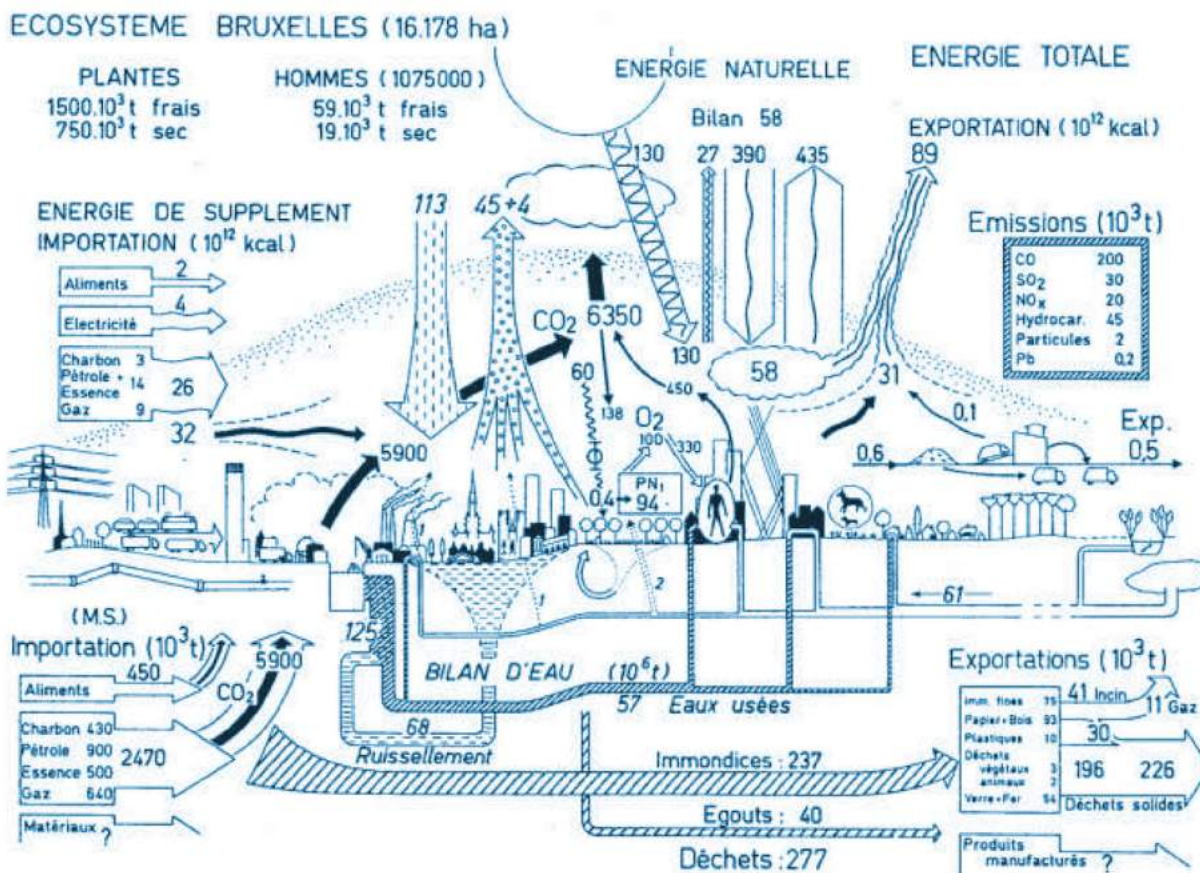
"Re-use, re-design, innovation and substitution" are generally seen as guiding principles for improving the sustainability of the use of materials in production and consumption chains (Ellen McArthur Foundation, 2012).

To meet the given framework, FABRIC, CE and LoUlsE-BATir (ULB) decided to reverse the usual way of working.

To test urban metabolism as a guide to identify chances for circular economy the consortium developed a way of working parallel both on a local and on a regional scale, implementing a small selection of four flows at three locations.



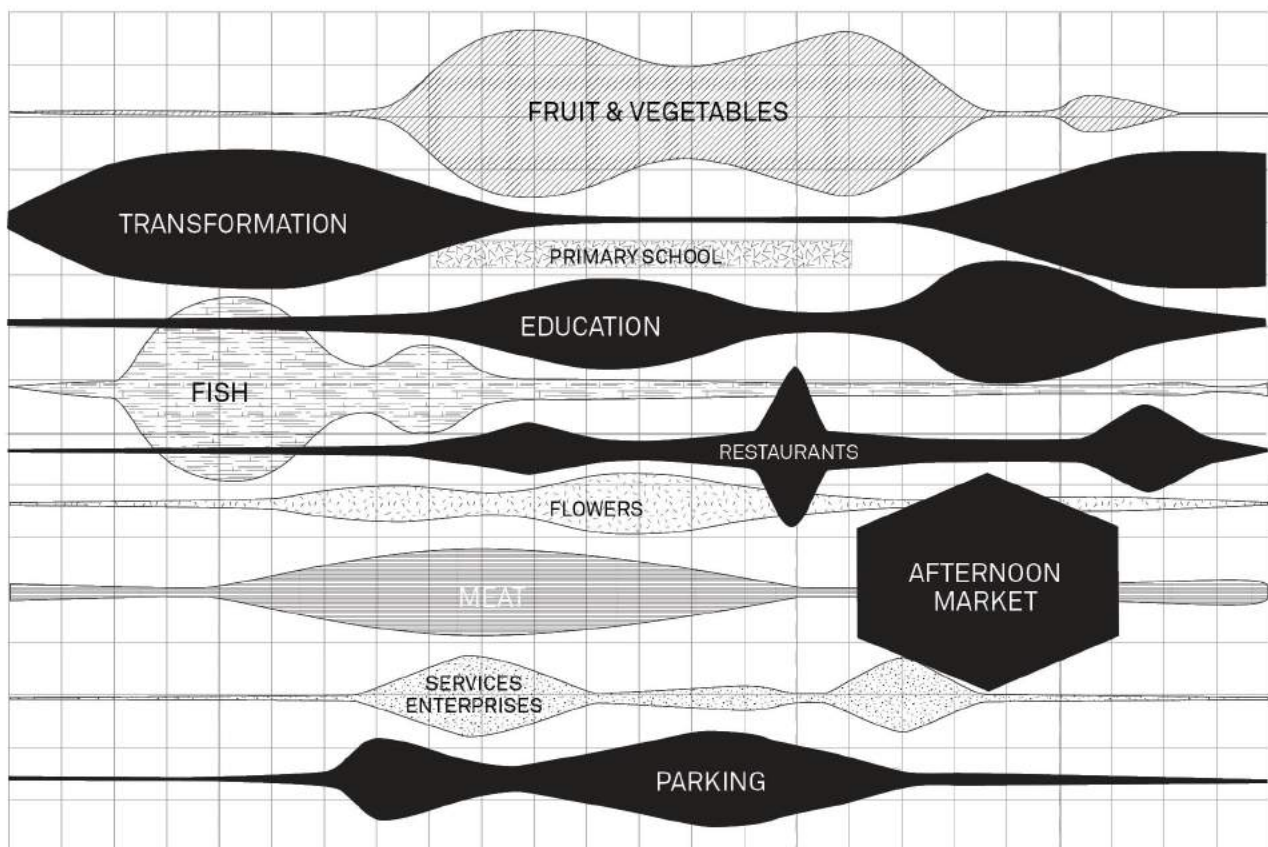
Geographical and spatial approach to flow study, pedestrian flow mapping of Brussels. Source: 'The Geotaggers' World Atlas #36: Brussels, Eric Fischer, 2010



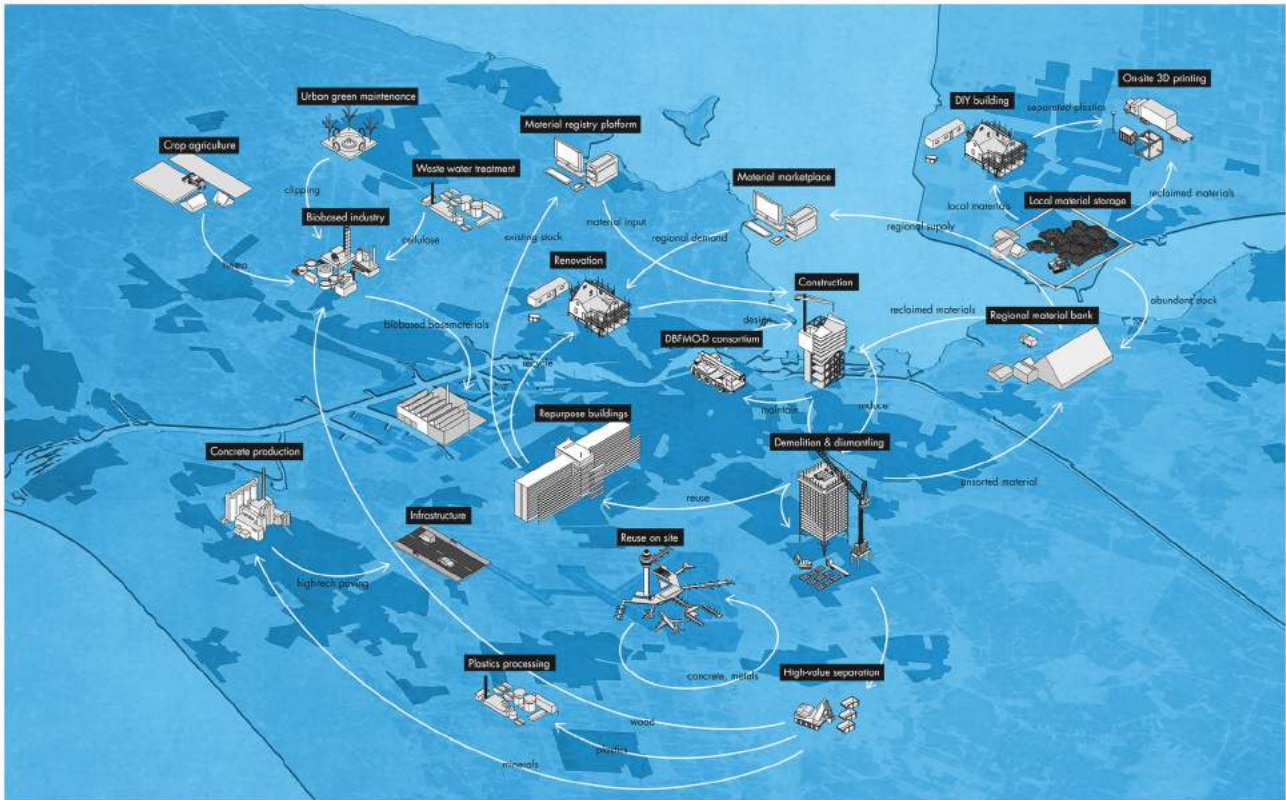
Study of flows based on production-consumption chains in Brussels. Source: Urban Ecosystem of Brussels, Duvigneaud & Denayer-De Smet, 1977



source: Designing with flows: Urban Metabolism for Rotterdam, FABRIC, JCFO, TNO, 2014



source: Upcycle, Barcelona, Cogenerative design strategies for a sustainable Urban Metabolism, ULB, IUAV, ETSAB, VUB, 2015



source: Amsterdam Circular Scan, FABRIC, TNO, Circle Economy, 2015



source: Metabolism of Albania, FABRIC, 51N4E, TUDelft, 2016



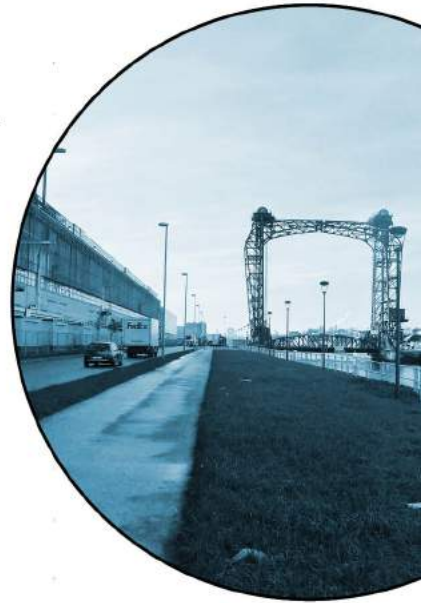
LOCATIONS AND FLOWS

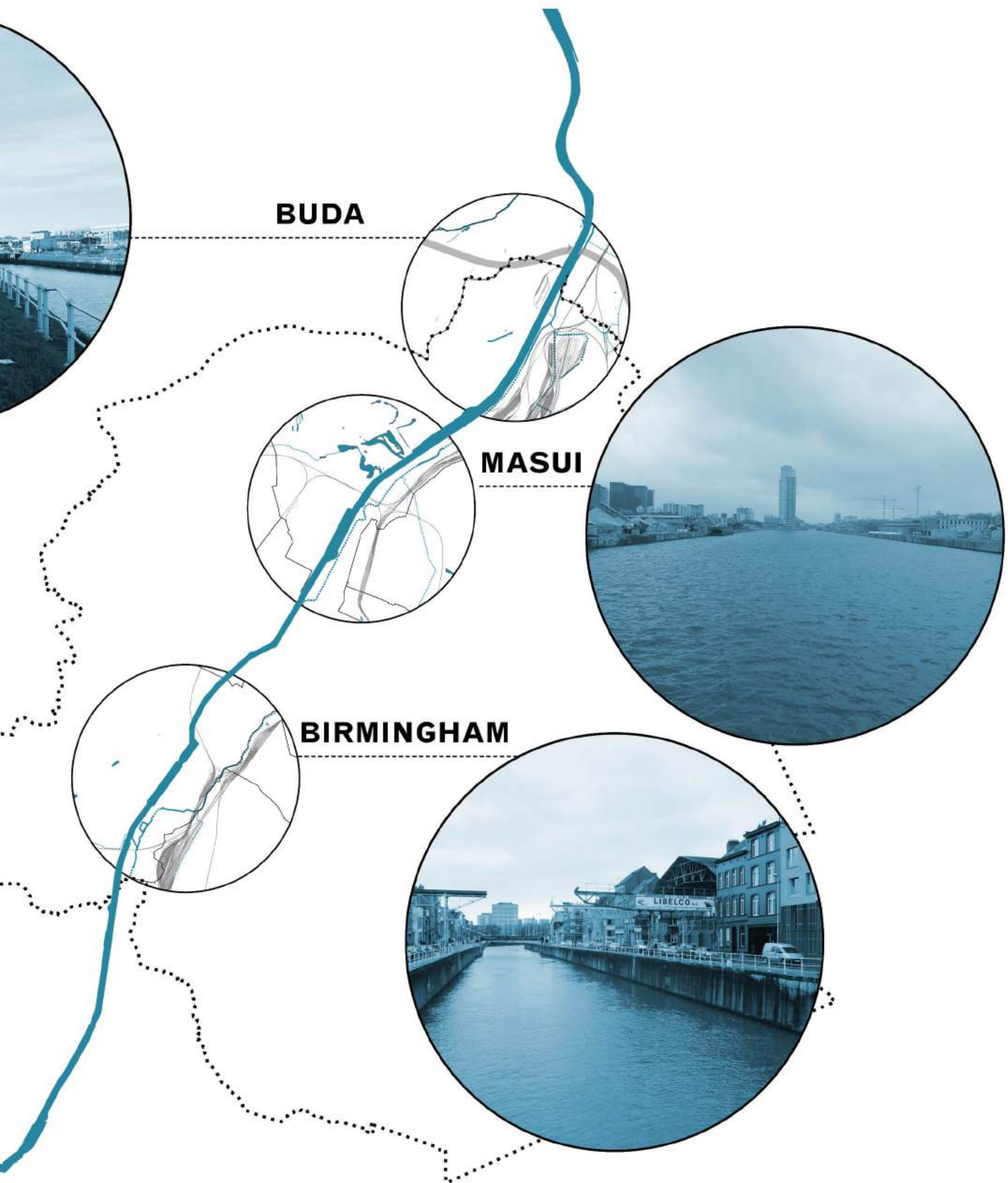
The combination between the flows and the sites was chosen to reflected different priorities and focus points of the region.

The flows were chosen regarding their circular economy potential both at the regional and local scale. The flow of Construction & Demolition (C&D) waste for instance represents more than a third of the total waste of Brussels and thus is the biggest waste flow in the Region. In addition, as Brussels is a relatively small territory mostly covered with residential buildings, C&D waste flows could become one of the main assets. The second most important waste flow in the Region is organic waste. Its re-circularization of organic waste could be beneficial not only for reducing the amount of materials sent to the incinerator but it could also have a very positive effect on urban agriculture. It is important to mention that in the case of both C&D and organic waste they are

spread almost homogeneously across the territory of Brussels and represent very constant flows. Therefore, these flows are very relevant for re-circularization. Sewerage and rain water are specific fractions of the water flow that where selected both for their presence in the city but also because of the devastating consequences they could have on the built environment (floods, pollution of natural water flows, etc.). Finally, the logistics flow is of high relevance for the health and the economy of Brussels' inhabitants, the traffic congestion, but also for the whole transportation network of Brussels.

The three specific sites on which the study focuses are all along the canal zone of Brussels, namely: Birmingham, Masui and Buda. They were selected for different reasons. Firstly, because they illustrate different challenges of Brussels and different approaches how to implement circular economy. The options range from making a modal shift for city logistics, the transition of informal economy and job creation, to the elimination of manufacturing industries by residential desires, and the management of clean sewage and surface water. These

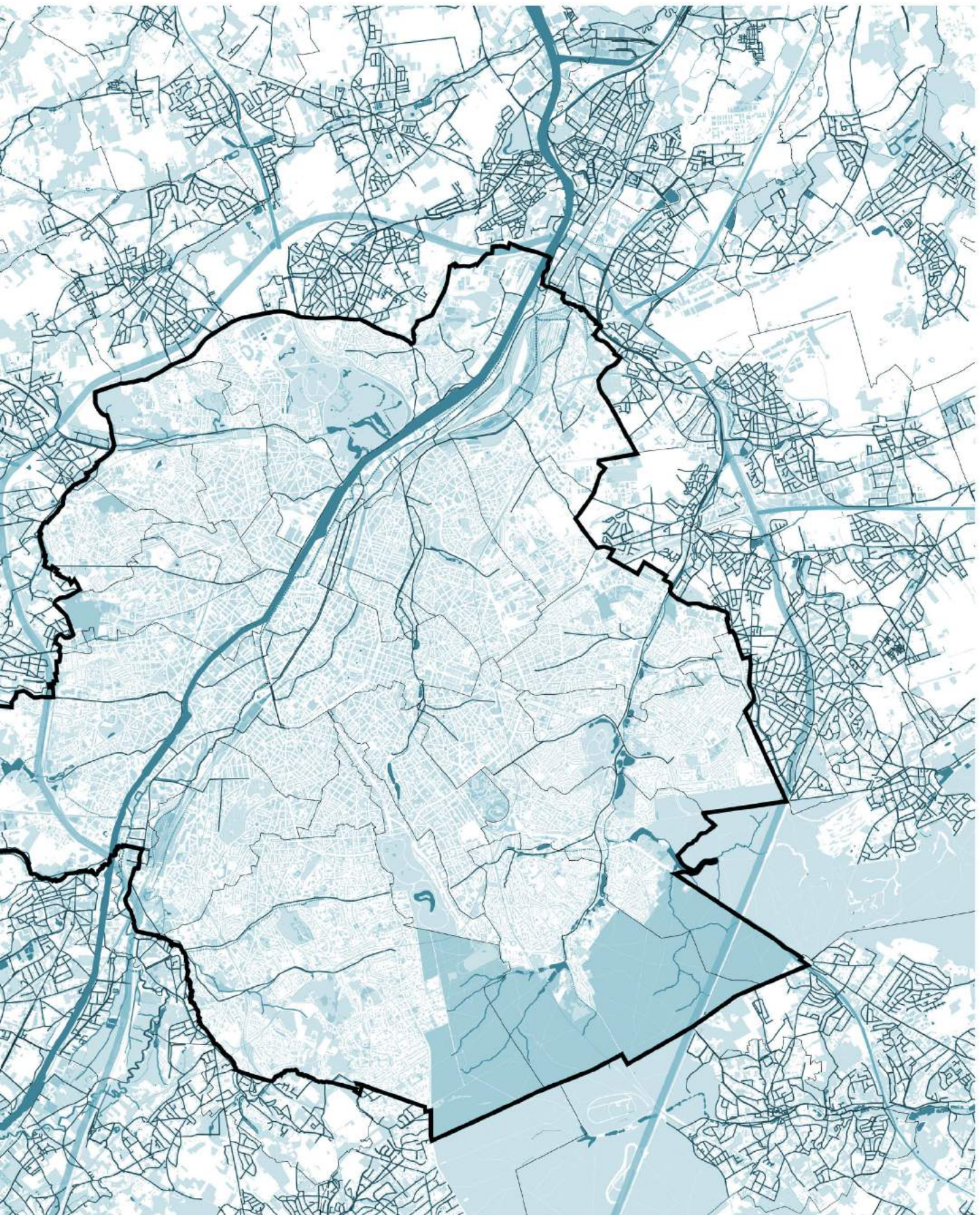




seemingly isolated challenges turn out to be very connected, first of all by the canal, but also because they are directly linked to the four substance flows that are of vital importance for Brussels: manufactured goods/logistics, organic waste, construction & demolition waste and surface water.

In addition, each site presented different configuration of an urban fabric and a different agency between residential, tertiary, industrial and transport activities. In order to maintain a coherent narrative for the entire project the three sites were chosen along the canal which was seen as a red thread for implementing circular economy in Brussels Metropolitan Region.







THE DOCA METHOD

The starting point at all scales was a structured procedure of gathering information on how the four different flows are being used and function using the DOCA-method. DOCA stands for gathering Data, Opportunities, Challenges and Anecdotes. The domain of Data concerns all available knowledge and data on a certain flow. With this knowledge it is possible to visualize the current infrastructure and its performance in relation to a particular flow. Anecdotes, on the other hand is the kind of information that is collected by interviewing persons and organizations that can be considered experts or end users. This information reflects trends and insights which are not (yet) translated into data collections like maps and data sheets, and therefore hard to find. The category of Challenges serves to collect knowledge on how the specific theme provoked decisions in spatial planning

and how these resulted in urban challenges. It is, as a matter of speaking, a collection of current spatial problems that can be analyzed and traced back by reversed engineering. Finally the category of Opportunities answers the question of the spatial ambitions. The dialogue between the Opportunities and Challenges describes how to get from the here and now into the future. While the Opportunities are found in visions, Challenges are there for real.

MAPPING
statistics
graphs
diagrams
datasets
maps

DATA
desk research
reports
database
monitoring

MODELLING
statistics
graphs
maps
infographics
photos
drawings
models

CHALLENGES
desk research
literature
reports
plans
documentaries



**SIMULATION**

visualizations
models
drawings
graphs
maps
infographics
videos

OPPORTUNITIES

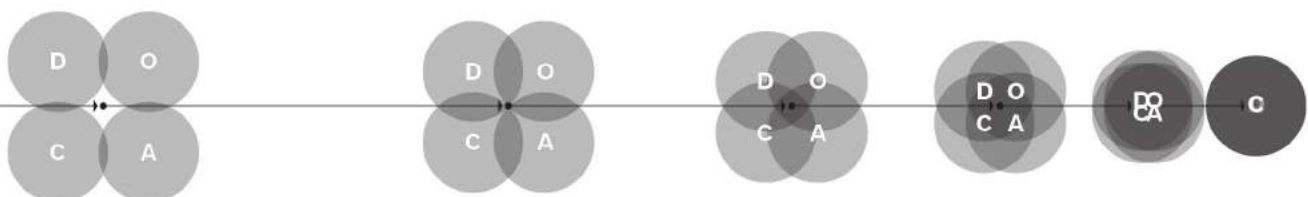
design research
workshops
reports
plans
visions

FIELDWORK

maps
photos
videos
statements
texts

ANECDOTES

field research
workshops
interviews
reports
documentaries
photo archives





PRODUCTS

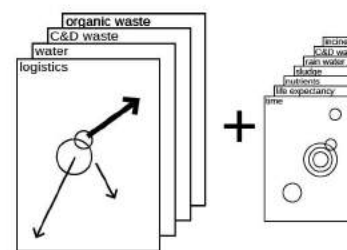
By noting all available information on the four flows at the three locations and mapping the existing infrastructure, quantities, speed and quality per flow, regional Flow Maps are constructed picturing the current state of the Brussels system. These maps formed the basis for what could best be interpreted as spatial hypotheses that were tested under the title of Urban Meetings. In these Urban Meetings specialist and anecdotal information was projected over the Current State Flow Maps, deducting Consequence Maps. Parallel specific local actors were analyzed by constructing their current and potential future Flow Diagram. In order to estimate what needed to change and what impact these changes could have also the existing system and the optional new system were constructed making use of Urban Transects: systemic descriptions of how space and actors operate. Then a new circular business

model has been drawn according to the implemented flows. To evaluate chances of success for circular economy per Flow/Actor, a combination of 6 strategies is formulated and drawn in axonometric representation for each site.

Finally, in the conclusive chapter of this research the impact of the proposed strategies is projected in 4 blue regional maps estimating how they would perform on different aspects ranging from their capacity to produce energy, to their opportunities to positively affect public awareness about circular economy in the city.

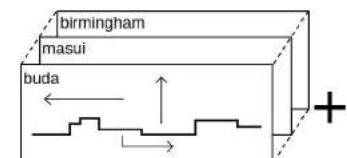
1. REGIONAL FLOW MAPS AND CONSEQUENCE MAPS

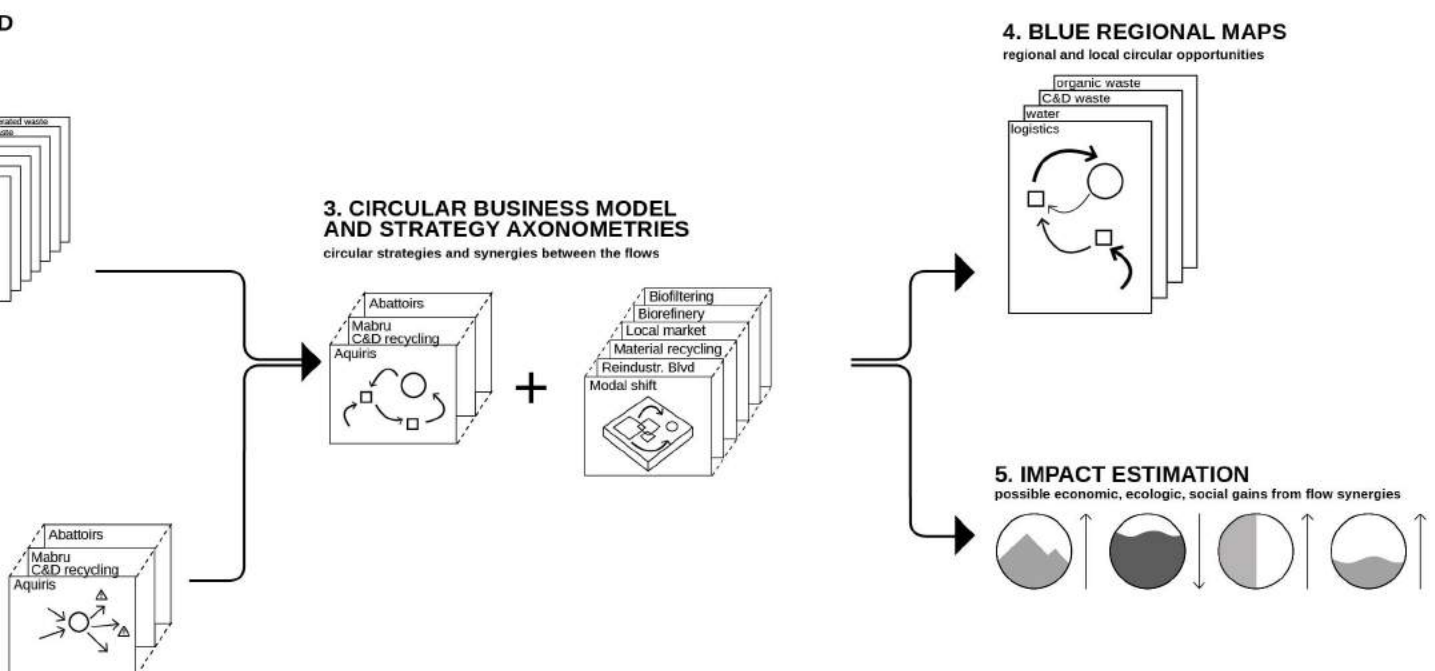
data collection and identification of value loss



2. URBAN TRANSECT AND ACTOR'S FLOW DIAGRAM

visualise the system and identify the stakeholders



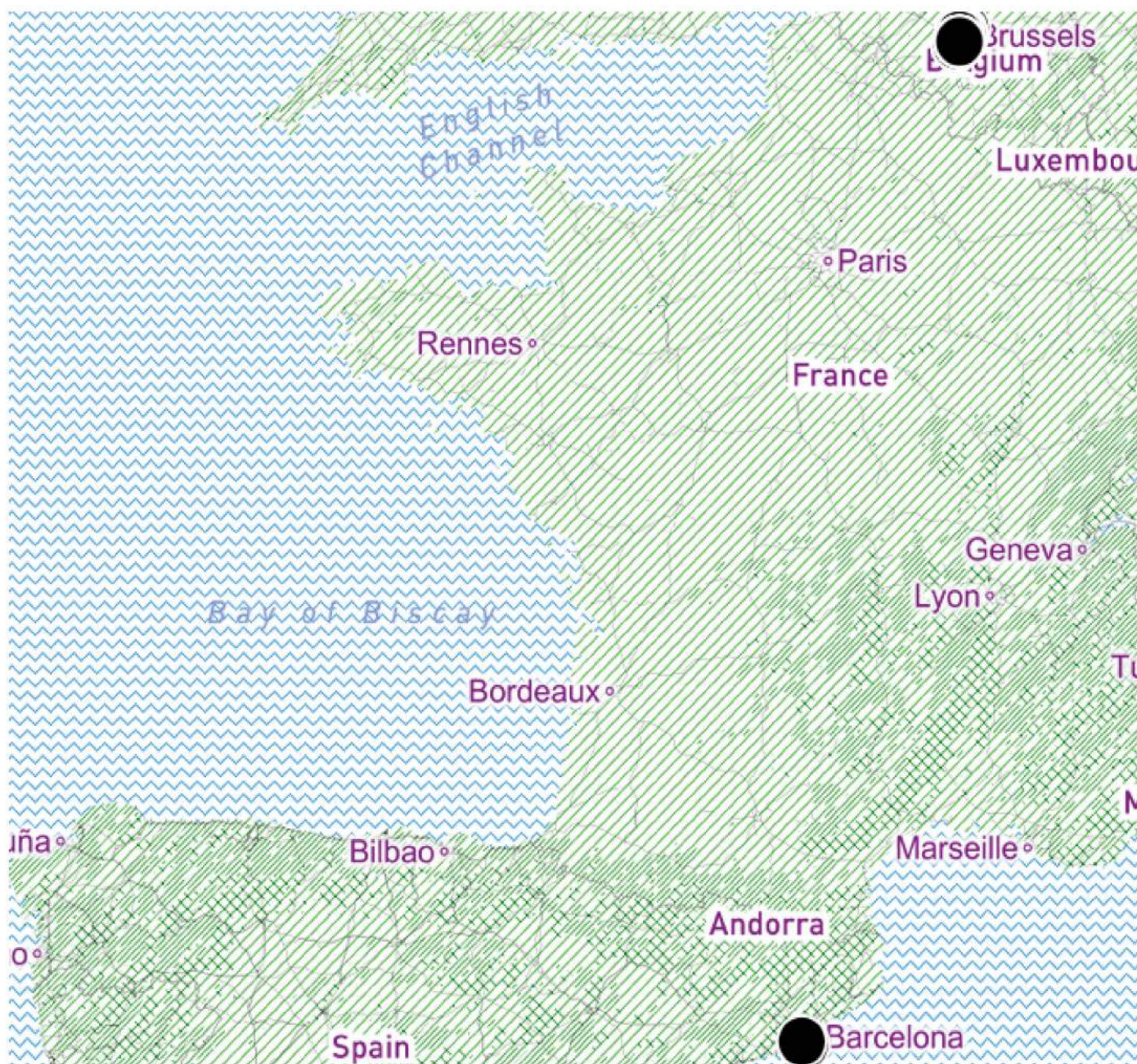




STUDENTS' WORK

During the Spring semester 2016, a group of master students from ULB Faculty of Architecture La Cambre-Horta has been invited to participate to a 2-weeks workshop organized within the frame of the Metropolitan e-Studio, an interactive platform for research by design in the four metropolitan valleys of Brussels, Venice, Barcelona and Rome.

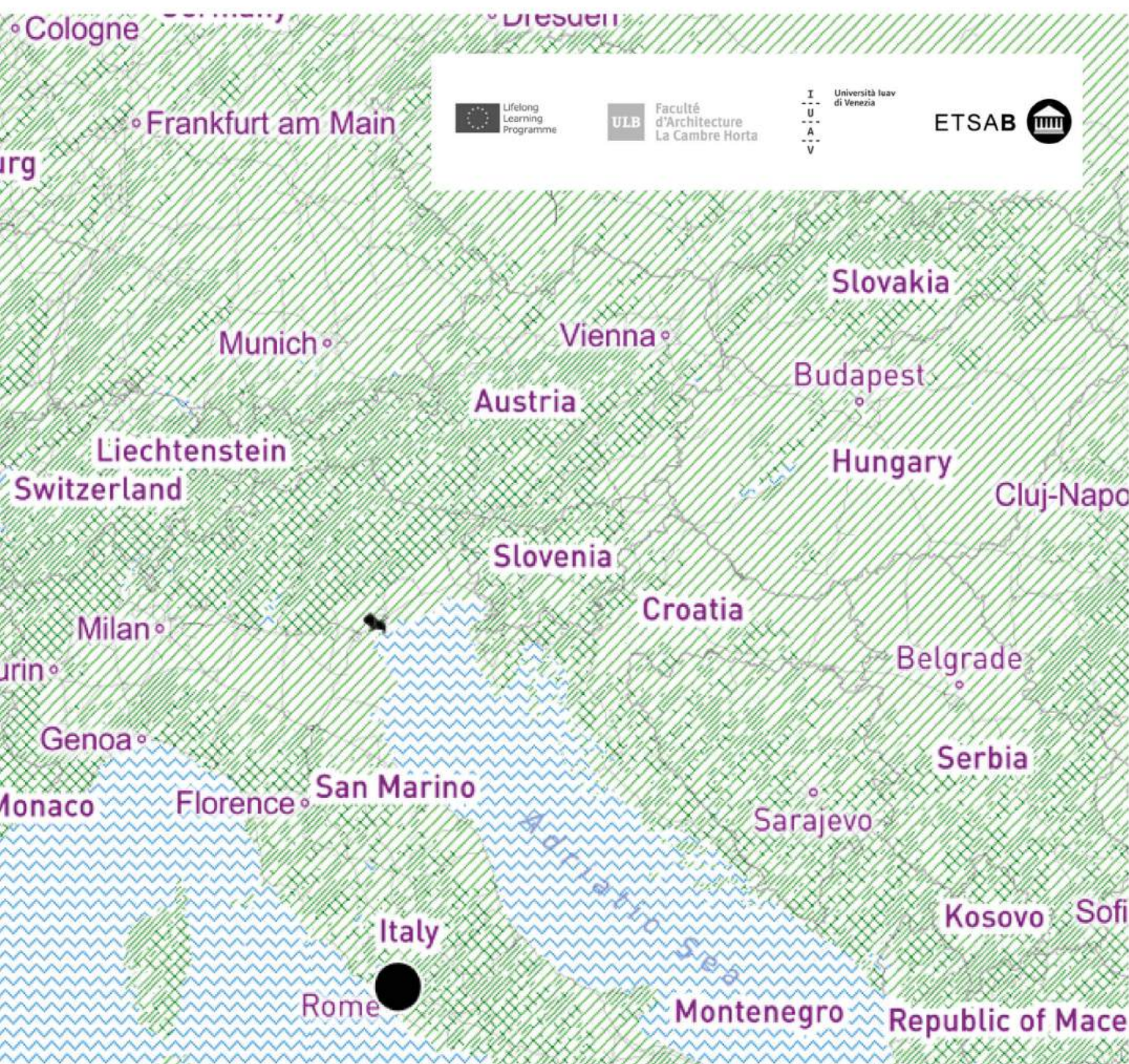
The work presented by the students includes a metabolic analysis of some of the companies



located along the Canal and on one of the three sites addressed in the Atelier BXL (Birmingham, Masui and Buda). From this starting point, each group of students sketched a proposal on how to make more circular some of the (productive) processes happening in the chosen location, paying particular attention to the impact that their strategy/design would exert on the

overall urban dynamics (e.g. other actors, public realm, new activities...). The work of the students can be found at: <http://metropolitan-estudio.eu/>

The goal of the workshop was to test and deepen spatially some of the hypothesis developed by the consortium FABRIC-CE-ULB and presented in the current document.

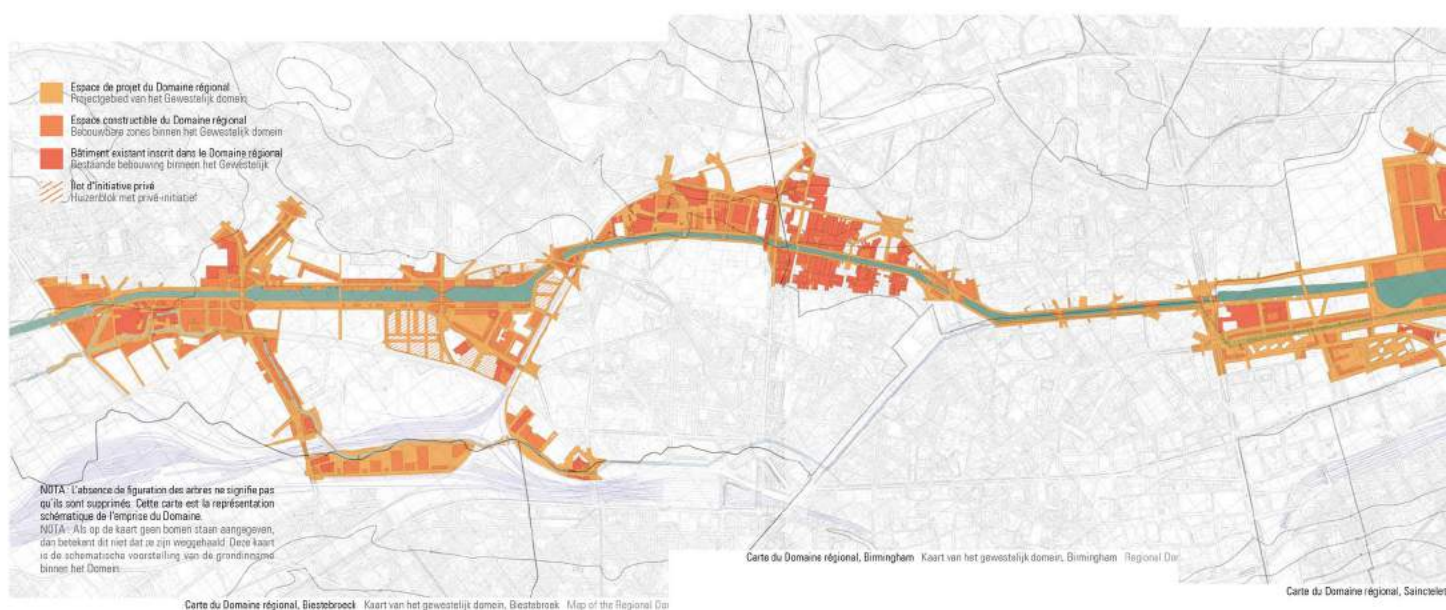


source: <http://www.metropolitan-estudio.eu/map/>



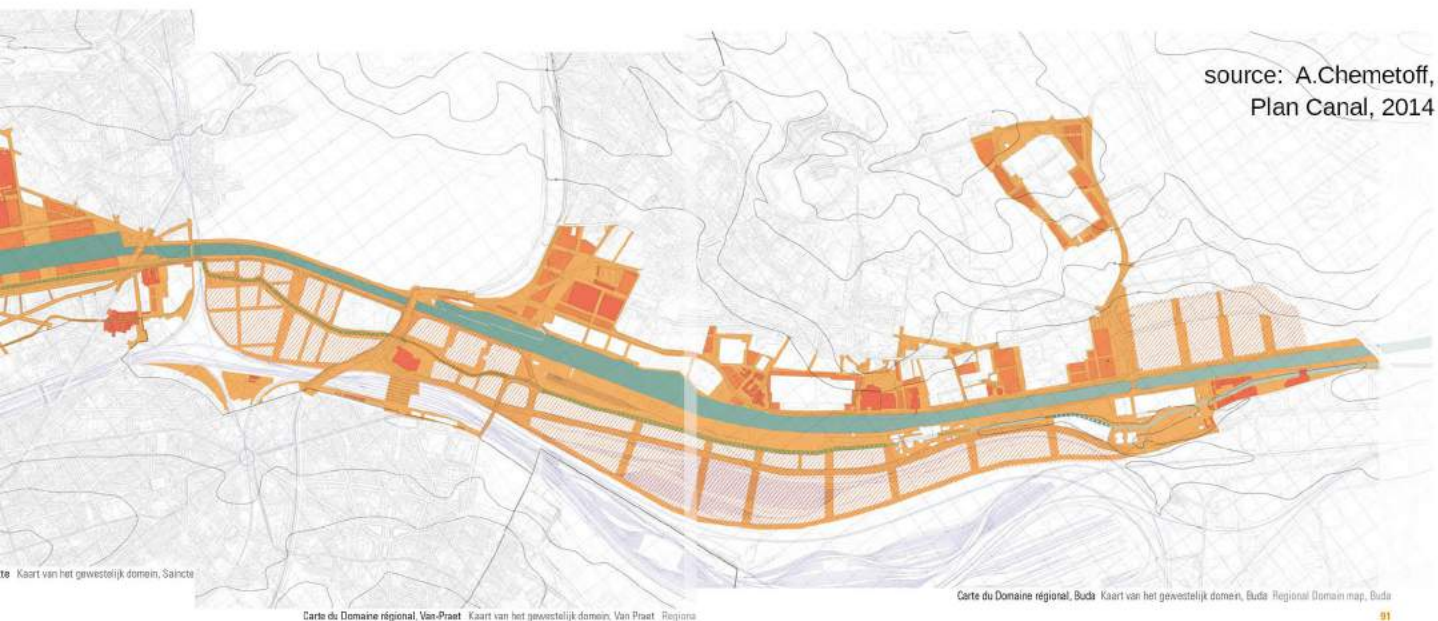
POLICY CONTEXT

To place our study within the actual policy context, three main reports were analyzed: the Regional Programme of Circular Economy, the T.OP Noordrand and the Plan Canal (Book 1 & 2). The analysis identifies not only the similarities between the scope and territory considered in this study but also discusses what approaches can be transposed from one realm to another and what



are the opportunities. All three documents agree on the need for a shared vision that gather efforts from a great number of local, regional and metropolitan stakeholders to transition towards a sustainable and resilient future. The study developed by .Fabric, ULB and Circle Economy applies the urban metabolism framework in

Brussels in order to identify and propose circular economy principles could partly help to present a single and unified solution for most of these challenges and overarching the three policy documents. The total analysis of the three reports can be found in the appendix of this report.





MATERIAL LIBRARY

Along the way of our study, a series of raw materials has been 'found' and selected because they are currently neglected or expelled despite their potential to be reused, create new local products or to reinforce circular processes. The aim of this library of samples is to establish a tangible link between the research and a wider public. The proposed strategies impact the Brussels territory in many ways: by adding new materials as catalysts for change, new products appear and modify the current market and appearance.

We consider this collection a logical step in the scaling-down process of a research that explores the territory at multiple scales. Moreover, materializing the results of a theoretical study is a way to arise a collective consciousness about the concrete challenges that the Brussels Region is facing.



source: Fomes Fomentarius project. Paddestoelen Paradijs Exhibition, 2012, Amsterdam (NL)





NETWORK OF NETWORKS

conversation with Annemieke Roobeek

We talked with Annemieke Roobeek, Professor of Strategy and Transformation Management at Nyenrode Business Universiteit since 1997. We met her at her office in Amsterdam where she leads "MeetingMoreMinds", an inter-company networking organization to promote professional development and accelerate innovation in a networked setting.

I think cities are very often lacking of an oversight. I am a strategist, I studied political science, international relations, comparative studies and I did my dissertation in political economy; I think that only by combining different disciplines it is possible to reach the bigger picture.

For me there are two main challenges that are worth working on: the first one is Healthy Society. I worked as a volunteer for 20 years in the supervisory board at the Free University Medical Center; but what I find interesting is that in order to make the society healthy you have to look outside of

the medical field, it's about making people aware about their lifestyle. The other challenge is Circular Economy; I work a lot on city development and intercompany networking. It is necessary to bring together different parties in order to achieve a collective intelligence. In order to do that you need a Webber, someone able to understand the bigger picture who also knows how to bring together the different actors. Webbers are the super-connectors and they always operate at the fringes to connect the different parts of the system.

I usually play a multiple role: I am the Webber, the designer, the conceptualizer and the developer. The first step of our research is to identify the right questions. Once you have them you can reach the tipping point to enable exploration and innovation. Twenty years ago I started building an ecosystem not around a patient but around a consumer that wants to stay healthy while being in the middle of a healthy society. There is an abundance of all kind of services but often there is no oversight. While trying to understand how to achieve that, I found out that individual companies had to collaborate much more with each other. I believe that from this network of networks we can reach the healthy society.



Last year we were asked by the city of Zwolle to organize a series of inspirational talks to open new ways of looking at the city and identify the possible challenging theme for the city for the next upcoming decade. We came up with Zwolle Circulair 2030 and we started studying the metabolism of the city, we worked on new ideas for system theories, system knowledge, networking, public-private involvement and ecosystems. What really interests me is that Zwolle is compact enough to get as many actors on board, to make visible but also understandable the meaning of transforming a city into a circular system in a decade's time. Although I had a chair for a metropolitan affair and I have always been working on

these very large megacities, I think that from an action-learning and an action-research point of view, cities of the size of Zwolle are the ideal environments. At this scale, you can do everything: political lines are shorter, things are easier to get arranged and you don't have to struggle with all the layers. In Europe there are more Zwolle's than metropolitan areas. In this project we also involved the Groene Brain and the Groene Zaak which are both strictly related to sustainability through academics and stakeholders. We transformed this project in a living lab from the very first moment in order to engage the people in a learning experience, we want to build an inter-vision.

I developed a wave approach because I believe in the evolution, development and adaptation process of cities. Every wave takes up to 3-4 months to reach economics, climate, citizens... In every wave we combine a different mix of stakeholders in order to create, wave after wave, a social fabric with an interdisciplinary understanding and able to see through the complexity. Every wave achieves at least one concrete goal and you can create such an ecosystem only if you overlay several of these waves.

When working with ABN Amro, we developed an ecosystem of actors related to sustainable logistics. Since the theme is quite broad we had to break it down to smaller topics (and groups) according to very specific questions. The innovation consists in this multi way of operating: having a conversation between several actors and companies where nobody can give an ultimate answer, where both the bank and the other companies can learn from each other. The ecosystem that we create has the shape of a multi helix with networks on different scales. The most interesting part is to see how these companies, apparently not directly related, come to collaborate with each other unleashing a collective intelligence. For each project, the way of working is the same but the initial picture is completely empty and a new challenge is in the

middle. In this multi-helix, never forget the advisory and the financial component. You will always have the knowledge of universities, companies and government (the triple helix) but this is not enough.

So I approach the companies, I do the interviews, it all starts with a lot of talking and getting trust. It can be quite challenging to gather many companies around one theme but I started building these networks in the '80s, I have been working for more than 20 years in universities and in advisory boards of companies; I became an expert of networking, I can combine these networks with the relevant questions and organize the work. There is a lot of knowledge to combine and you have to be able to look 20 years ahead.

Urban Metabolism always involves governmental parties but they are not the movers of the whole process: the government will not come up with solutions, it can help setting up a group or to articulate the question but you need many other parties to execute and develop it. I believe in the private-public interplay but the action and innovation comes from a wider involvement. The way you organize this ecosystem is quite new and collaboration is the key: without it we will always under deliver to our potential.

We did a project on money laundry and we showed that growing plants for the drugs world is exactly like growing tomatoes, you need the same financial controls. Therefore we invited the top professionals of the non-criminal sector and we asked them to think as if they were working for the underworld. The interesting part is that they know very well what they're not supposed to do but, once you know that, you also know what to do. This way we managed to develop new models to find money laundering activities and tax heavens. We were the first to deal with big data analysis in a social responsible way with the private industry and this is something the governments often hesitate on. We took all the responsibility for this dangerous research and we managed to open new ways to use the private/public data in a responsible way. People are more open to change if the solutions come from themselves.

When we research the big data, we interpret it in a collective way and this is why you have to build an ecosystem. You need at the same time people that can generate the data and people who can interpret it, an interdisciplinary group to enable the collective intelligence, otherwise data itself doesn't mean anything. We organize small groups and every quarter we set an inspirational general meeting. The network can grow

or shrink in size, it's temporary. As a political scientist, I hate institutions that exist forever, they always involve politics. In temporary networks there is a common goal and when you reach it, there are all kinds of regrouping that happen without my intervention.

We recently did a study for the city of Rotterdam, more specifically on the southern part of the city, where there is a very high crime rate, an area where 150 nationalities coexist in a very fragmented environment. I call it invisible insecurity, nobody feels safe on his own in this part of the city. We built a new ecosystem and we invited companies to discuss, we showed what the patterns in the area are and why criminals settle there. You can spend 20 million euros on economic social development but it will still not work. When looking at the bigger picture of the city you realize that this part is completely detached. Last spring the project was on the financial newspaper, I insisted for this to be published for its enormous learning effect in using big data in a social-responsible way.

Sometimes frictions can occur, mainly due to the fact that our projects aim to long term goals while politicians, civil services and companies have a very short horizon. Citizens have an even shorter view: they complain today and they want to have

it fixed tomorrow. We try to overcome these disagreements by developing the “greater vision” all together, this way we can help them visualize the future starting from today. I put the main ingredients on the table and mobilize actors: I am a designer, I give it content and bring it into motion. But I can’t illustrate the picture myself, otherwise it would be imposed; it’s a shared narrative, a moving target. I need more Webbers in the city though. We organize workshops in order to find these figures and I recognize them in the middle of a crowd, I am very sensitive to that.

It’s fundamental to build up a strategic vision bigger than one single territory. Change shouldn’t overcome us but be an invitation to participate. In every project we find out that many things already exist but are just not related yet. Everything is in separated functional silos, a heritage from a tayloristic past, and we try to connect it through new networks. I think the next generations will know better how to do it, they cross the borders much easier. So the biggest challenges are to overcome the silos and get rid of the idea that what you do has an impact tomorrow. First you need a vision of a circular city and then you start reasoning back. We try to distract people from what they need to do tomorrow and make sure they are aware of the real challenges of the future.

02

BIRMINGHAM







CHARACTERISTICS

Birmingham is an area south of the center of Brussels, it includes segments of Anderlecht, Molenbeek, and Saint Gilles. The area is densely built and combines both residential and industrial areas along the canal.

Birmingham is also known for its slaughterhouse - Abattoir, attracting over 100.000 people each weekend. Adjacent to the Abattoir, the Heyvaert neighborhood starts, internationally known for its second hand car trade. Due to its proximity to the city center and infrastructural nodes like, Porte de Ninove and Gare de l'Ouest, Birmingham illustrates how car oriented the Brussels metropolis is, especially when it comes to moving goods.

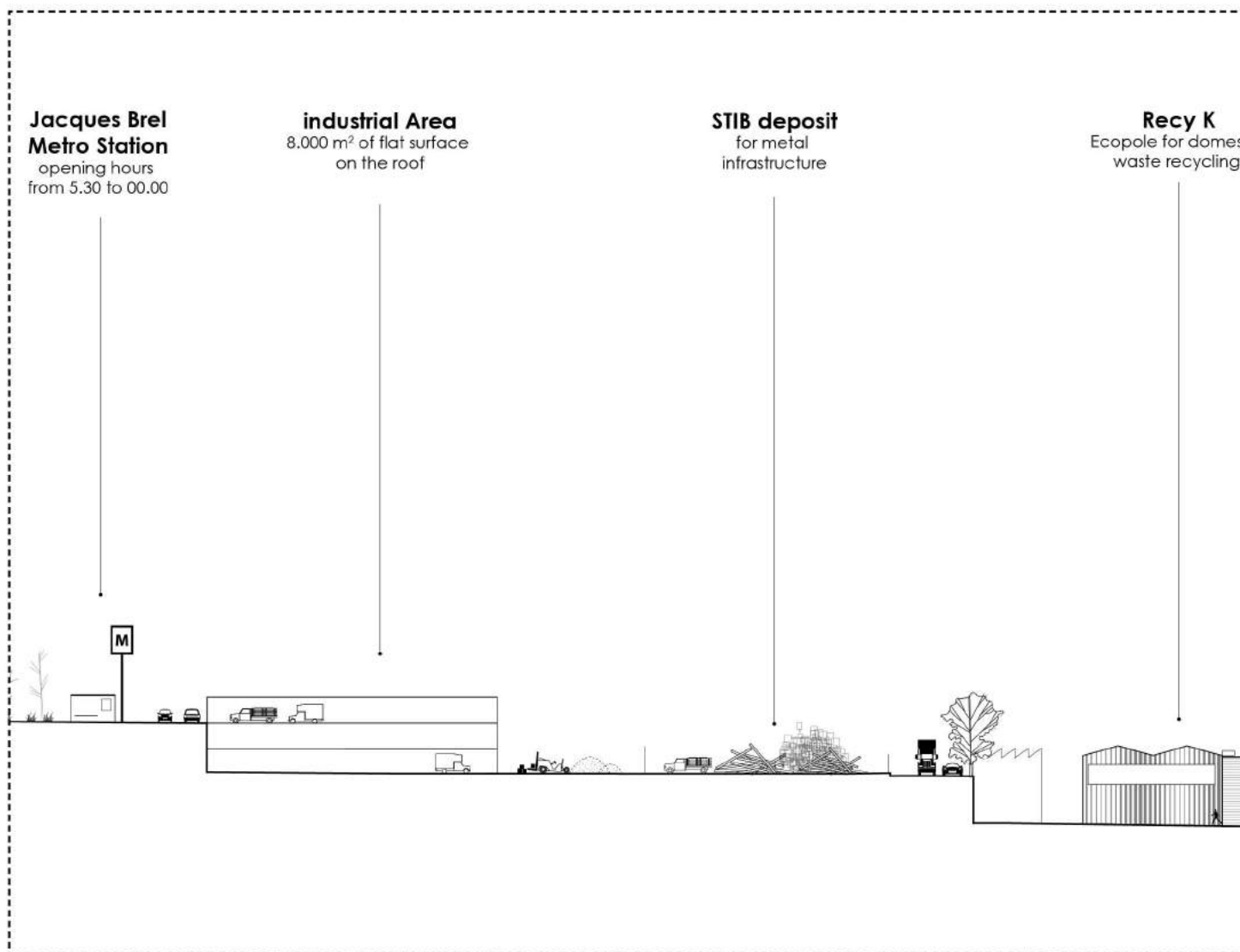
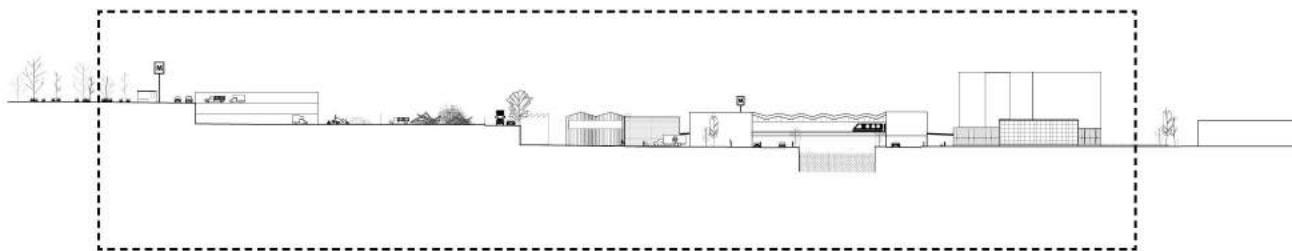


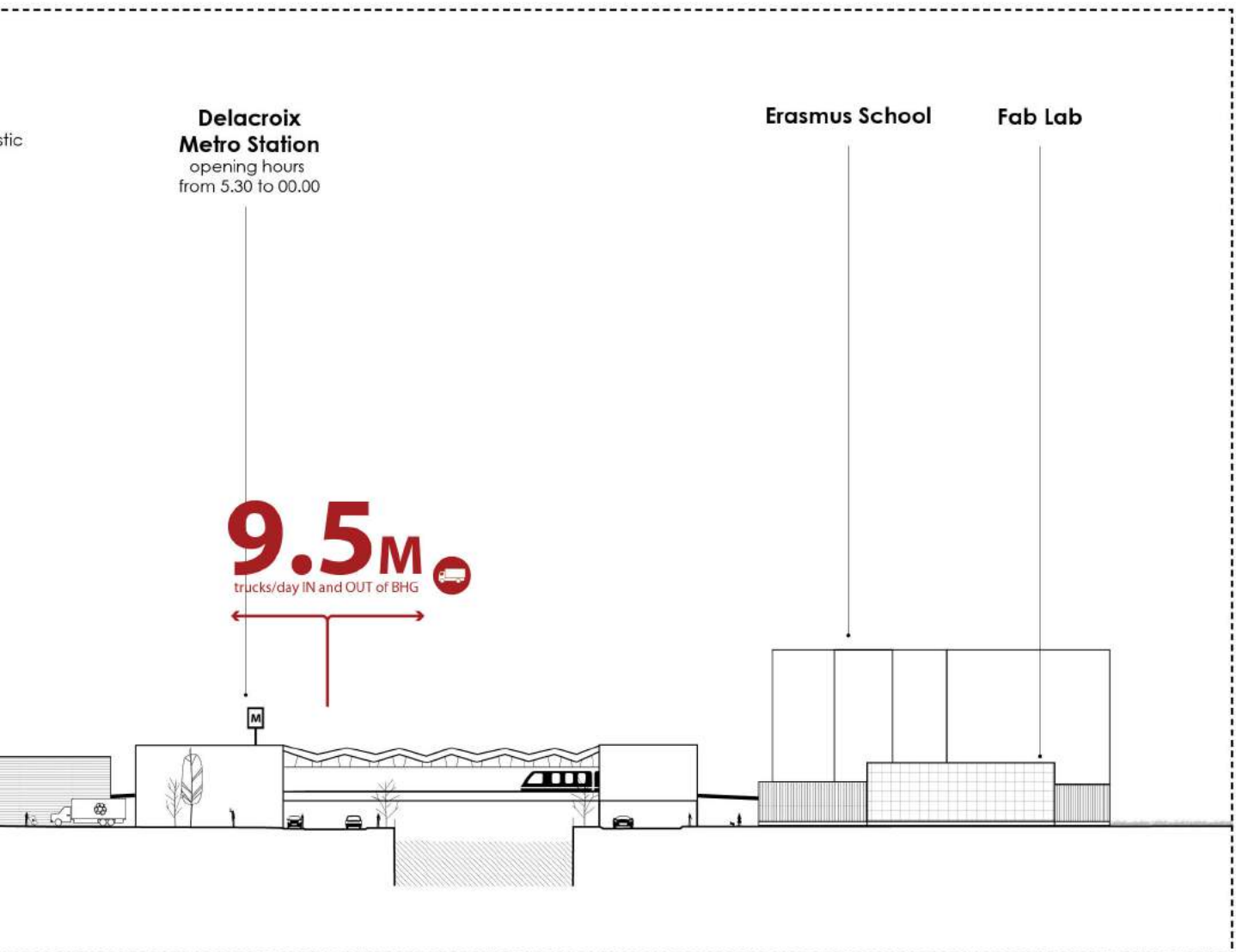




The existing urban configuration of Birmingham can be summarized in an Urban Transect: a section in which the key players, key infrastructure elements, topographical features and typological characteristics are brought together.

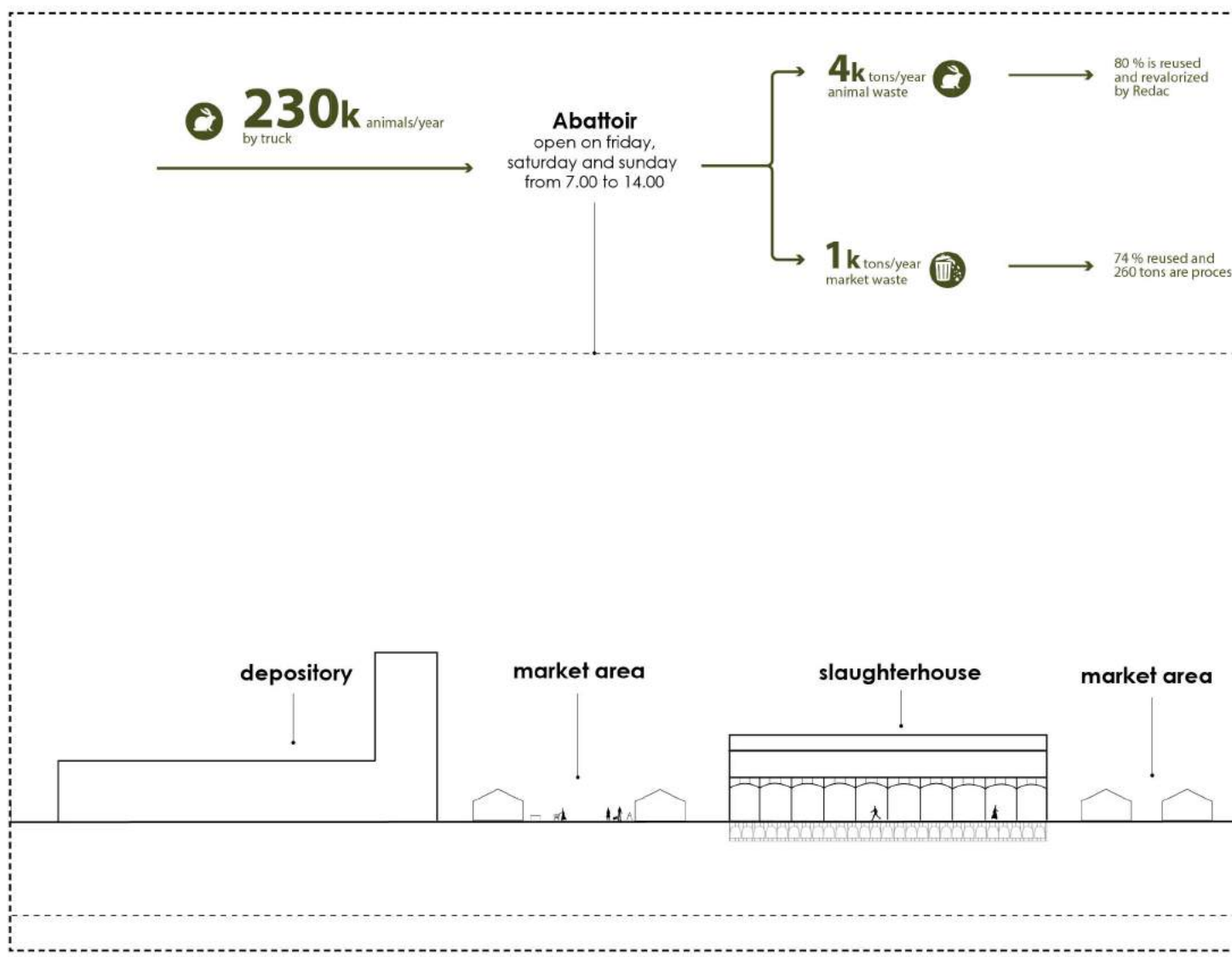
URBAN TRANSECT





In the case of Birmingham, there is a number of things that stand out in this Urban Transect. First is the intersection of public transport lines like the metro, and infrastructural arteries such as the Canal. Also the Anderlecht-Cureghem Abattoir stands out as a major player. And the area around Heyvaert Street is clearly recognizable.

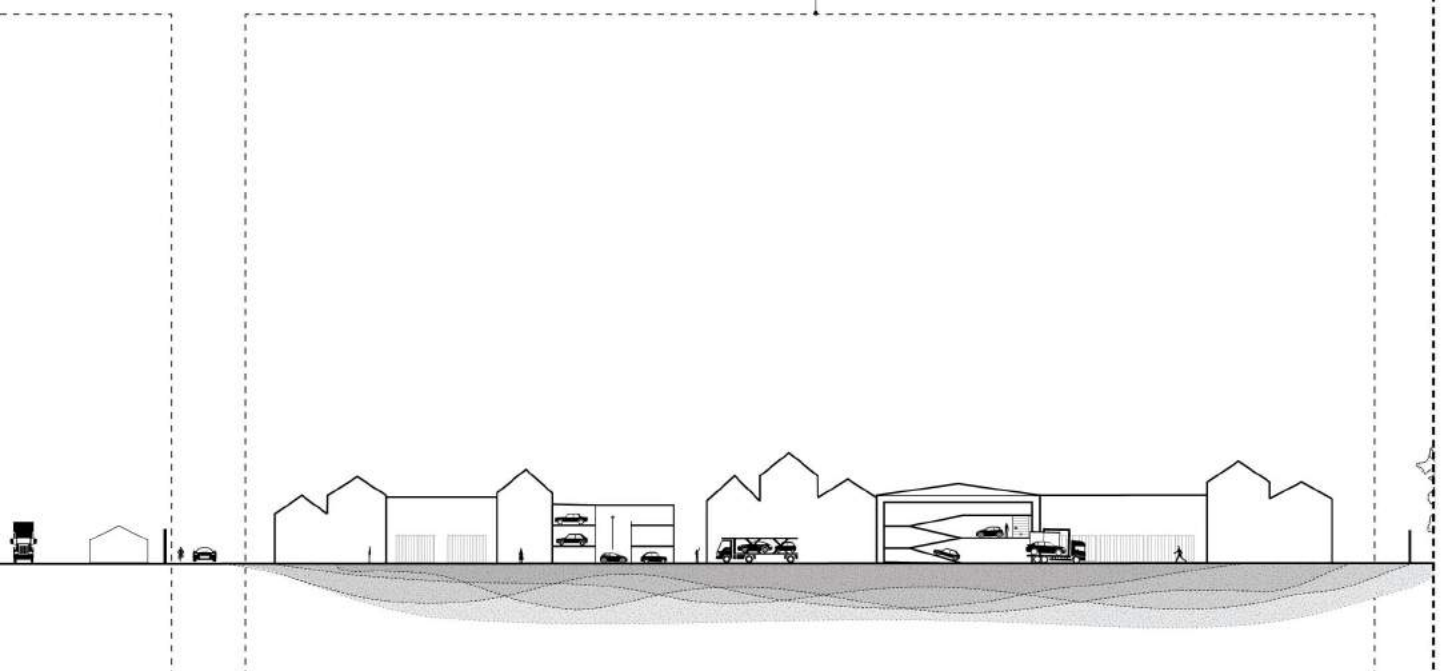
Concluding from the Urban Transect, two material flows in Birmingham stand out: Logistics and Organic Waste.





2nd Hand Car Market

sed in Quevy



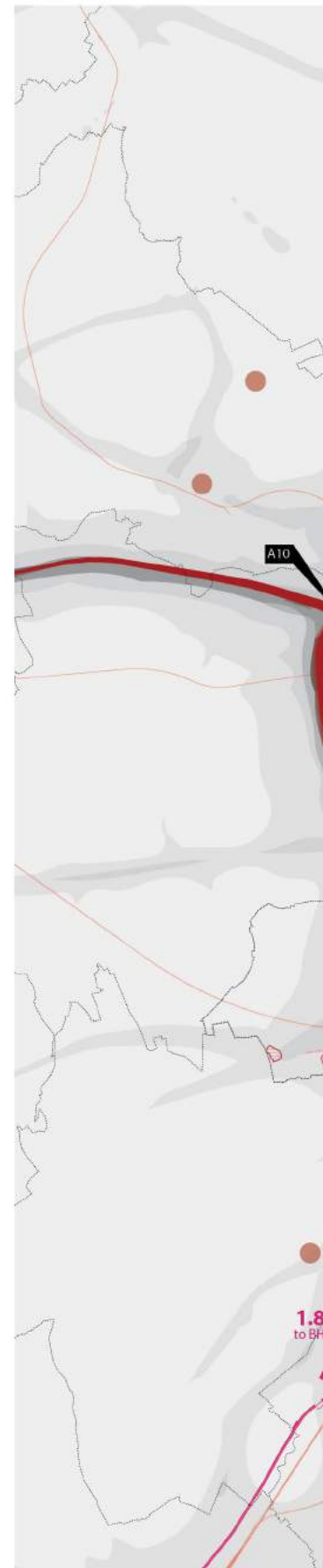


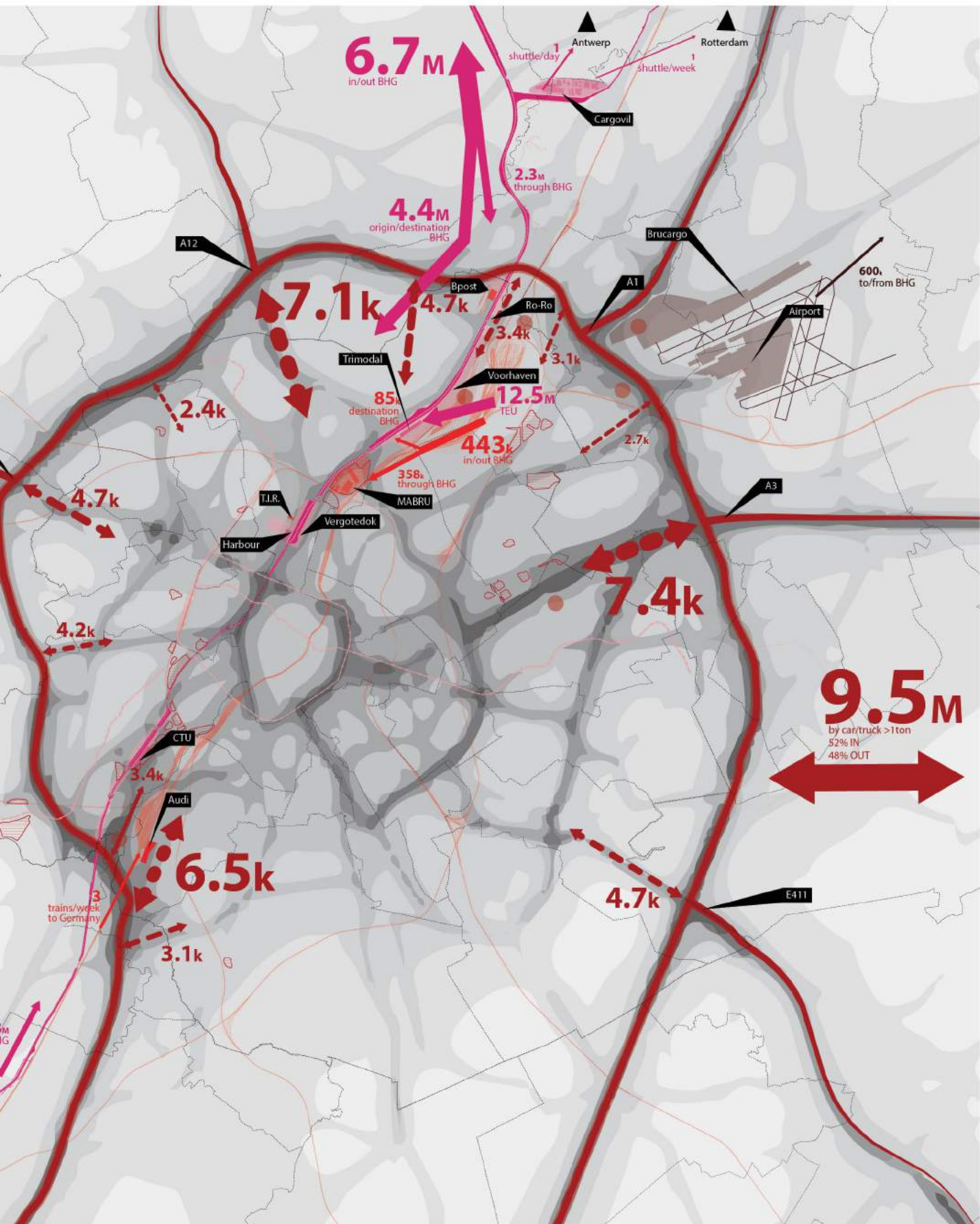
end user.

At the end of their life cycle these goods are generally transported to the incinerator by garbage truck.

FLOW MAP: FREIGHT

Mapping the flow of freight to and from Brussels on a regional scale the following picture emerges. Currently 9.5 million tons of freight is transported in and out the Brussels region every year, using car infrastructure. The Canal is used for the transport of freight as well, but its extent is smaller, resulting in a total of approximately 6.7 million tons flowing in and out yearly. Finally, the Audi factory in the south of the city operates a small part of the railway infrastructure for the supply of specific goods. For the distribution of goods through the city the dominant mode of transport is the car since Brussels city logistics is organized around a limited number of big distribution centers located in close proximity to the ring. From there, goods continue traveling by truck or are delivered to the







CONSEQUENCE: AIR POLLUTION

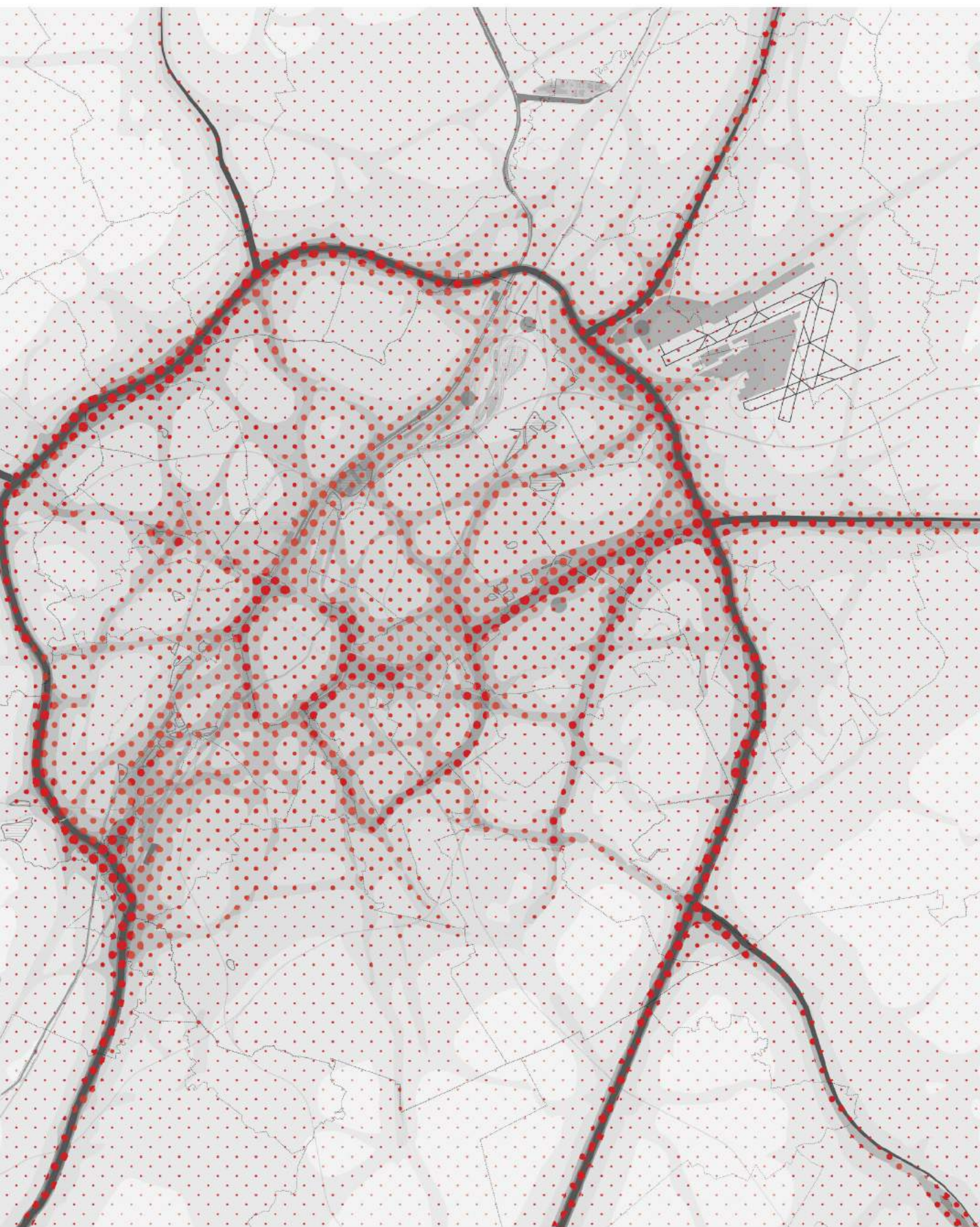
Besides the fact that trucks and vans are often not full when they deliver goods to end-consumers, and almost always are empty when going back, there are in the current distribution system more forms of losses to identify.

Decrease in air quality is one. The enormous amount of car traffic related to city logistics contributes to air pollution and poses a threat to human health. In the air quality map of the city, significant areas turn dark, indicating where NO_x emissions are high and life expectancy is under pressure.



NO_x in $\mu\text{g}/\text{m}^3$



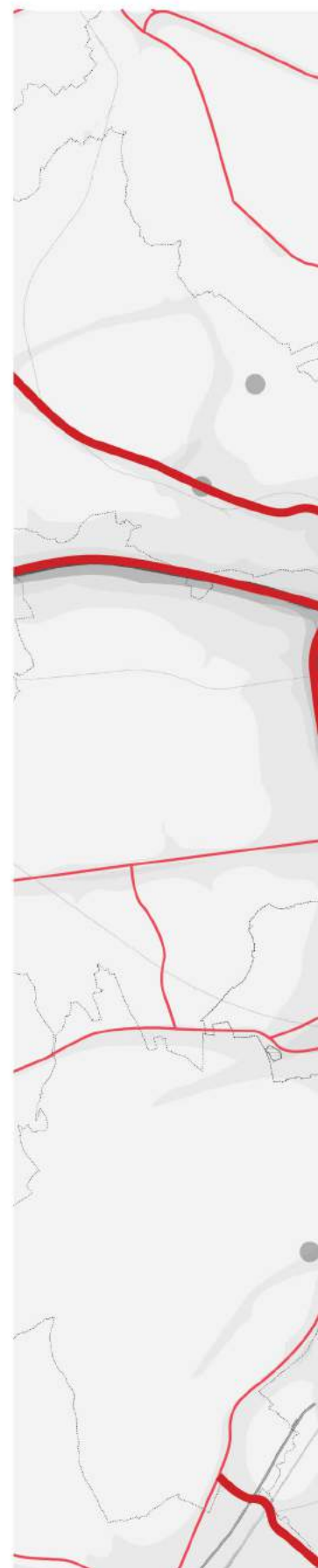




CONSEQUENCE: TRAFFIC CONGESTION

Another negative consequence is traffic congestion. In a map of time loss, car routes stand out as dark arteries. Better use of transport movements by connecting delivery to pick up points in the same area - reverse logistics - is a first step. Smarter cross-linking different modalities and making better use of different off-peak hours in these modalities could also bring improvement.

Finally, designing and introducing new infrastructure for sustainable transport is a more fundamental solution. Especially in Birmingham, it makes sense to test all the components of this Modal Shift because nodes of public transport (metro and trams), the Canal and car infrastructure here are within cycling distance from both the center and the ring.







THE AVANT-GARDE IN THE LOGISTICAL DOMAIN

conversation with
Philippe Lovens

CityDepot is a young company which is developing a strategy to improve city logistics by strengthening and optimizing flows of goods and offering storage to shops and firms growing in city centers. Their goal is to intensify those flows allowing more fully loaded trucks to circulate within the city's heart and, by that, promoting collaboration over competition in the logistic domain. They are also trying to develop reverse logistic integrating in that way the notion of circular economy. We met with Philippe Lovens, one of the five co-founders.

"Initially, the idea was to ease city centers' congestion. The aim has always been to collaborate with shops in the city center and to contribute supporting local economy. All circular economy projects are nothing more than the continuation of that."

Now implemented in 8 other cities in Belgium, CityDepot was first created in Hasselt in 2011 as a non-profit organization. By 2014 it was established that such a project could be economically viable in such a small city.

The organization then had the opportunity to take part to the LaMiLo (Last Mile Logistics) project in Brussels which was a success and proved that this type of service could be applied to bigger cities. After completing their business model, they looked for an investor and that's how Bpost entered their capital in May 2015. A year and a half ago they began operating in Antwerp, Ghent, Bruges, Charleroi, Liege and Leuven and are now planning on opening in Namur, Mons and Courtray.

The idea is to create a network of hubs at the scale of the whole Belgium.

During that implementation period several cities requested their help in finding logistical solutions to their specific issues. At first they were doing it at the same time as they were developing CityDepot but now that their operations are set, they can't experiment anymore. Hence they are launching a new non-profit organization, LoLa (Logistic Lab), which will run as an incubator for innovative ideas to solve those issues.





As they are emergent and represent a sort of avant-garde, all of their ambitions aren't achieved yet and would need further time and attention. Such is the case for their Last Mile Logistic strategy and the use of eco-friendly vehicles which aren't established in Brussels so far or, at a further temporal scale, multimodal transportation which is, for now, only an idea.

In matter of circular economy, the huge issue is to establish reverse logistic across the Brussels's Region. A circular state for such a company would be to transport as many goods as possible on their way in as well as on their way out of cities. However, although they are gaining some success in cities such as Hasselt, the Brussels Region is still resisting to this practice. The reason for that lies in the fact that Brussels isn't as much an exporter as Hasselt. Thus, in addition to the export business, they are progressively turning to waste collection. They already started with a few types of waste specific to their recipients or to logistics. For instance, they gather wooden pallets, plastic and carton packaging, glass and sometimes even electronic devices.

They now aspire to further develop this activity to truly fill their trucks on their way back. They are even thinking of creating something particular for the construction domain. As they believe it is a separate

flow, the idea would be to implement a Consolidation Centre dedicated to construction materials.

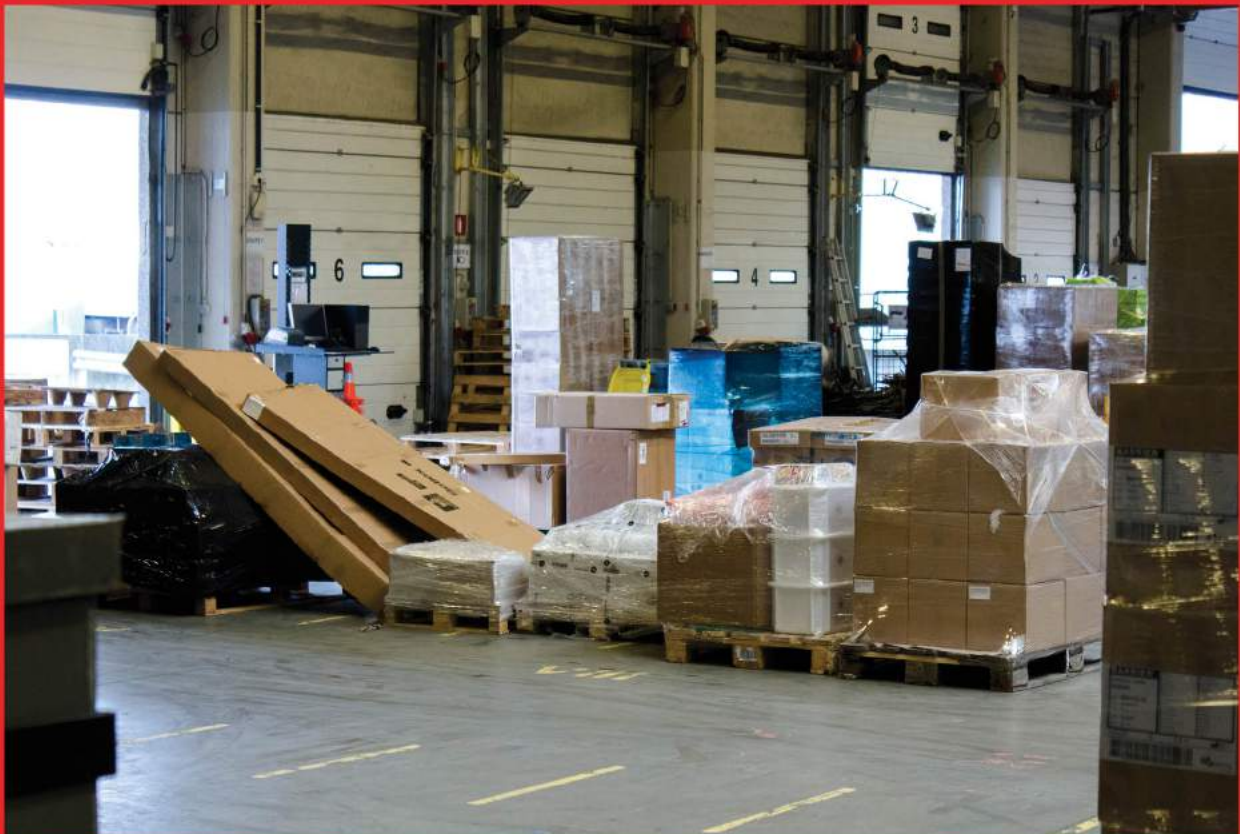
"The idea is to, someday, have a specific Consolidation Centre and then work with actors such as Rotor. We're not there yet but hopefully a test will soon be conducted in Brussels."

However, at the moment they can only transport clean waste such as cardboard, pallets or glass. That would be a serious drag which could only be overcome by changing the current range of vehicles. As this is not an option, they could only concentrate on things that can be transported on pallets or on completion materials.

Nevertheless, in order to consider any new collecting process, they first need to find existing sectors to transfer the waste they plan on collecting and massifying in their distribution center.

"The part we can play as a transporter is to close the loop. The challenge is in finding existing sectors but what we can do is really to physically connect people."

To get to know actors from those existing sectors and start working with them on concrete projects, they entered the PREC (Regional Plan for Circular Economy). For



instance, together with Oxfam and Les Petits Riens, they are now figuring out in what way they can contribute to clothes collection.

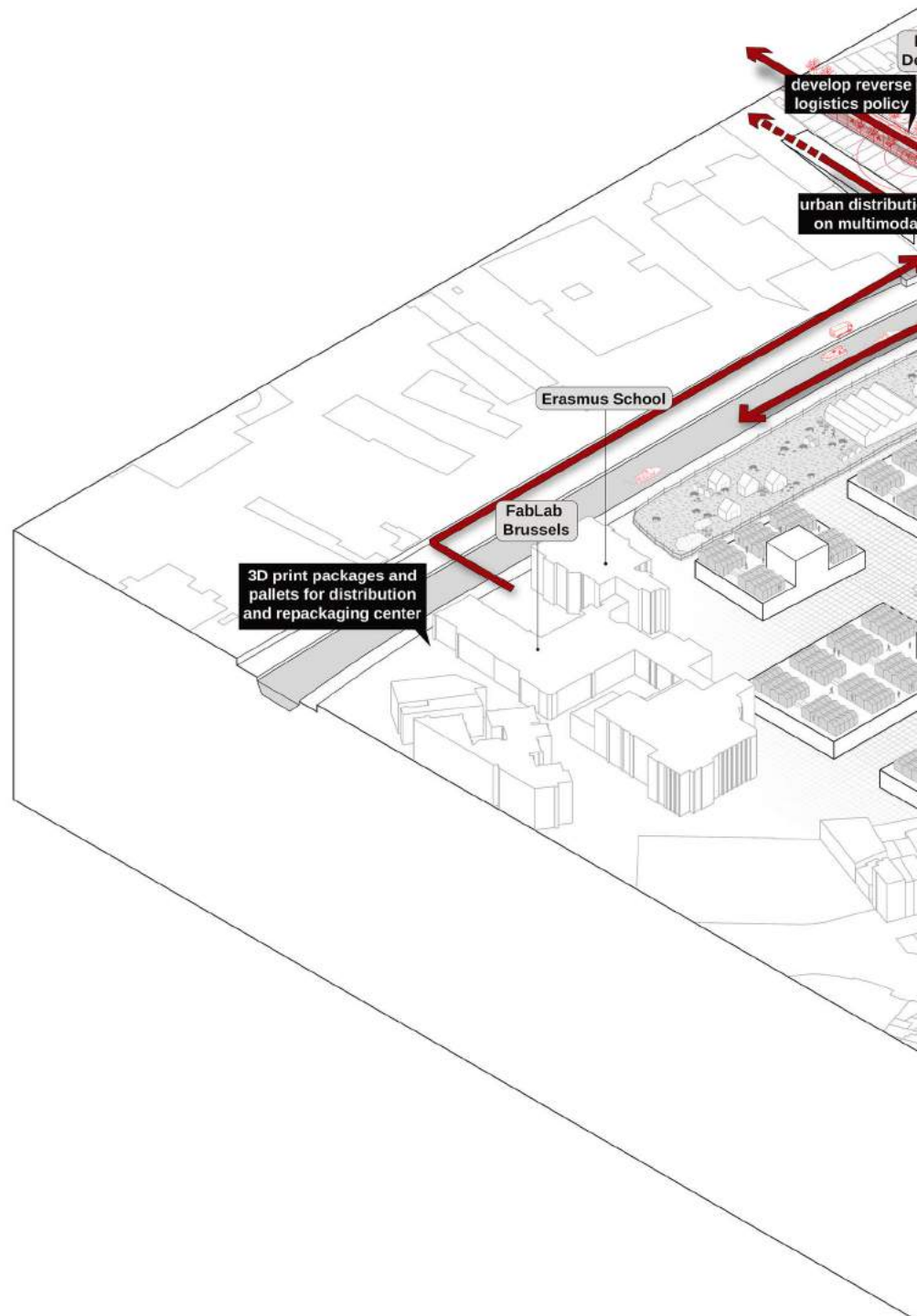
"We have yet to meet with ABP¹ as there are a lot of possible synergies. Indeed, we reach places they aren't used to go to a, therefore it's a partner we have to meet."

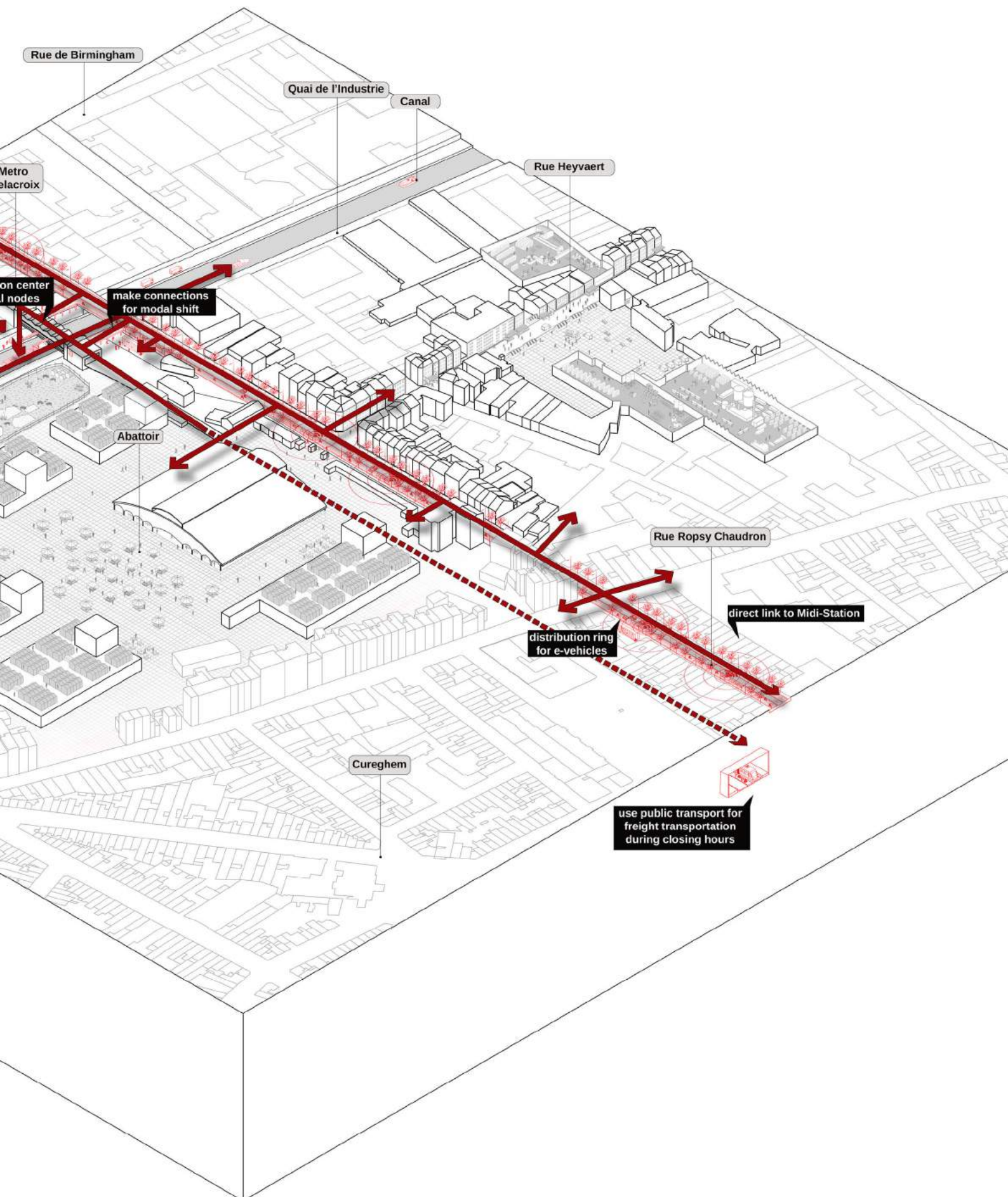
1 - In french Bruxelles-Propreté, the public actor of the region responsible for waste collection and environmental issues.



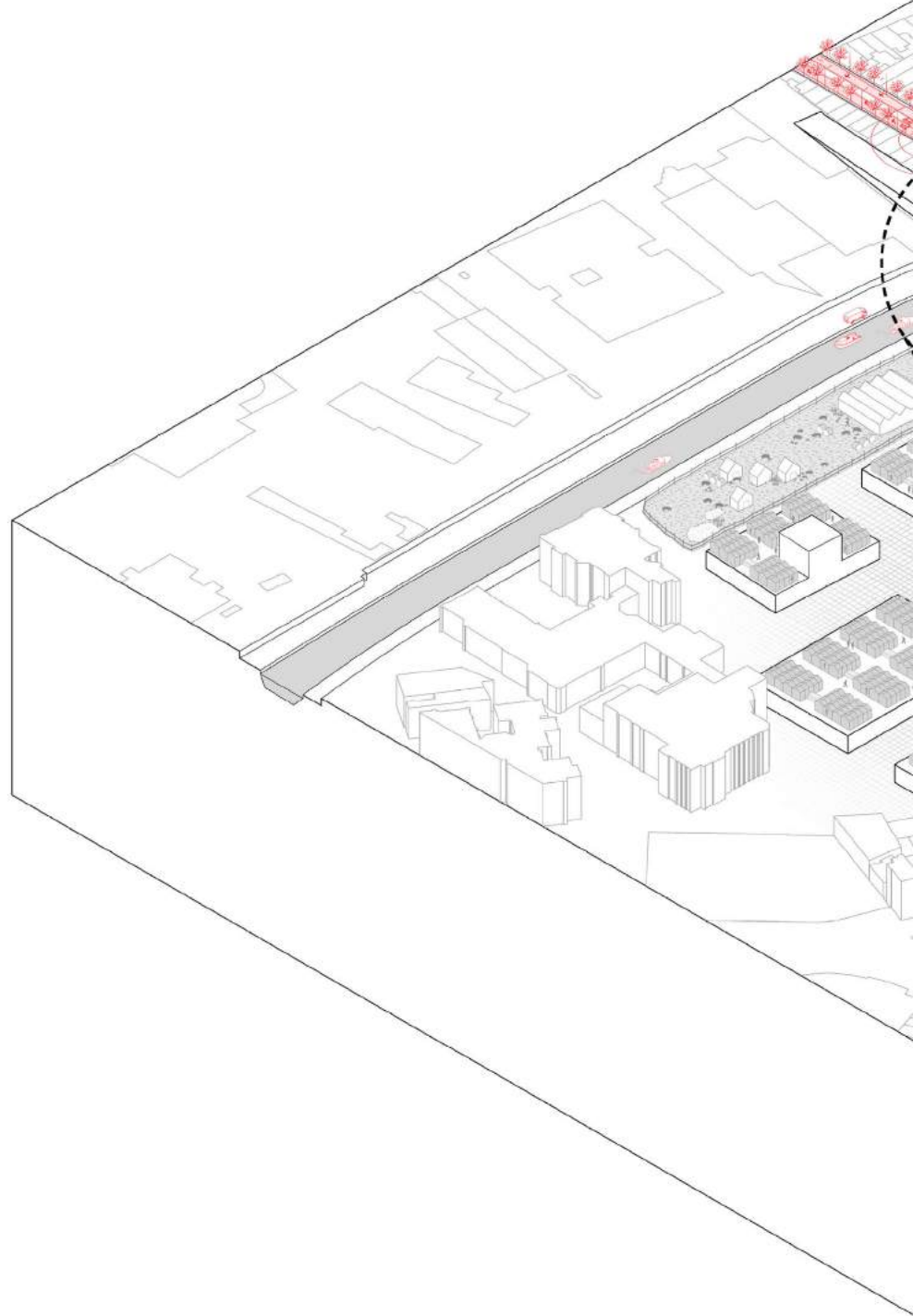
MODAL SHIFT

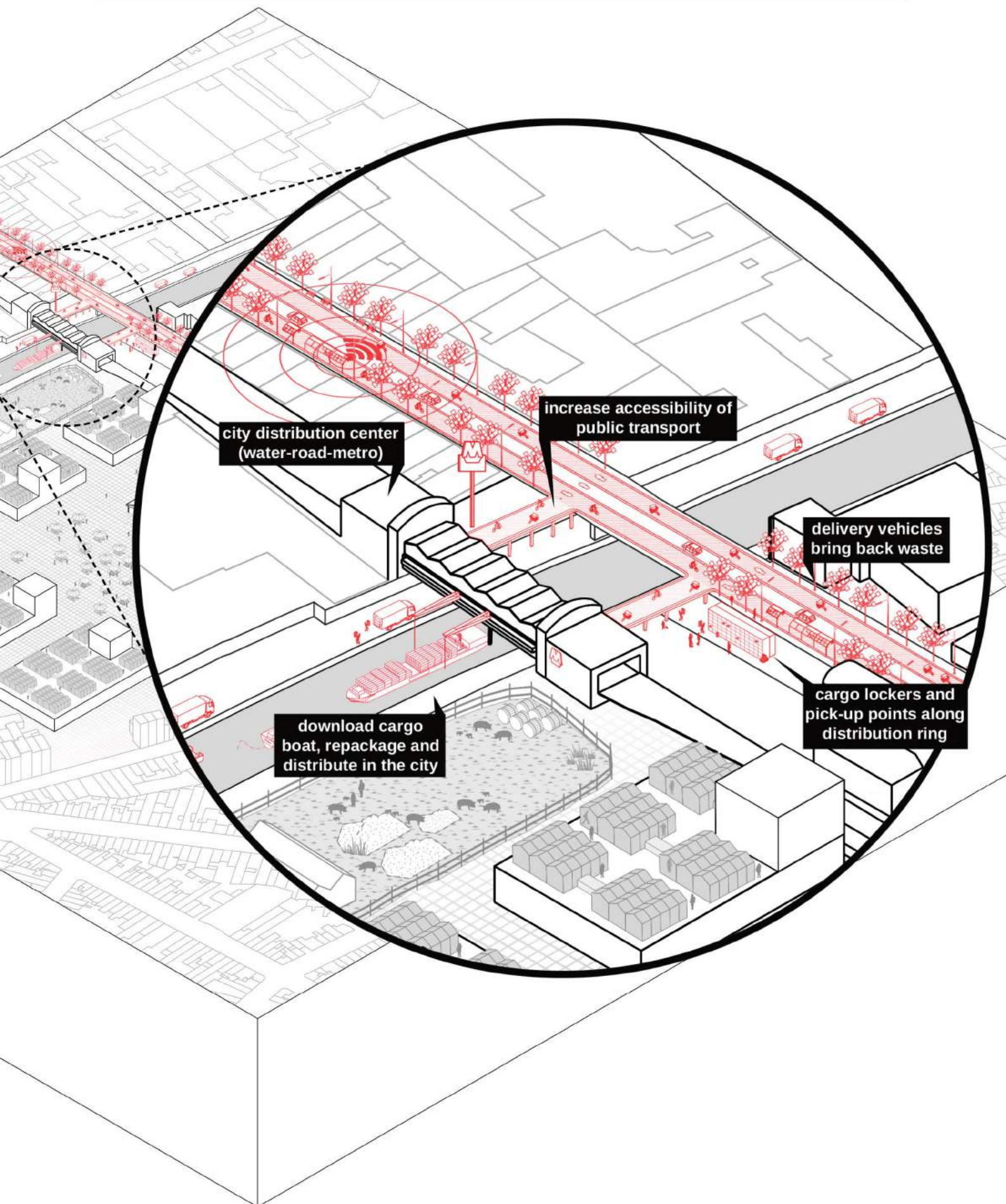
In order to reduce the motorized freight traffic that currently passes right through the city center, and to accommodate the needed Modal Shift an e-loop is needed. The e-loop is a newly designed inner ring for electric traffic. The trajectory of the ring is composed by connecting existing trough ways. Cargo hubs connect the e-loop with the motorway network, with public transportation and with the canal. This new inner loop is positioned within cycling distance from both the city center and the ring, making it plausible that all freight will be distributed to end-users in the whole city using human powered modes of transportation.

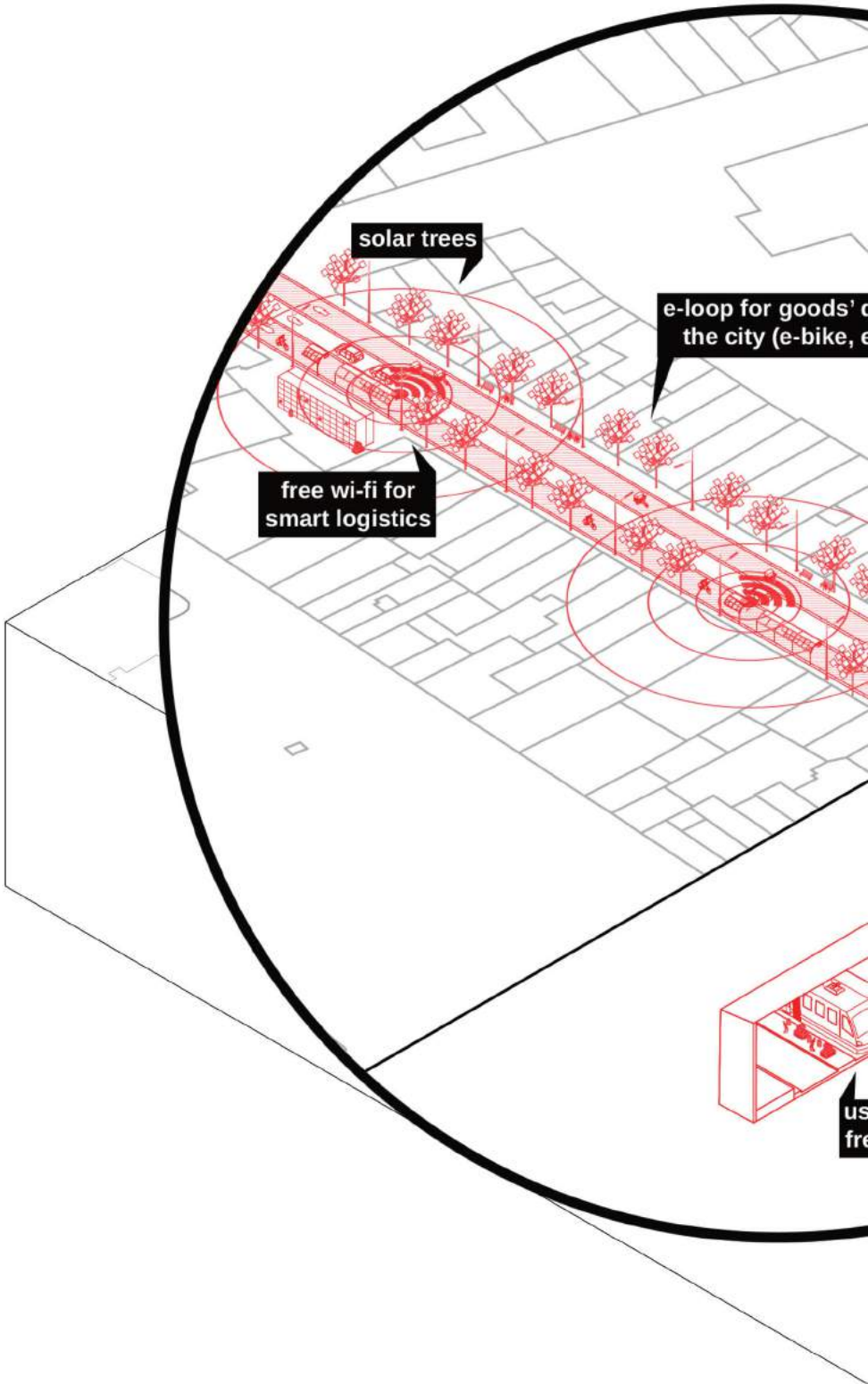


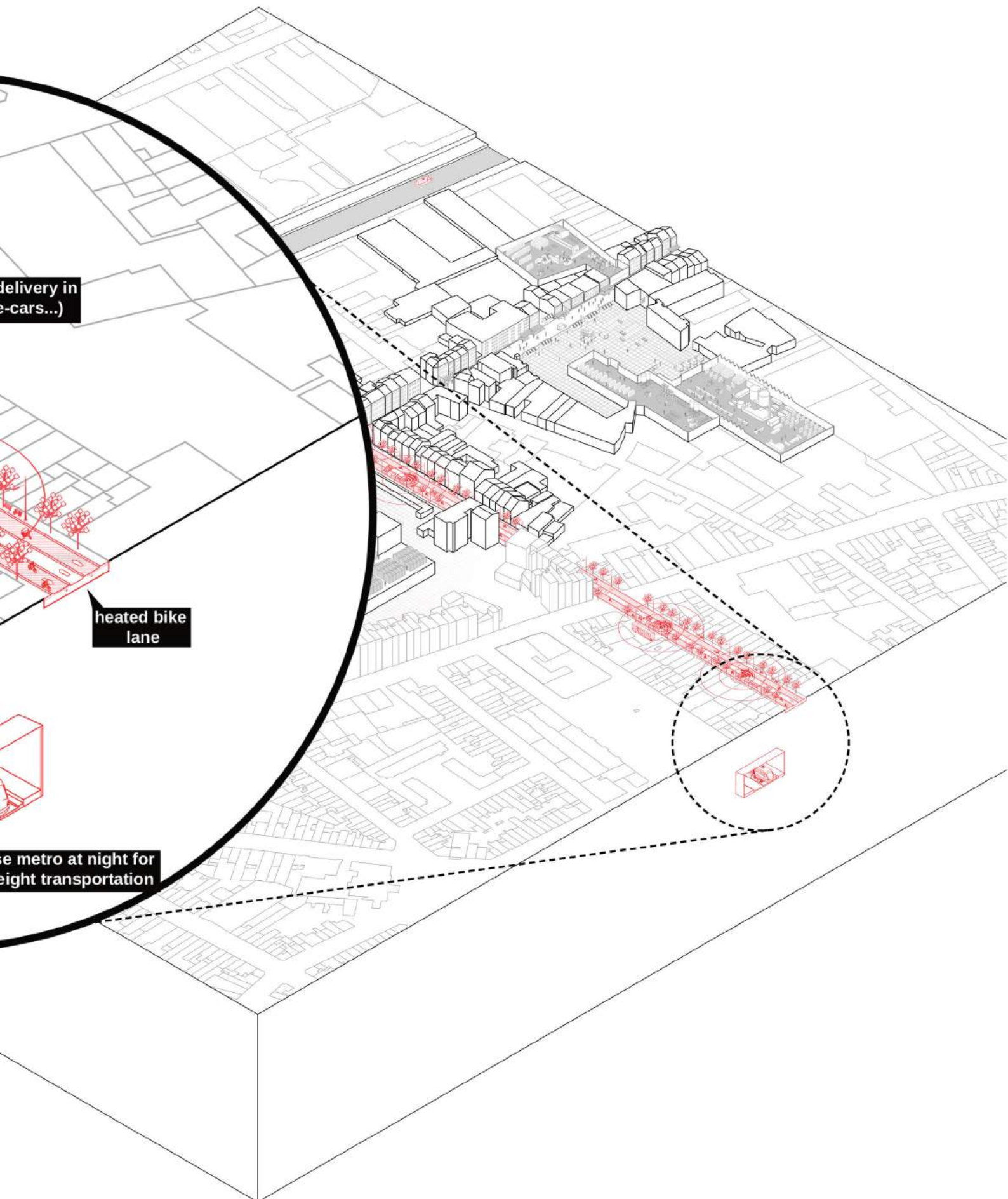


Along the loop, hubs are installed – for instance at Delacroix station. At these points, loads are transferred within a dense distribution network that comprises bicycles, electric delivery vans, boats, cargo lockers and pick-up points.











**CITIES ARE A TESTING
GROUND FOR SMART MOBILITY**
conversation with Tom van Lier

We talked with Tom van Lier at the exhibition in Bozar A good city has industry, in Brussels. Van Lier is a postdoctoral research associate MOBI led by Prof. Cathy Macharis at VU Brussels. His main focus is evaluating sustainable transport solutions according to cost/benefit analysis from service companies to private end users.

When looking at the logistic flow in Brussels, road transportation appears to be the clearest issue with intense traffic congestion and increasing air pollution. Is there any less visible urgency that you would like to point out?

One aspect that we are always struggling with is the lack of data: very general data are available in huge quantities and are currently not processed, they mainly concern the trucks above 3.5 tons which are the only ones that are required to pay km charge. The smaller vans are not registered and are constantly raising,

driving through the city poorly loaded or even empty: it's absolutely not sustainable but definitely less expansive. The increase of ecommerce and home deliveries is changing the way urban freight is delivered: when people are not home the trucks have to pass a second time, or they send stuff back, generating consistent reverse flows.

It's a complex and controversial issue: on one side smaller vans are much easier to maneuver through the city but on the other hand they create a much larger congestion and this fragmentation in small units is not sustainable. Our research group at MOBI includes a team of economists and engineers studying technological improvements such as long lasting batteries for small electric vehicles and making current or future means interesting on the market.

What are the tools that MOBI has developed to overcome this controversial decision-making process concerning the mobility of goods in the city? Are there pilot projects where you've been able to test them?

The Multi-Actor & Multi-Criteria Analysis (MAMCA) is the main tool we've developed and we apply it in various circumstances when we have several alternatives to compare. Each scenario has different solutions and they all bring



different impacts, the MAMCA is a social cost-benefit analysis from different points of view. It consists in 7 steps: the first one is to identify alternatives (1) and the stakeholders (2) that will be impacted by the scenario. For instance, for freight distribution there are 5 categories of stakeholders: the shipper sending the good, the transportation company bringing the goods around the city, the receiver, then there are two additional actors, the government and the citizens, representing the societal point of view. The next step is to identify the criteria (3) and weight them (4), a company for example will be more interested in speed improvement while government will

enhance sustainability and costs, citizens will focus on traffic safety and noise pollution, the shipper on the quality of his delivery system. It is important therefore to evaluate the different alternatives (5), every stakeholder looks at a specific solution from a different perspective and scores them with different criteria, we have to evaluate the impacts (6) for each stakeholder taking into account their own criteria. The MAMCA doesn't result in stating the perfect solution, it is a tool meant to analyze and visualize (7) how several alternatives impact the different stakeholders on specific criteria. It can be very useful when developing a new strategy, if you realize that it doesn't score

well for a certain category of stakeholders, you can think of side solutions to implement it.

In the past, all the pilot projects that the Government has set up stopped right after the testing phase just because a certain category of stakeholders turned out to be too penalized. If you can have a better overview on the impacts of a certain strategy and find out in advance what aspects will generate a bottleneck, you can use this awareness to implement them since the start; people will feel heard therefore will be more open to accept innovation.

Another interesting tool is the Location Analysis Model for Belgian Intermodal Terminals (LAMBIT). It's an intermodal simulator looking at the market area of an intermodal terminal. To reach sustainability goals, a modal shift is surely required and for instance in Brussels this means increasing goods' transportation over water and rails. Having a harbor in the city center and the possibility to reorganize cargo distribution are a unique opportunity. At the moment, the port of Brussels is mainly used for importing raw building materials, import/export of second-hand cars and a very little container activity. But there is much more potential in its capacity. If you want to create a new intermodal terminal, the Lambit looks

beyond the Brussels territory: this tool studies the different municipalities around the designated area for the terminal and analyzes the economic advantages of a container activity from those municipalities to the terminal. The possibility to palletize construction materials has created new opportunities to transport them, for instance using the waterways. When planning an intermodal terminal you also have to take into account if there are enough palletized goods in the surroundings that would make it economically interesting. The most important parameters become then distances and volumes.

What do you think will be the spatial impact of these multimodal nodes at the urban scale? How will a modal shift impact the city and the design of its infrastructures?

I find the idea of an e-loop quite interesting. It would be great to have urban distribution centers nearby the city center, well connected to the water and road infrastructure. Previous studies showed that between 50 and 58% of all logistics flows in the city can theoretically be transported by bike. It's a big number but it also has important costs because of the fragmentation of the deliveries and because of human labor. In reality, it would be impossible to put the whole 58% of goods on bikes, not only for its costs but

also because you would have to change the whole infrastructure.

Spatial design is crucial to make cities more sustainable. There is still a lot of unused capacity in the transportation system such as using the public transport during off-peak hours or improving the use of waterways and rails; but this also means reorganizing the whole infrastructure, it has to guarantee a certain fluidity, maybe separating logistics from leisure, otherwise it would collapse. It's a constant attempt to optimize the available space, maybe the taxi & bus lane could be shared with small electric vans at specific moments of the day.

Another aspect is that buildings are now often inhabited by a hundred of small companies and they all have their fragmented deliveries. You can easily find out that 200 trucks are delivering goods in the same place within a single day. It's invisible from the front side of the building but people living on the other side start complaining about the amount of trucks congesting their streets. Moreover, very often these buildings are not designed to receive so many daily deliveries and it's rare to find that loading docks have been integrated in their initial design. This is something that architects should take care of, otherwise the trucks will keep stopping in the middle of the street to load

and unload their cargo. Charging spots for electric vehicles are already located in the city but nobody knows exactly where they are; many stakeholders are still reluctant to switch to electric mobility, they are worried about its costs and efficiency. The e-loop would be the perfect ground to test new technologies and make visible existing facilities.

What role does reverse logistic play in the global picture? What are the possible scenarios to implement it?

I consider it crucial: it would partially solve the problem of empty vehicles circulating through the city. With the growth of e-commerce, this problem should be bundled from a regulatory perspective: if the shipping costs would be internalized, the amount of transports would be consistently reduced.

This fragmentation is even more relevant for the construction logistics flow. Thanks to the BIM (Building Information Model) system, you can actually control which building component has to be where and at what time. As you suggest in the Circular Scan you carried together with TNO and Circle Economy for the city of Amsterdam, in the future, transportation companies will remain the owners of the materials in the building and they will be responsible for recovering them when the time to demolish comes. They are

immediately notified about any change or maintenance on the building. I also share the idea that, after dismantling, materials should immediately become available to be relocated on another project, a stock market for building materials should exist. Materials often arrive much in advance and lay on site for months until they are not useful anymore and have to be sent back. By using a BIM model you can actually plan and bundle deliveries but also avoid reverse flows.

Some transportation movements are inefficient because of their very low loading rate, but some others are just unnecessary. When thinking about possible solutions for sustainable transportation we take into account the 4 A's: *awareness*, making stakeholders aware of the impact of their movements; *avoidance*, the most logic and efficient way is always to avoid the transport; *act & shift*, if you can't avoid it then try to make it as sustainable as possible; *anticipating new technologies*, making sure that future technology can easily be integrated in the system. Flexibility is an important aspect: the transition to electric vehicles (from renewable sources) is indeed the way to go but in the future there might be new technologies impacting mobility and we need to leave some space for implementation. To evaluate the sustainability of a specific solution,

we do an external cost calculation: we try to estimate the actual impact, not only in terms of air pollution and CO2 emission but also noise, congestion and safety. For example, for logistics e-highways there are different options: we can either install a network of cables to which the vehicle can hook up automatically and then achieve its last mile delivery with its own battery, or we can install a battery inductive charging on the roads. The first one requires additional poles along an existing road while for the second one we would have to dismantle the whole road network. The external cost calculator has a policy impact: the European commission is aiming at a full internalization of external costs and companies are more and more aware of this.

What is the role of political borders in the implementation of logistic network in Belgium? Is there a homogeneous improvement through national policies?

When the km charging has been introduced, each region was entitled to adopt the scheme that suited them the best. For instance, Brussels is the only region where taxes are not applied on smaller vehicles. For some companies it's more convenient to stop at the regional border and enter the Brussels with the small vans below 3.5tons. But the fact that freight mobility is completely privatized

somehow makes things easier, for public mobility is even worse: the regional public transport works but connections between regions are very poor. For people mobility these borders are bigger, at the regional but also local scale (between the different municipalities). This is also one of the reasons why some concrete good solutions have been refused in the past. Sometime the only way is to show the economic added value of a proposed strategy. Public transport though is on top of the hierarchy of political agendas while freight is quite low. The city of Brussels is now reconsidering the importance of a freight plan as they realized that if you want make a city attractive and livable you also have to deliver goods in a very efficient way.



REFERENCE PROJECT

The Calgary Peace Bridge is an example of successful new bicycle infrastructure to accommodate an increasing number of people commuting to and from work utilizing Calgary's pathways. The bridge is used by 6000 people a day and has ranked among the top 10 architectural projects and among the top 10 public spaces of 2012. The next challenge is to design as well for freight and still create these high quality public spaces.



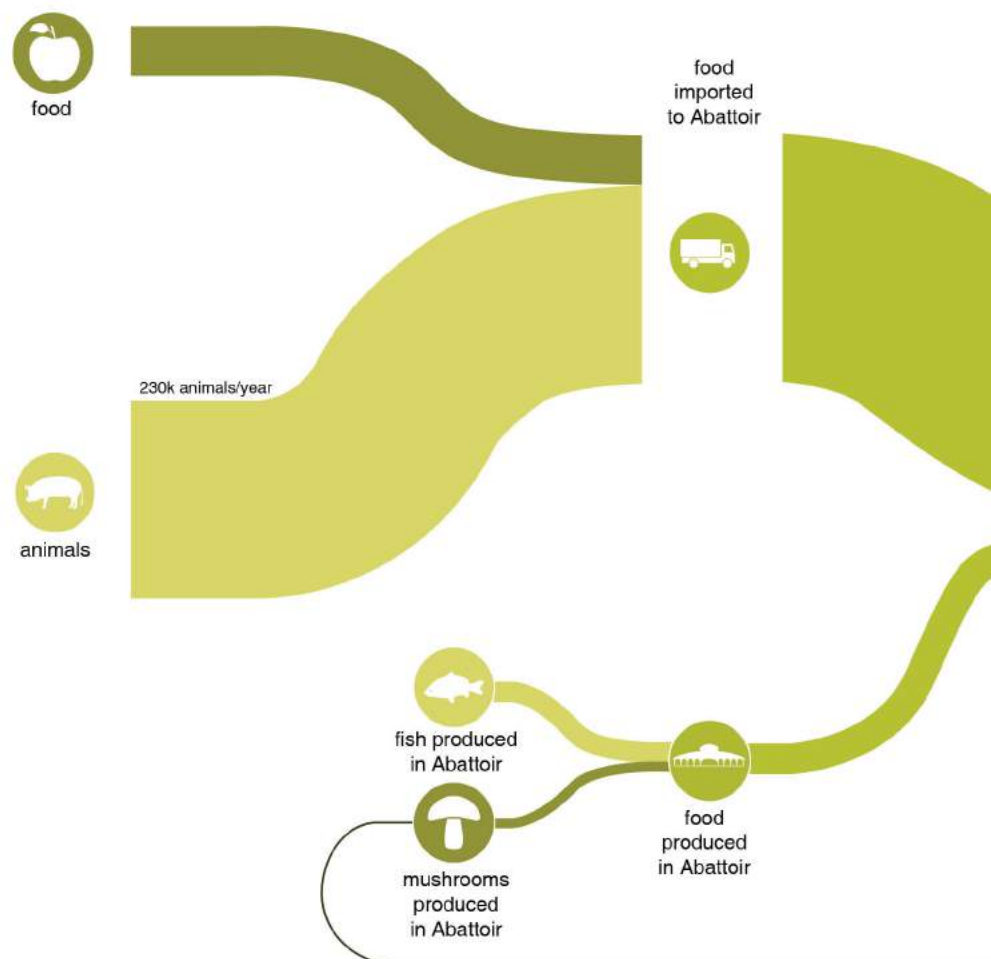


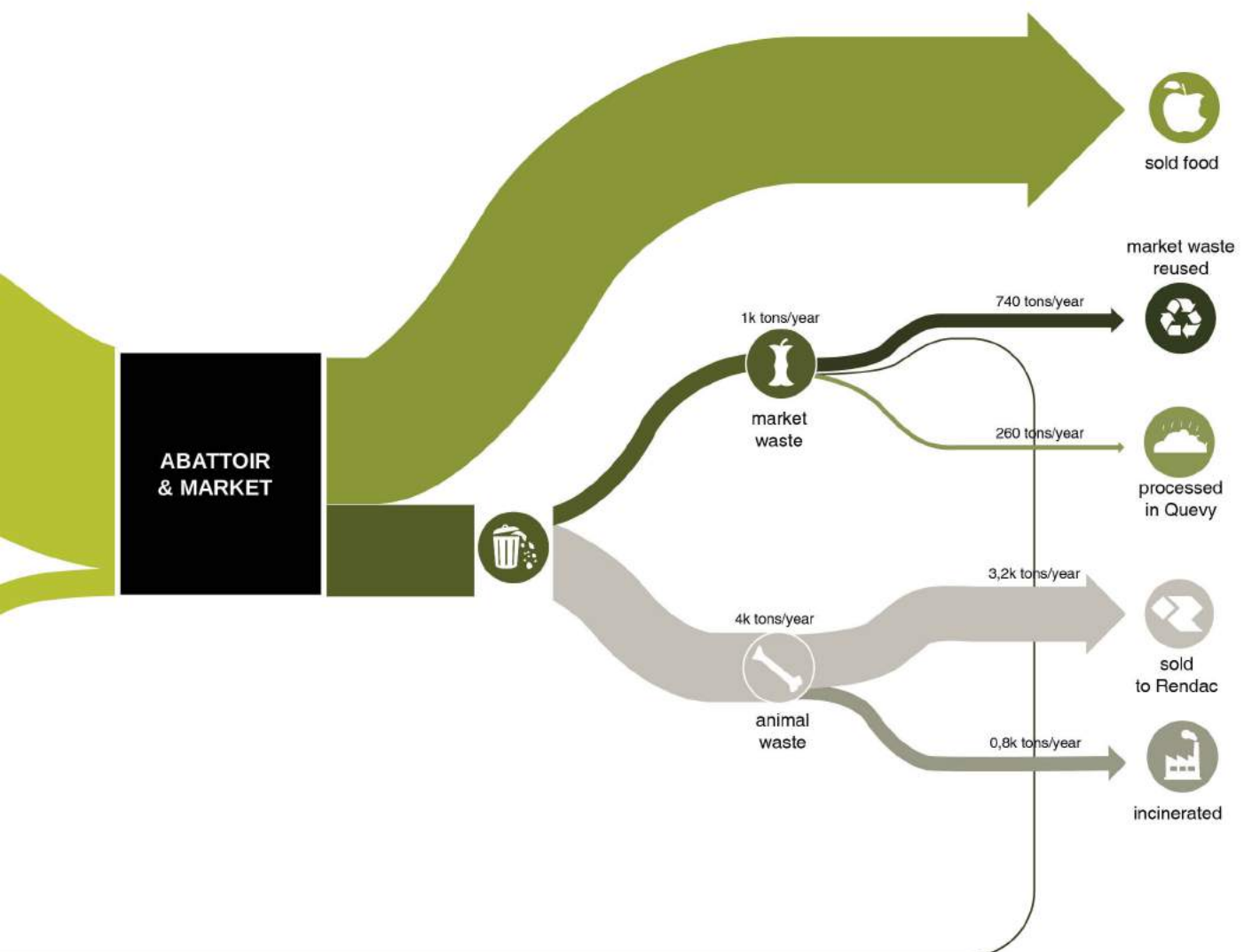
REUSING ORGANIC WASTE

When it comes to organic waste in Birmingham, Abattoir and its food-market is a big and interesting player.

The Abattoir produces 4 kilo tons of animal waste each year of which 80% is sold to Rendac, a company situated 20 km away. Also the food market produces 1k ton of organic waste per year, which is transported by truck to Quevy, at the border with France.

The question is how Abattoir could improve its organic waste since it is already quite optimally organized. The observation that in our Western culture a relatively large part of the animals that are slaughtered remains unused - for chicken this comes down to 32%, but for sheep this is about 48% - gives space to explore other options.



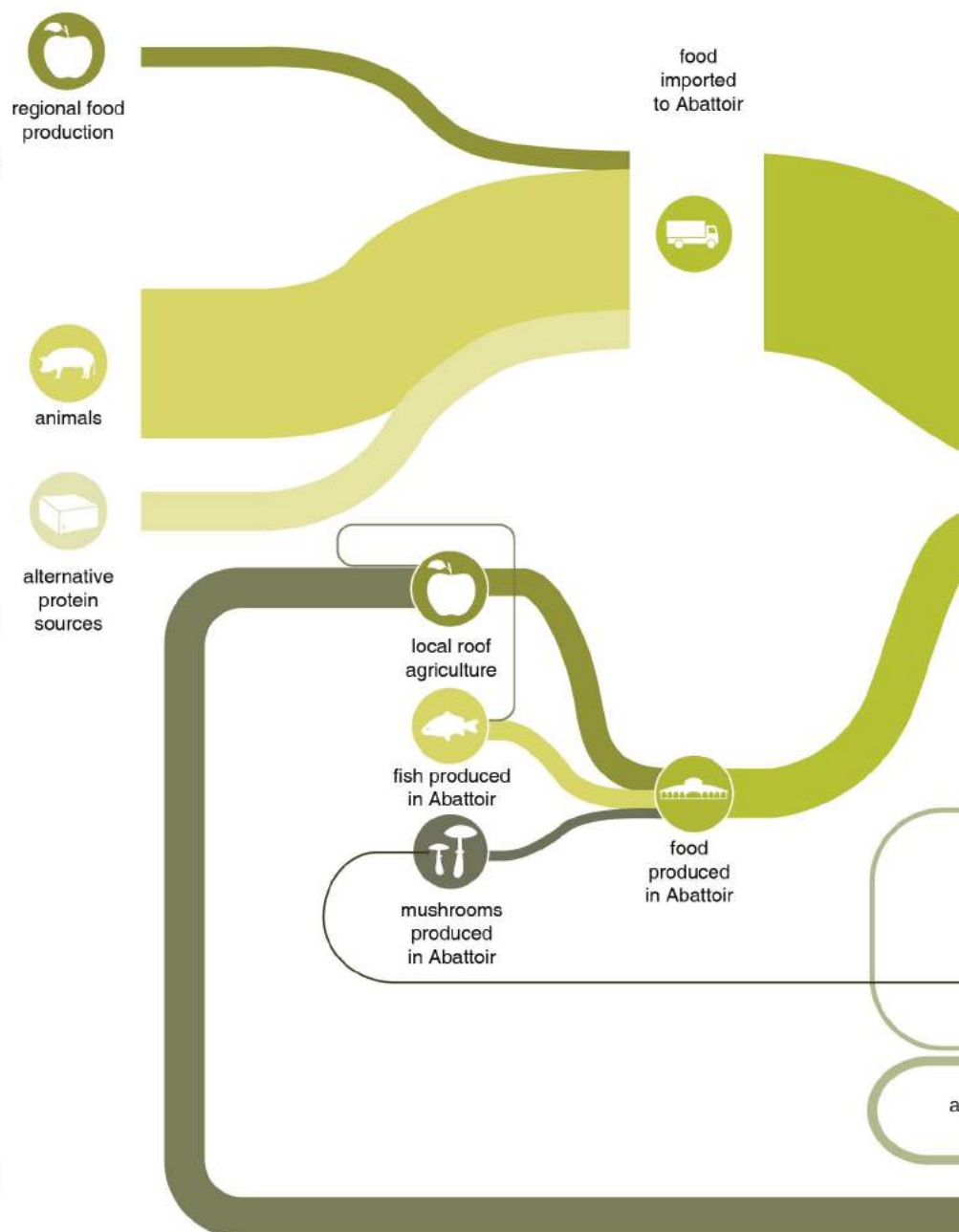


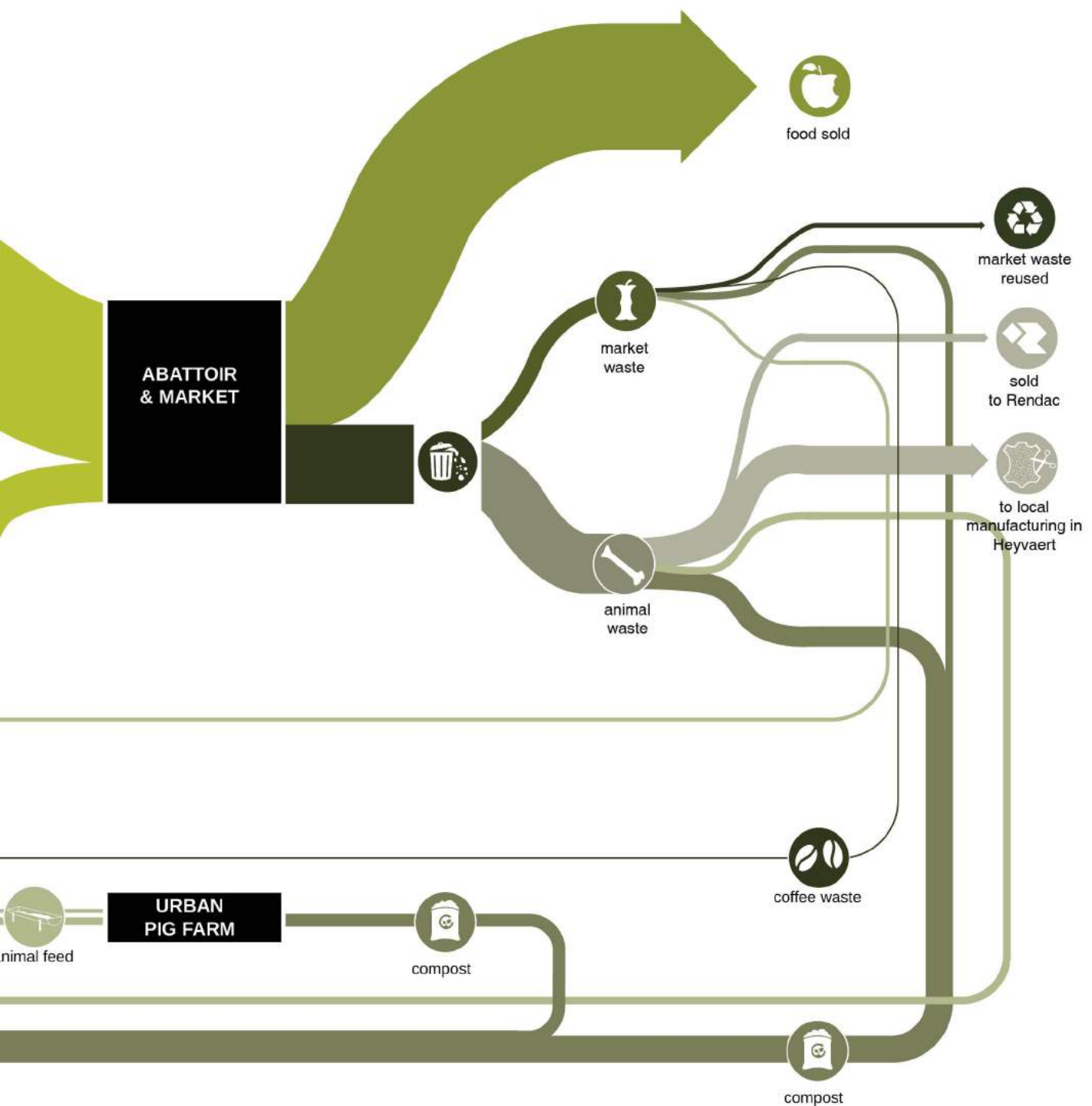
As already proposed by Abattoir itself, a specific part of the organic waste stream that is not derived from slaughter products may be used to grow mushrooms. But there are also examples in which, under controlled conditions, animal waste is re-used as a nutrient for other animals.

The existing plans of Abattoir to breed fish using aquaponics could benefit from this. Also an educational application is imaginable: setting up a leftover- farm, not to significantly contribute to meat production, but as an opportunity to illustrate the complete cycle.

Even more important than producing actual food, Abattoir could also invest in using a fraction of their animal waste for widening and diversifying products.

It is known that what is not used for human or animal consumption can still be used to make a very wide range of products and create new industries. The palette ranges from leather industry to cosmetics and even printing industry. Abattoir thus can become a local source of secondary materials rather than a producer of waste.



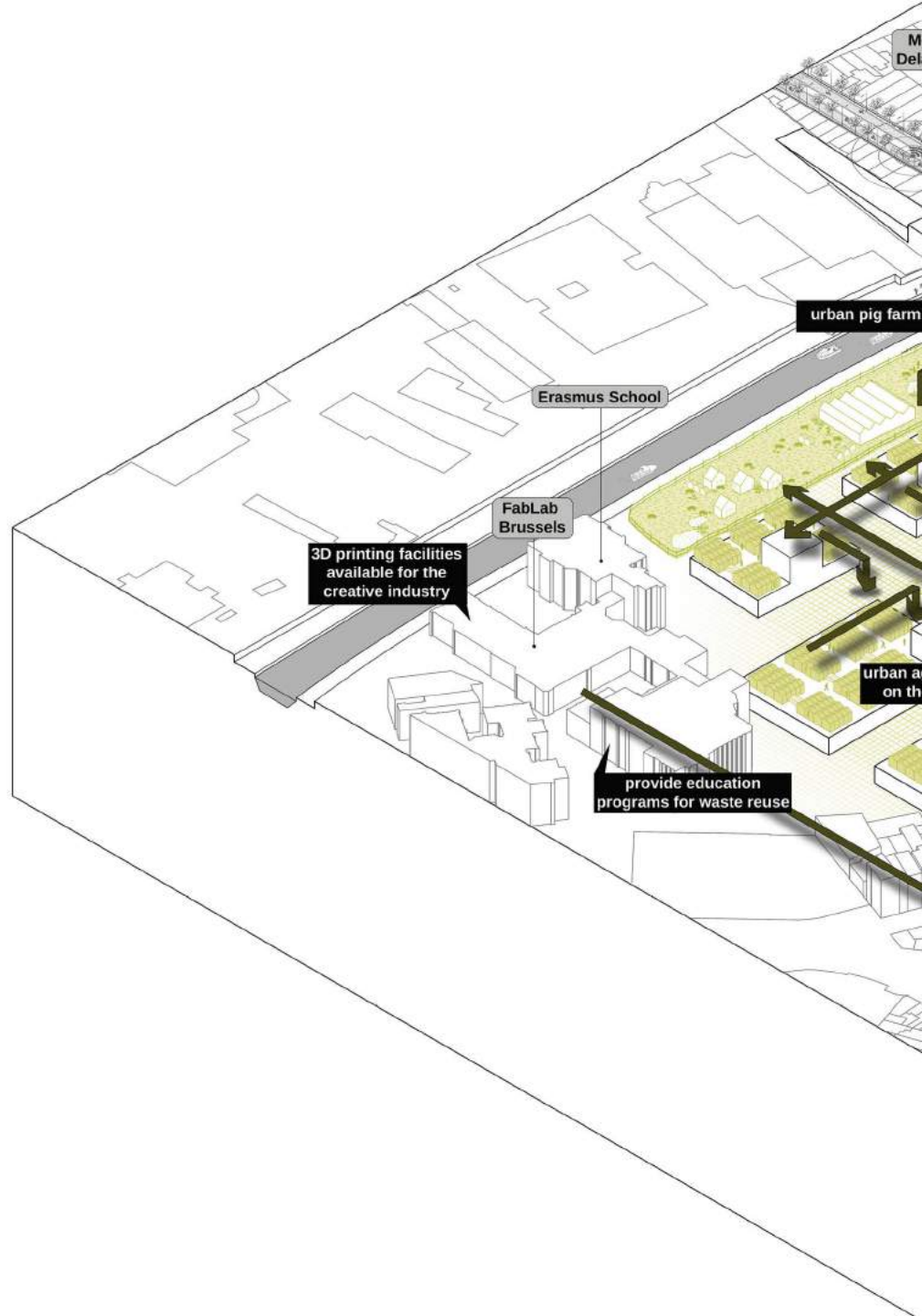


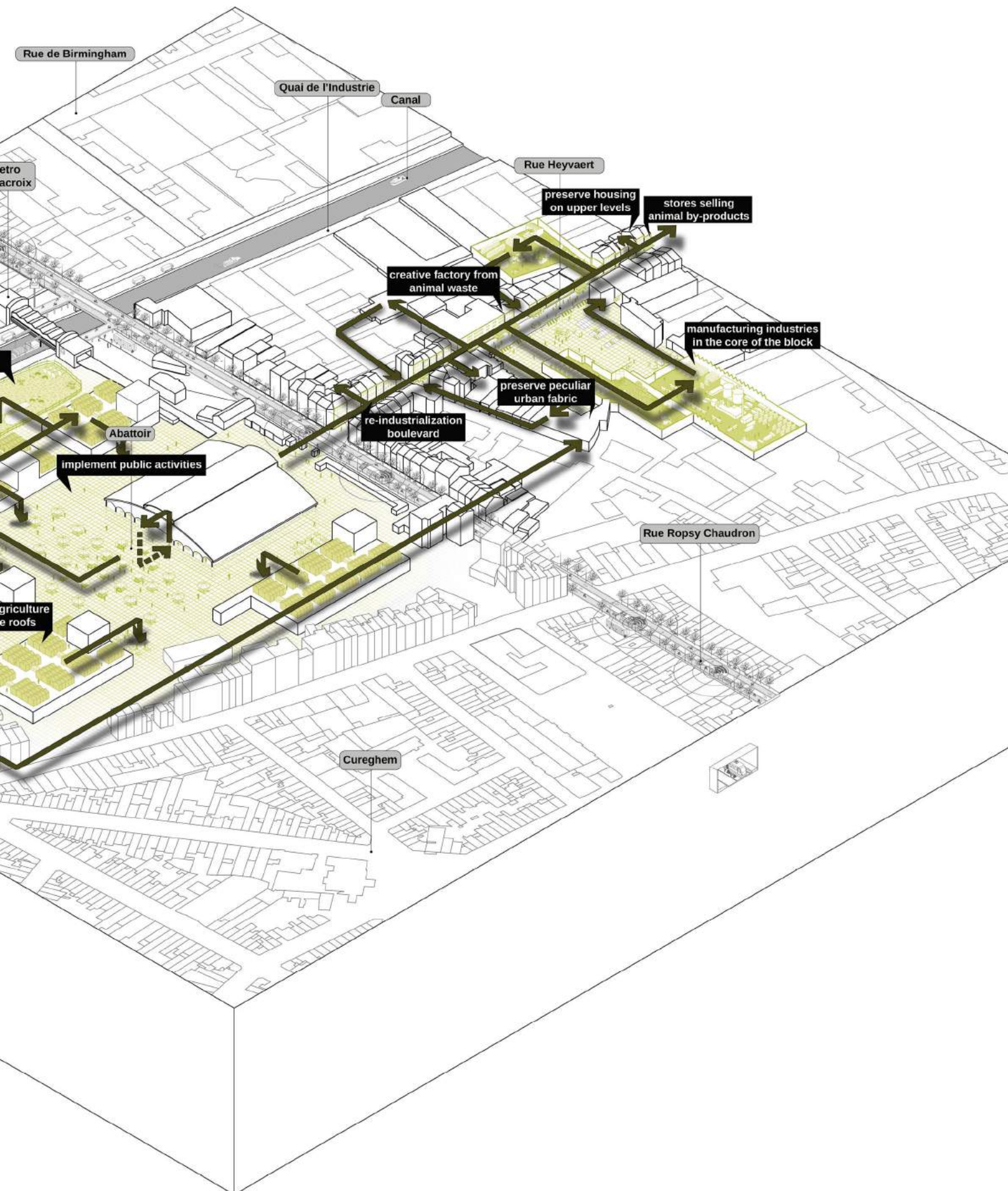


ANIMAL WASTE AS A NEW ECONOMY

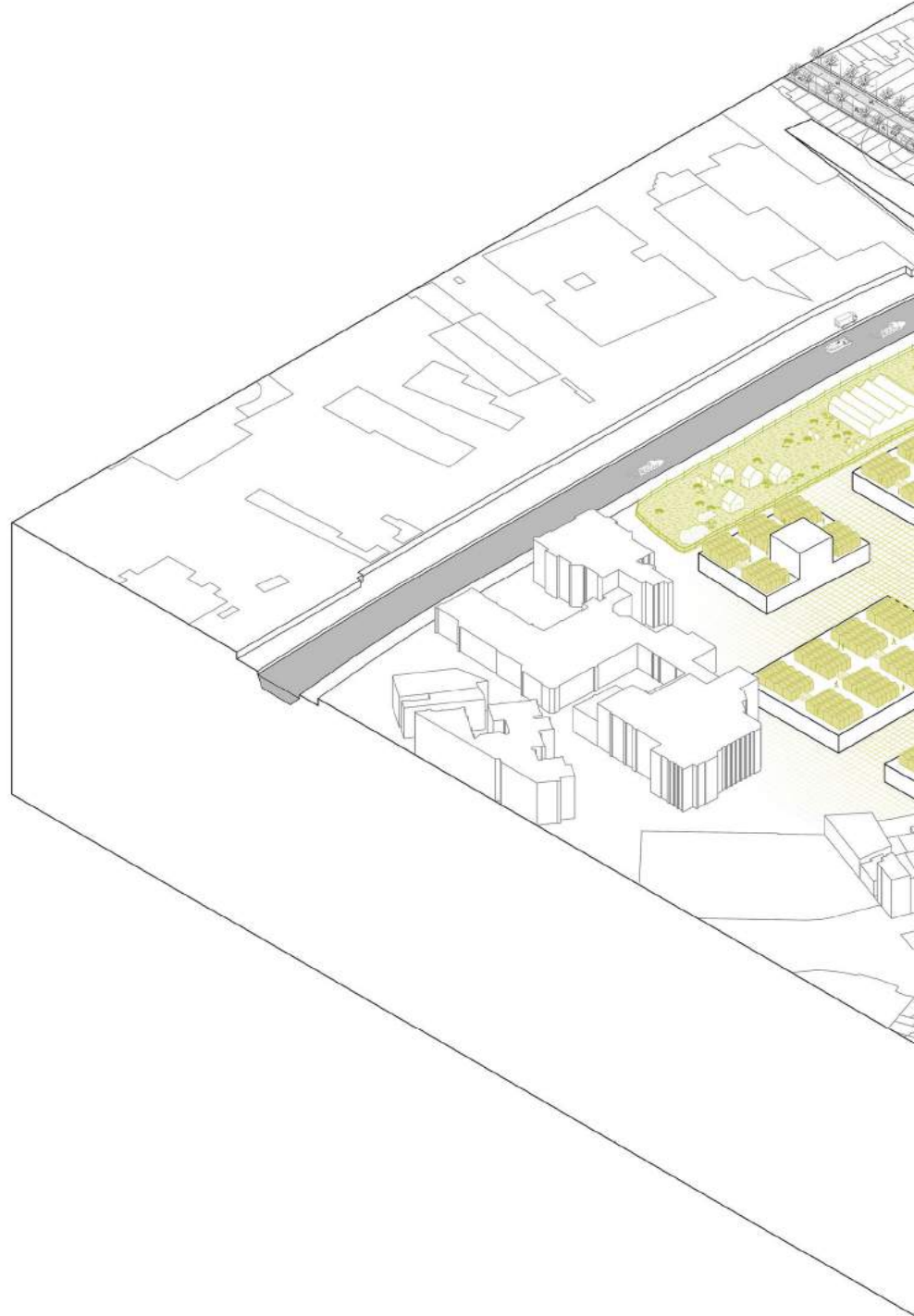
With the moving out of the second hand car activity from the adjacent Heyvaert neighborhood to the new roll on-roll off terminal at Schaarbeek, many low qualified jobs threaten to flee the neighborhood. Furthermore, approximately 10 hectares of the land currently occupied by car trade activity will become vacant.

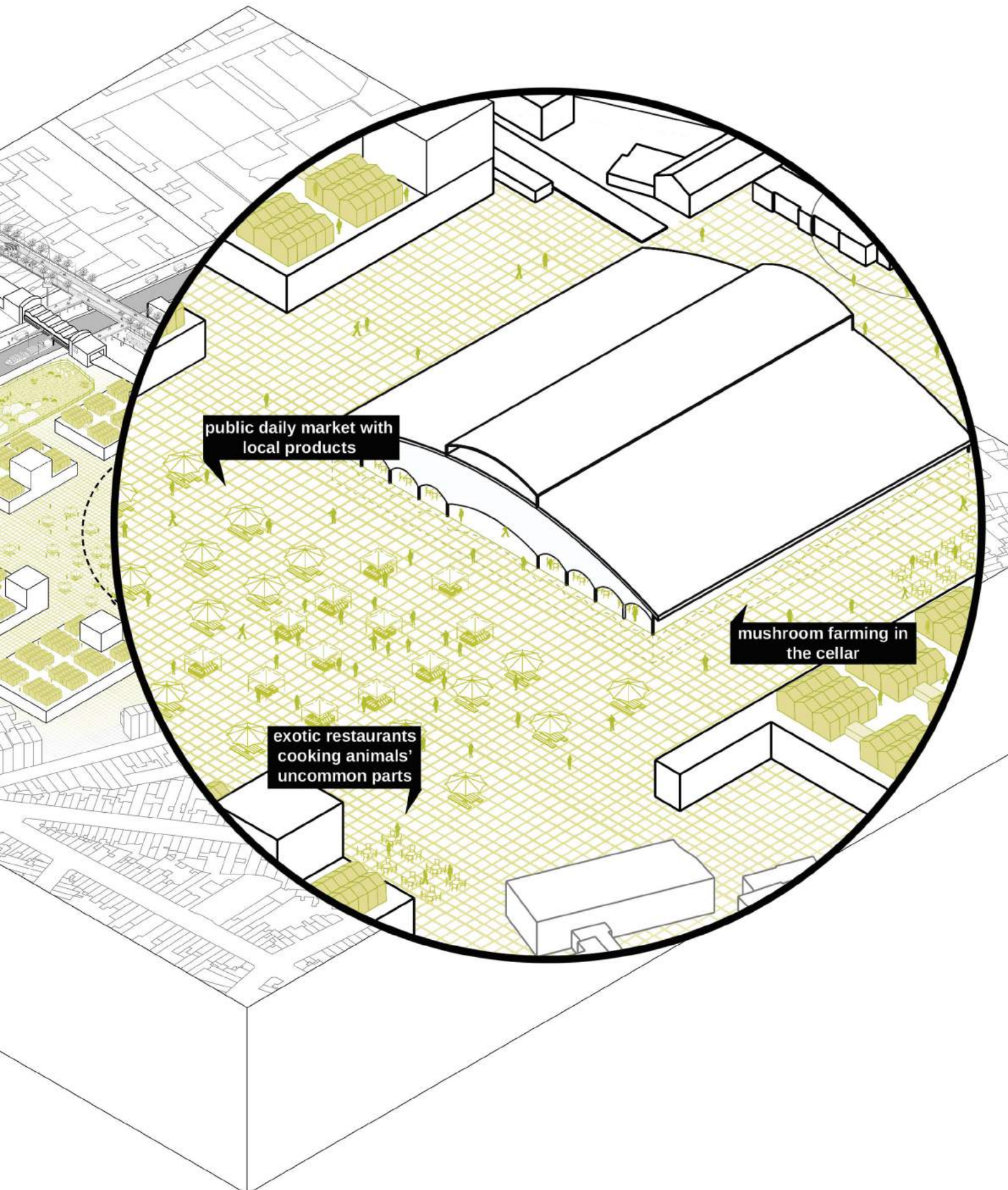
Traditionally related manufacturing industry clustered around Abattoir, resulting in a unique urban fabric. With the departure of the second hand car market that managed to inhabit this tissue, it is now likely to fall prey to thorough transformative to a conventional residential area as can be seen at other locations along the canal.



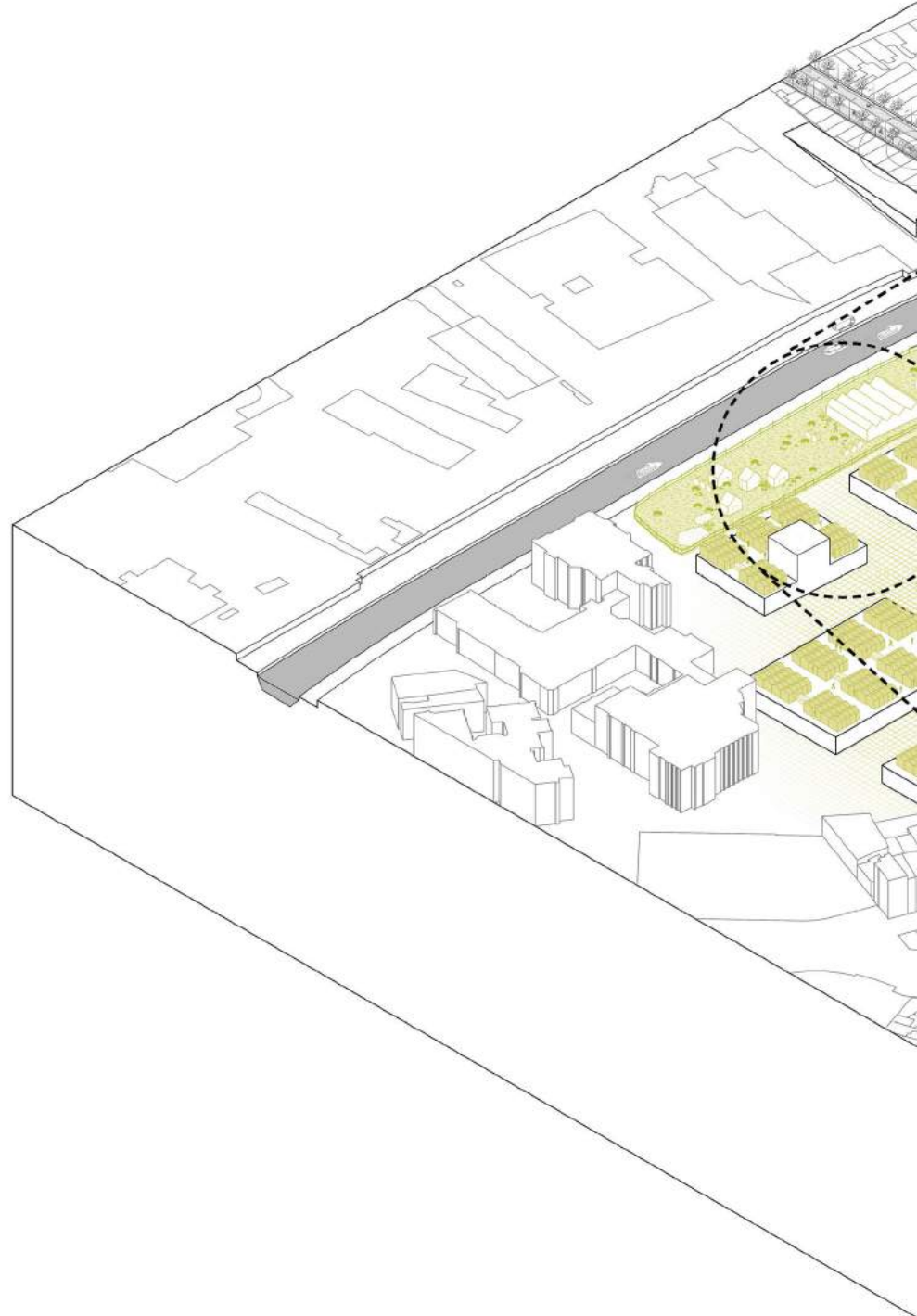


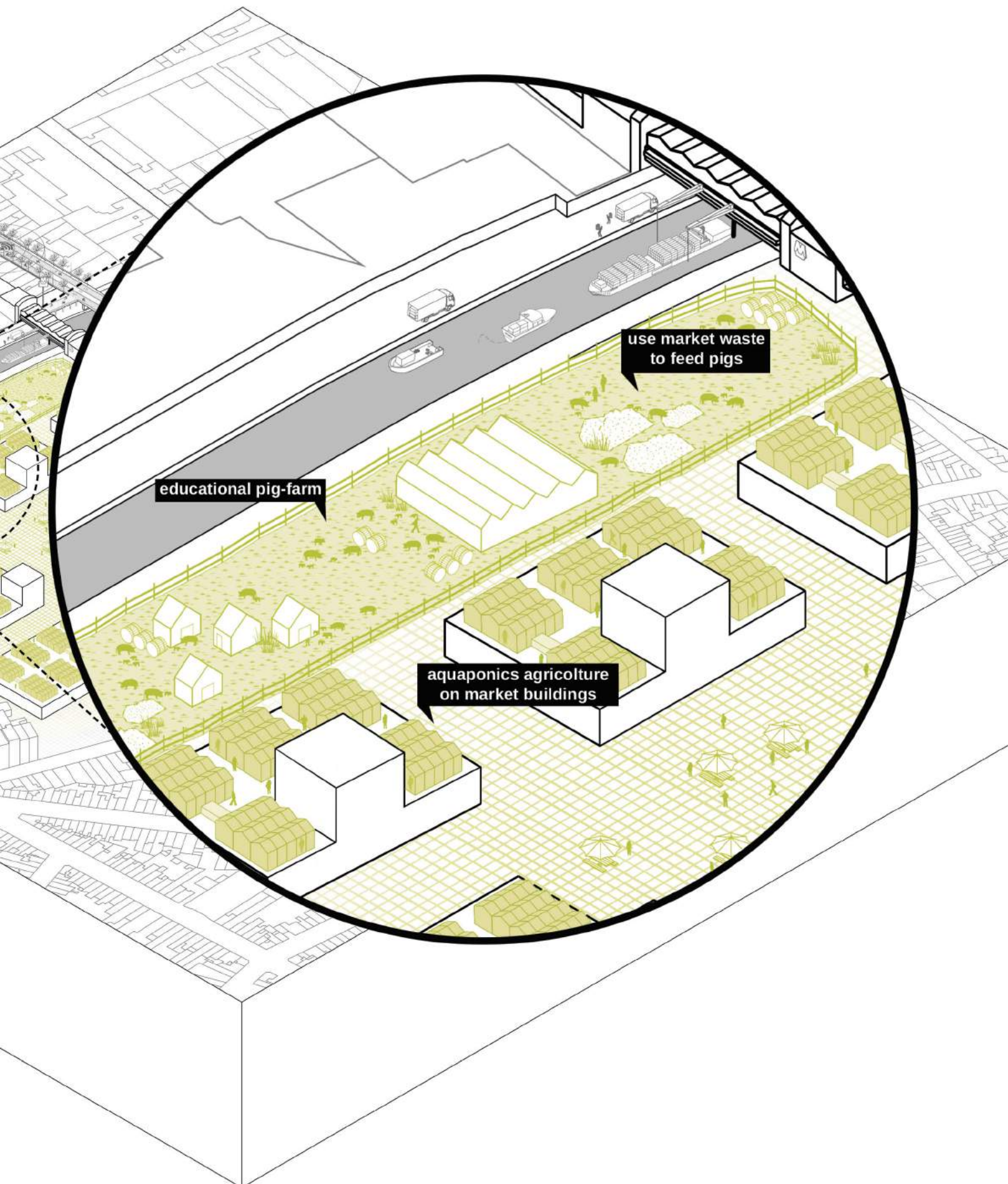
Knowing that Abattoir has the ability to develop into a supplier of secondary materials for an industry that traditionally inhabited Heyvaert Street, a unique urban situation is created.



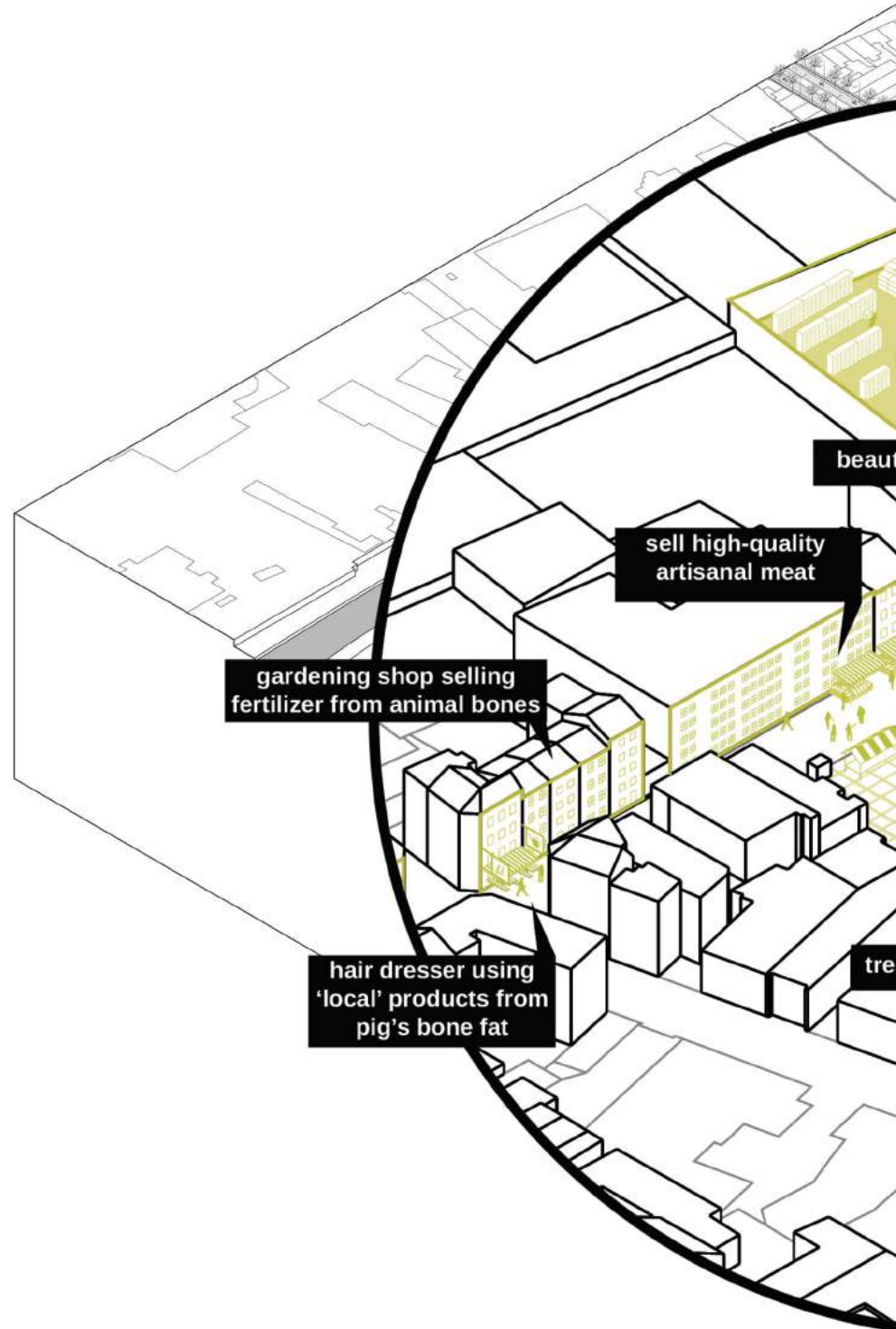


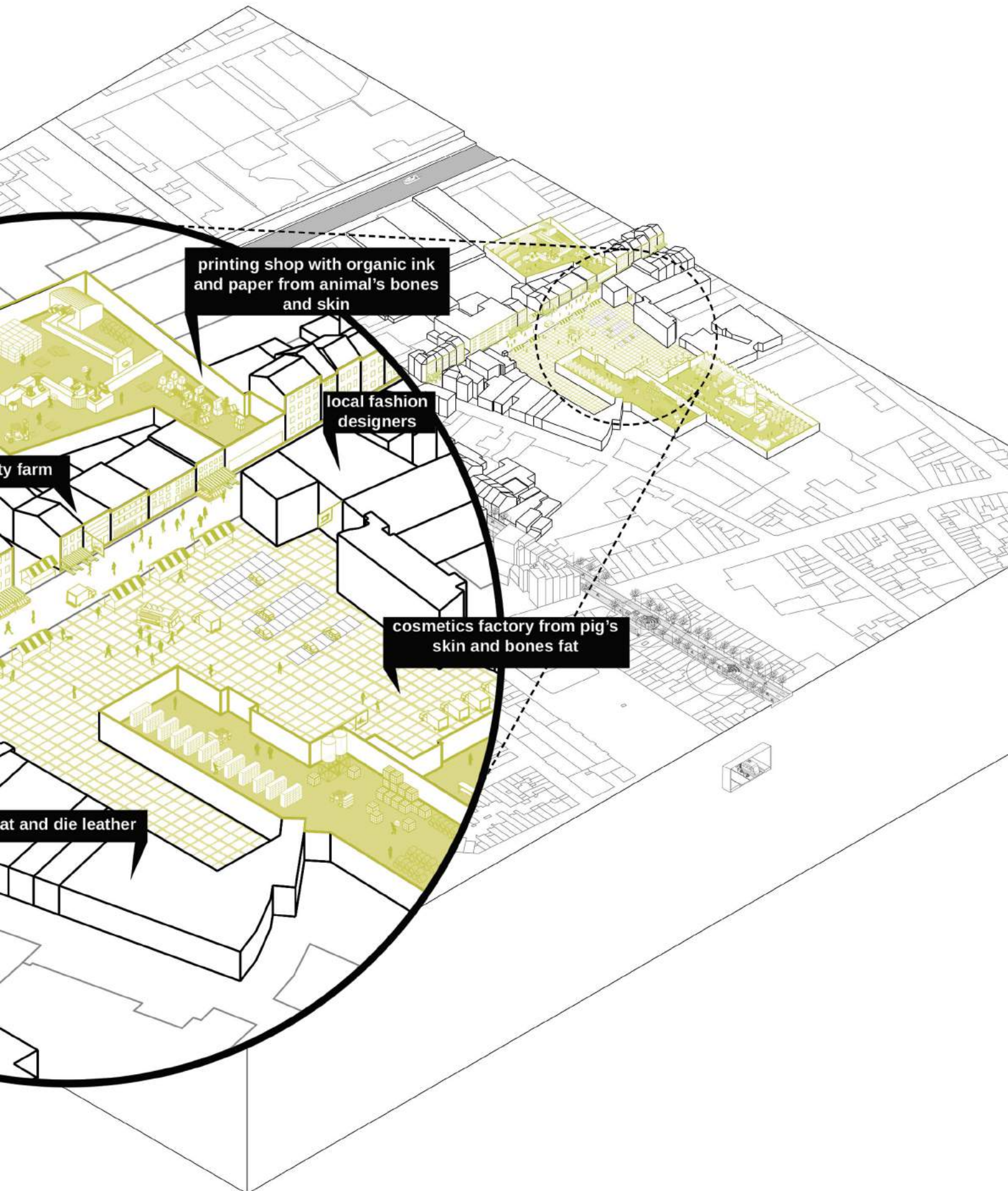
The question is whether it is possible to use Abattoir as a catalyst. First investigations suggest it can! By locally using a fraction of the waste produced, Abattoir can have its own pallet growing mushrooms. Introducing fish farming and local pig farm that feed on animal leftovers are tickling ideas, but they need further investigation.





The challenge thus is to maintain both jobs and this historical urban tissue around Heyvaert Street by finding a new use: an environment where industry and residential program are still happening side by side. If we concentrate for instance only on leather and bones, new opportunities for Heyvaert Street are created ranging from cosmetics factories to printing facilities using organic ink. From an economic perspective all these activities need some protection and nurturing. That is exactly what the linking of Abattoir and Heyvaert Street will do. They could be made into a special economic zone in which startups inhabit and preserve the existing tissue by re-using it.







ECONOMIC ISSUES IN ORGANIC AND ANIMAL WASTE

conversation with Mohammed Ibrir and Patrick Leonard

Abattoir is an anonymous company that owns Anderlecht's slaughterhouse since 1983. Its core business is situated in the rent of infrastructure and space. We met with the two waste managers of the estate, Mohammed Ibrir, who mainly takes care of market waste, and Patrick Leonard, responsible for environment and energy, focused on animal waste.

"We still pay the enterprises for waste handling and transportation even when it's a direct primary matter to them. As long as the offer exceeds the demand it's going to be the case, we'll always be the ones paying. When they'll start struggling to get supply then we'll be able to negotiate a reversed bill."

It was in 1888 that Anderlecht's municipality granted the concession for the construction and operation of the new slaughterhouse inaugurated in 1901. The first company to run it was named "Abattoir

et Marché d'Anderlecht", it then came back to municipal property. In the 1980s, while the public institution desired to dispose of it, a group of butchers came together to buy its assets and revive the business. Abattoir s.a, first called Abattan, has been running the place since then.

About nine years ago they started an uncommon program, which goes beyond their legal obligations, to reduce and manage waste. Fostering recycling and reuse, they actively seek for solutions to avoid incineration or putting waste into landfills.

"General policy is to concentrate similar material in one place and, from that, trying to find for each one of them the best solution, either reuse, elimination or recovery."

Even though some materials have financial value, their waste management activities cannot yet generate extra profits as, for now, it is at a loss.

As they don't have much space, they can't treat waste directly on their site. Indeed, the enterprise's aim isn't to motivate production on site but rather to allow other actors to transform and sell products. However, the implementation of an Urban Farm on the roof of their new meat market or the mushroom growing activity initiated



in their cellars might bring a change in the current dynamics.

"In fact, the major projects of the company are located in new facilities and infrastructure."

Evolution in regulations and in matter of hygiene enforced them to plan a new slaughterhouse. That brought them to introduce an upgrading process of the estate which concerns, among other things, the construction of several new buildings.

They generate quite diversified flows of waste, involving different kinds of outlet and actors in charge accordingly.

General collection is handled by ABP¹, which also deals with the four glass containers on site whilst palettes are evacuated by Shanks.

Apart from those, they distinguish two categories. While the issue for animal leftovers is mainly to find new outputs, general and market waste have to be tackled at the source.

"Here, we have 600 hawkers and 50 permanent merchants. It's huge what it generates in terms of packaging floods that leave as waste."

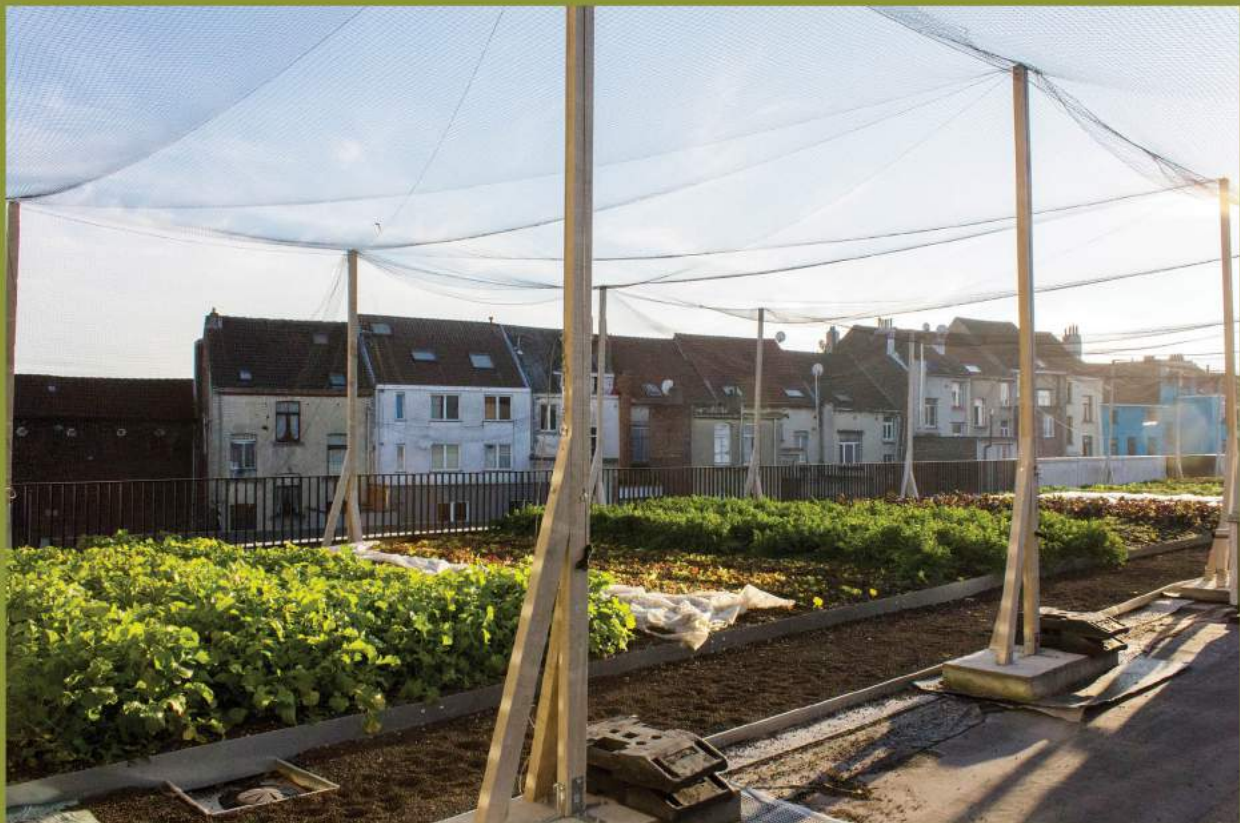
1 - In French Bruxelles-Propreté, the public actor of the region responsible for waste collection and environmental issues.

To achieve their goal, they developed restricting measures such as plastic bags prohibition, and the obligation for merchants to sort their litter. They progressively started offering a sorting point and several collection services. Organic waste collection is ensured by Vanheede and sent to a biomethanization center in Quévy while carton packages are sold to Joseph Michel Papier. The profits created from those partially permit to compensate the costs engendered by other waste management.

"We work with enterprises recovering and transforming waste. They then redirect it where it needs to be."

A rather unusual practice of theirs, CollectMet, even acts directly on leftovers preventing unsold market stocks from being thrown away. It represents almost 4 tons of unsold food that is collected from merchants every Sunday and redistributed to people in social difficulty or to non-profit organizations .

In matter of slaughter waste, they mainly deal with Rendac, a treatment company located in Denderleeuw. This one charges for the transportation and handle of different types of classified material. Their destination is determined according to the risk of infection that the animal leftovers might present. Also depending on the





category, animal waste can be used as a by-product for the fabrication of pet-food or in cement kilns as a coal substitute. Blood, on the other hand, is recovered by a different company which retrieves protein used for colorants or in the making of certain medicines. Oily slime is salvaged by RécupOil and serves as fuel additive. Furthermore, Abattoir houses one of the last skin traders in Brussels, who collects the animals' skin directly at the end of the slaughter process. After applying a salting technique, it is sold and shipped to leather manufacturers in China, Vietnam, Bangladesh, Morocco or Spain. Finally, Abattoir possesses their own sewage plant enabling them to treat the water employed in the butchery chains. For now, making profit with animal waste is not likely. However, they could find a few leftovers that could directly be valorized, but at such a small quantity it wouldn't be interesting, nor viable.

They look into every alternative to separate new types of waste that could have market value in a wider circuit. For instance, at the moment they are thinking of collecting and selling aluminum cans.

In the past, they used to clean their stables with recovered water. However, they had to put an end to it because European standards required testing methods which were far too expensive. Such is also the

case for rainwater.

"Sometimes, well quite often even, we encounter such situations where we could provide an implementation of the current system but the regulation is so restrictive that, when it doesn't forbid it, it sets unsustainable conditions."

In general, return on investment and mass effect drag down most of possible progress. Besides, to actually start having a circular economy and sell their waste as by-products, they would need to develop a specific treatment on site. However, that is inconceivable for a matter of space and equipment.

Those obstacles were the reason they had to abandon their bio-digester and compost unit projects, for instance. They commissioned Atrium over a decade ago to review those possibilities. Concerning the bio-digester they couldn't reach an appropriate size; either it was too small and didn't have enough capacity, either it was too large. Furthermore, their dense urban location and their large public activities increased the risk incidence.

In any case the greatest restraint of all is the impossibility for them to make any more major investment.



REFERENCE PROJECT

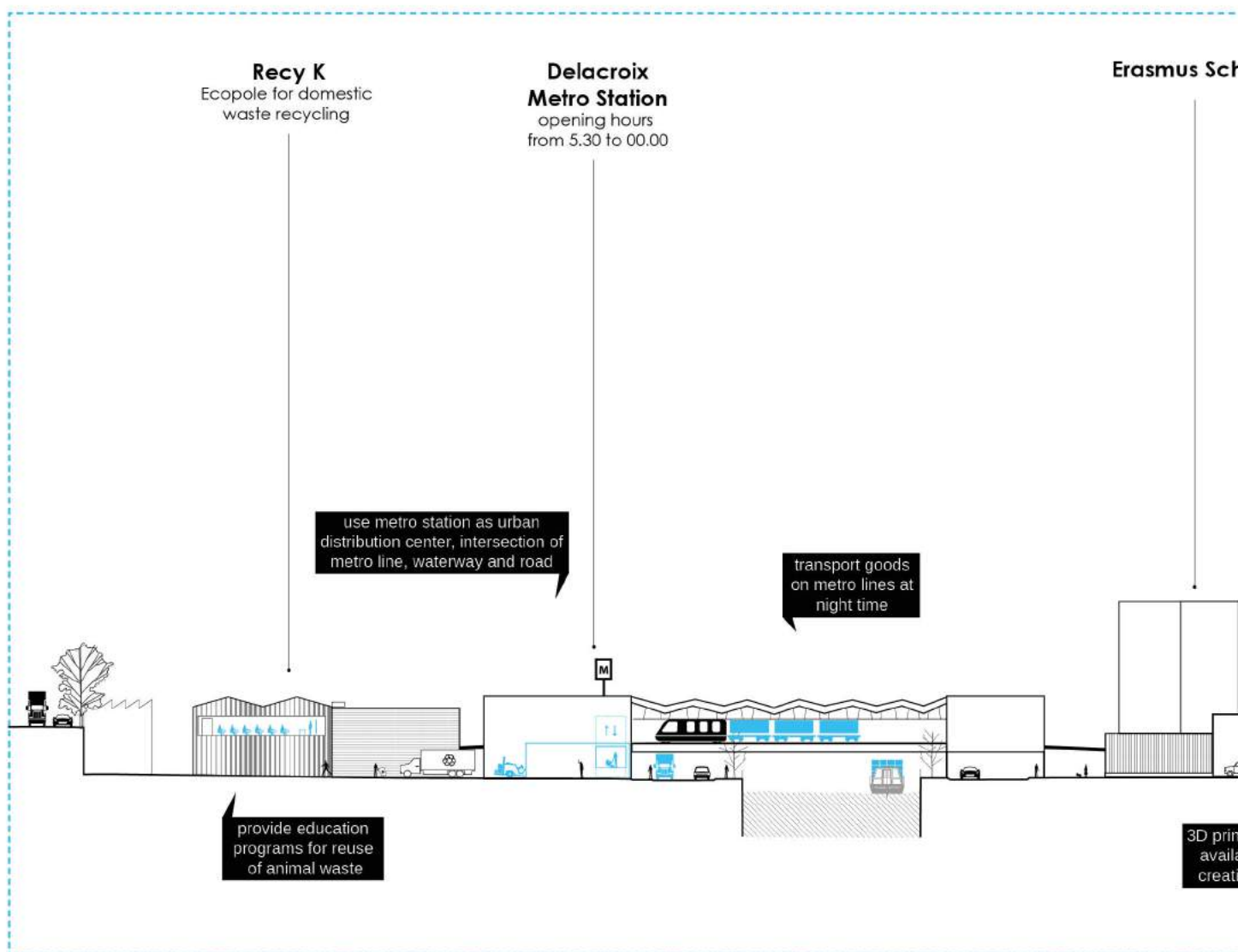
By seizing the opportunity left behind by the departing second hand car trade and making use of the capacity in the urban fabric and the presence of a local supplier for secondary materials, a new space for admixed urban environment can come into being. By redesigning the street profile transforming it into shared space streets and utilizing the zoning plan (which foresees a mixture of functions for the first two storeys), a new typology is made: a street for reindustrialization. The result comes close to what urbanist Jan Gehl describes in 'Making cities for people'. At the level of the street this means for instance making shared spaces rather than dedicated ones. In Gehl's design for Brighton's New Road: a street where cars are welcome, but on people's terms.



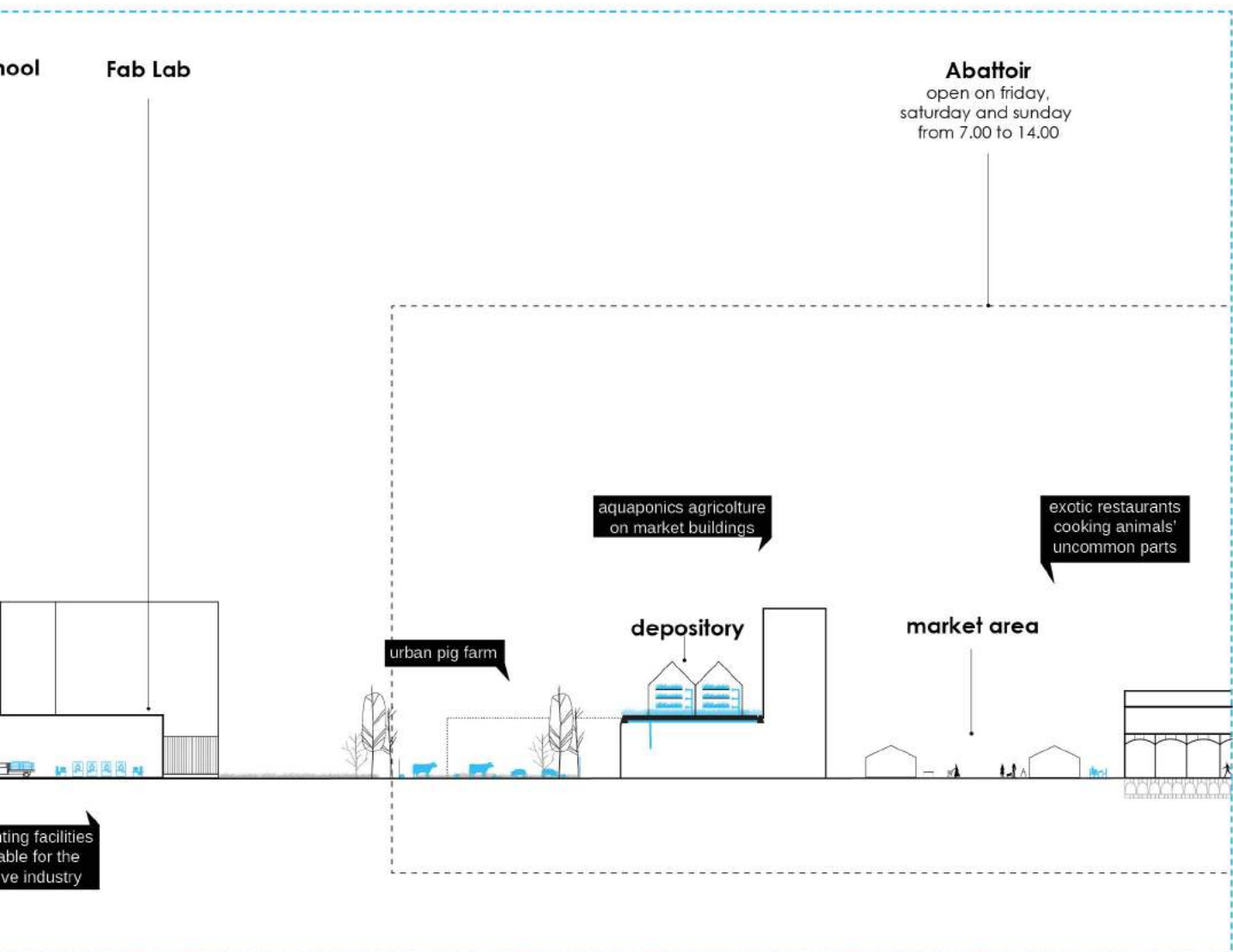
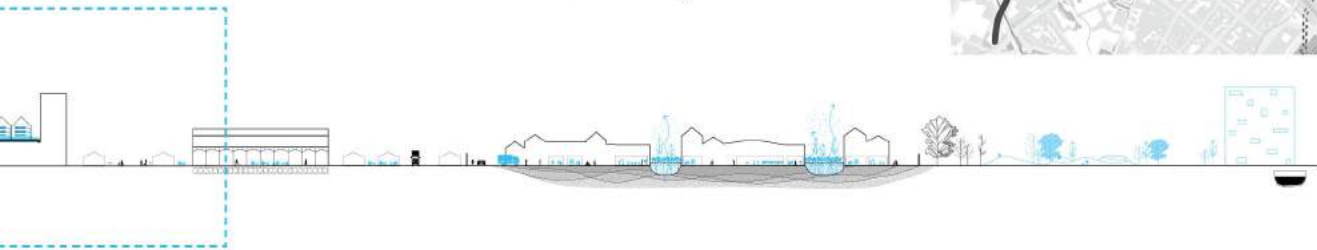


SYNTHESIS

The new transect of Birmingham thus manifests the modal shift, represented at Delacroix metro station and it shows Abattoir as urban catalyst for Heyvaert street. At Delacroix station the growing flow of people and goods will get better connected. Not only different modes of transportation can be linked here - public transport, car, bicycle, boat and pedestrian

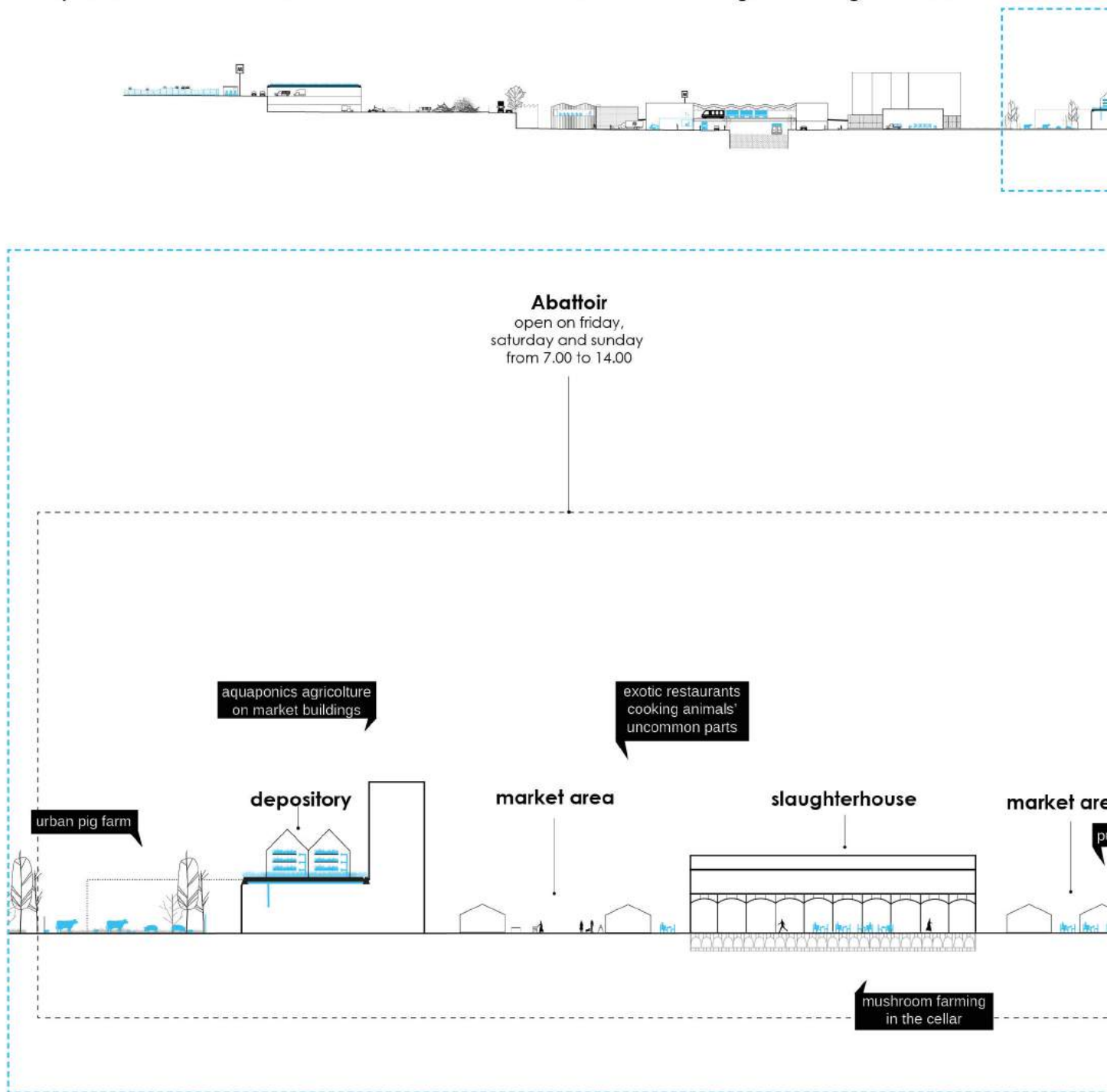


– this hub also has the ability to better accommodate logistical challenges of the age of internet shopping. At this location the throughput on small (electrical), transport is organized, better facilitated to move through the dense urban fabric. Here one also foresees facilities - cargo locker - that ensure that delivery and pickup of online orders never miss out. But one can also imagine that



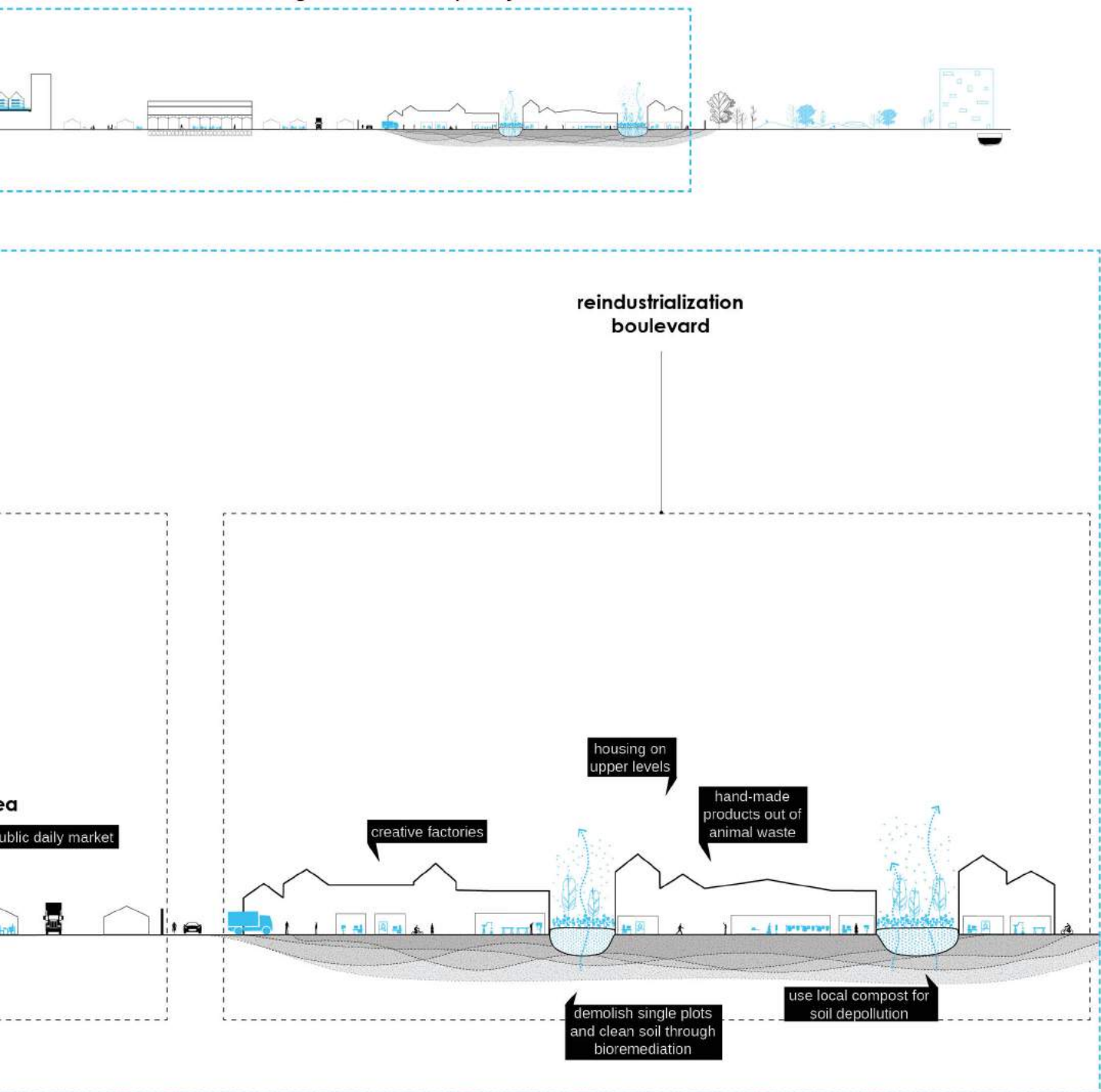
Delacroix will benefit from being connected to new infrastructure, the new bicycle inner ring for electric transportation: the e-loop. This e-loop is not only important for the delivery of goods it will also help returning them. With the growing market for internet stores the need for a good reverse logistics dramatically increases. The e-loop accommodates both movements

– delivery and pick up – making sure that no delivery vehicle will move through the city half empty any more. The chain around Abattoir is aimed at preserving the urban fabric around Heyvaert street by re-use this tissue again. The legal means to allow live and production in this area are used to its maximum. By setting a climate that encourages making industries



that use organic waste from Abattoir a new chain of activity is activated that will give the area new impetus. To help start this transformation the street profile of Heyvaert Street is changed into a new urban typology: the re-industrialization boulevard. In other words, by seizing the opportunity left behind by the departing car trade and making use of the capacity in

the urban fabric, space for a mixed urban environment comes into being. Through the use of designs for changing both the street profile (into shared space streets) and the zoning plan (a mixture of functions for the first two floors), the street is prepared to accommodate returning industrialization hence making a re-industrialization boulevard.





03

MASUI





CHARACTERISTICS

Since the 19th century Bassin Vergote has been the place where city and industries meet.

Here, at the heart of the Masui area, metal recycling facilities, warehouses for building supplies and three cement factories currently coexist along the Canal's banks surrounded by a growing number of residential neighborhoods.

These industrial activities form a sharp contrast with the multicultural district on the East side of the Allée Verte, resulting in a boulevard that effectively has one urban side and a fenced side.

A little further North in Masui this contrast between city and business even grows as one of Europe's biggest markets for fruit and vegetables functions as an island in the city.

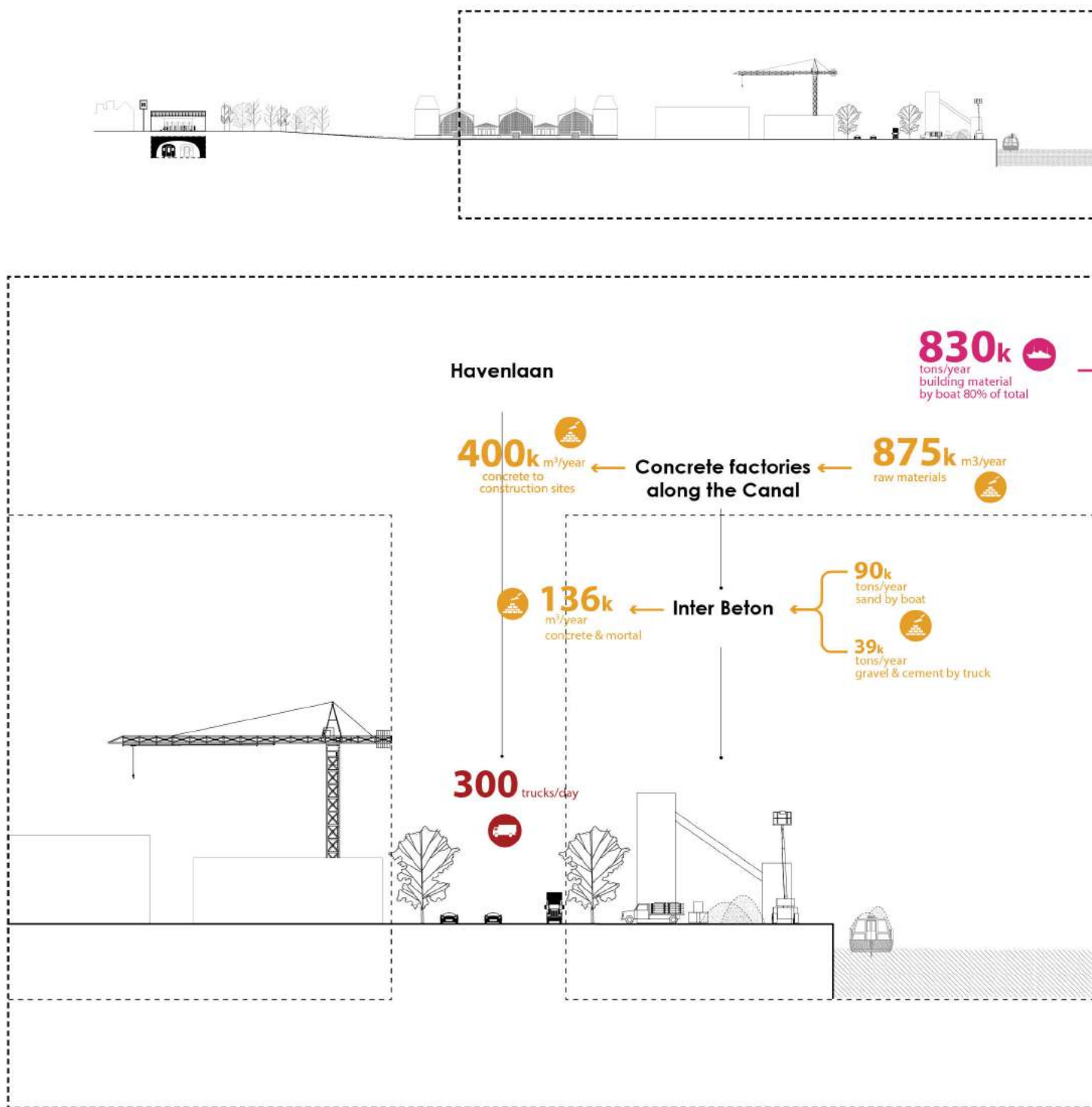




The existing urban configuration of Masui can be summarized in the following Urban Transect.

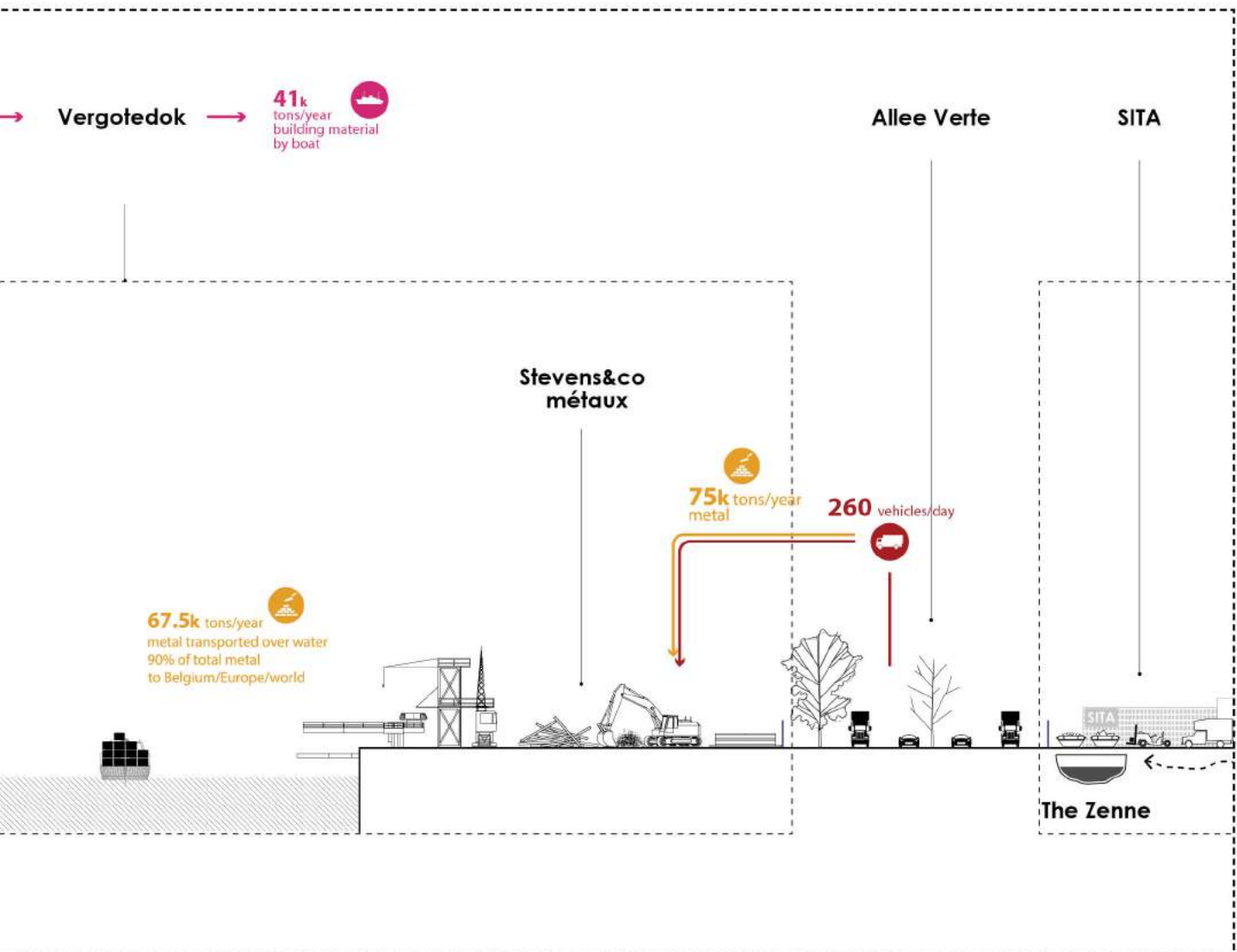
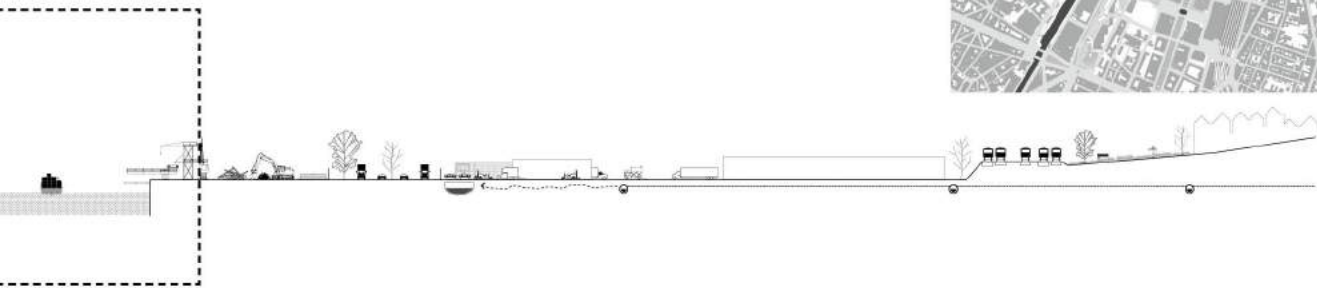
On the one hand there are large scale transformations visible in the area around Tour & Taxis. Also the concrete industry

URBAN TRANSECT



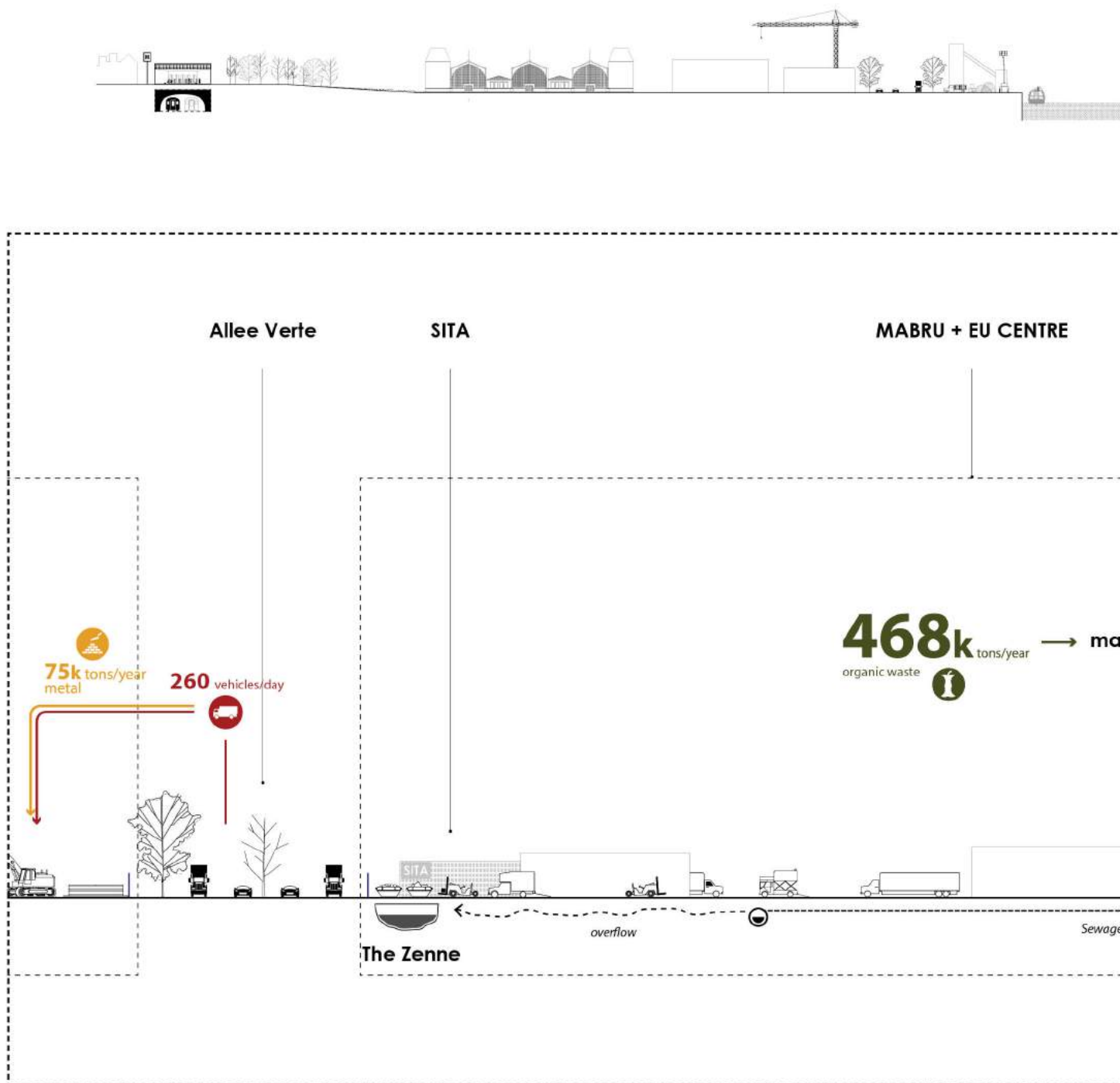
of a company like Inter Beton on the West quay of Bassin Vergote is clearly distinguishable. On the East quay we find Stevens & Co, a major player in the case of metal recycling.

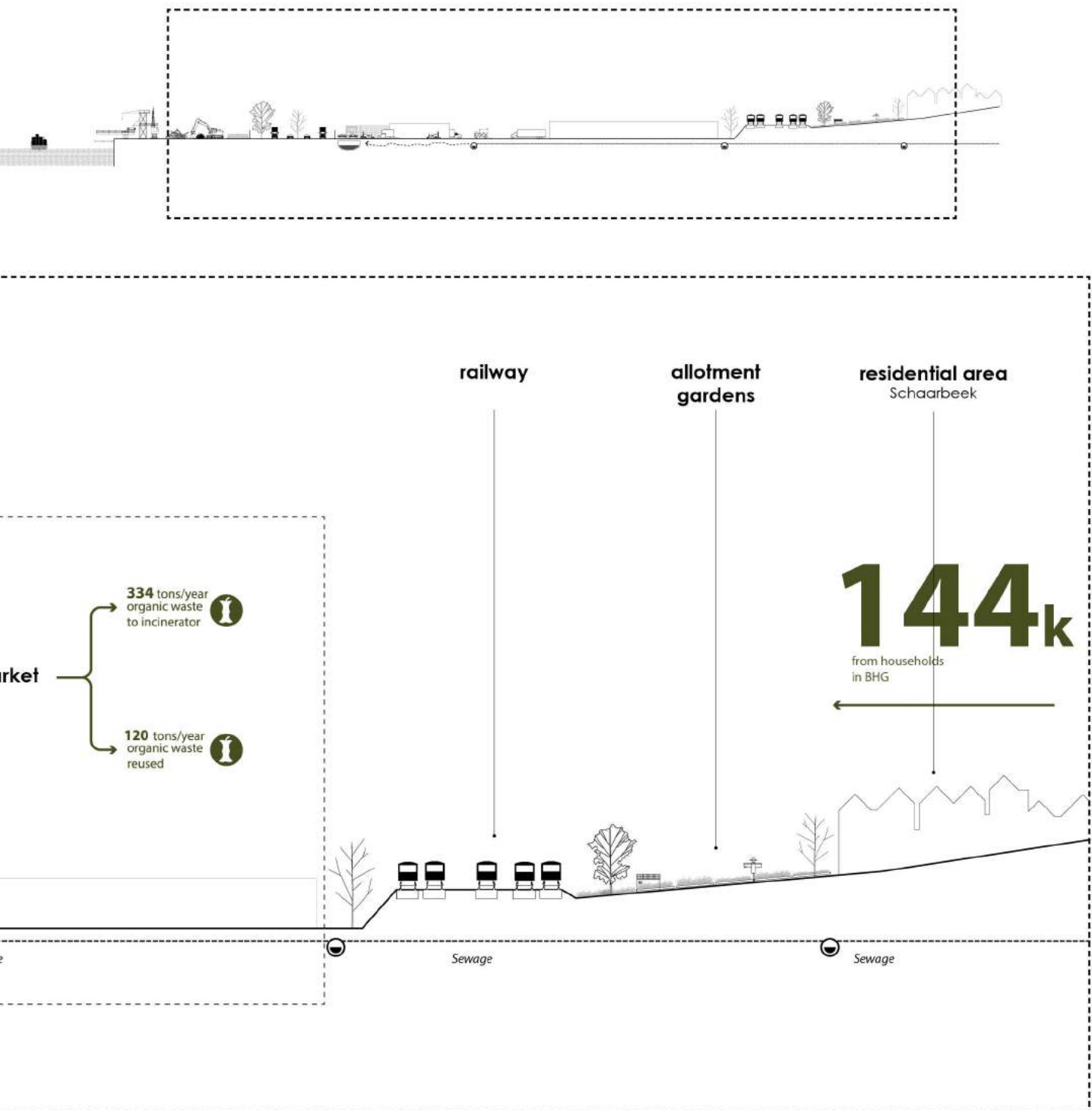
Also MABRU and EU Center (the largest



morning market for fruits and vegetables) is an important actor in the area.

Translated into waste streams two flows in Masui stand out: Construction & Demolition Waste and Organic Waste.







FLOW MAP: C&D WASTE

When looking at C&D waste on the regional scale it becomes clear that the Canal accommodates the majority of the flows for building materials: 2.4 million tons come in each year. These are mainly raw materials, like sand, gravel and clinker that enter the city to be processed in new construction projects. Everywhere in the region, new constructions, renovations and demolitions are happening requiring raw materials to flow in but at the same time causing a constant flow of waste. From the 650.000 tons of C&D total waste coming from sites in the city, private companies like Sita, De Meuter and Stevens & Co recycle 85%. But this number is deceiving. The high percentage of recycling is mainly achieved because it is expressed in weight, making the fraction of inert waste (that is generally

down cycled as an aggregate in concrete or asphalt) add strongly to the total number. A logical question thus is: are there opportunities to make the use of C&D waste more circular? More precisely this would mean a change for the building industry as a whole: moving from demolition, downcycling, importing raw materials and semi-manufactured products, to an economy of smart dismantling for high value. In addition, using secondary materials that are made from reused materials and adding more bio-based materials would be an interesting option, creating a more sustainable and a wider range of production.

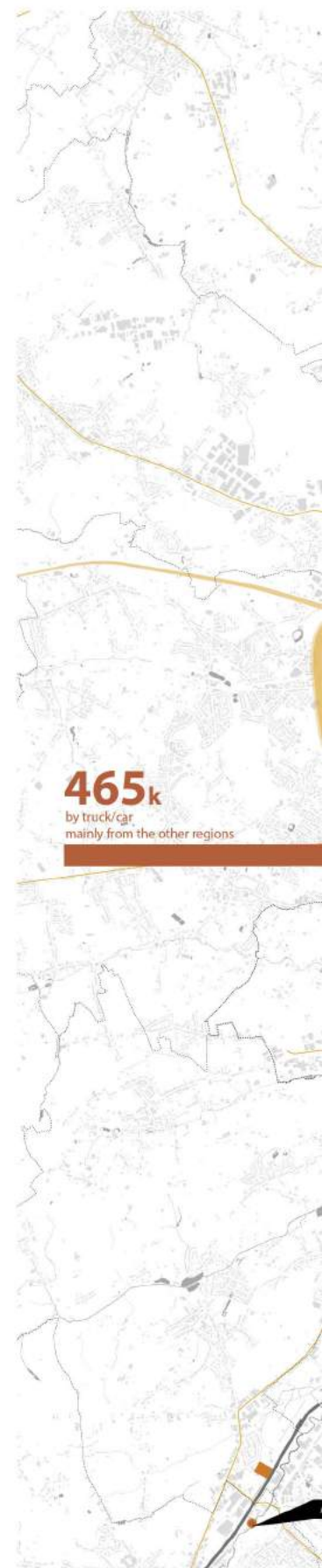


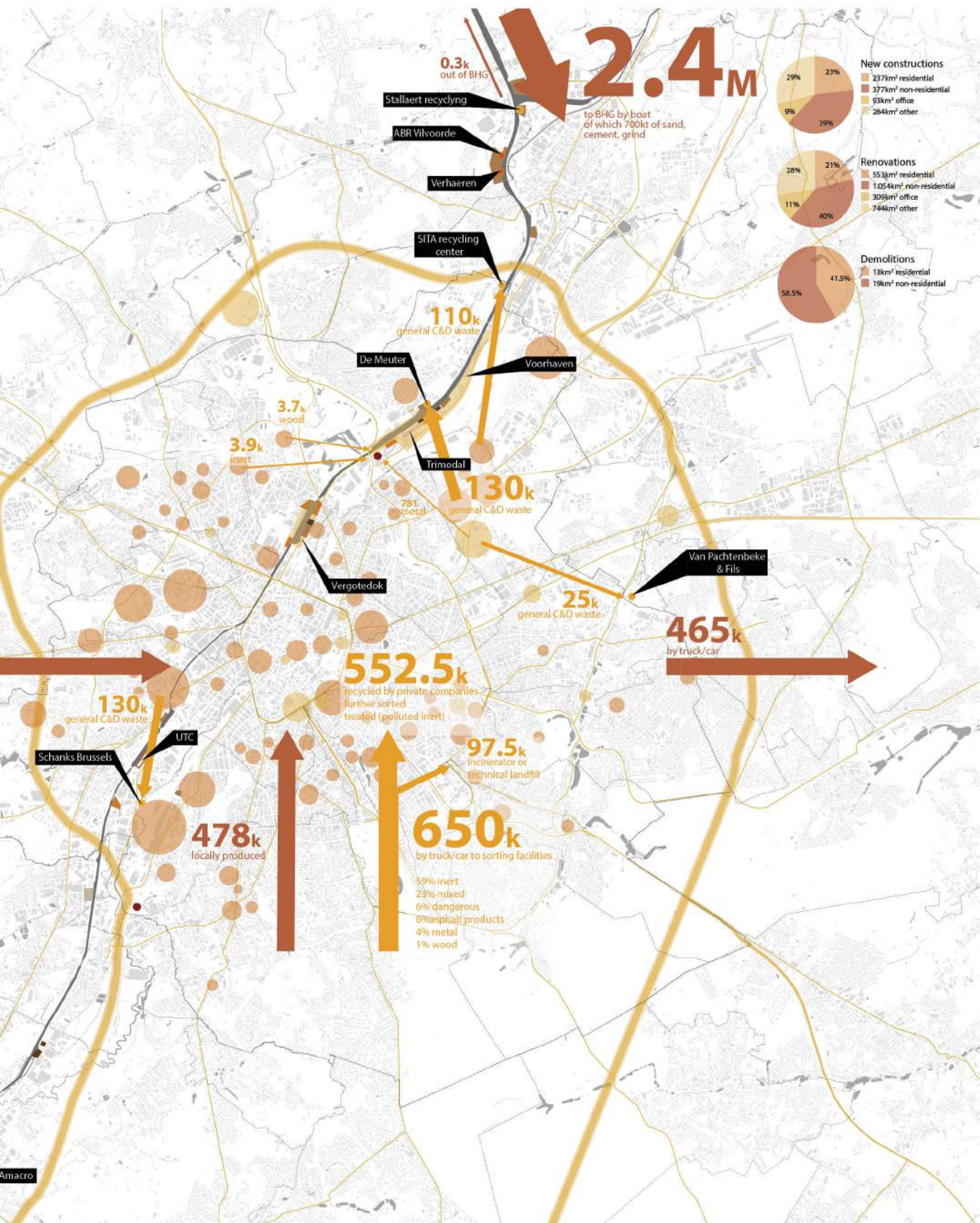
tons/year building materials



tons/year C&D waste

- regional containerpark
- C&D treatment facilities
- inert treatment facilities
- metal recycling
- C&D materials
- wood recycling
- construction training
- concrete plants
- new housing
- new offices
- UTC

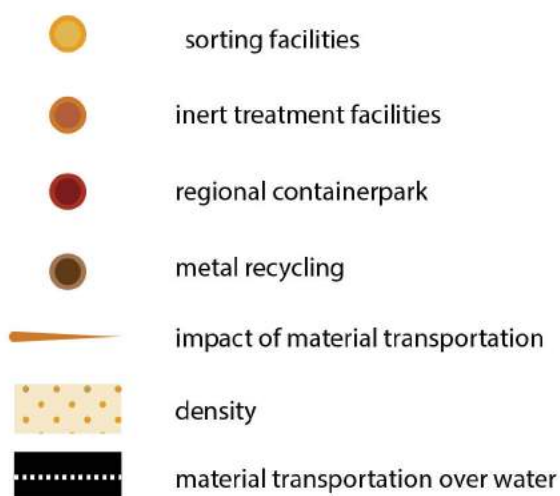


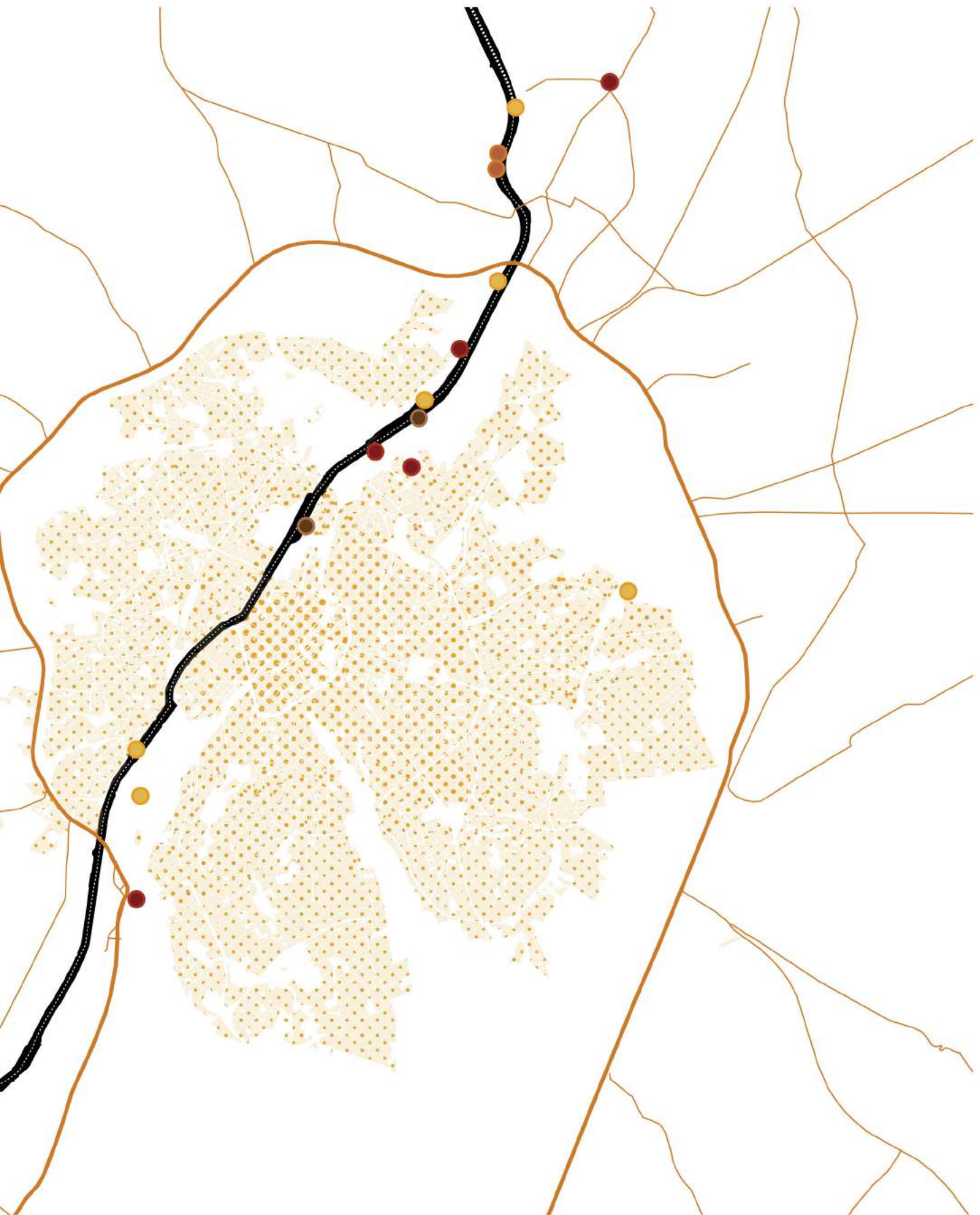




CONSEQUENCES: LOSS OF VALUABLE MATERIAL

When looking at recycling businesses it is clear that they are now clustered outside the city center, along the Canal. As the total constructed area of the city is potentially the area where C&D waste can be 'harvested', the most obvious infrastructure to transport this waste to recycling companies is the car infrastructure. But it is questionable whether the Canal could be able to play a greater role in the discharge of materials. Currently the waterway is mainly used for the export of scrap metal. Another question is whether the Canal could help bringing in a higher percentage of secondary materials made out of recycled products for the construction industry. In this way, the Canal could act as the backbone for the construction industry in two directions.







A SORTING CENTRE IN THE HEART OF BRUSSELS

conversation with Sven De Meuter

De Meuter is a demolition and excavating company which has expanded over time into a concrete recycler and a sorting center. We met with Sven De Meuter on the sorting site along the Brussels's Canal.

"There were no recycling facilities when we started in 1985-1986."

The firm was created in 1972 and covered at the time only demolition and excavating activities. During the 80s they started large-scale operations. In Brussels, for example, they contributed to the construction of the little ring's tunnels and to the destruction of the viaduct. In Liège, Limburg and in the Netherlands they demolished huge coal mines.

In the same period they established their ABR center in Grimbergen, a Crushing Centre for secondary aggregates. At that time, there were no regulations for recycling in Brussels, nor in Europe. During the 90s, they started an asbestos removal activity which was launched with

the Berlaymont building, house of the European Commission's headquarters. Following the demolition fever of the moment, they specialized in towers dismantling such as the iconic Lotto and Martini towers in Brussels. At the end of that decade they started sorting waste they collected on construction sites to recover wood, cardboard, scrap metal and hard plastic. The site evolved and now treats all kinds of waste from diversified sources such as green organic waste, mix waste or even glass. They also have public contracts with several municipalities such as the city of Brussels which drops off the garbage collected from public trashcans here.

Finally, in the years 2000 they opened a center for soil treatment in Grimbergen.

The beginning of their sorting activity was largely linked to the increasing State taxes on waste disposal while its improvement responded to the requirements of the market itself.

"Sometimes market's impulsion is more stimulating than the legal framework."

The high constraints forced them to tighten their sorting. Such is the case for wood, plastic and plaster recyclers who set their acceptance standards at a purity rate of 99%. This forced them to strengthen their dismantling and sorting criteria.

The increasing complexity of construction techniques and materials also played a role in this evolution. It's still one of the challenges they have to face now and will probably also have to face in the future. Indeed, the more intricate materials are, the more it becomes technically complex to recycle them, resulting in the necessity to use more expensive technology, which at term will inflate costs. For instance, employing polyurethane foam as insulation increases the time and difficulty of dismantling as it becomes very hard to separate each component of the wall. Moreover, it can make it arduous to reach the required purity criteria concerning concrete recycling.

Likewise, some of the raw materials brought to the market nowadays can't be recycled, nor incinerated. Such is the case of cellular concrete blocks such as Silka or Ytong blocks.

"So with all those products we're going to have enormous problems in the future. Either we have to improve the recycling technology, which will make it more expensive, either we have to lower the norms for recycling, but then waste will increase. So that's a huge challenge."

The second-biggest challenge ahead is located in the logistic domain.

"This, I'm afraid, is going to be a catastrophe."

The first issue is traffic congestion. For instance, in 1986 a truck could drive back and forth from the city center to their site in Grimbergen (a 24 km trip) up to 10 times per day. In the 90s this number lowered to 8 trips per day, in the years 2000 to 6 trips and nowadays it only makes 5.

"For the job 30 trucks used to do back in the days, we now need 60 trucks."

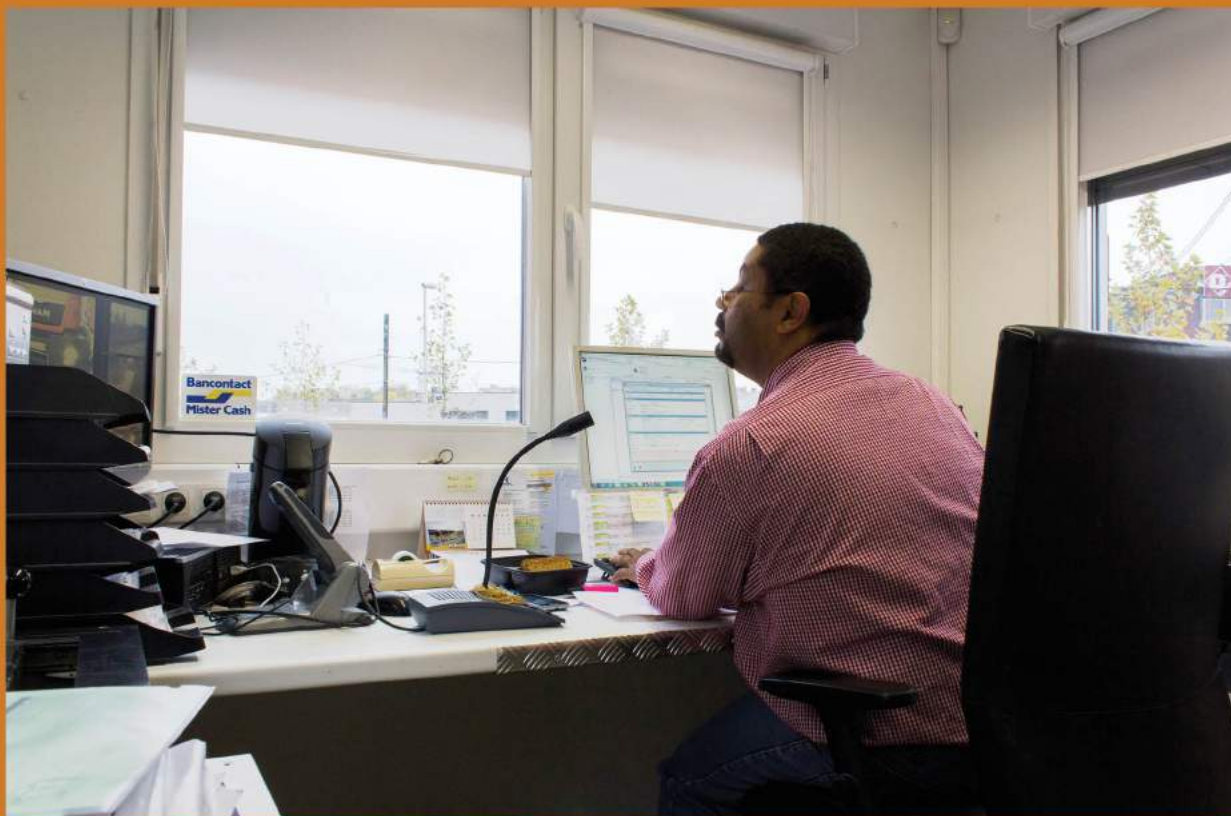
On top on that, the rise of those traffic issues within the city is convincing some politicians to limit the activity of large tonnage trucks, above 10 tons, in the city center. As the current range of vehicles they use is between 25 and 30 tons that would multiply by 3 the number of vehicles on the road.

To these particular issues, they don't have, nor see, any solution at the moment.

They are already avoiding circulation of empty trucks by developing a reverse logistic strategy and by partly using the Canal, mainly for earth transportation. This type of shipping is constraining though, because, in order to be cost-effective, boats have to be filled during the day.

They are aware of the new systems and technologies for waste collection, yet,







they see it as a threat or a potential unfair competition.

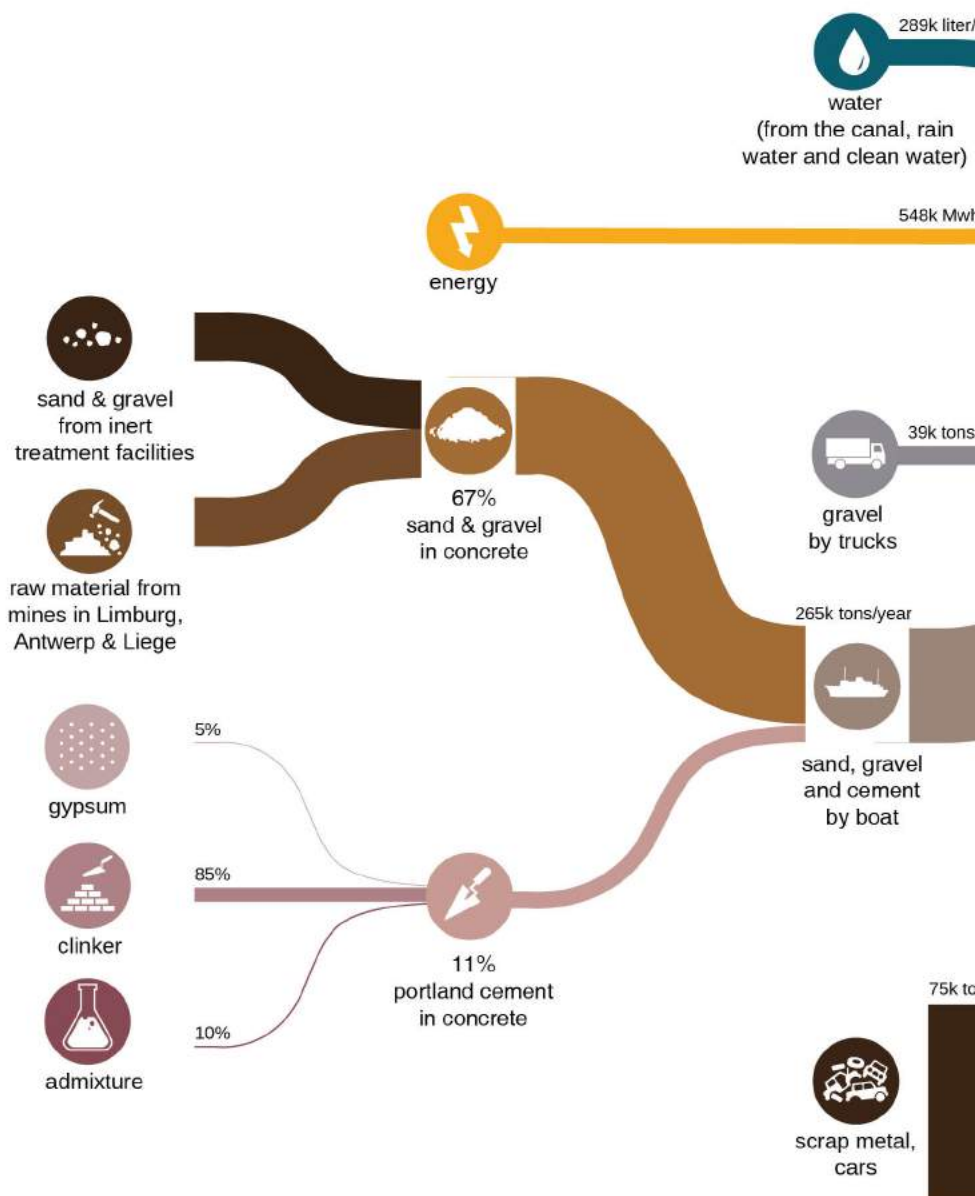
In terms of re-use of construction materials, they claim to be doing it for 40 years now.

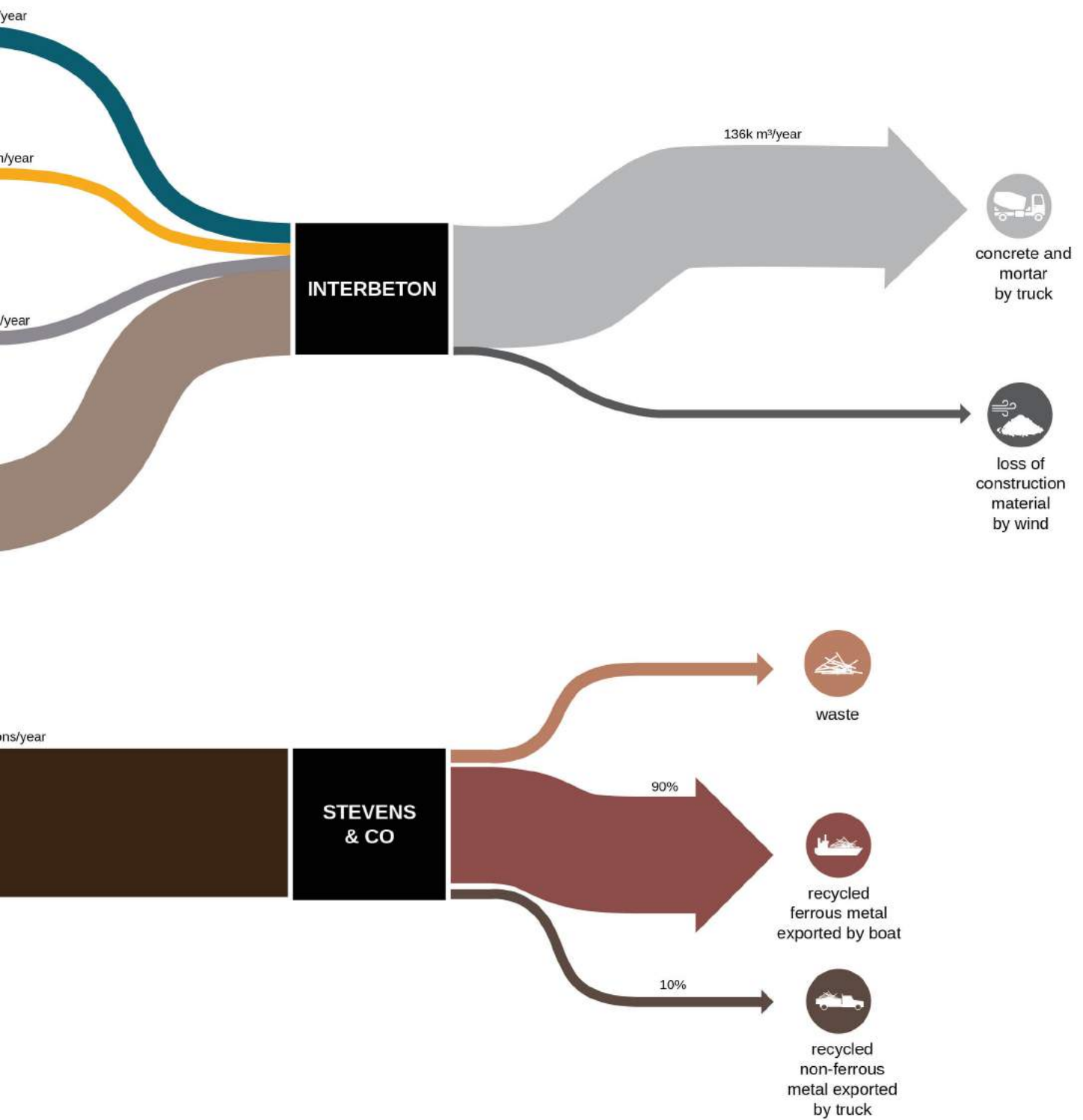
"As a child I would clean bricks on construction sites."

They even have specific machinery to take mortar off bricks. The main challenge here is to be able to list reusable materials before the dismantling and find a match between the offer and demand on the market and to have enough storage space available. According to them, it would be much more profitable to sort C&D waste directly on site rather than doing it in their center. However, this dismantling process would require other actors on sites to have the same sorting knowledge as Demeuter's employees, which involves a necessary complementary education.

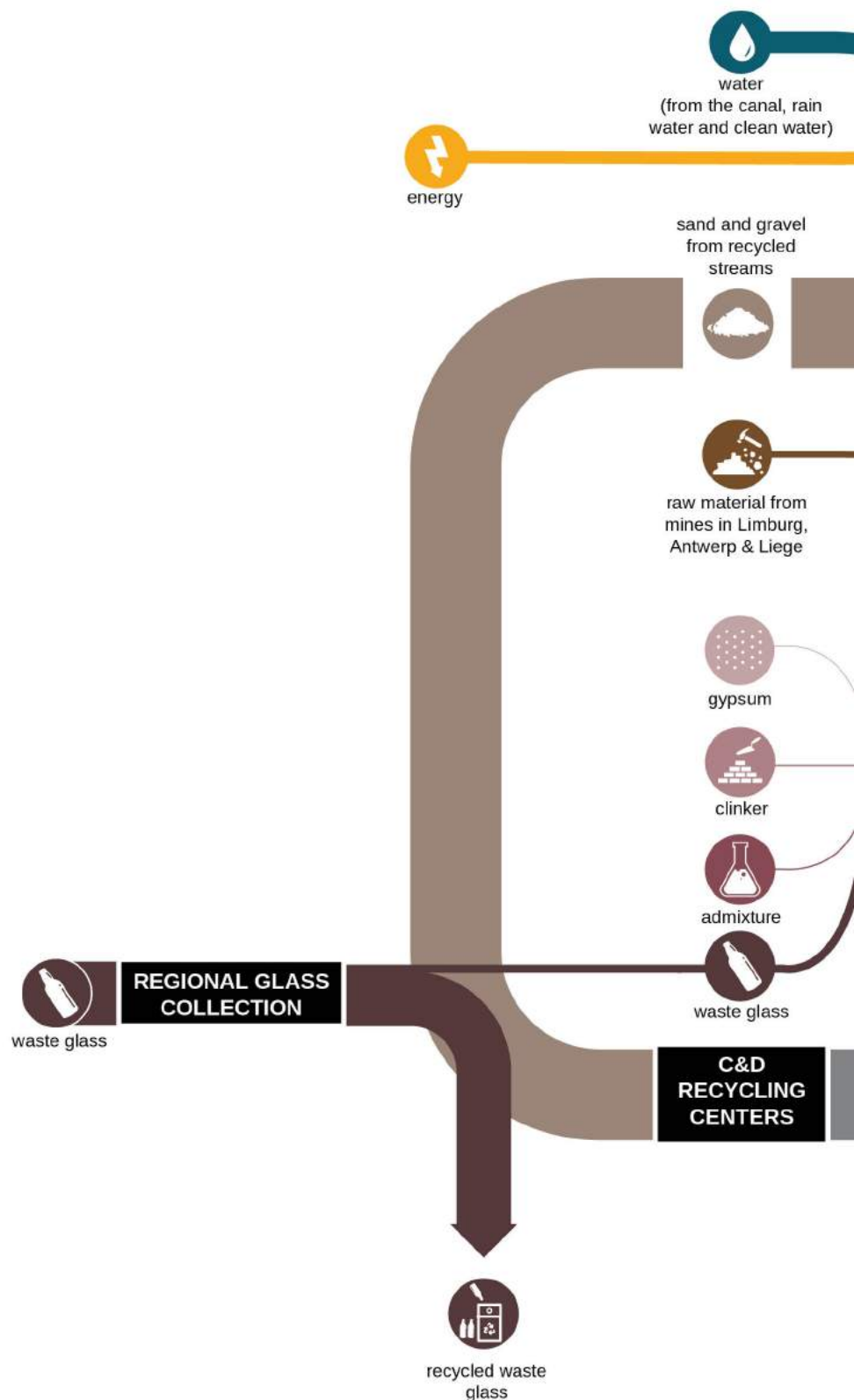
PRODUCTION OF RECYCLED MATERIALS

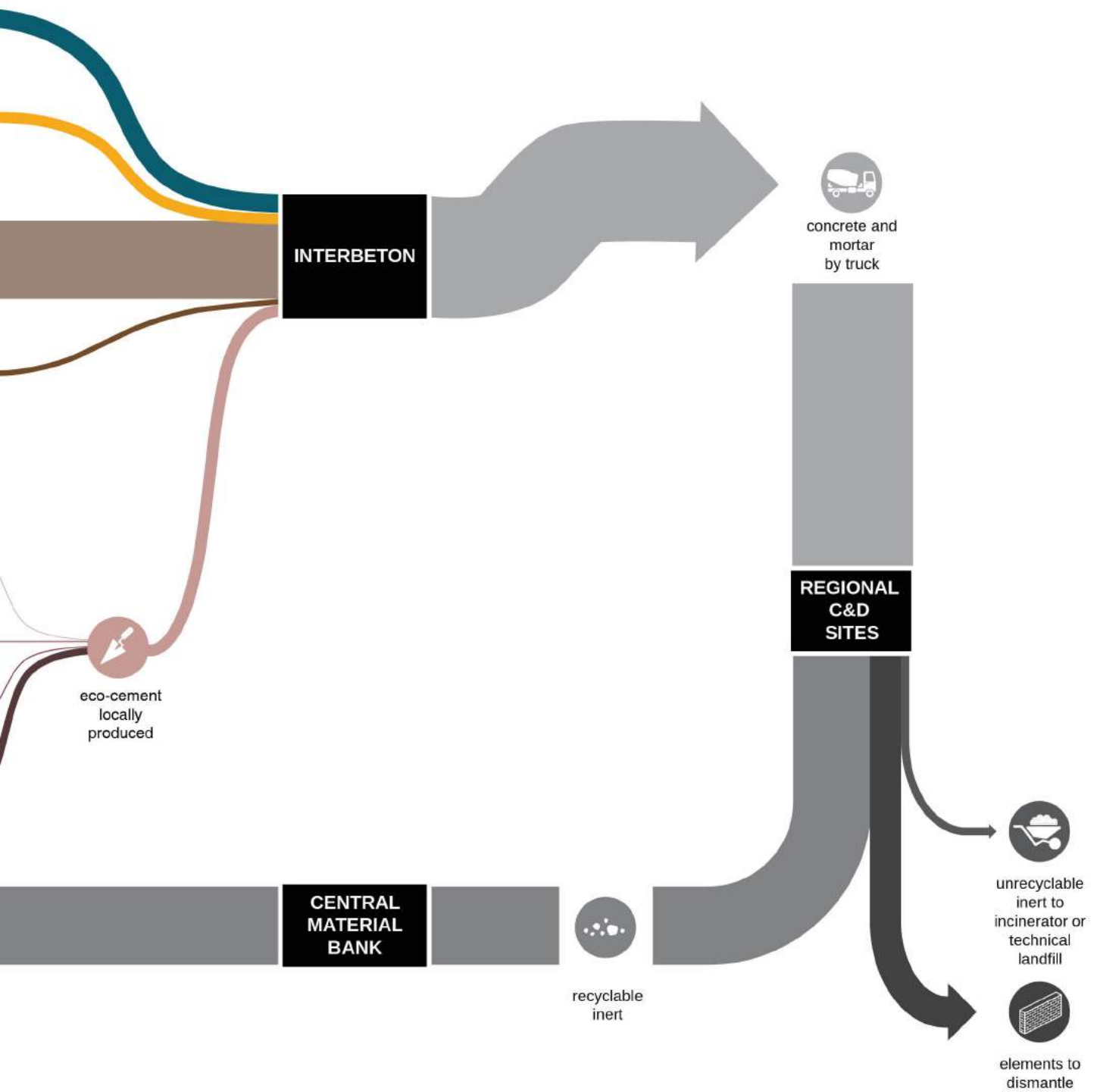
Looking more closely at the flows that enter and leave Masui at Bassin Vergote two actors are analyzed: Inter Beton and Stevens & Co. At the input level Inter Beton is depending on many raw materials that have big environmental impacts, for instance 'clinker', the essential element for concrete. The production of cement is responsible of 5% of global CO₂ emissions. For Stevens & Co on the other hand the out-going streams are standing out, showing that 90% of what is sorted is exported, meaning that all potential value added to re-used new raw material happens elsewhere. Nowadays there is a growing tension between industry at Bassin Vergote and the new residential developments. The nuisance of noise and sand is growing because it is affecting more and more people.





To keep the economy in the city and prevent the area from transforming into a high-end residential neighborhood, the economy needs to change its character. Instead of only large scale export of metal and concrete, that has little relation with the surrounding city, also production of end products and import could happen here, bringing an added value for the citizens. Interesting opportunities arise when we manage to base the current industry more on recycled materials. For a company like Inter Beton this would mean that it could reduce its environmental footprint by working with clinker extracted from recycled glass. Also other raw materials could be substituted by new materials if the collection of C&D waste on a regional scale is improved, for instance by the introduction of a material bank.

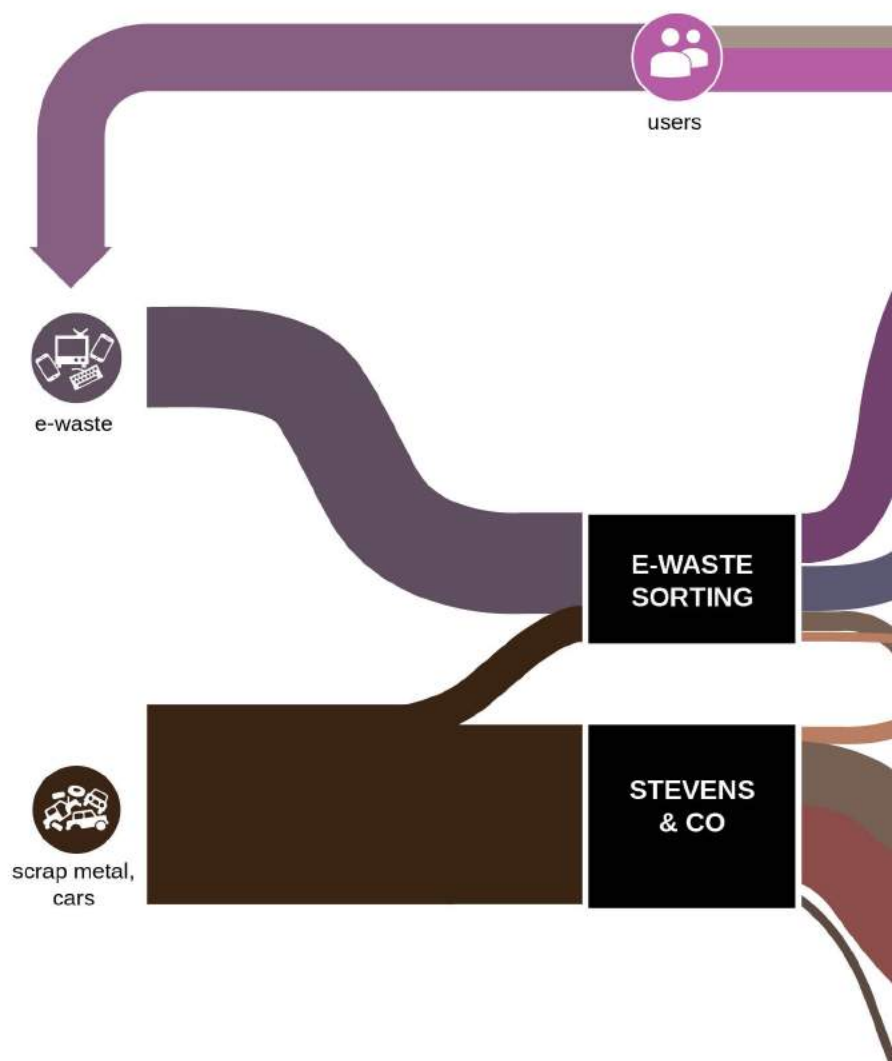


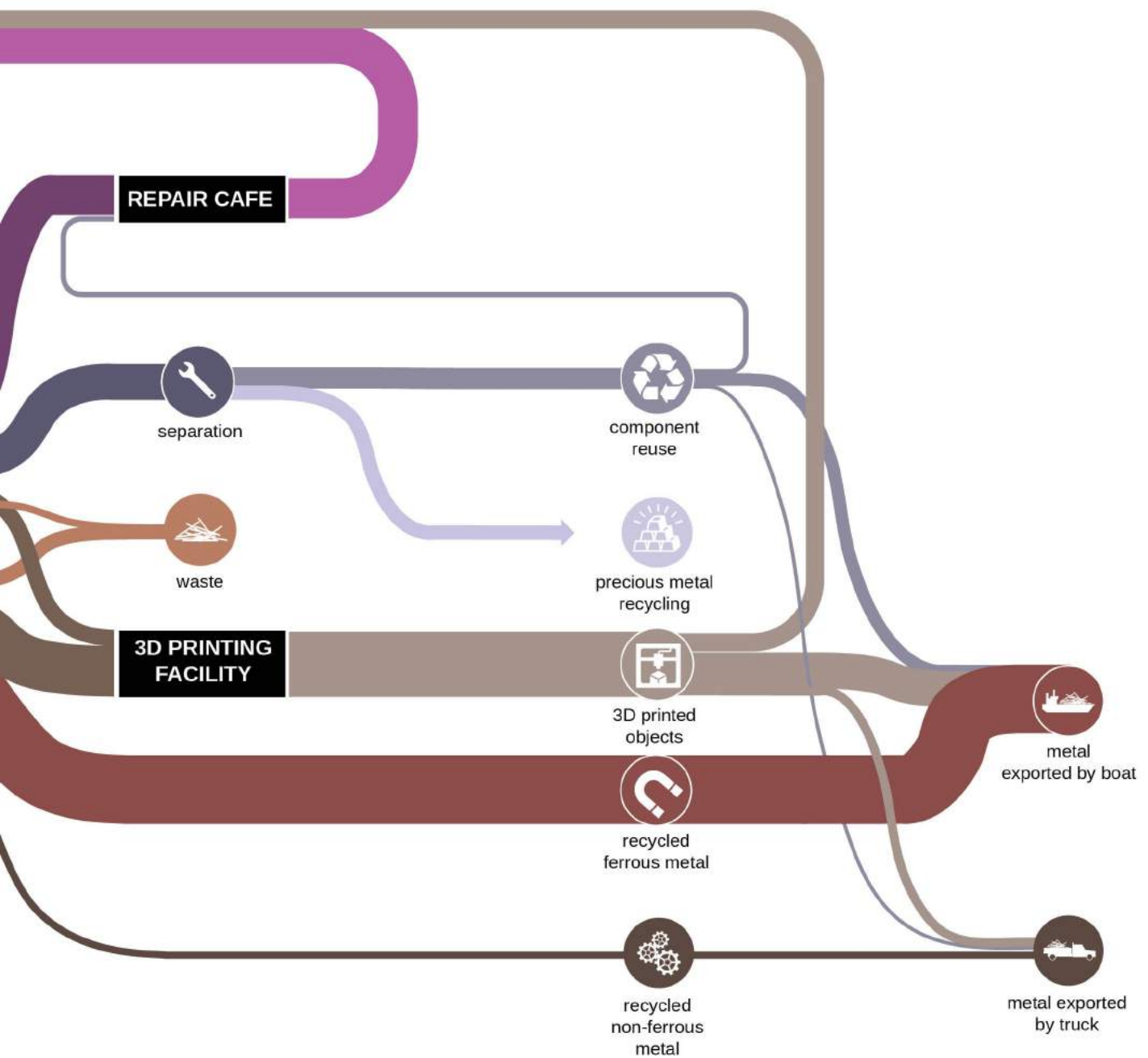


For Stevens & Co re-connecting to the city means broadening its activities to also collecting and sorting e-waste.

Also through the collection of e-waste it can engage into 'repair', a sector whose importance is actually growing.

But it also means that room needs to be made for a manufacturing industry which 'feeds' directly on collected materials and turning it into products people want to buy, for example using 3D- and 4D- printing and sand casting.







URBAN MINING AND POLITICAL TENSIONS

conversation with Stephanie Thomaes

A. Stevens & Co is a family business specialized in metal trading. They possess three firms in Flanders, one in Germany and another one in Charleroi. In Brussels only remains a transport enterprise and their site along the Vergote Basin for which they have a concession contract with Brussels's Port, effective until 2031. We met with Stephanie Thomaes, responsible for all companies' environmental issues.

"We are Circular Economy. We are one of its links. We take waste, recycle it and re-inject it directly into production."

The story began in 1935 when Grandpa Stevens and his wife arrived in Brussels. In their little house in Molenbeek-St-Jean, they rented their garage to a man who turned out to be a scrap metal dealer. This man was always carrying a lot of money, which convinced grandpa Stevens that it was a lucrative field. That's how, little by little, he launched his own business concentrating mostly on

non-ferrous metal such as aluminum, copper, zinc, tin or brass.

During the war, and a few days before Brussels's liberation, he was caught in a shooting and killed.

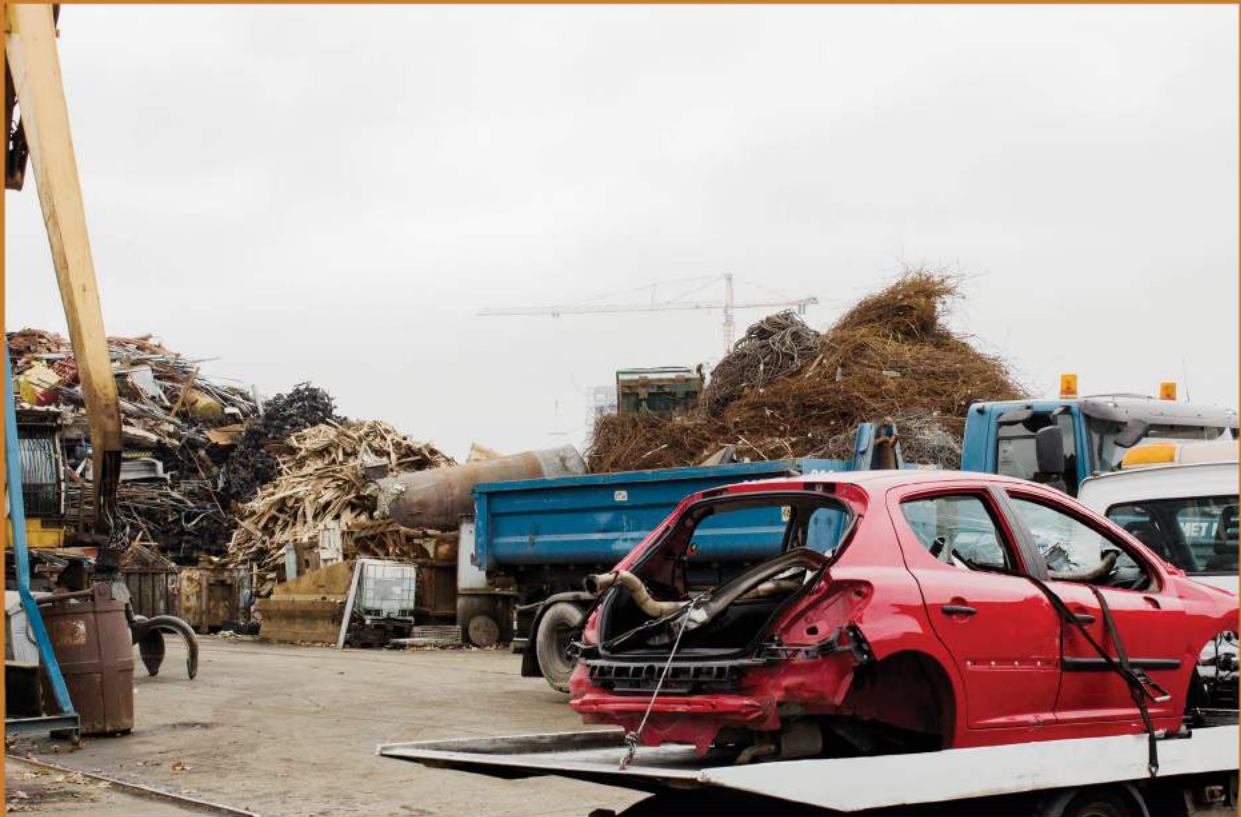
His widow, along with her sons, took over the company, still collecting from private individuals, while other families were concentrating on war metal.

In the 1950s, as the ECSC (The European Coal and Steel Community) was established, she sent one of her sons to Switzerland to learn German. The company was then able to benefit from the opening of the new German market.

In 1956, they acquired their actual site along the Vergote Basin from another scrap metal dealer. From this point on, the company really started expanding. They bought several new sites in Willebroek and in the Limburg, they opened an office in Germany and began to improve their equipment, installing a shredder (the first in Belgium) and using containers.

Their activities consist of buying, sorting, treating and selling all kinds of scrap metal ferrous and non-ferrous. The profit varies depending on stock market values.

"It can be tanks, containers, tramways, and so on. We have contracts with public actors such as the STIB, police-stations, fire brigades or even container parks."



They also gather end-of-life vehicles for which they have a specific facility in Brussels. Following the European Directive in that matter, they clean up cars by taking out the battery, the catalyzer, the tires, the gas and all liquids.

"Our strength lies in the fact that there is no intermediate between us and the final destination."

Along the Vergote Basin they also sort the scrap and prepare it to be transported either directly to smelters or steel manufacturers, or to their site in Genk to get into their shredder. They practically don't incinerate anything nor put waste in landfills.

"Landfilling and incineration are very expensive which isn't that bad as it encourages us always to do better."

Most of their incomes arrive by road as they have a huge diversity of suppliers. Once treated, 90% of their outcomes are evacuated by waterways.

"The fact that we are in Brussels' heart and that we have fluvial access is really our major asset."

One of the issues they are facing is that even though the matter they deal with has a positive value it is still considered

as waste. Hence, it is subject to a very controlled and complex legal frame.

"Inspectors frequently come to visit our sites to check that everything is in order, that water spillage is in order that we don't create too much dust, and so on."

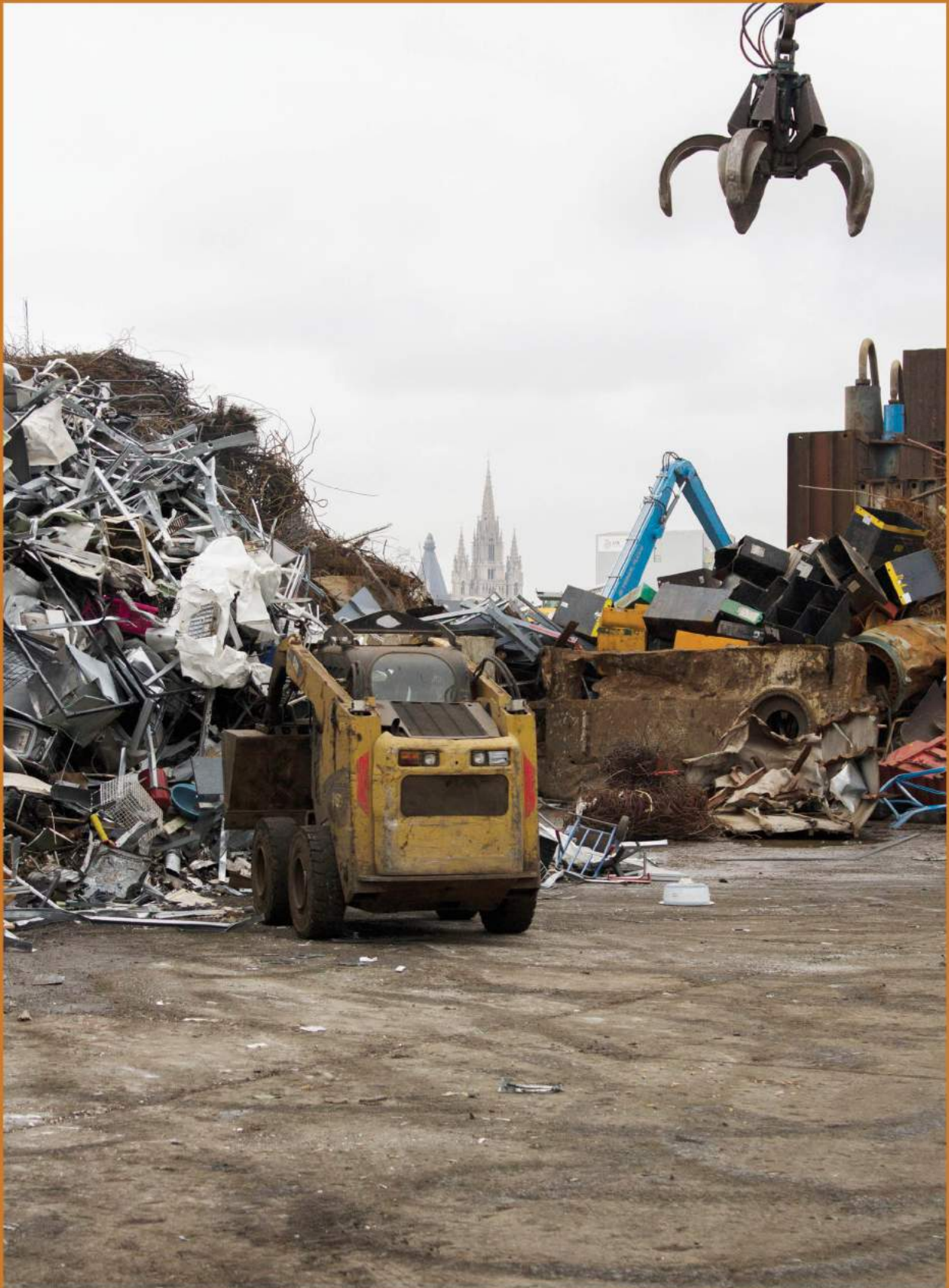
On top of that, in Belgium, environmental laws are federalized. One load transiting through their different sites can then be subject to three distinct legislations, one for each Region.

As the European Directive establishes recycling targets, they have to trace every element that enters their grounds and be able to say where it is sent or treated.

Circular Economy is a peculiar matter to their business as they already are an actor of it. As so, they can't initiate real changes in their operations to stick to the concept. Indeed, they believe they are situated after the reuse phase, once the substance or the product has become useless. Therefore, a more appropriate notion to them is urban mining.

"Society's rate of consumption entails a very high demand in production while available natural resources are shrinking and so the obvious solution to that is recycling. There's nothing better than a city for that as it is a huge source of production with consumption points at every corner."





And so Brussels is an endless source of metals and materials that we collect and evacuate by waterways."

However, an opportunity they have identified as a potential key sector is electronic and electrical waste. Most of those are treated outside the regional borders whereas it could be done here. This phenomenon can be explained by the fact that it is a free market even though public authority enforces a recovery duty for those substances.

"There should be an obligation to follow a proximity principle, at least in the public market for instance."

These specific items are also subject to a European Directive and to certain collection objectives, yet the Brussels Region displays the lowest volume of waste per inhabitant at Belgium's scale.

"Whereas Brussels is a consumption center, there's only 4 kg of electrical and electronic waste collected per inhabitant¹. It's absurd, this means that everything ends up in Flanders or Wallonia."

The difficulty would then lie in the capacity to reach those flows.

At last, there is the political pressure that

arose from the Plan Canal a few years ago.

Arguing that the city was being modernised and that it needed more residential buildings, the political team demanded them to move away from their actual location.

"This is reflected in this huge tower they built right next to an industrial area. Because as long as they don't change the PRAS² we're still in an industrial area."

It has been very difficult to emphasize their point of view but after explaining their operations the decision makers seemed to understand the usefulness of the firm. However, they still require from them a better urban integration and the development of other economic activities.

It is actually the reason why they are planning to launch this electrical and electronic waste project. It would open 30 additional jobs and it would need a lot of unqualified labor.

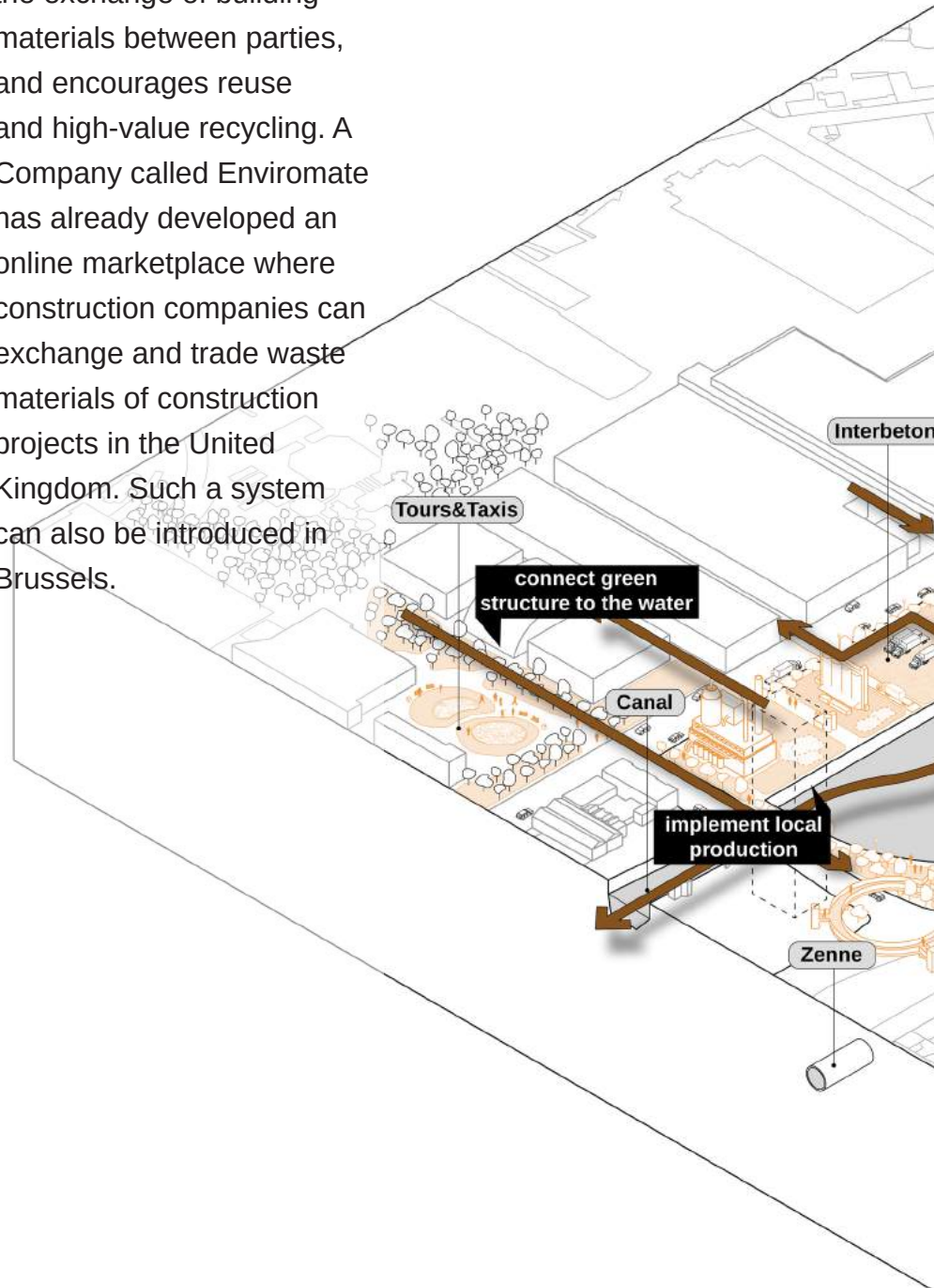
1 - In Flanders the rate is of 11 kg per inhabitant and 9 kg per inhabitant in Wallonia.

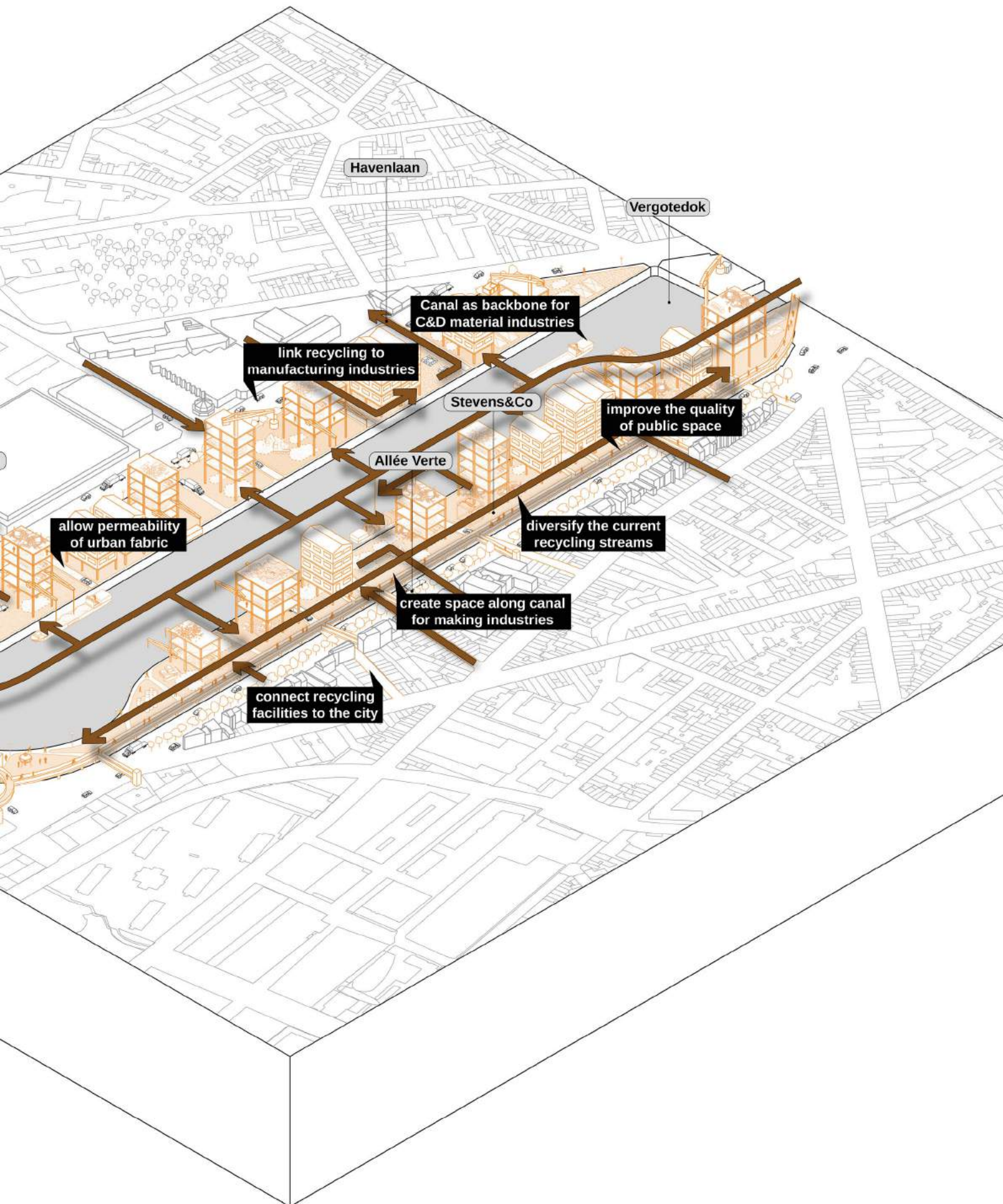
2 - The Regional Land Use Plan or, in French, Plan Régional d'Affectation du Sol

RECONNECTING CITY AND INDUSTRY

In order to make city and industry coexist peacefully at the Bassin Vergote, two new ingredients could be added to the current picture: a regional material bank optimizing the production of new raw materials out of recycled ones, and the insertion of new small scale manufacturing industry. A regional material bank will dramatically improve the potential to re-use the enormous flow building materials Brussels. Via an online marketplace, supply and demand of building materials for local construction projects can be aligned (by means of GIS data) (Zhu, 2014). Besides information on the building, an information management system, building passports, and information on the quality and quantity of materials used in a

specific building can be documented and made accessible. This provides opportunities for trading and the exchange of building materials between parties, and encourages reuse and high-value recycling. A Company called Enviromate has already developed an online marketplace where construction companies can exchange and trade waste materials of construction projects in the United Kingdom. Such a system can also be introduced in Brussels.

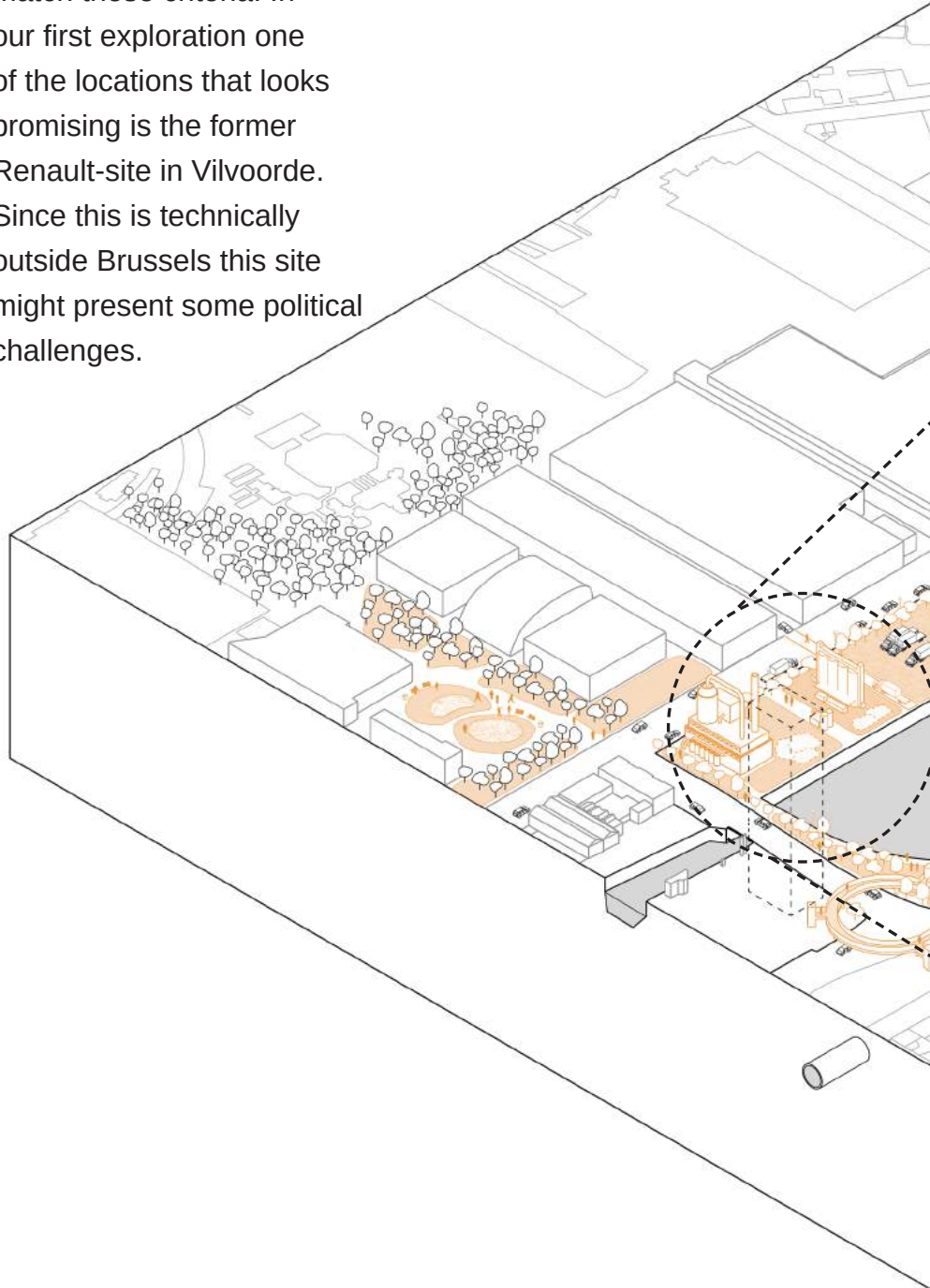


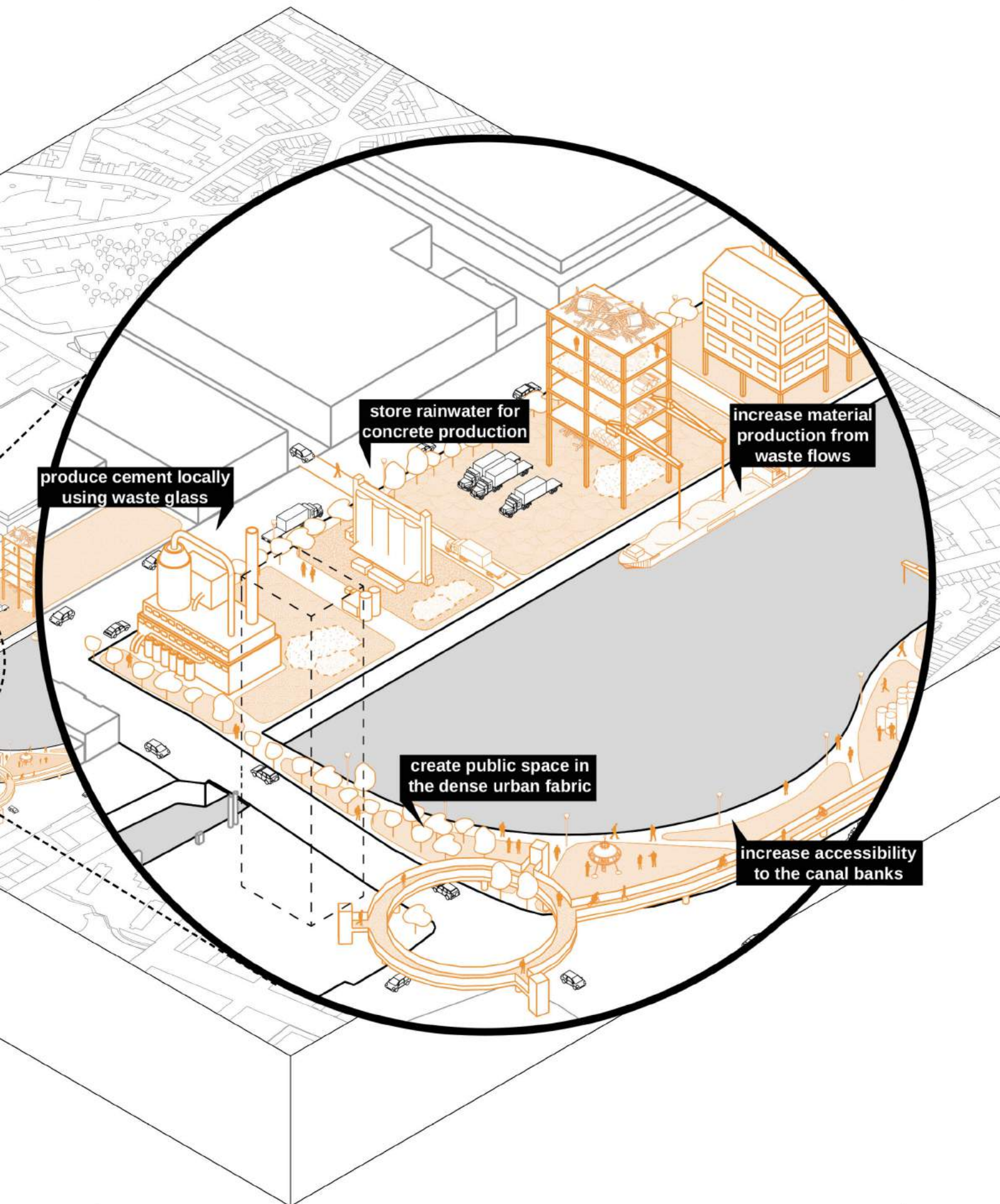


Because of the fact that in Brussels still a substantial concrete manufacturing industry is present at Bassin Vergote the material bank here could specialize in producing new raw materials for concrete out of recycled materials. It could for example provide a serious alternative to the imported clinker (which can be partly produced out of recycled glass), but also sands and other additives for concrete could be made from recycled materials. Using 3D- and 4D printing technologies can help producing affordable custom made building elements, with a minimum amount of waste. Both the newly made raw materials and printed building components can be sent back inside the city using the Canal. There they can be processed into final produced and moved to their final location.

A metropolitan material bank for Brussels thus needs to be situated somewhere in the region at a location with enough space available, that is easily accessible by car and where the Canal

is within reach. There a number of options spatially since there are brown fields in the Brussels region that match these criteria. In our first exploration one of the locations that looks promising is the former Renault-site in Vilvoorde. Since this is technically outside Brussels this site might present some political challenges.

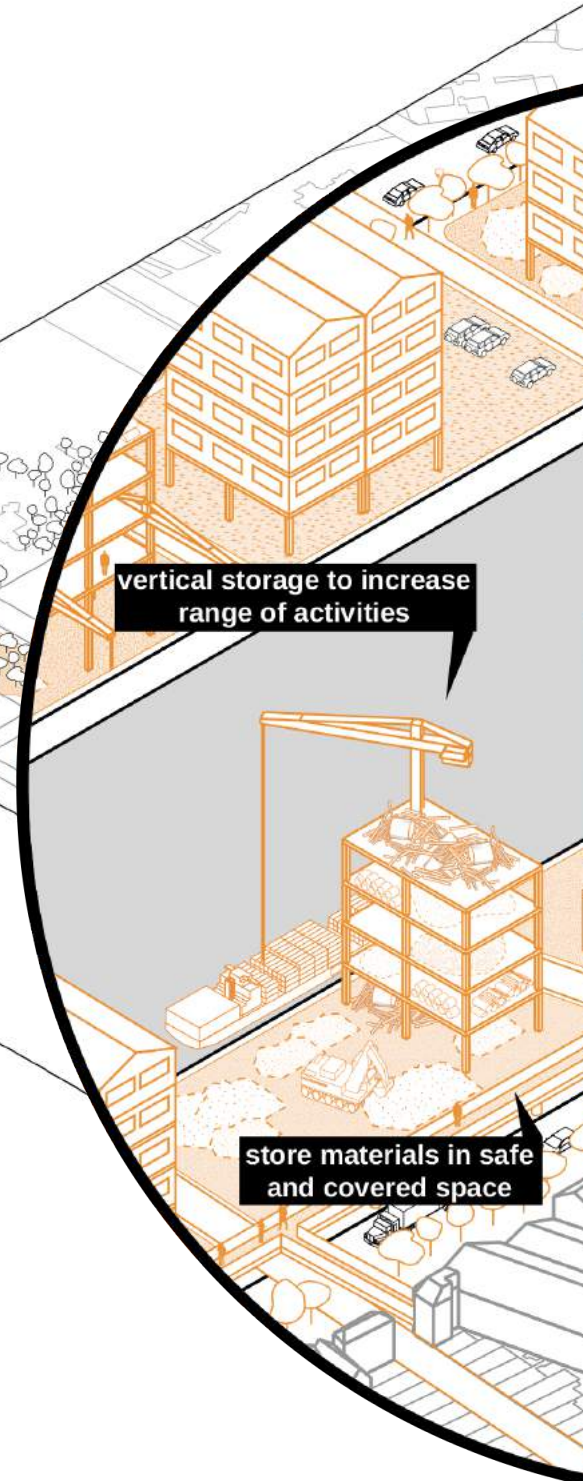


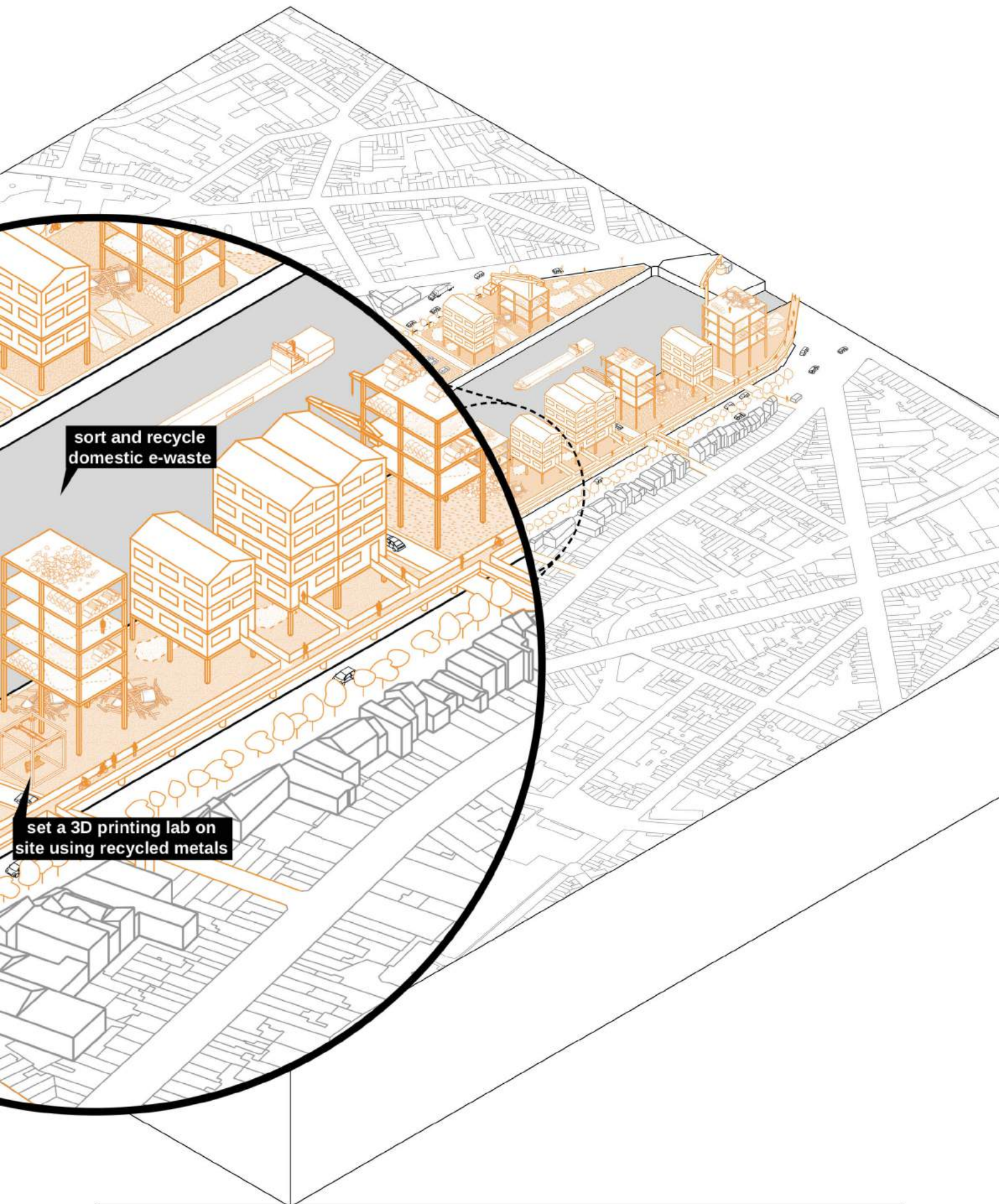


When looking at existing recycling industries at Bassin Vergote there is a growing desire to better connect to the needs of the people. A company like Stevens & Co there for wants to broaden its collecting activities and start collecting e-waste, a growing waste flows in the city. Especially e-waste now is a flow that citizens on an individual level find difficult to solve. Most people have multiple electrical appliances that they don't know how to properly dispose. To tackle this problem in other cities, we have looked at the option of introducing e-waste supermarkets. These supermarkets at the center of a local, network, would be an ideal place to get back a deposit on your old smart phone and other forms of valuable waste, representing the next link in the collection and processing chain for valuable residues. Given the fact that in Masui there is an existing collection network in place that wants to extend we looked at how to better connect this to the activities of people.

We think connecting collection and custom

made production at Bassin Vergote could do just that. If companies like Stevens & Co not only widen their scope of materials to collect, but also focus on how collection and reuse can be connected on site there are many possibilities to connect to the city. First of all not sending of the majority of the collected material and reuse it elsewhere would provide local jobs and knowledge development. But also in terms of awareness and educational value the option of being able to show in one are where materials are collected and how they are transformed into new things is valuable. In urban terms this could completely change the quality of Allée Verte, making it into a true two sided boulevard that is a destination in itself.







THE RISKY BUSINESS OF CONSTRUCTION AND DEMOLITION MATERIALS conversation with Maarten Gielen

We met Maarten Gielen at the Rotor warehouse in Vilvoorde. Maarten is one of the partners of Rotor since the beginning in 2005. He is very much involved in field of salvaged building components and he takes part in the new branch of the company called Rotor Deconstruction. Through this project, Rotor dismantles and sells reusable materials from transformed or demolished quality buildings.

What are the origins of your practice at Rotor, is it a conscious decision to work with relocated materials or is it generated from the need to face existing challenges in the Brussels Region regarding Construction and Demolition Waste?

We started out as a design office, just a few people doing temporary installations and private interior designs. We realized quite soon that something had to change in our way of working: when an architect orders a pallet of new bricks, they all come in the same size, on the exact date you

ordered them and with a technical sheet providing any information possibly needed. If you later decide to order more of them, they will be in the exact same color and characteristics as the initial ones.

There are many benefits in working with new materials that make it possible for designers to draw lines, imagine the most abstract concepts: we usually fill in the texture of the material when the project is already in its latest design state. It is impossible to work this way with relocated materials therefore we started searching for strategies that would allow us to work with reused materials with the same ease as if they were new. This also means changing the way of representing the project for instance.

Construction materials are one of the very few resources that Brussels has but it's one of those streams for which the Region supports the costs without any benefit. Almost 95% of building waste is exported to Flanders so the added value of it leaves the Region. Potentially it could be a resource: it could create a certain amount of local jobs that are very difficult to outsource. When working with new materials, material dealers act like banks in the construction industry. When dealing with second hand materials this figure is missing and you have to figure out a new economic model where the client has to





pay up front and take risks.

How can we deal with regional material resources from a systemic point of view instead of focusing on economic and political aspects? What kind of opportunities would arise from it?

In Brussels, the problem is that the borders are drawn very badly therefore a lot of expenses are densified in the center while their revenues are situated in the Flemish territory. If we look at the situation from a geographical point of view it is a rich Region, while from a political point of view it's very poor. Despite the reiterated initiatives to open a dialogue between the different communities, there has been no actual coordination until now between them. I honestly don't understand why, it would be way more effective to draw a bigger circle and start placing things where they suite best. For example, if you have a high surface business with a low added value, you should be able to place it outside of the center but still consider it as part of the city.

From a systemic point of view all borders are rather disputable but in the specific case of Brussels some borders are more arguable than others. But there is also a bright side of this sometimes-absurd situation. Since Brussels is the capital of the three regions and somehow Europe, we have a sort of free market for

governments. This means that if you're situated in Brussels you can apply to projects financed by Flemish organizations and vice versa. Because of the lack of communication, this system can very inefficient when dealing with big projects but quite performing for smaller initiatives like start-ups. There is a high price to pay for our political mess.

How would you describe the outside world the urgency of looking at Construction & Demolition Materials flow?

In the past 15-20 years the main focus within architecture has been on energy efficiency. This means that we only looked at improving the time frame that goes between the day the project is delivered and the day it stops being used. Solutions like adding more sheetrock or glass wool in your walls make your energy balance very efficient but, if you consider the CO2 emissions produced by the construction industry, the impact is still massive. We believe the only domain where huge economies of efficiency can be made is in the embodied energy of materials. Our aim is to accomplish a transition in material cycles, re-organizing and re-thinking material economies in a way that it would become appealing also from a political point of view.

Construction and Demolition waste is a decentralized resource, you can't have the monopoly of reclaimed bricks in Brussels. Literally, anybody can come up with innovative solutions and start a business right away, you need very little investment costs and most of it is labor. Since already the 16-18th, these businesses were family-run and it was a fast way to emancipation. A lot of people working on construction sites are independent workers in a very precarious situation. Those days they don't get called for a specific mission they drive around the city with their van collecting waste materials that they sell to scrap dealers. At the moment, it's not an industrialized system but maybe it should be. Take for example the market of raised floors in Brussels. To my sense, about 30-40% of all office spaces use the same type of floor and yet there isn't one company who thought of a system to lease them. You could even have an external entrepreneur linking the producers with end users. It would be like choosing between buying a second-hand car from a certified brand or directly from a car dealer, both models can coexist.

When looking at Brussels, how would you improve the current system and how do you think it would affect the architecture practice in the future?

Small steps like a shift from taxing materials to taxing labor would already

make a big difference. There are about 100 companies throughout Belgium that are officially dealing with second-hand materials today. Once again, their *modus operandi* is very informal and they have a hard time sourcing materials because of the strict regulations concerning construction and demolition sites. Everything has to happen fast, most of the deals are made on site. There is the need for a new figure, a sort of *reversed architect*. The same expertise you need when planning a building (carrying load of each type of floor for example) is required for dismantling it.

That's the niche in which we place ourselves, we are a sort of door opener: we dismantle the building, we finance the operation, we harvest the material and redistribute it to different dealers. Last year we started working on public tendering. It is quite hard to work with public commissioners: they have their own legal department and also a very strict legislation on public tenders while the dismantling and harvesting process is still quite unclear and informal. Therefore we wrote a manual explaining to public commissioners how to tender deconstruction projects going from organizing the sale, managing responsibilities, setting criteria for entrepreneurs... The document was first written in French and then translated

to Dutch, even though legislation is the same within the whole Belgium, it got stuck in the middle of the conflict between French and Flemish municipalities and authorities. It's a pity that political borders have stopped this project, 1.000 up to 1.500 direct full time jobs could have been created in the whole of Belgium, I think the reason for this is conservatism.

We live in a society based on having everything new, when we look at the future, we rely on the hope for new and more performing materials but how can we improve what already exists? What needs to change socially, legally, politically and what do you think would be the spatial impact of it?

In the construction business, the biggest problem is risk management. Some products have a high value and low risk. For instance, a doorknob in stain steel costs 20€ and is probably not going to break for the next 200 years and even if it does break, it's not a big deal; you can replace it with a new one within 25 and 200€. On the contrary, a button for a fire alarm initially costs 6€ but if it doesn't work properly it would comport high risks; in this case you have a very low value and very high risk. With relocated materials, we try to keep ourselves on the side of high value and low risk, this is our safe zone to operate at the moment.

In terms of legal policies, there are a lot of habits in Belgium that could change. Take for instance the stones used to edge off the sidewalks: they are typically in blue limestone and their technical sheet specifies that they should all have the same length. Such a policy generates big losses in the second-hand industry: when you break up five different streets there is minimum a 40% loss if you have to respect this principle, moreover there is absolutely no technical reason for this to exist. We've started writing alternative technical specifications for specific materials. The problem is that every sentence you remove could have huge consequences on the construction site. It takes about a year for the stakeholders to verify its accuracy.

Is there also any spatial or operational improvement that you would suggest? For instance what would be the needed infrastructure to move around materials or what would be the space needed for the sorting process?

Two are the challenges that have stopped us from growing rapidly: first, it's very hard to finance this kind of projects, you need to invest a lot of time and money upfront and banks are not really interested in financing it. Time also plays a very important role: if you look at the building life timeline, once the decision has been made the demolition part has to happen very fast,

sometimes within 2 weeks. When possible, we try to transport the materials directly from the deconstruction site to the new owner otherwise we use transportation companies as buffers: they pick up the materials, keep it for few months and then distribute it to the client. For financial reasons though, most materials need to be sold before they leave the building. There is always a large quantity of materials, the real problem is finding new users. We have to pick the low-hanging cherries and sell them as quick as possible before we actually go up the tree. It's important to keep the cycle very short in order to maintain the material as economically viable as possible, avoid commercial risks, extra transportation etc. This goes in conflict with the idea of providing relocated materials with the same services as new ones but this is what matches the economic premises that exist now.

As suggested in your study, material banks are a viable option and for some specific materials they already exist. I think it is important to have companies specialized in diverse materials and operations because dealing with glass partitions or raised floors demand very different skills and know-hows. The scale at which you operate is also very relevant to make it economically interesting. The US market is a well-functioning model: a tax reduction is applied on relocated materials, therefore

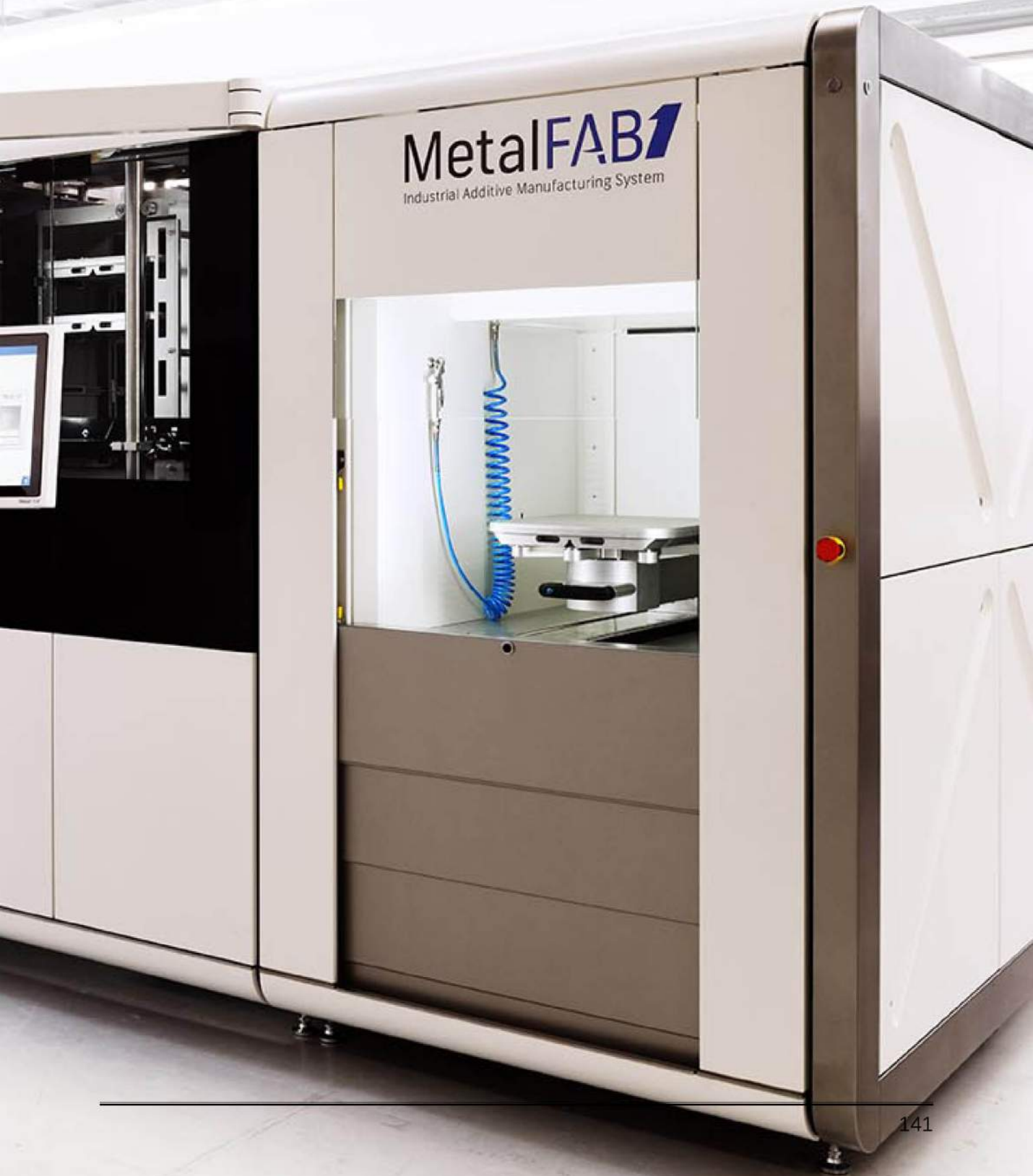
construction and demolition companies are motivated to hire high-qualified labor in order to guarantee a high quality of the harvested components. In Belgium they offer to give us the materials for free but very often we find it damaged or incomplete.



PROJECT REFERENCE

With the introduction of digital production techniques, the creation of unique products for the price of mass production has become plausible. Even producing truly workable components for machines is not far away. A company like Additive Industries is already testing a 3D printer that can do this for its customers. If this technology is linked to materials obtained from recycling processes, it becomes possible to show the whole cycle of production, use and reuse at one location, and it is additionally conceivable that people really begin to understand the needs and benefits of recycling.





FLOW MAP: ORGANIC WASTE

Besides C&D waste Masui is also a relevant area addressing organic waste. Maps show that there is a high percentage of organic waste in the total flow of household waste in Brussels. Currently household waste incinerated. In most dense urban fabric it is difficult to separate organic waste from household waste since most people don't have space to separate their waste flows. MABRU and EU Center in that respect are interesting and significant exceptions in Masui. MABRU and EU Center together produce more than 450 tons of organic waste per year, making them an important player in the city. A small fraction of this waste flow is re-used but more than 70% is incinerated next-door in Neder-Over-Heembeek. In terms of functioning currently MABRU and EU Center form an island in the city. They

receive everything from outside of the city and accommodate the trading of the goods and dispose what is left over. Since the two operations are very contained one could think of actions to improve the collection of waste flows on this 'island'. Because potentially MABRU and the EU Center could deliver the highest quality of unprocessed organic waste from fruits and vegetables in the city. This waste in turn could be used for instance as animal food, but it can also be the start of a number of products that would improve the connection between MABRU, EU Centre and the city.

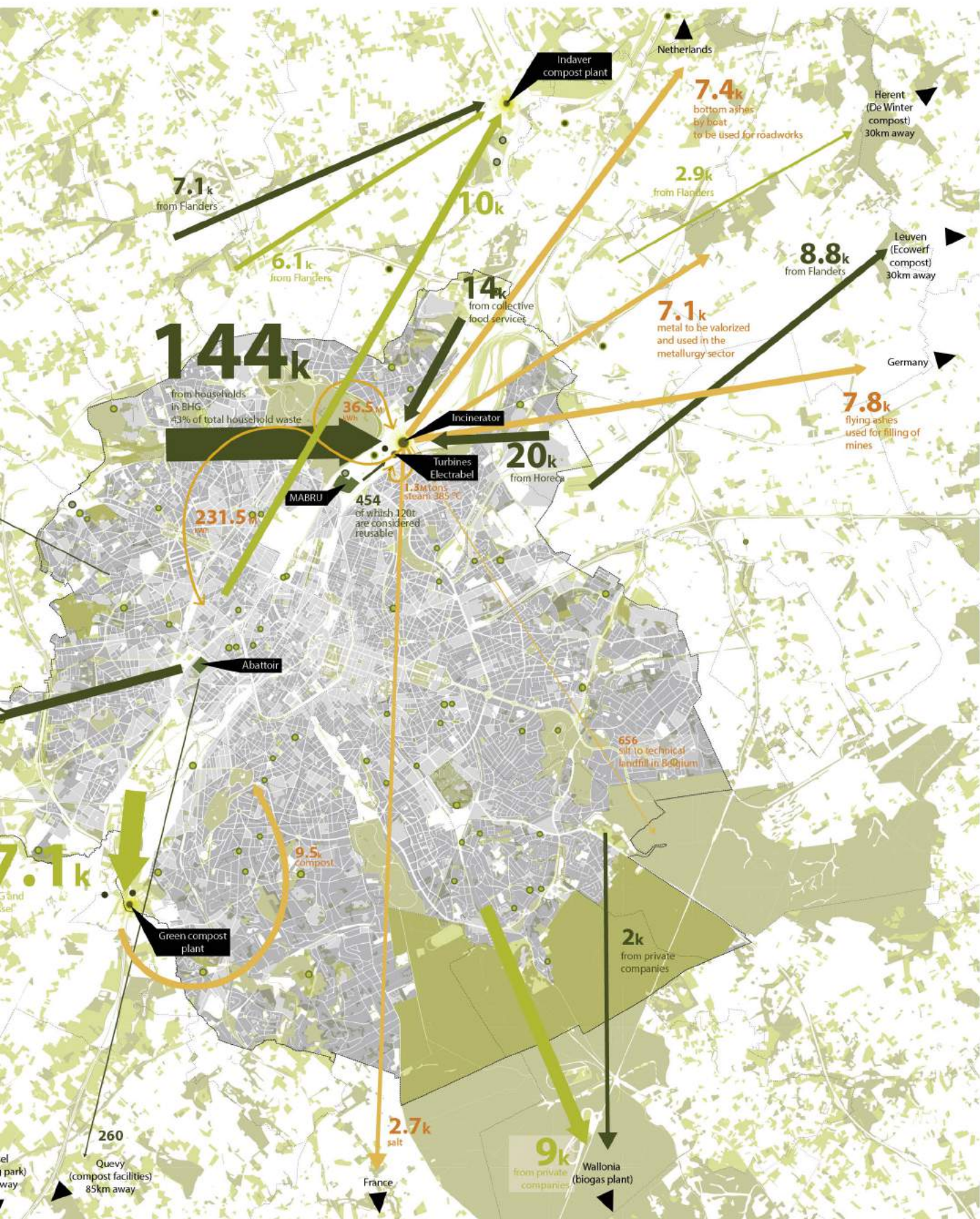
 tons/year of food waste

 tons/year garden waste

 tons/year processed waste

- SITA containerpark
- INTERZA containerpark
- NET BRUSSEL containerpark
- Compost containerpark
- INCOVO containerpark
- mixed area (office, Horeca, facilities)
- residential area
- green areas
- natural areas







CONSEQUENCES: LOSS OF ORGANIC WASTE

The challenge of MABRU is to collect organic waste in its purest form so that all its fractions will be optimally used. In reality, this challenge exists also at the household level. If we are able to collect untreated fruit and vegetable waste separately, it becomes plausible to use it as animal food, compost, for biogas production, flavors enhancer and as raw material for bio-plastics.

To do so the current network of collection points should be drastically intensified, making sure that collection points are at walking distance from people's house. If this succeeds, an additional beneficial effect is that the existing road network will be used less intensively since less waste is going to the incinerator, as more will be recycled locally.

For MABRU and EU Centre, reusing organic waste locally offers the opportunity to also

improve its isolated position from the city. Taking advantage of the fact that the market is only functional until 11 o'clock, the rest of the day the area could host more public activities. Introducing recycling restaurants can be a first step. Taking advantage of the abundance of roof surface available, these restaurants can use organic waste to 'feed' to their roof-top gardens that in turn provide the vegetables that are needed in the restaurant. But also in a more direct way these restaurant profit from MABRU and EU Center. Already restaurants like 'IN STOCK' in Amsterdam and Rotterdam pick up unsold products at super markets and have their chef's make daily surprise menu's with the 'harvest of the day'. Also a local brewery using left over bread is a good option to use what is now wasted and at the same time connect to the people of Masui.

- urban compost facilities
- allotment garden
- regional compost facilities
- incinerator
- impact of waste transportation





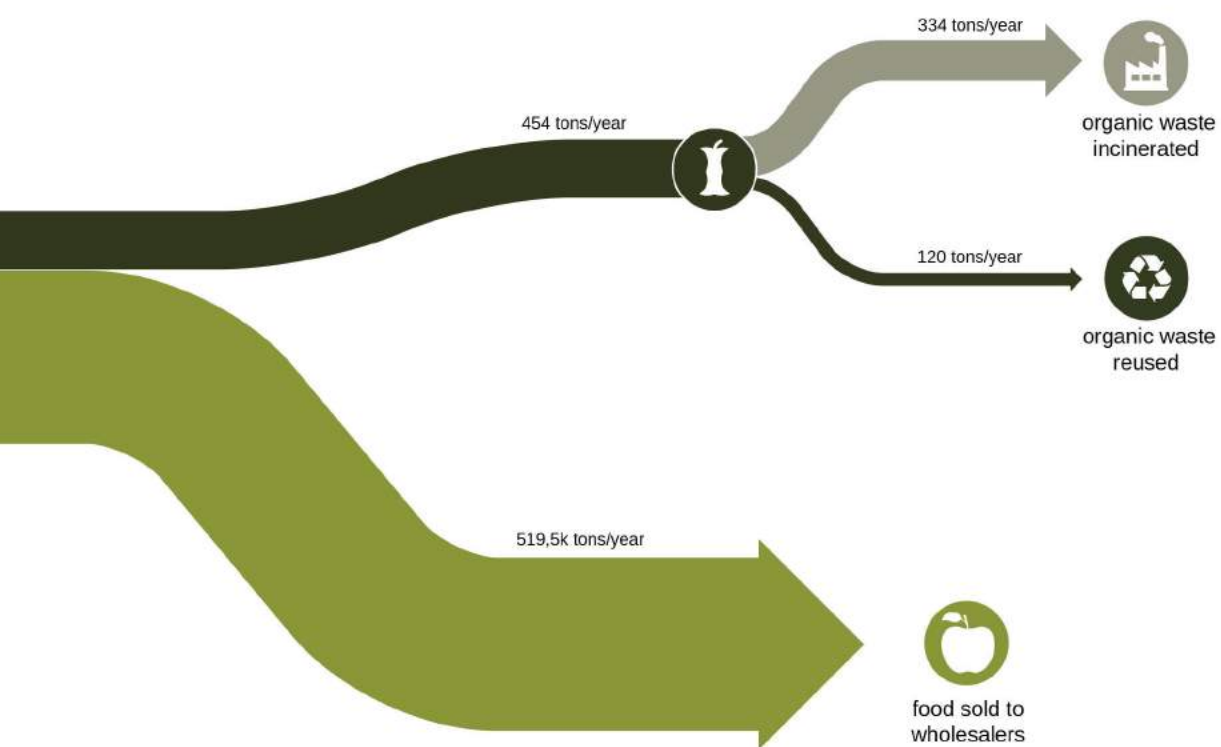
USING ORGANIC WASTE AT MABRU

The present flow diagram for MABRU is quite simple: agricultural products are brought into the area and are sold to traders. The waste that occurs in this process is currently only reused in a small percentage.



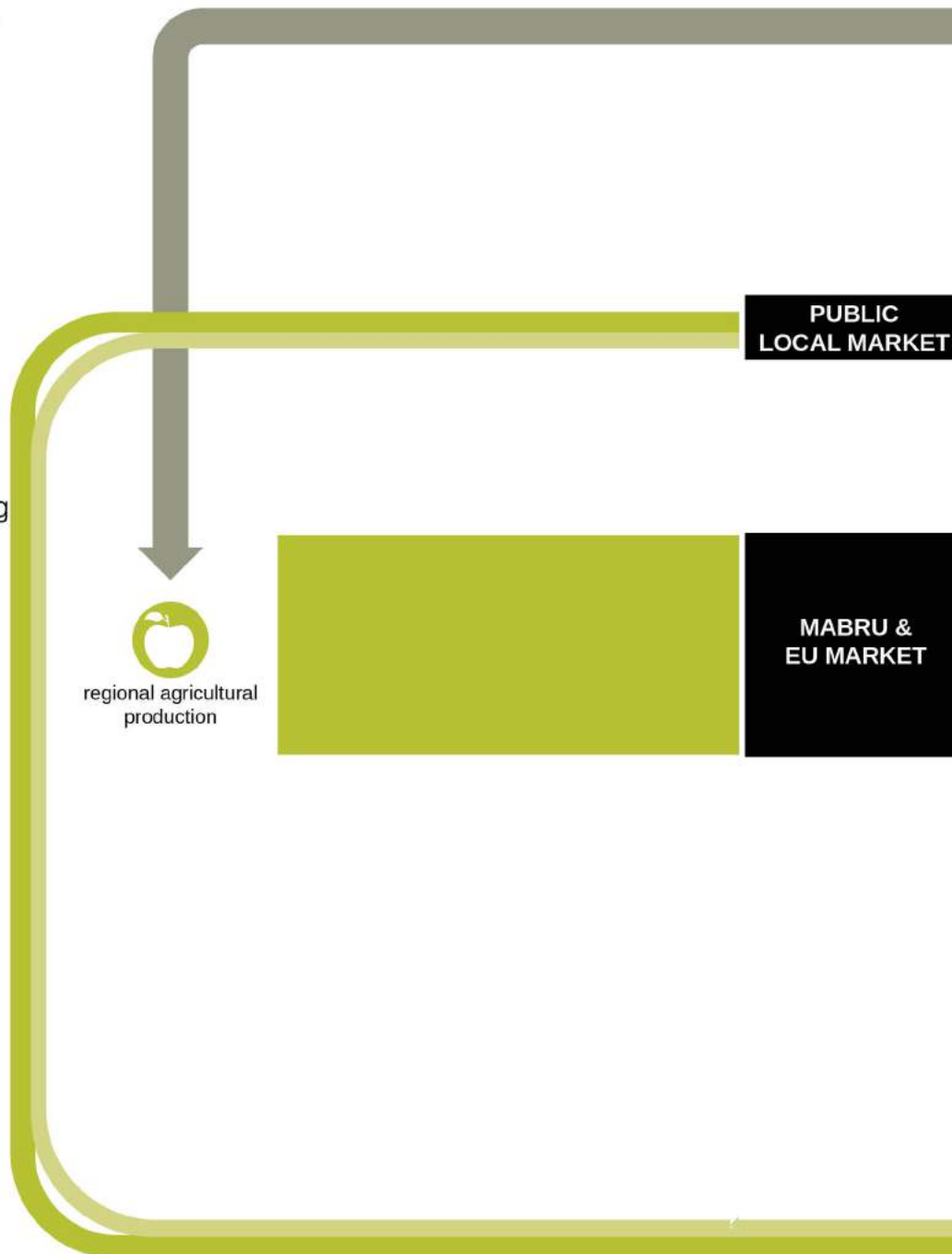
regional agricultural
production

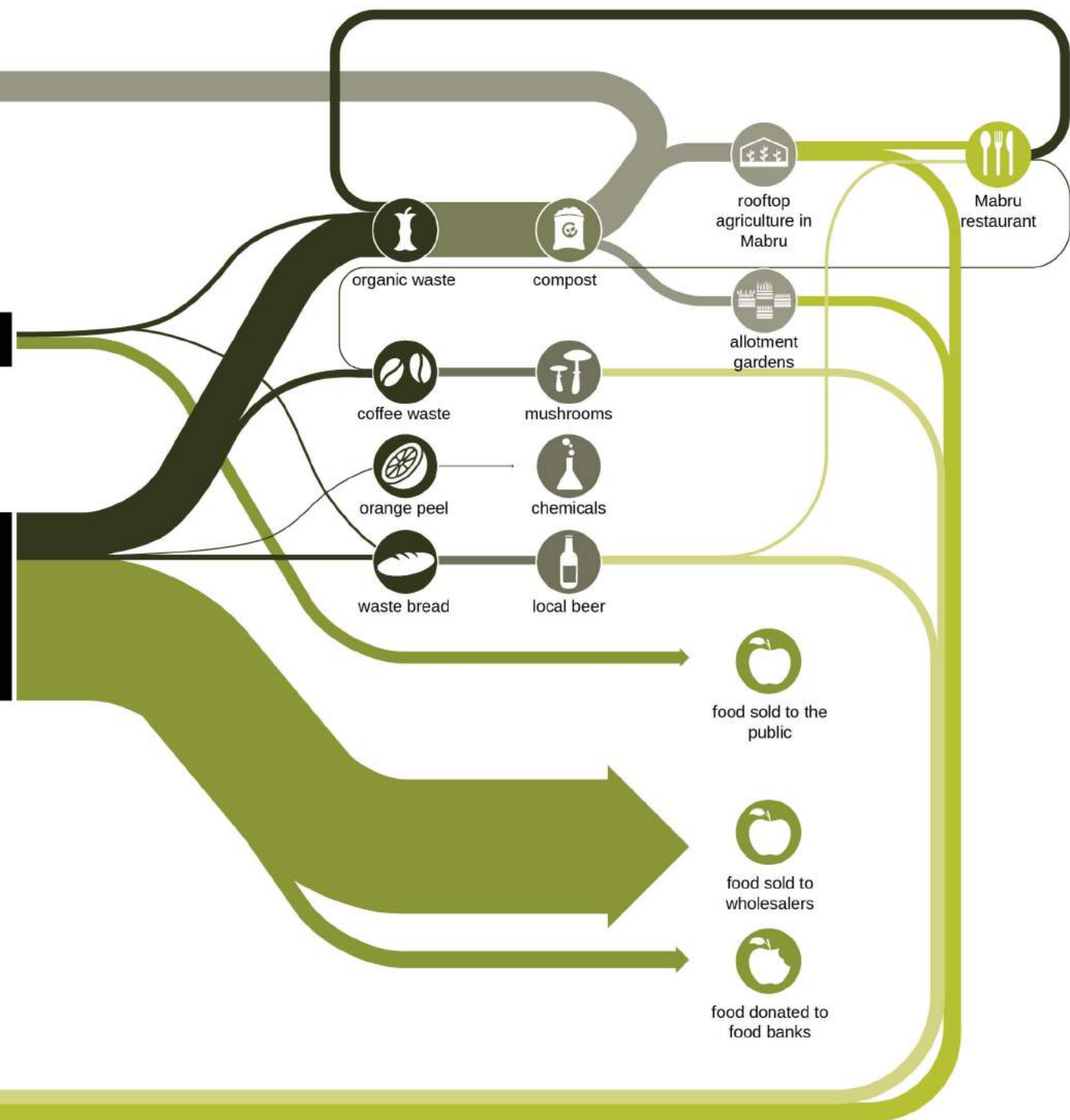




As MABRU internally functions like a closed entity, it is here conceivable that all the different types of organic waste can be separately collected.

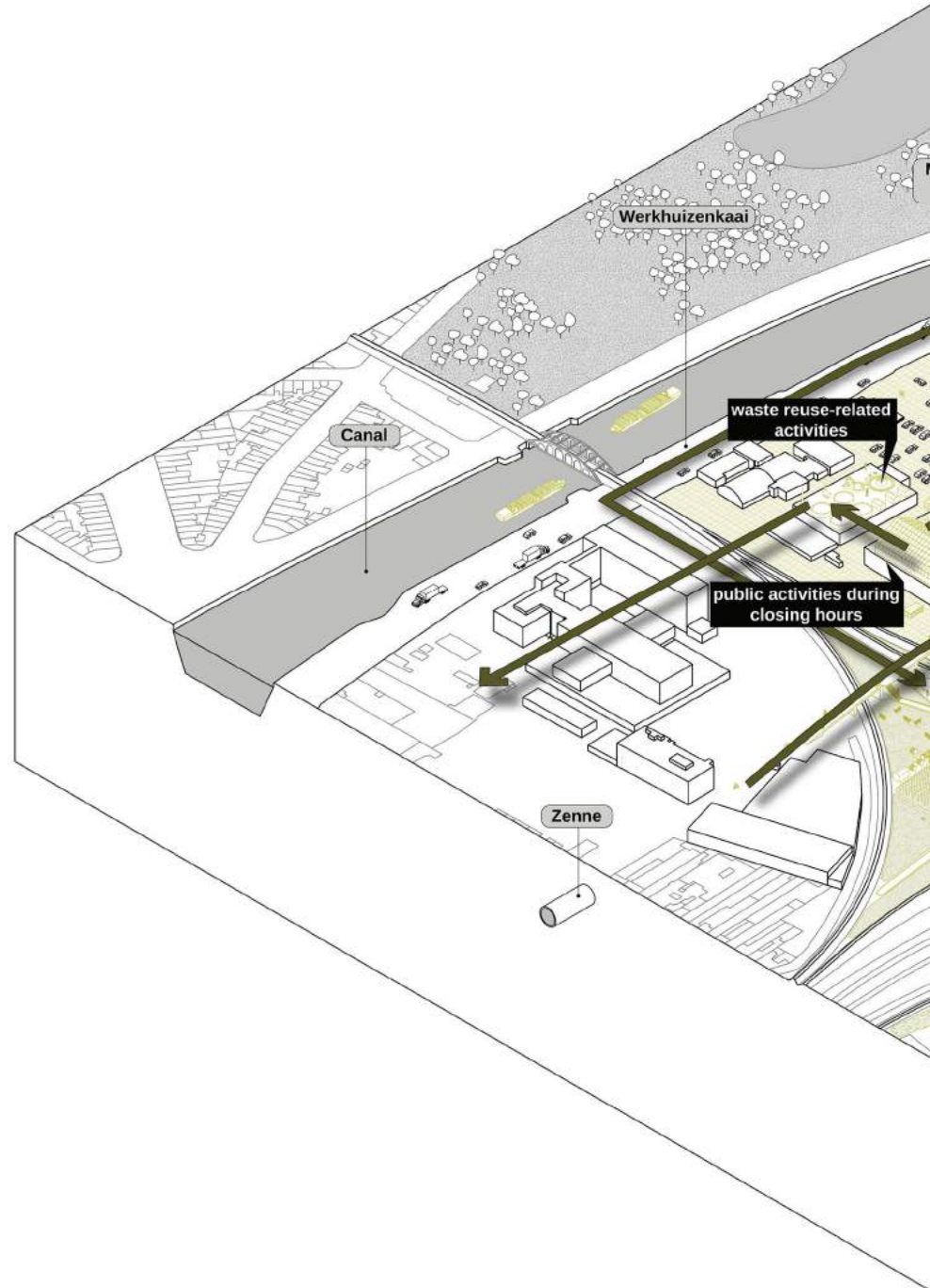
This means that citrus fruits (particularly peels) and coffee grounds could be collected separately and be reused for different purposes: peels for making chemical substances such as flavor enhancers, the coffee grounds as a breeding ground for mushrooms.

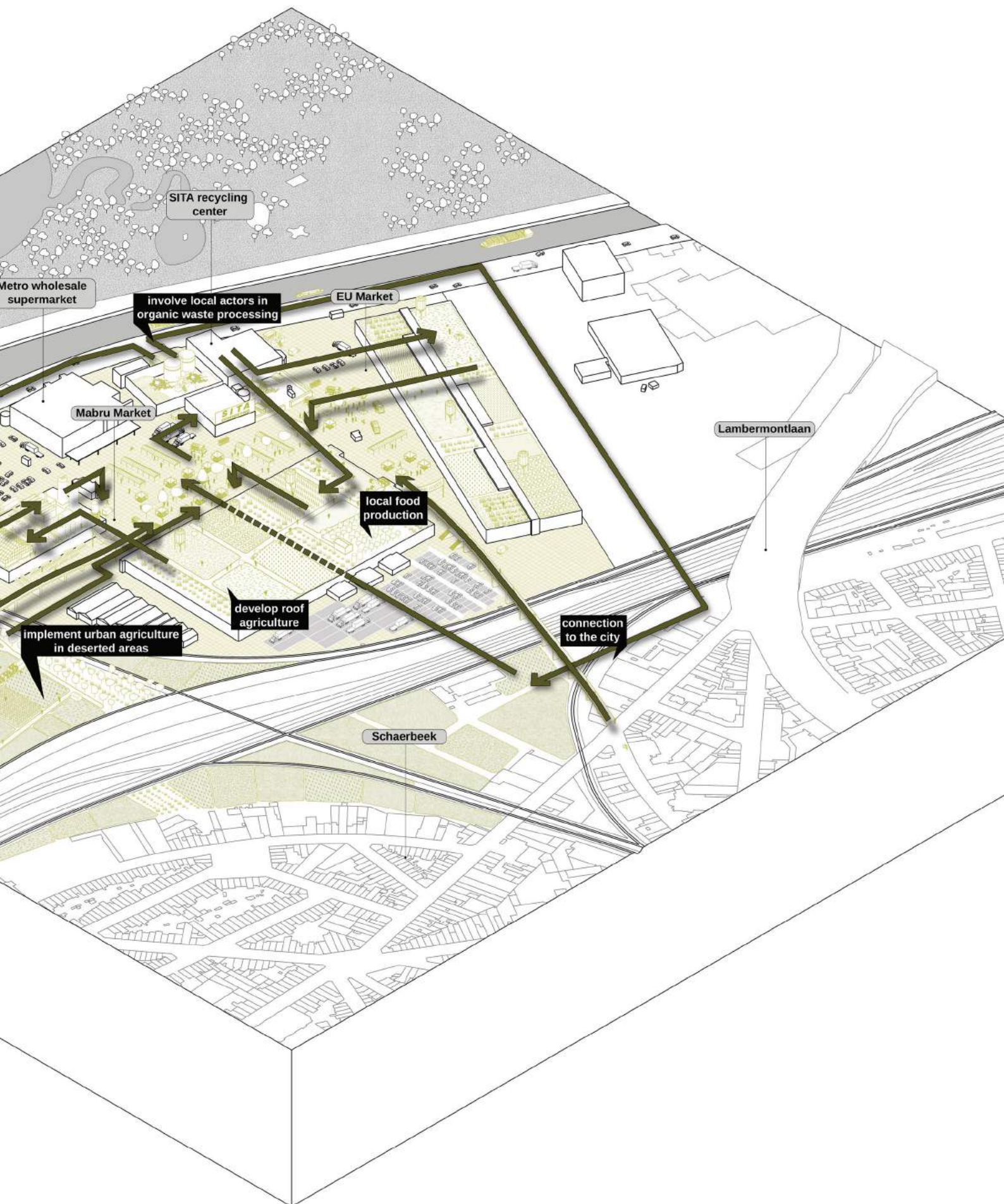




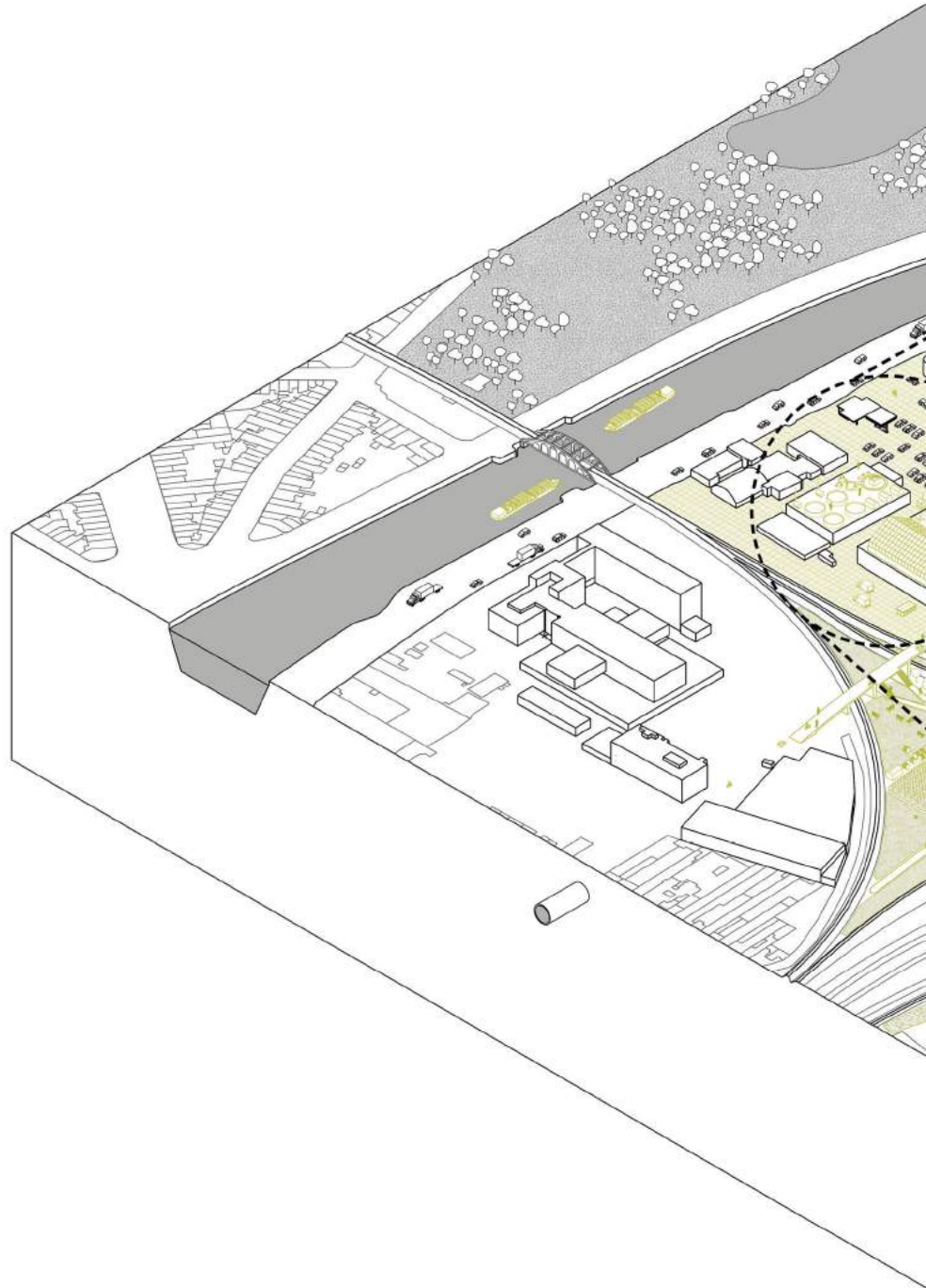
LOCAL URBAN FARMING

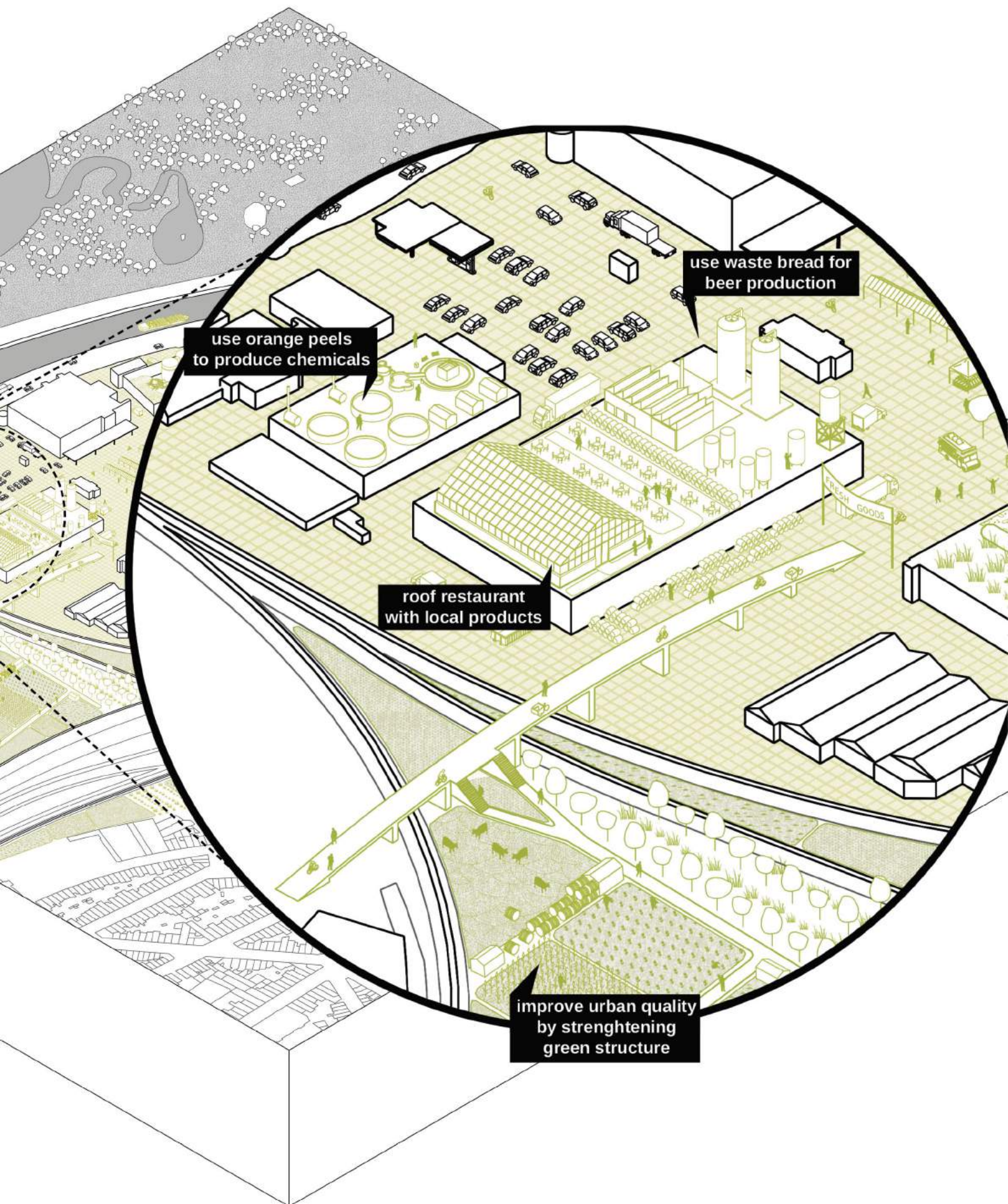
Combining the fact that only a low amount of waste is reused with the fact that MABRU is a morning market, that there is an existing knowledge on site on composting – Sita – and (roof)space available, makes this site attractive for different forms of public activities that feed on organic waste.



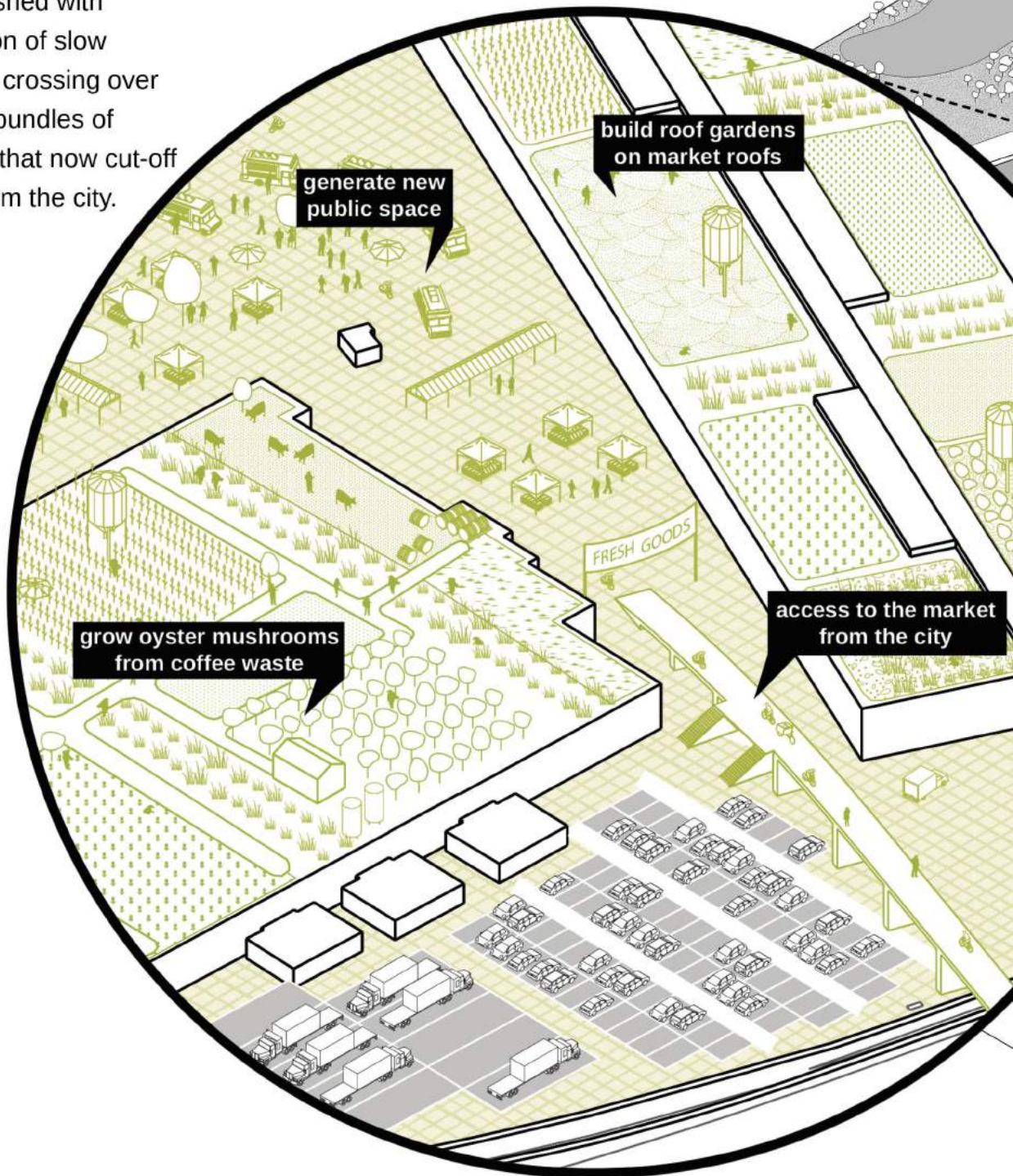


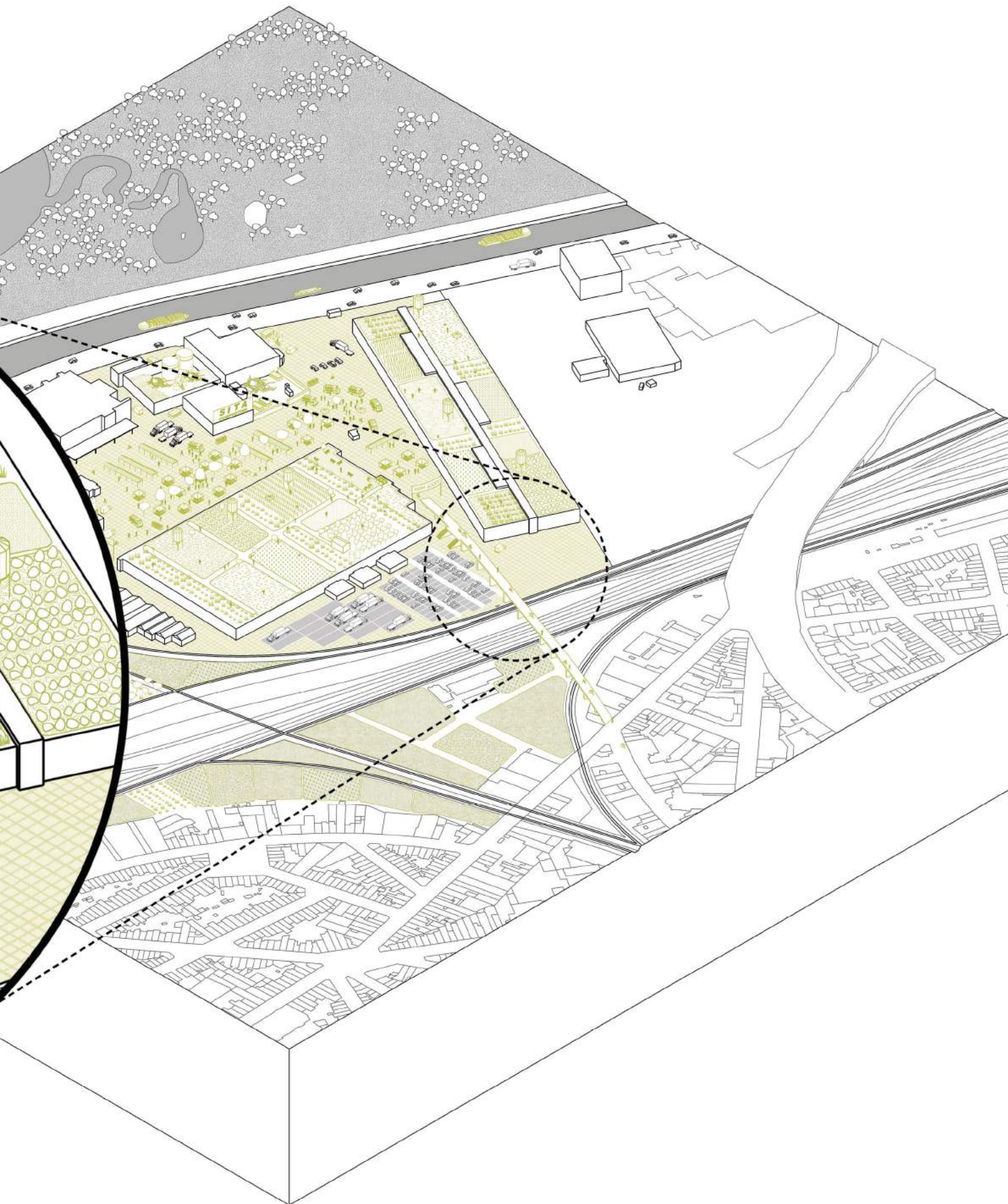
Potentially, public attractors like roof-restaurants blend in with new industries that use organic waste for making flavor enhancers and bio plastics.



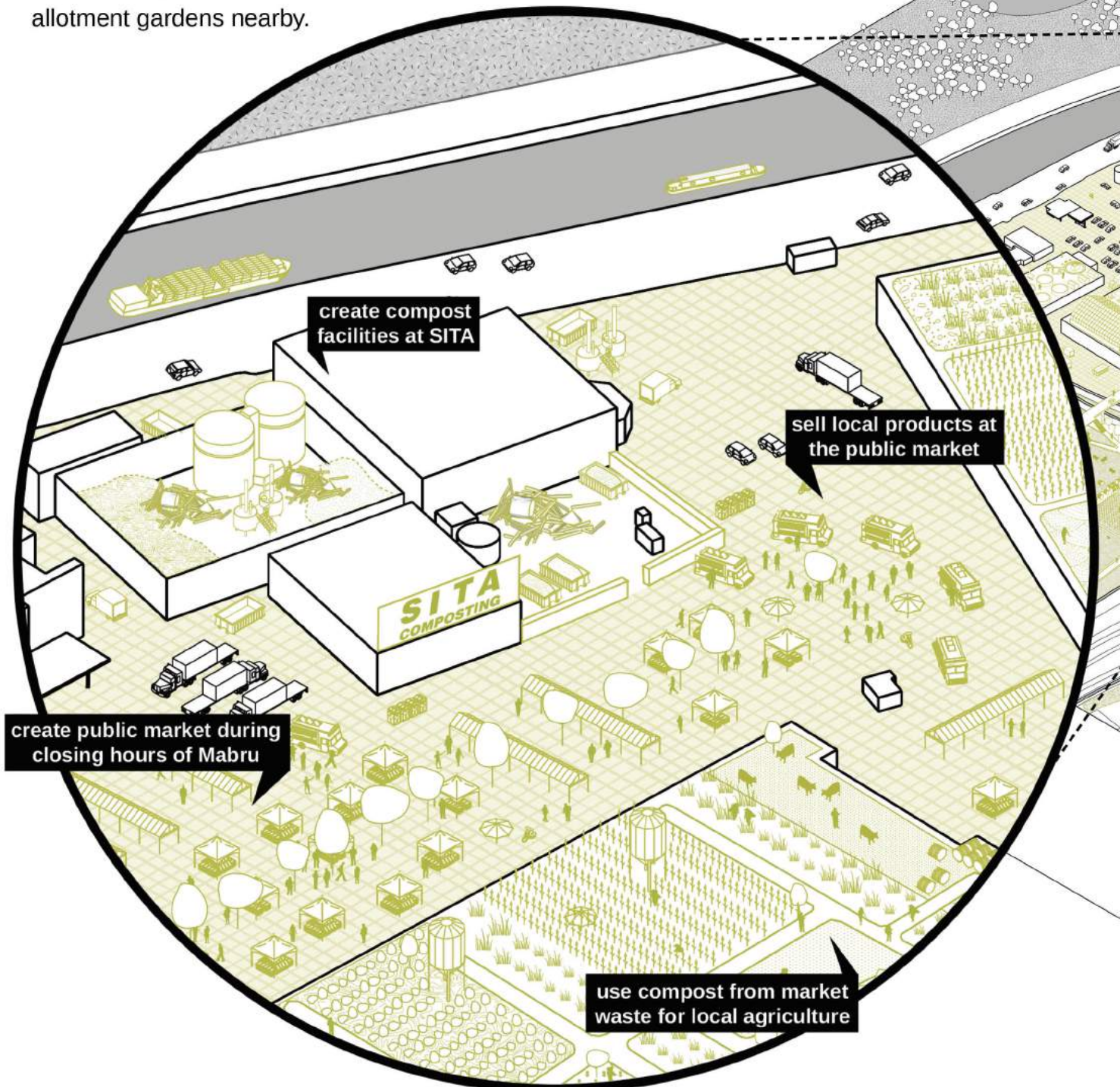


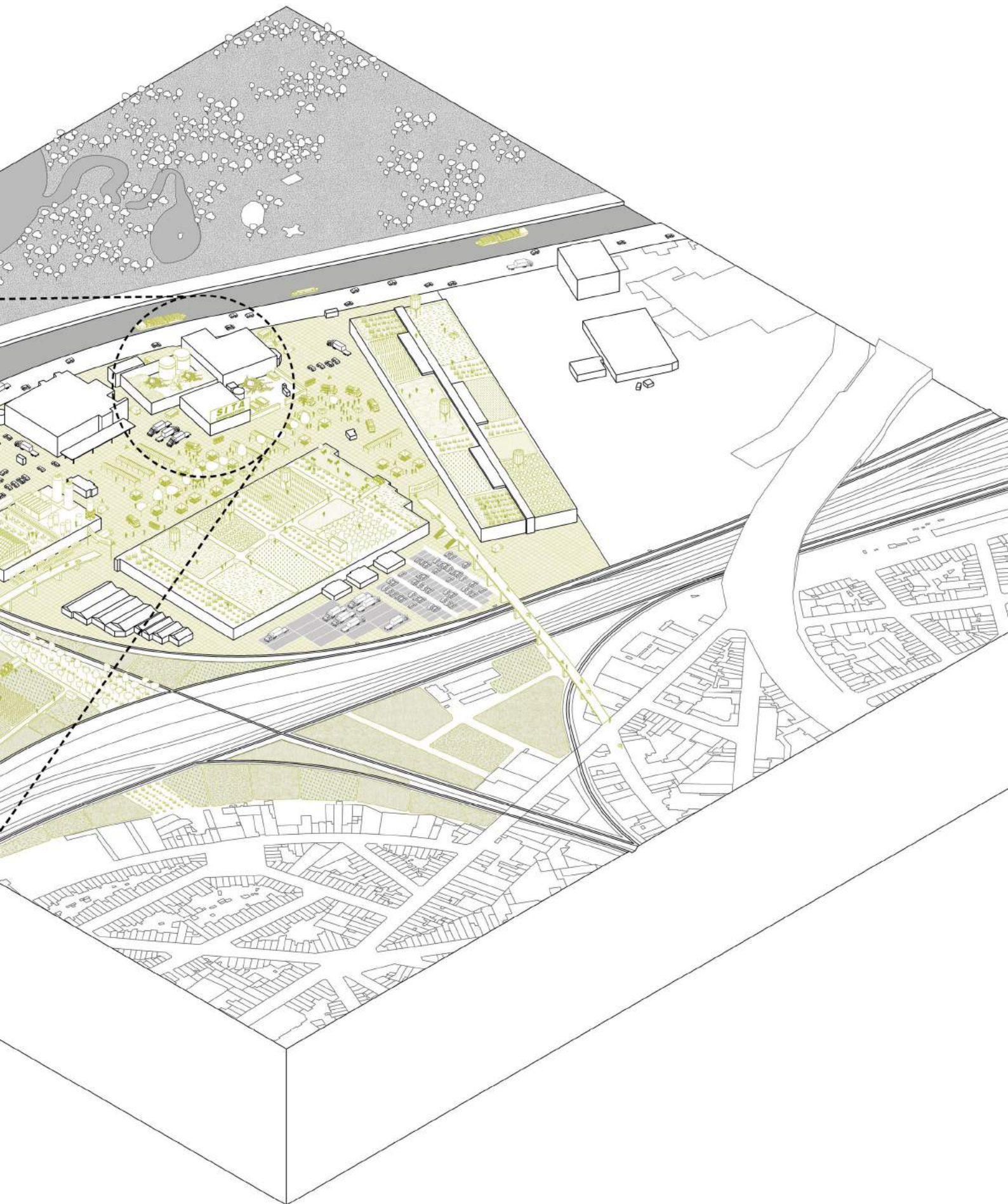
Next to programmatic connections to the surrounding neighborhoods offering attractive local products, the isolation of MABRU in a physical sense can be diminished with the introduction of slow traffic bridges crossing over all the heavy bundles of infrastructure that now cut-off the market from the city.





Connections with surrounding activities can also be made through complementary activities such as the SITA site processing the organic waste from the market and redistributing it as compost to allotment gardens nearby.







EDUCATE PEOPLE THROUGH THE PATH TOWARDS WASTE VALORIZATION

conversation with Nicolas Scherrier

We met Nicholas Scherrier at the new headquarters of the IBGE in Brussels. Scherrier is in charge of regional strategies for resources and waste management in the Brussels Region since 2012. He has been actively involved in several educational projects regarding the implementation of sorting and recycling processes of organic and construction waste in Brussels.

What do you consider the main challenges for the organic waste flow in the Brussels Region?

There are several big challenges right now regarding Organic Waste. First of all is the fact that the households waste is currently not sorted, everything goes directly to the regional incinerator. This is quite serious because we are not recovering anything from it, not even heat since organic waste contains 80% of water and it needs to be dried before being burnt. It is not efficient, very energy consuming and with a low

heat capacity. It would be way more efficient to recover heat only from residual waste.

Another issue is waste valorization: in Brussels we have very little green surfaces; there are only few farmers, forests and parks. This implies a low regional demand for compost and exporting it would unbalance the price-value ratio of the product. According to the waste hierarchy, the first step is prevention and in order to address this topic the IBGE set up the Good Food Strategy which involves actions for households, professionals, canteens, enterprises, retailers... Along the food chain from producer to consumer around 30% of the food is wasted and we are willing to work on every segment of this chain including distributors, logistics, and manufacturers to improve it. The first action is to generate awareness, explain people the different processes and meanings. The region is mainly populated by retailers and consumers. Only by explaining people the difference between selling date and expiration date would make a big improvement. We use medias such as TV, internet and advertisement but also organize actual training courses. There are initiatives like *Compost Master*, *Garden Master* and *Master Fridge*... We also organize meetings with the canteens: we discuss their habits and advise them on



how to educate the children that, as young consumers, will share the practice at home with their parents.

We have organized as well the *Ugly Food Campaign* that aims to teach to retailers, producers and consumers to go beyond the concept of a “good size” or “shape” for food.

How does the management of Organic Waste deal with political and administrative borders in Belgium, is this fragmentation also taken into account in the PREC? A flow like organic waste doesn't really respect borders, is there a vision going beyond

them?

So far we haven't even talked about it. The PREC is only for Brussels, like anything else: you pay taxes in the place you live. The hinterland of Brussels is mostly under the competence of the Flemish region. I only see two possibilities: one is cooperation, the other one is strengthening the existing limits by working as an island and making sure that Brussels recovers all its waste itself or makes a product out of it (like compost for instance) able to reach the market according to the demand and offer of the end users.

One of the targets of the PREC is to implement local circular economy in

Brussels and to create new jobs. This is one of the main points of the PREC; local means first Brussels and then, depending on the streams, it can be enlarged to the rest of Belgium, or even Europe. We want to end the current practice of exporting Organic Waste to our neighboring countries in Europe, in Asia or Africa. Not only for environmental issues but also to bring the economic added value back to Brussels. If we can manage to sort waste and make new products out of it (as compost, recycled metals, building materials...), they can be sold wherever the market needs them. But in order to allow the product to leave the region we need to make sure it respects the law in Flanders for instance. It depends very much on the type of waste, for Organic Waste is quite challenging because of the low value of its by-products.

Another improvement could be done in the collection of waste. The best option would be to have a *"pay as you throw"* system, like in Flanders, where you pay per kg of waste you produce. But in Brussels most of the citizens think waste collection is free because they pay an annual regional tax that includes also waste management. If a politician would suggest to change this, he would become very unpopular. Probably it should become mandatory in the whole EU. It's really hard to organize the sorting process because people don't

see a direct economic gain, if they don't do it they would still pay the same amount of money per year and by doing it they would have to keep an extra bag in their house, it takes a lot of space and they are afraid of the smell.

Speaking about lack of space, do you have an idea of the spatial outcomes of these new strategies for Organic Waste? How will the city and its infrastructure change according to the future practices?

Duplicating the number of trash bins in each household might seem irrelevant at the regional scale but at the scale of the single house the spatial impact is huge. The only solution I can imagine for this at the moment is again prevention, for both organic and residual waste.

In some cities like Antwerp, they replaced the old door-to-door collection system with specific bins underground where you can voluntarily bring your waste. I believe that only the distance you have to walk from your house to these bins makes you think twice before throwing something out, the sooner you fill your bag the sooner you'll have to go empty it. This method is also very efficient from a logistics point of view: it takes 15 minutes per week to empty them and the bags don't have to lay on the streets, prey of any sort of urban animal.

A substantial change in waste management will affect also the functioning of the regional incinerator. As an environmental agency, we want to avoid incineration as much as possible; it is the very last step of the pyramid together with landfilling, which luckily is not in use anymore in Belgium.

With the PREC we are really trying to improve the recycling process by improving the collection system and facilitating recovery of the Organic Waste at the regional scale. In fact, removing organic waste from residual waste would cut its activity by almost 50% and it would also improve its heat capacity (which wouldn't be supported by the current incinerator because of a too high pressure). Therefore you can either close one of the three ovens and redesign a new system (which is not really profitable) or you can import residual waste that would be incinerated somewhere else anyways. Although it's 20 years old, the incinerator (half owned by the Region and half from the private sector) is still a source of income for the Region because of the incineration fee. Interesting enough, this money is dedicated to finance our environmental projects, it's a sort of compensation.

We are aware of the initiatives to recover proteins, enzymes and plastics from

waste. They have a very high monetary value but unfortunately they are still at a very early research stage. At industrial scale the only options we have for now are composting and anaerobic digestion.

If we zoom in to the local scale, what do you imagine could be the social effects of the transition towards a circular system for households? When people start composting or sorting their own waste, in a first moment they are driven by an environmental motivation. We try to use this as an entrance door to share an environment-friendly behavior.

Some cities like Ljubljana, in Slovenia, have demonstrated that when the waste collection and valorization system is working at the big scale, the costs to run waste plans diminish, and the money is returned to the citizens, like a company that shares its profits with its employees. When they stopped burning their organic waste in order to convert it into gas and compost sold to local farmers, the region cut their costs by half. We want to share these successful stories such as Ljubljana, Milan, Amsterdam and hope for a positive effect. Starting from the current situation we can only improve, the rest is only about economy: people would change habits if there is a noticeable economic gain.

Last year we've accompanied nine

restaurants through an educational path to change their practice in cooking, to think of menus with low waste production, to properly sort their kitchen waste... It might sound quite basic but very few restaurants currently do it and the profit they have from a lower waste fee is an incentive to continue doing it. In the past we had a law that guaranteed retailers they would get back the VAT from unsold products only if they threw them away. Nobody was donating products to food banks because of this. Through the Good Food Strategy we are trying to help retailers build a partnership with at least one food bank in order to get their VAT back. They now have an economic incentive to do it and they're proud as well to show their customers their involvement in environmental issues.

For important actors like Mabru Market and Abattoir it is definitely interesting to adhere to these initiatives since they produce so much organic waste. We are guiding and advising them in this process. In 2010 we started evaluating the organic waste produced by Abattoir in relation to local compost production and local farming. When I speak about Organic Waste in Abattoir I am not talking about animal waste though. This is a complete different story. Animal by-products are a big issue, they include not only animal leftovers from the slaughterhouse but

also every product that contains animal derivatives such as eggs, milk etc. There are a lot of sanitary restrictions and not enough knowledge on this topic. It's more expansive as well and a lot of companies don't want to deal with it; if you think about it, almost every cooked food contains animal by-products. Hopefully it will soon be discussed in the EU commission.

We've talked about the urgencies of Organic Waste in Brussels and we've mentioned the PREC and the Good Food Strategy as two different approaches to deal with it, is there any other initiative that you would like to mention?

Well, there is also the Waste Management Plan. The Good Food Strategy is very much related to food of course, the PREC is really about economic animation, while the Waste Management Plan is wider, it covers the previous two and has a very long lifespan. In fact, it assesses the situation of Organic Waste in Brussels, gives a vision and directions to accomplish it.

The PREC has given coherence also to actions that were already in place, it has enlarged them at a regional scale and framed them in a clear context. These economic actions are fed by the regional plan, the PREC is as well one way to demonstrate industries that there is a

concrete aim for improvement and also a real budget to realize it. I should also mention that there are many private and group initiatives done by single households or specific companies that have started this process on their own, even without us.



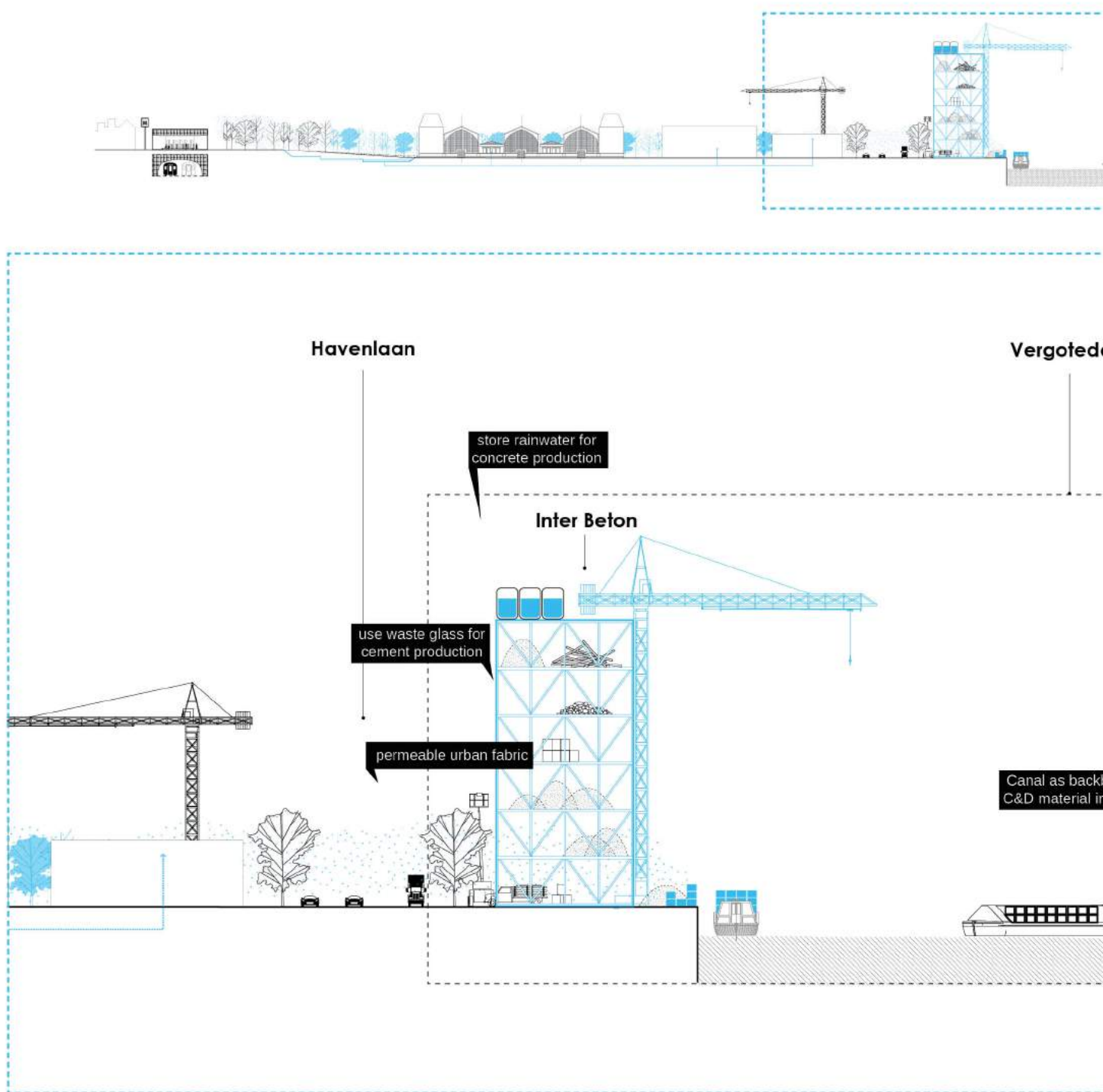
PROJECT REFERENCE

In more and more cities restaurants that use local products are popping up. This example of Stedsans ØsterGro in Copenhagen goes one step further. It was one of the first restaurants to be situated in its own rooftop farm. It takes little effort to imagine how this typology could be linked to the local production of compost so that a closed and local system of production and consumption is established.

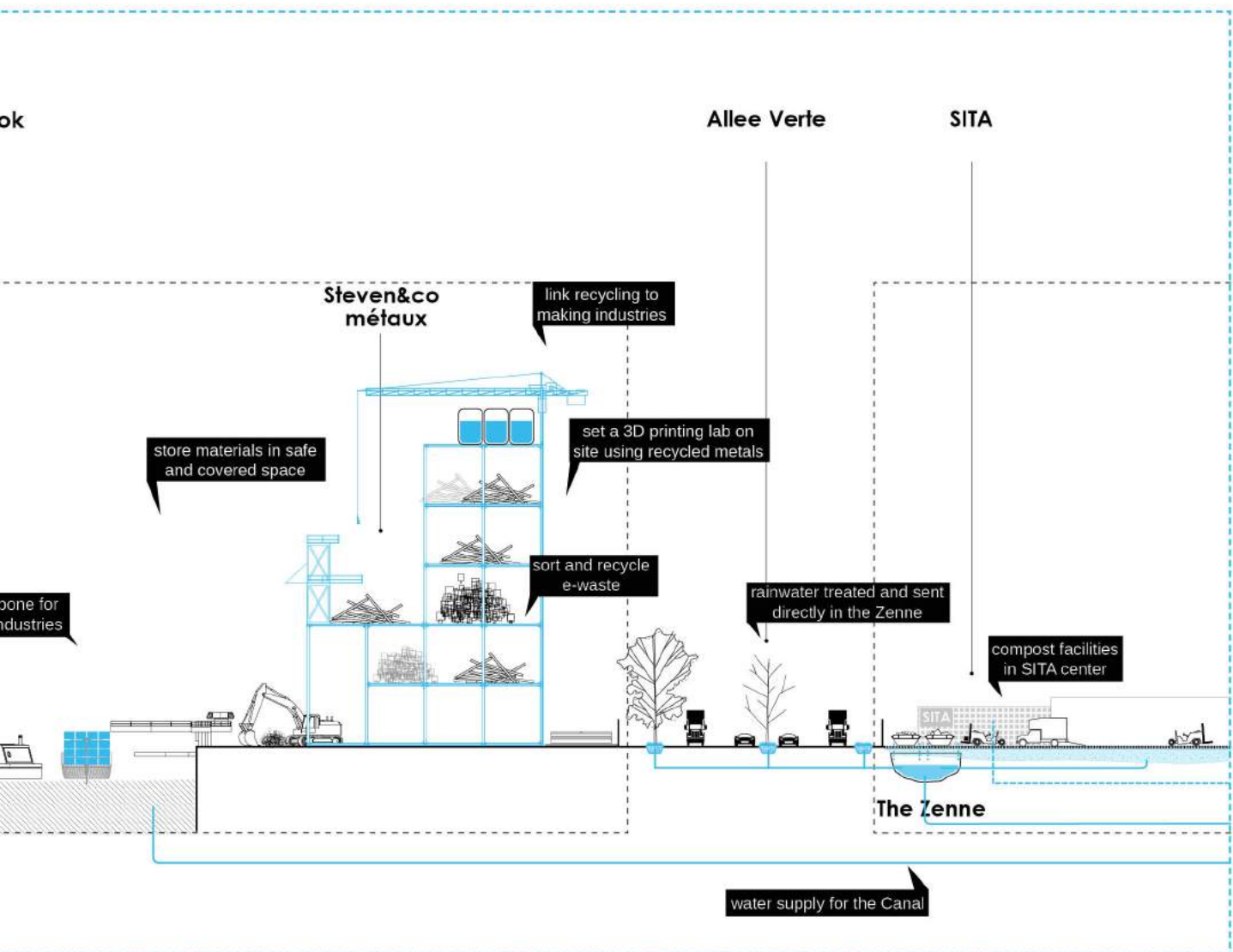
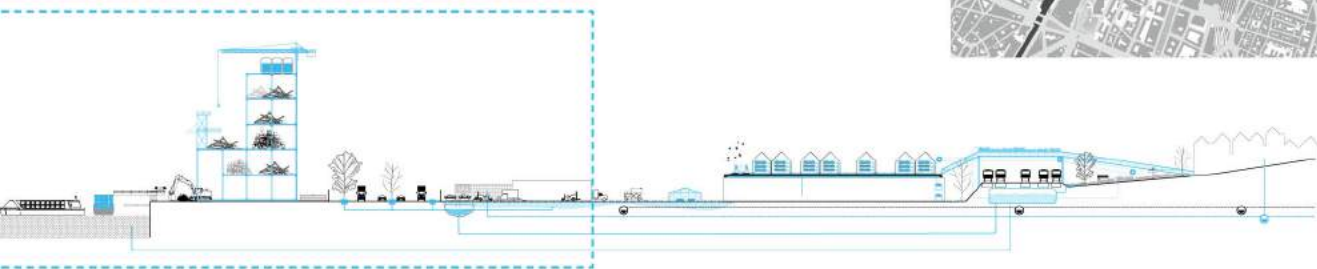


SYNTHESIS

The new Urban Transect of Masui thus combines manufacturing industries based on using raw materials made out of re-used materials. At one end of the spectrum are manufacturing companies using C&D waste to make new building materials. These companies get a significant part of their base material from the newly created



metropolitan material bank, situated at close distance to the ring and with a direct link to the northern trajectory of the canal. At the other end there are the recycling companies that now connect to a wide range of materials and recycling here go beyond collecting and sorting. Recycling now has a manufacturing component to

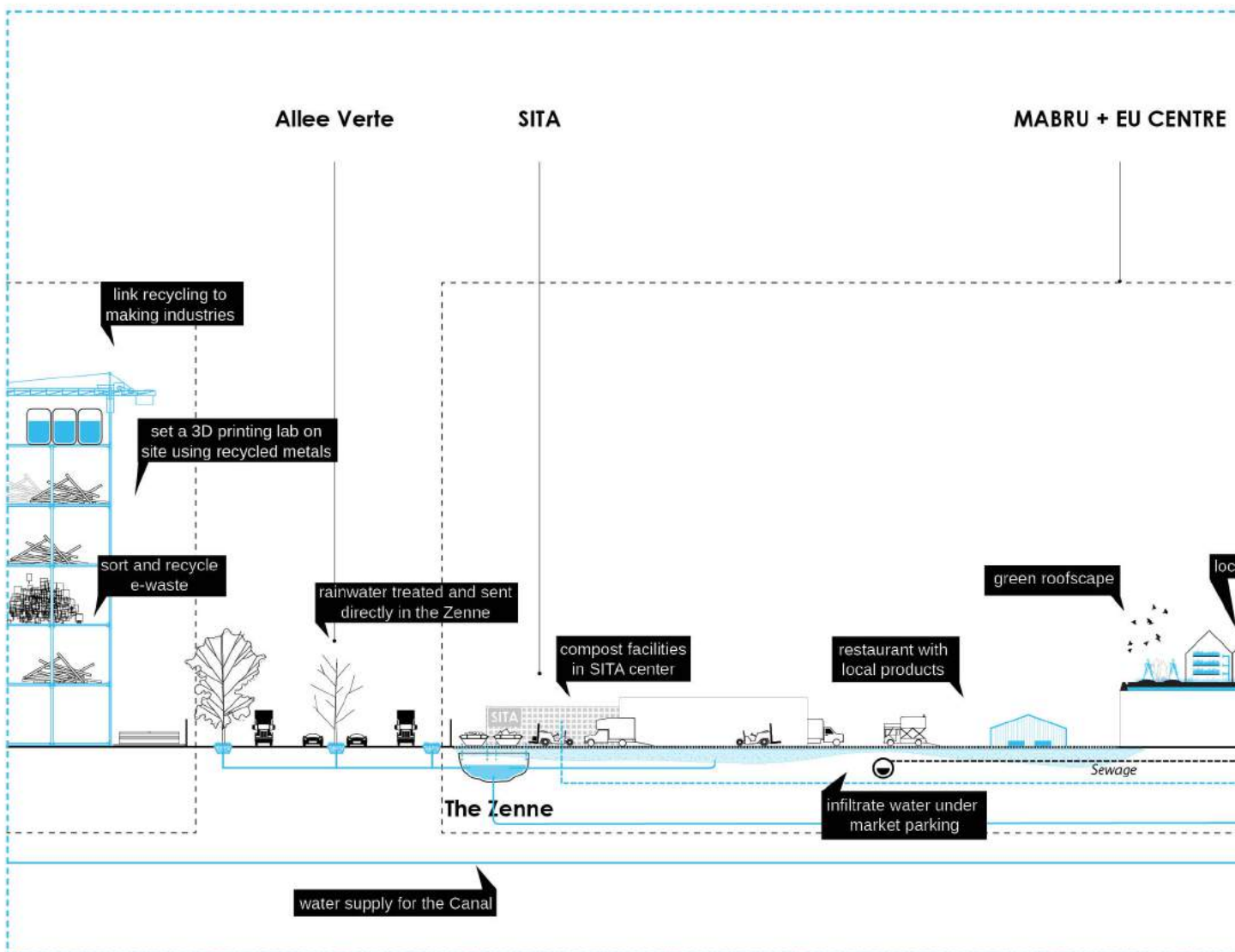
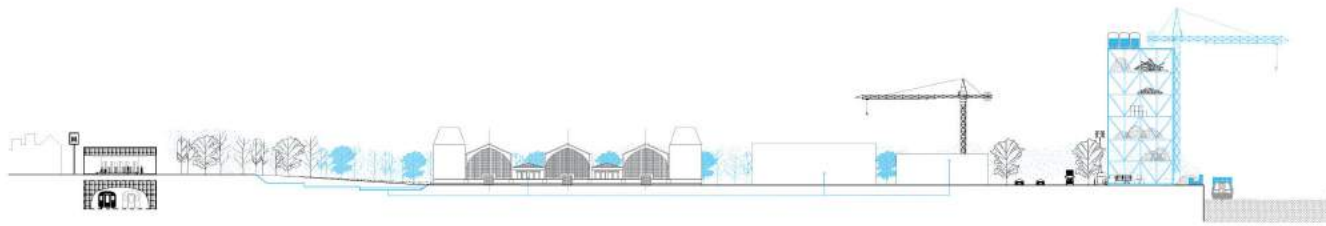


it in which knowledge and technology are produced locally.

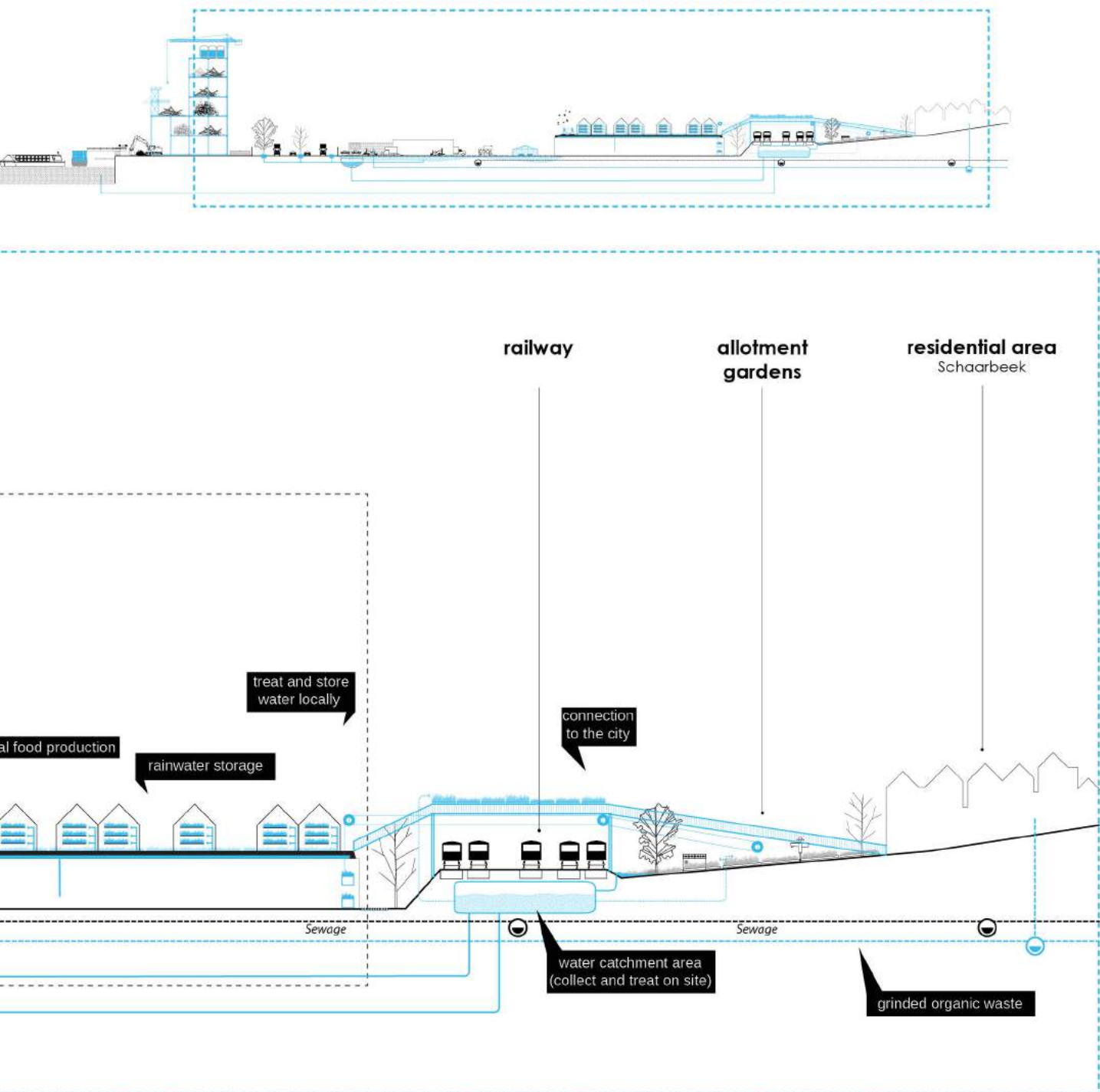
An upcoming waste flows such as e-waste is harvested here and connected to new small-scale manufacturers that provide tailor made mass production items using for instance 3D-printing. The Allée Verte can evolve into an attractive double-

side destination in itself.

From the perspective of organic waste Masui is a logical testing ground for 'recycling food'. The isolation of MABRU and EU Center now turns out to be an advantage since the island-condition of these operations provide the best opportunity to control and optimize the



collection of organic waste. What starts from inserting local restaurants can grow to an advanced network of left-over-markets, recycle restaurants, composting and fertilizer production plants, the production of organic flavors and bio plastics.



04

BUDA

schuise
brussels







CHARACTERISTICS

Buda is located at the border between Brussels Capital Region (BCR) and Flanders. Besides administrative borders, here the Canal clearly transgresses physical borders cutting through some natural topography. Like most expanding cities, Brussels has a tendency to push out its industrial environment.

This dynamic is tangible in Buda especially since three municipalities are meeting here in the Noordrand: the City of Brussels, Maelbeek and Vilvoorde.



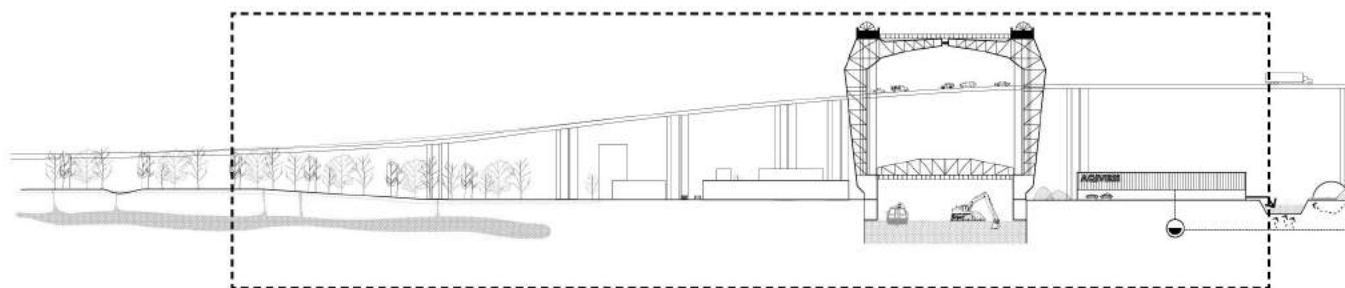


URBAN TRANSECT

The existing urban configuration of Buda is summarized in the following Urban Transect: first element to appear is the large flow of organic waste transported to the incinerator using the ring, about 144 kilo tons a year.

The ring is an present but strangely detached piece of infrastructure in Buda.

To bridge the height difference between the



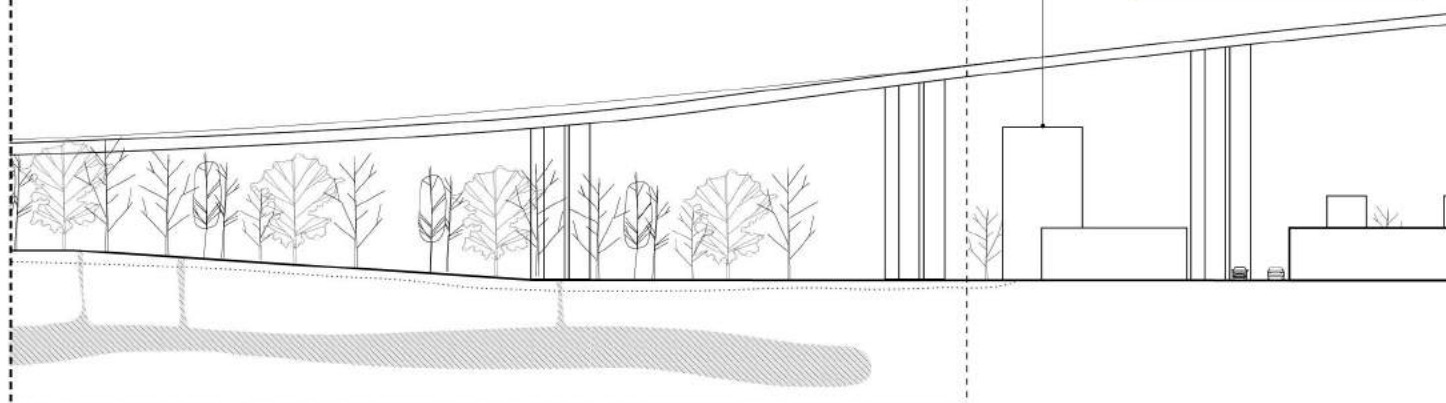
Park 3 Fonteinen

Solvay Campus
Innovation center

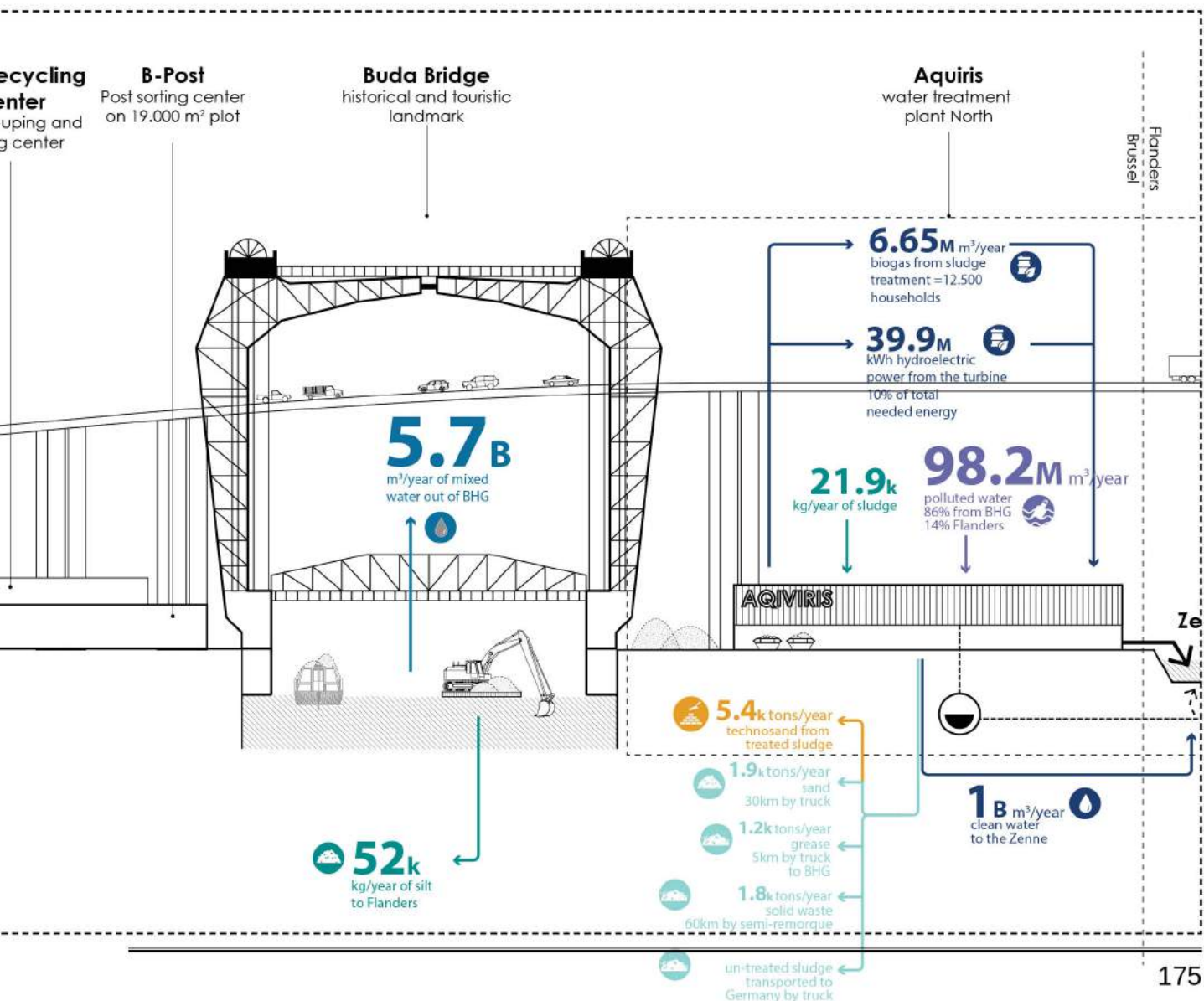
SITA Re
Ce
C&D gro
sorting

144k

tons/year of un-sorted organic waste
from households in BHG directly
incinerated



park of Drie Fonteinen and Machelen and still allow sea vessels to sail into Brussels the 'Viaduct Zeekanaal Brussel-Schelde, lifts the ring to 35 meters at Buda! The result is a fantastic view for motorists over Brussels and a piece of infrastructure that is visible everywhere in area but never really interacts with it.

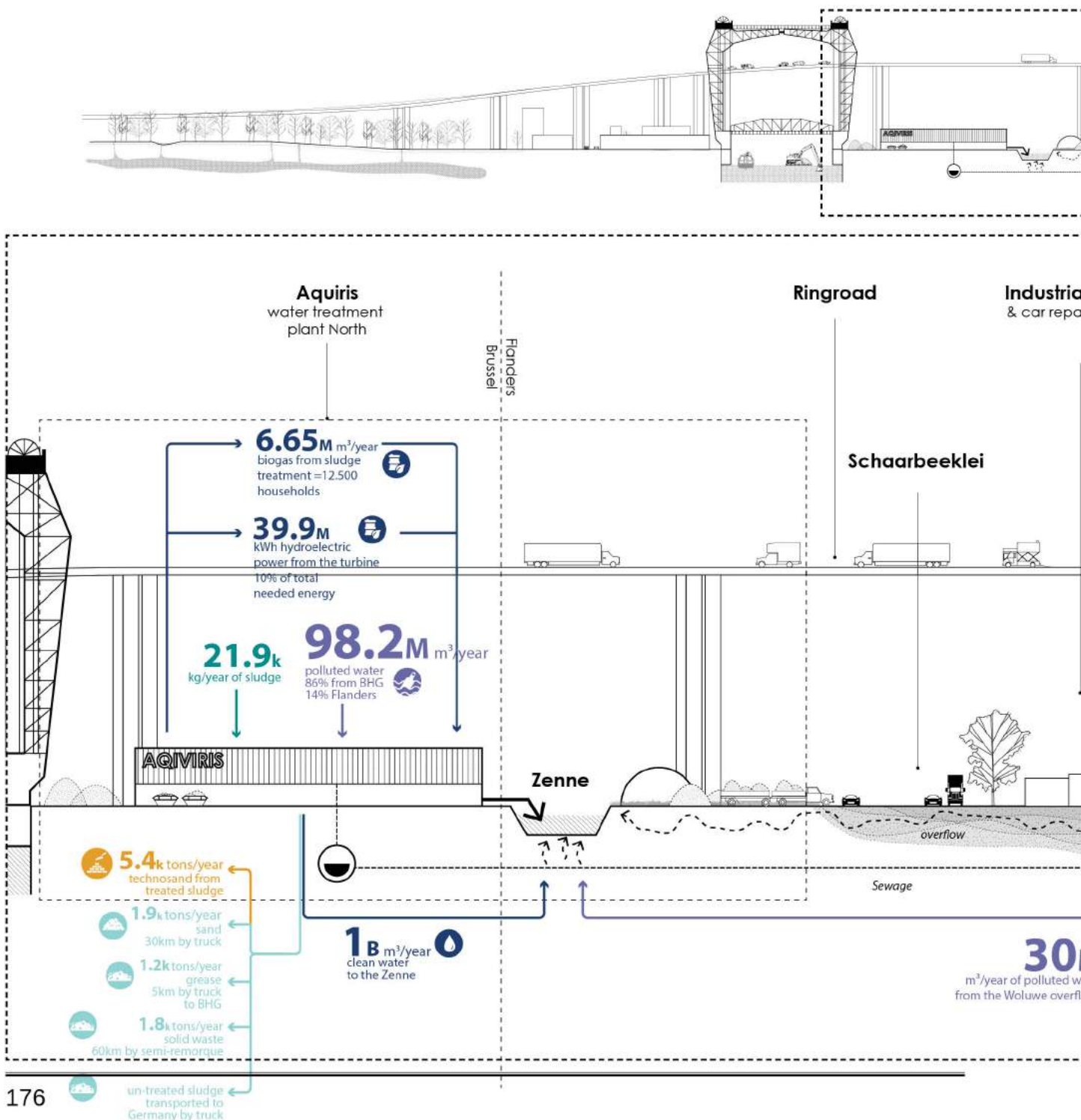


With the viaduct indirectly two other important infrastructures in Buda are introduced: the Canal and the river Zenne. They reveal the presence and significance of water in this area.

Water is a wide and divers flow that is composed of sweet water, rain water and all sorts of polluted waters such as grey and black water from households. In this

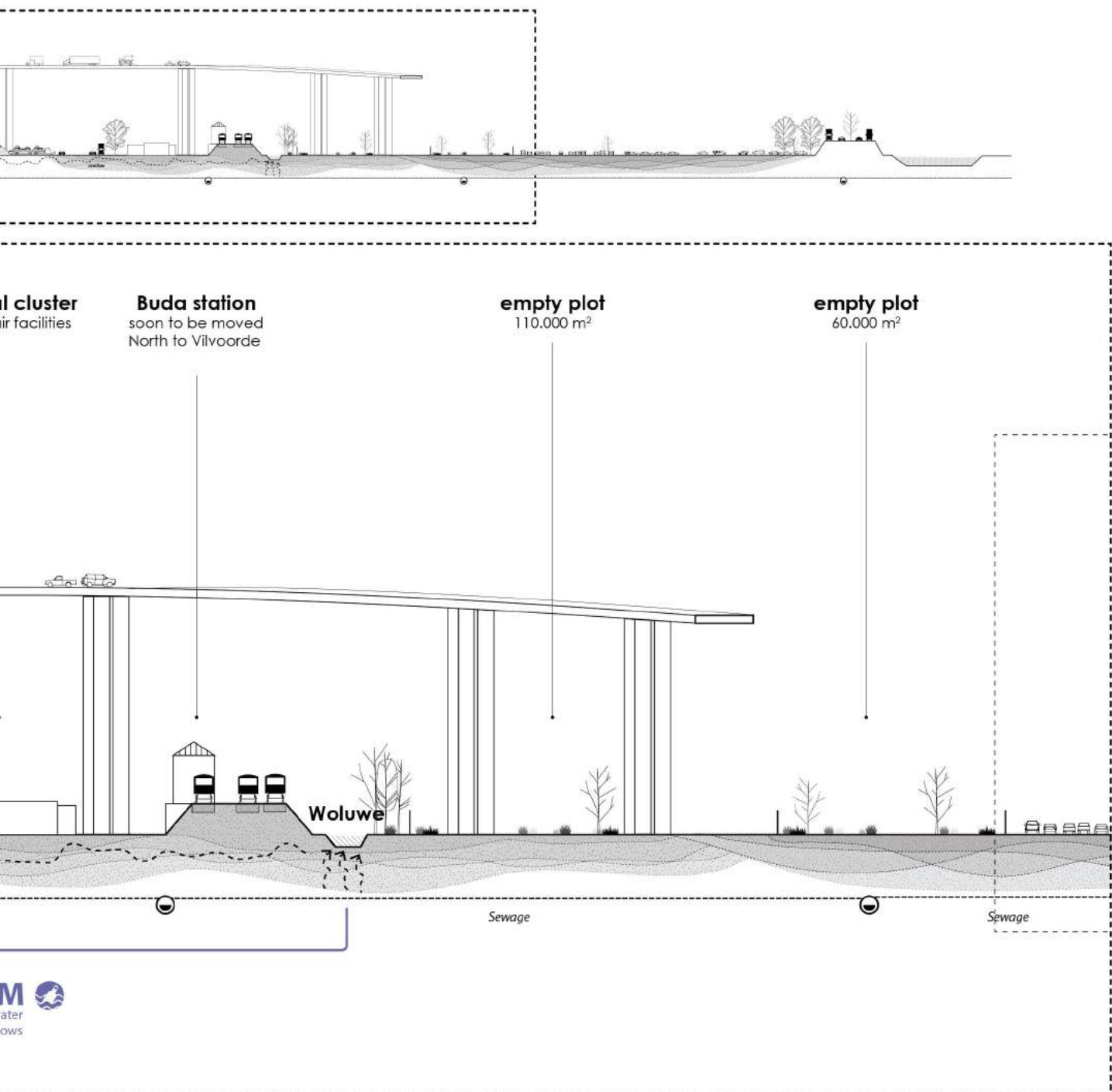
study we focus on two types of water: sewage water and run-off rain water.

Since Brussels is located on the Zenne valley, a small tributary of the Schelde, run off rain water for centuries has played a role in the city's development. Thanks to extensive urbanization most of the streams that originally linked to the Zenne now are



running under the city fabric. Furthermore the only unobstructed waterway now running through Brussels is the canal. Right next to the Canal at Buda, the main water treatment plant in Brussels is visible, namely Aquiris. This all immediately makes evident that sewage water is a very important flow in this area. At Aquiris the majority of all black water of Brussels is

processed into surface water and released into the Zenne, leaving the area to the north. Thanks to the current sewage system that doesn't distinguish between black water or run off rain water Aquiris also in times of heavy rains has to cope with rain water.





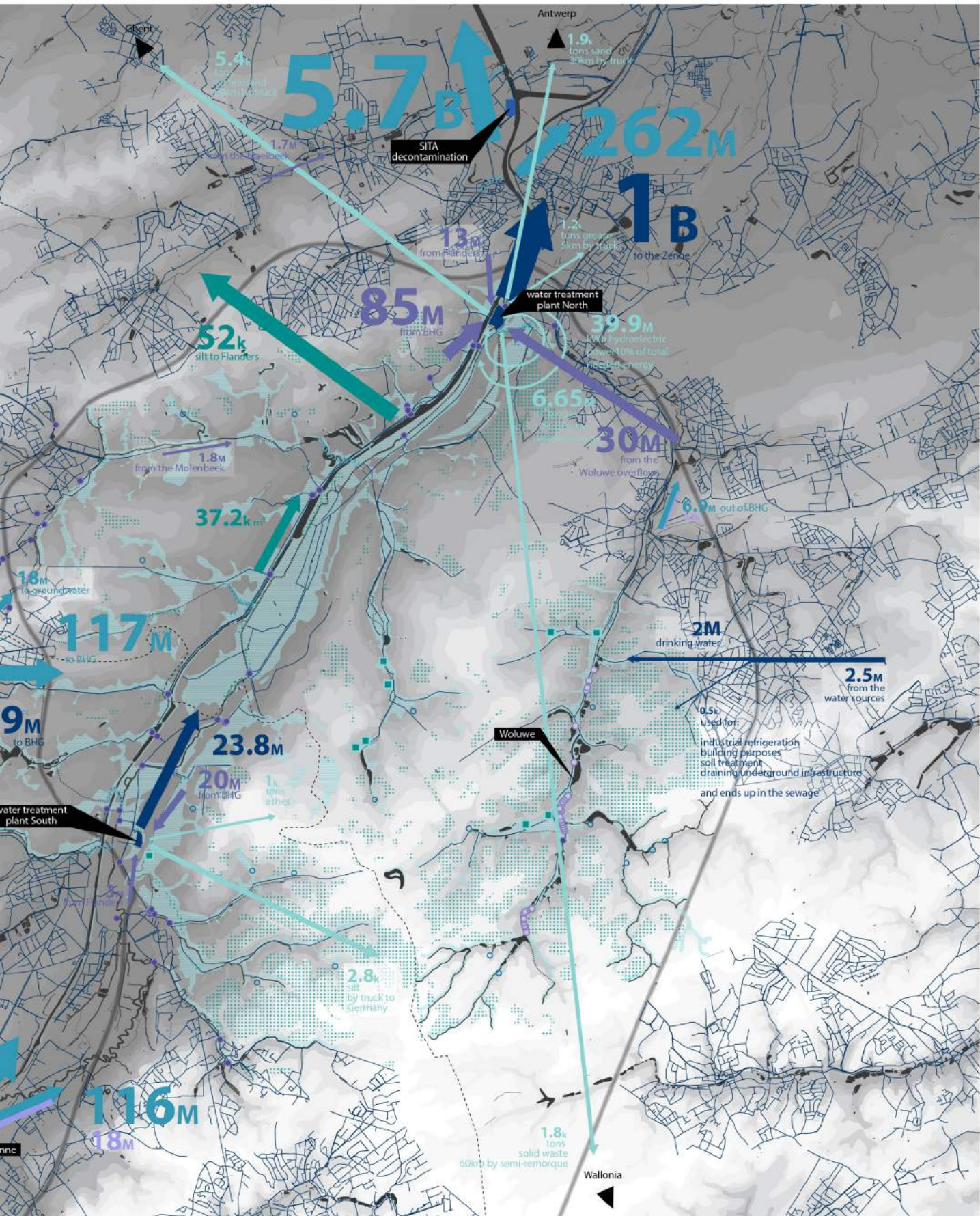
FLOW MAP: WATER

Brussels sewage is processed to surface water at two treatment plants, one in the South and one in the North. The latter purification plant - Aquiris - by far is the largest one and handles approximately 80% of the total supply. After purification, Aquiris discharges its water to the Zenne, which re-surfaces at the treatment plant after having travelled through the city largely underground, flowed through pipes.

In addition to the Zenne, many other natural streams have been channelled over time, some even totally disappeared in order to make room for urbanization. The dense drainage network which once served the whole valley where Brussels has been built, was quite disturbed from its original configuration. As a result, an

increasing number of places in the city is facing today regular floods resulting from the increasing number of peak rainfalls.

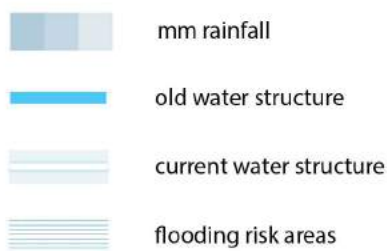


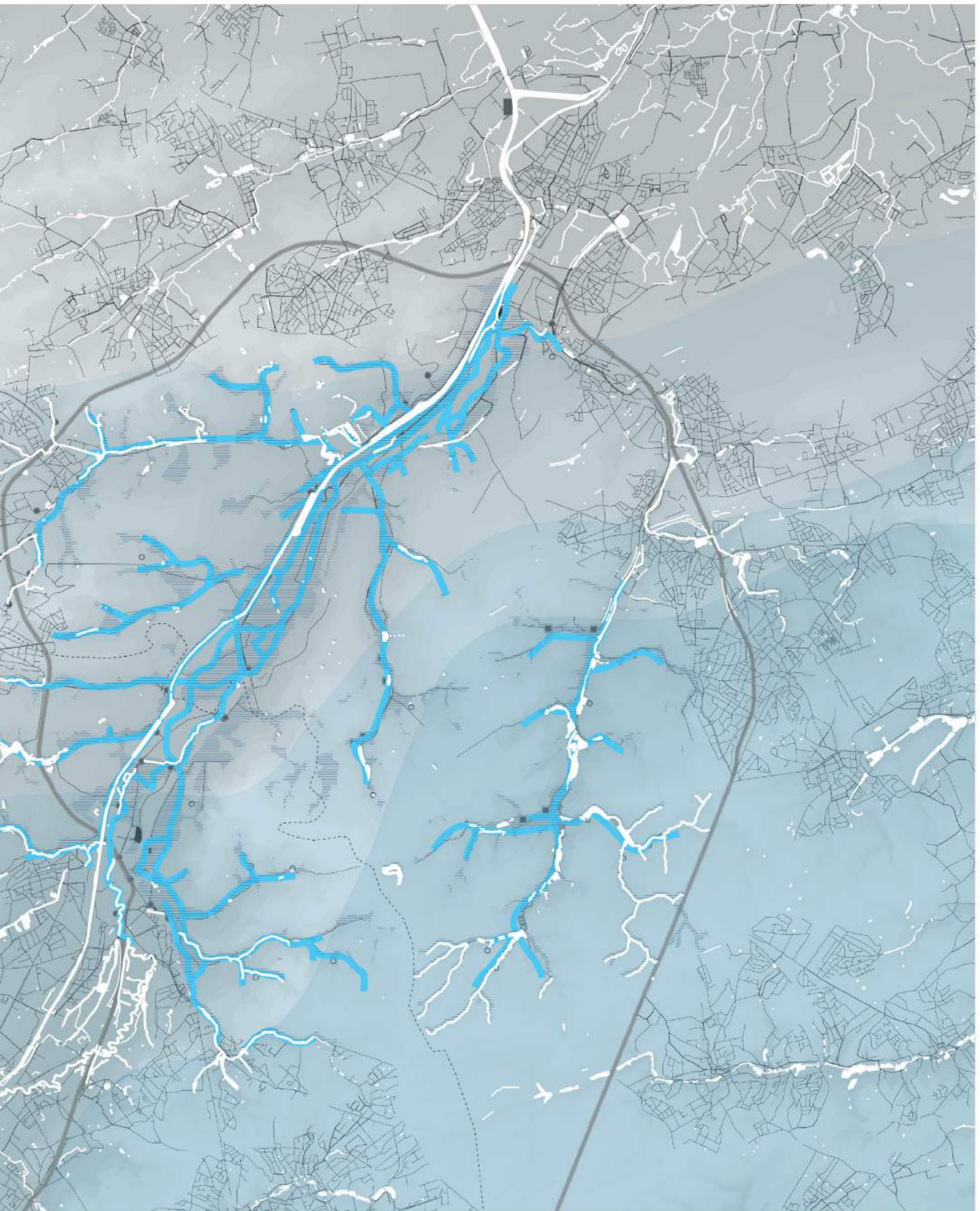




CONSEQUENCES: RAINWATER

Another major challenge when it comes to wastewater is to ensure that rainwater does not mix with sewage. If we keep these two streams separated, the relatively clean rainwater can directly be reused, and the overflow of untreated sewage due to an overloaded system at peak moments can be avoided.





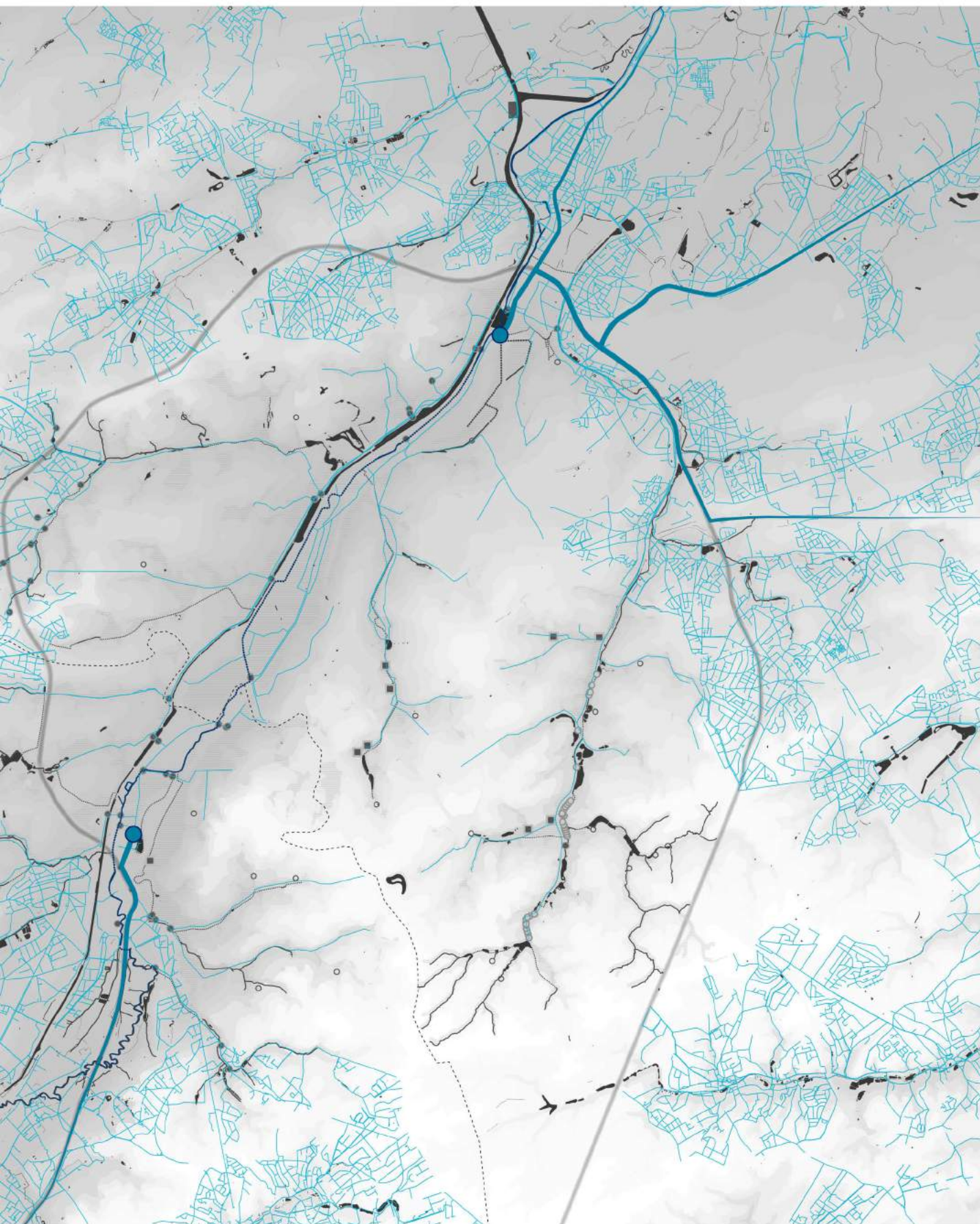


CONSEQUENCES: SLUDGE

Moreover, the sludge extracted from the water represents today a missed opportunity as it is currently transported away by truck while it could be used for the production of biogas or to produce new construction materials such as Technosand.

-  sewage network
-  impact of sludge transportation
-  water treatment station
-  Zenne

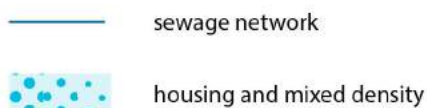


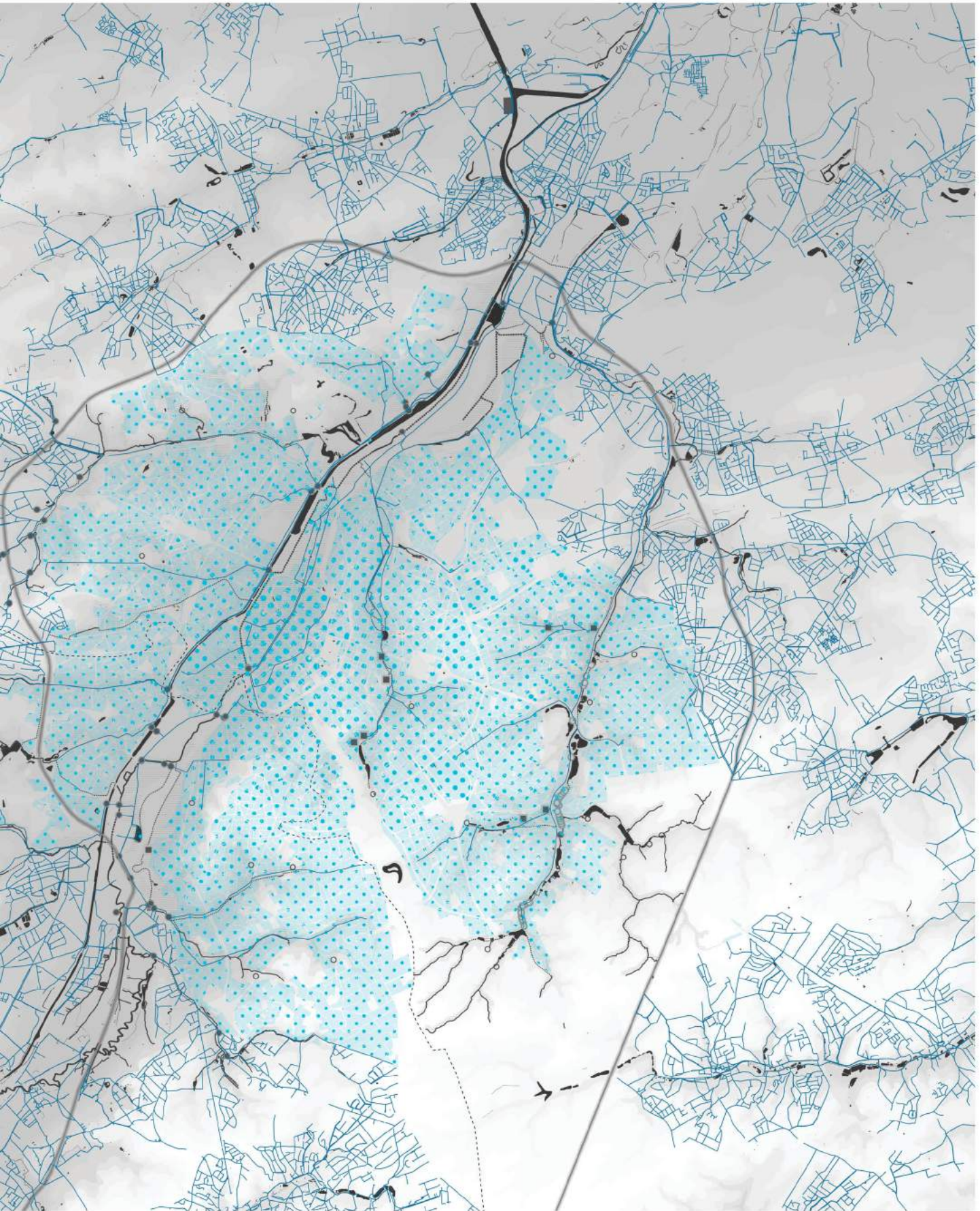




CONSEQUENCES: SEWAGE

Sewage water contains many nutrients and other valuable substances like drug residues. Potentially, the total built area of the city is the best spot to 'harvest' these nutrients. Although it is technically possible, at this moment this doesn't happen yet: valuable resources thus flow away. Future European legislation is likely to insist extracting more from the sewage eventually. To do this there are still some challenges to overcome and one of them is to avoid peak feeding due to heavy rainfall.







**WATER MANAGEMENT: A
DEMOGRAPHIC CHALLENGE FOR
THE BRUSSELS REGION**
conversation with Marc Rigal

The northern water-treatment plant of the Brussels Region is the largest in Belgium. Very recent, it was first put in service in 2007.

We met with its general director, Marc Rigal, who answered our questions.

"The European Capital starts thinking of its excrement flow only at the dawn of the twentieth century."

Until 2001, when Brussels's southern water-treatment plant was inaugurated, all the municipal waste-water was spilled either in the Senne or the Canal. Furthermore, the capacity of this first plant was far too low¹ to manage the entire flow coming from the Region. On the other hand, and already at the time of its implementation, it wasn't compliant with the requirements of the 1991 European directive concerning urban waste-water treatment.

¹ - It was conceived for 360,000 population equivalent (p.e.)

In order to face this issue, an open call was launched between 1996 and 97 for the installation of a new northern water-treatment plant.

In 2001-2002, a 20-year concession was allocated to Aquiris, a Veolia subsidiary, which is currently running it after funding, conceiving and constructing it. In 2027 though, it will return to public property. The main challenge during their first nine years was to overcome an over-exploitation of the facility. Indeed, at the time studies were carried out to program the facility, Brussels's population seemed to be rather declining or at least stable. Initially conceived with a capacity of 1.100.000 population equivalent, the northern plant now turns for over 1.280.000 population equivalent. Furthermore, it had to compensate the lack in nitrogen treatment from the southern plant. In order to absorb overflows, several adaptations had to be made which led them to exploit the plant in a tensed condition.

At the moment, the plant doesn't generate any profit and operates approximately at balance but they did have a few troubles at first. On the one hand, the construction costs were higher than expected. On the other hand, they had to argue for several years with the Brussels Region which didn't want to recognize the fact



that they treated more waste-water than planned.

"That is sorted out so we are, we could say, at balance."

Due to the inappropriate capacity of Brussels's sewage management, and to the impossibility of the southern plant to significantly contribute to it, the major challenge the northern plant will probably have to face is the ability to handle the water flows in case the Region's demography continues growing.

Aquiris is partially powering itself for about $\frac{1}{4}$ of its consumption. It has a hydraulic turbine, photovoltaic panels and it also recovers sludge with a digestion system. This last source of energy shows Aquiris already took a step towards circular economy.

"We have already started exploring possible directions to recover what we have."

Indeed, they extract sand from sewage water, on the condition that it has a sufficient grain size, and then put it back in the system as a construction constituent. The sludge treatment they have also leads to what they call techno-sand which is only composed of mineral tailings. Those residues can be used in the building

industry or for road surfacing. However, required standards of purity are very high and most of the time the sludge ends up incinerated.

They also lead researches and developments for every resource that can be sought in waste-water. They experimented the production of bio-plastics, biopolymers and studied the possibility to retrieve nitrogen and phosphor for various applications such as the production of fertilizer.

Putting such pilot-projects in practice on the plant seems, however, quite irrelevant and the only realistic implementation would be in the industrial field.

"All these technologies exist but in municipal water and especially in Brussels, all those specific elements are present in extremely low concentrations."

To try and recover components at these low concentrations would involve excessive investment costs.

For all other waste, it appears to be even more complicated as they don't collect enough of it and certain flows are really inconstant. Furthermore, they can't consider manufacturing or distributing the by-products themselves. Hence what is done with collected refuse is out of their purview and most of it is simply evacuated and destroyed.





Another issue is the excess of sludge generated by the water treatment, which is, at the moment, either used as a coal substitute in cement industry or transported to incinerators in Germany. A solution they foresee is to eliminate this surplus of sludge within the Brussels Region, using the incinerator, which would require some minor modifications. Along with the Port of Brussels, they also explored the possibility to recover this sludge by transporting it over water to a centralized drying unit. However, another source of sludge would have to be found as the current water flow and its composition are highly unstable and depend on the weather conditions and seasonal streams. They would also have to find a way to make the shipping costs-effective.

"We could even go further, we could co-digest part of the Region's organic waste. We already talked about it, maybe one day it will happen."

Though, in order to even consider increasing their production of biogas a complementary source of organic waste would be necessary. For instance, they could selectively collect organic waste from the Region and treat it locally, Aquiris has already explored this opportunity together with Brussels Energy. Involving other companies like Mabru Market to this

initiative is for now quite complicated as they already have contracts with other biomethanization plants.

"The Brussels Region has a peculiar problem. Every potential source of biogas is already exploited outside the Region."

At last, the prospect of introducing algae water purification in their treatment plant isn't at all realistic to them.

"If it was possible to treat waste-water with algae, honestly, it would be known."

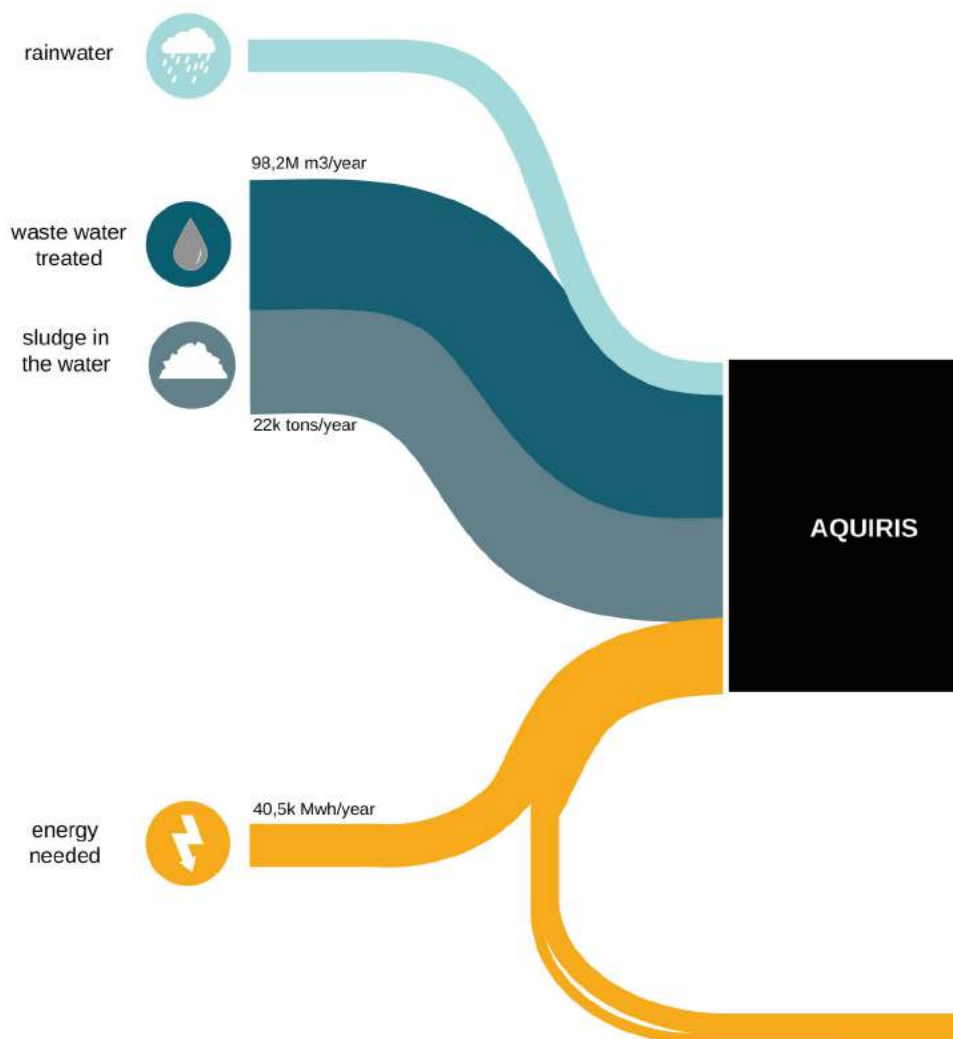
There seem to be some rare situations where the water is polluted by one organic component which can be eliminated by vegetal activity. However, these specific cases occur for a unique component whereas municipal sewage water is a huge mix. Furthermore, water sanitation requires to produce steam and to raise temperature to accelerate the dissolution process otherwise compounds remain stable.

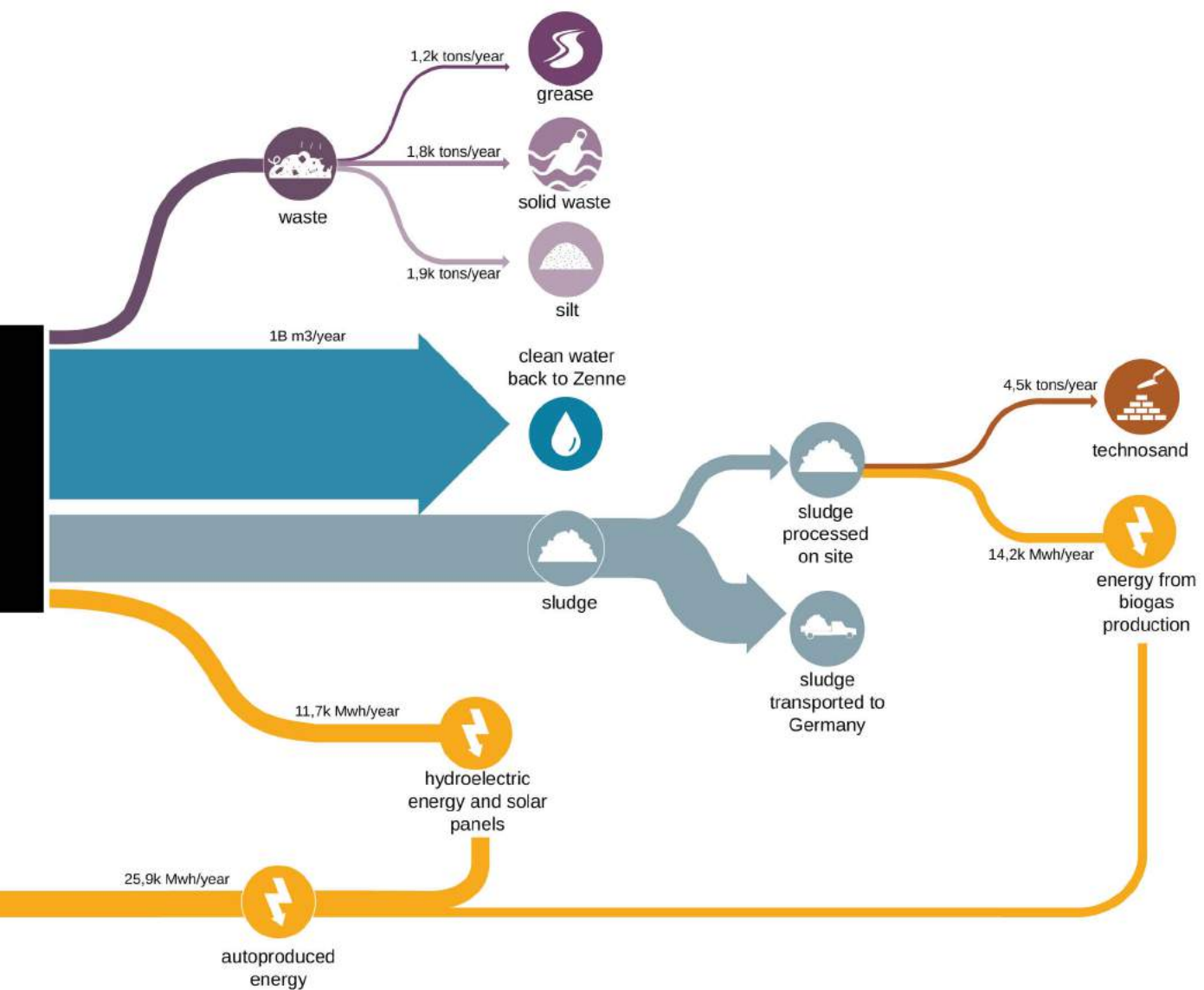
"I don't see how we could find the miraculous plant that would absorb nitrogen, phosphorus, carbon and mineral matter all at once."

TREATING WASTEWATER IN AQUIRIS

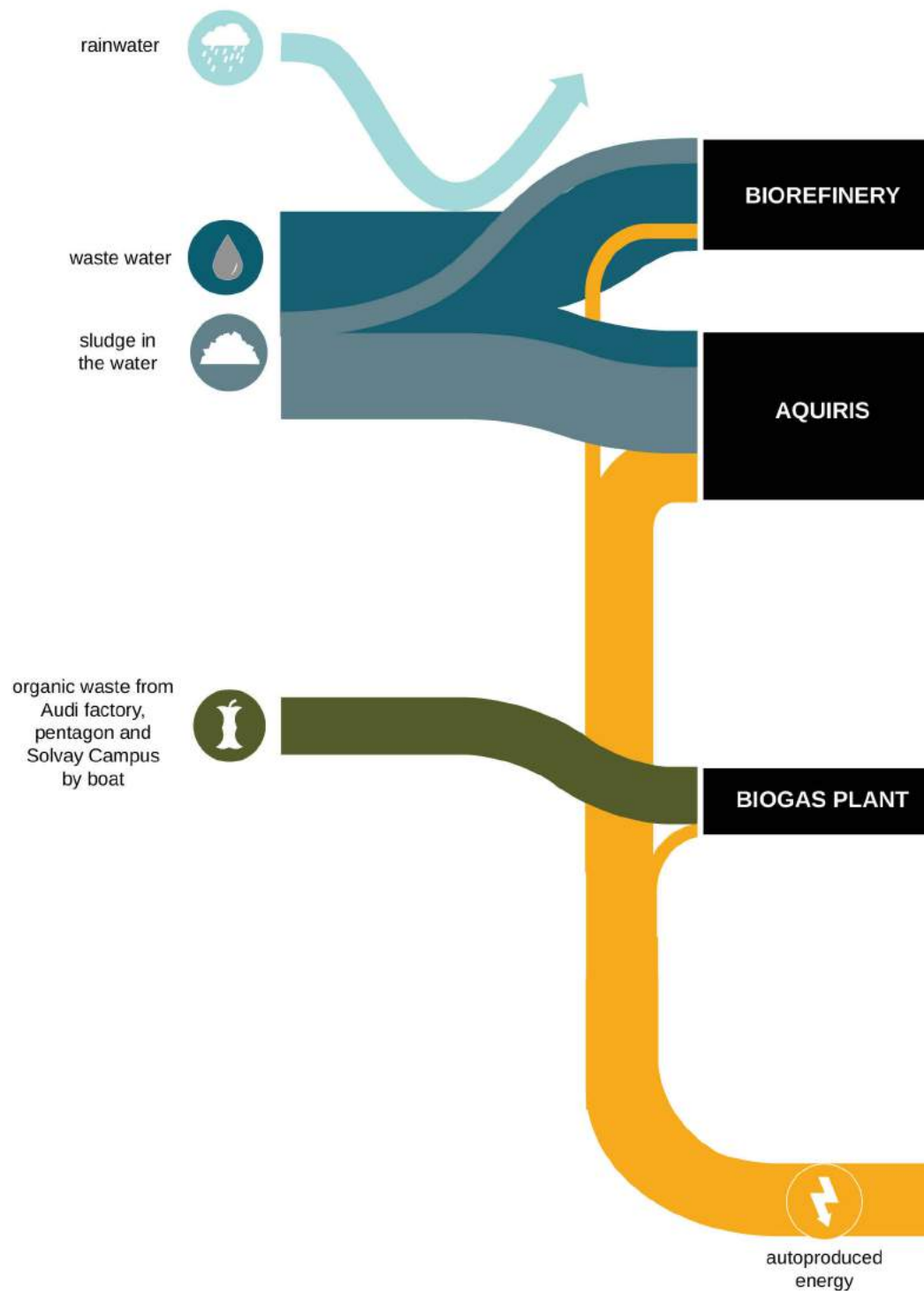
In the flow analysis of the major player in sewage water, a number of things stand out.

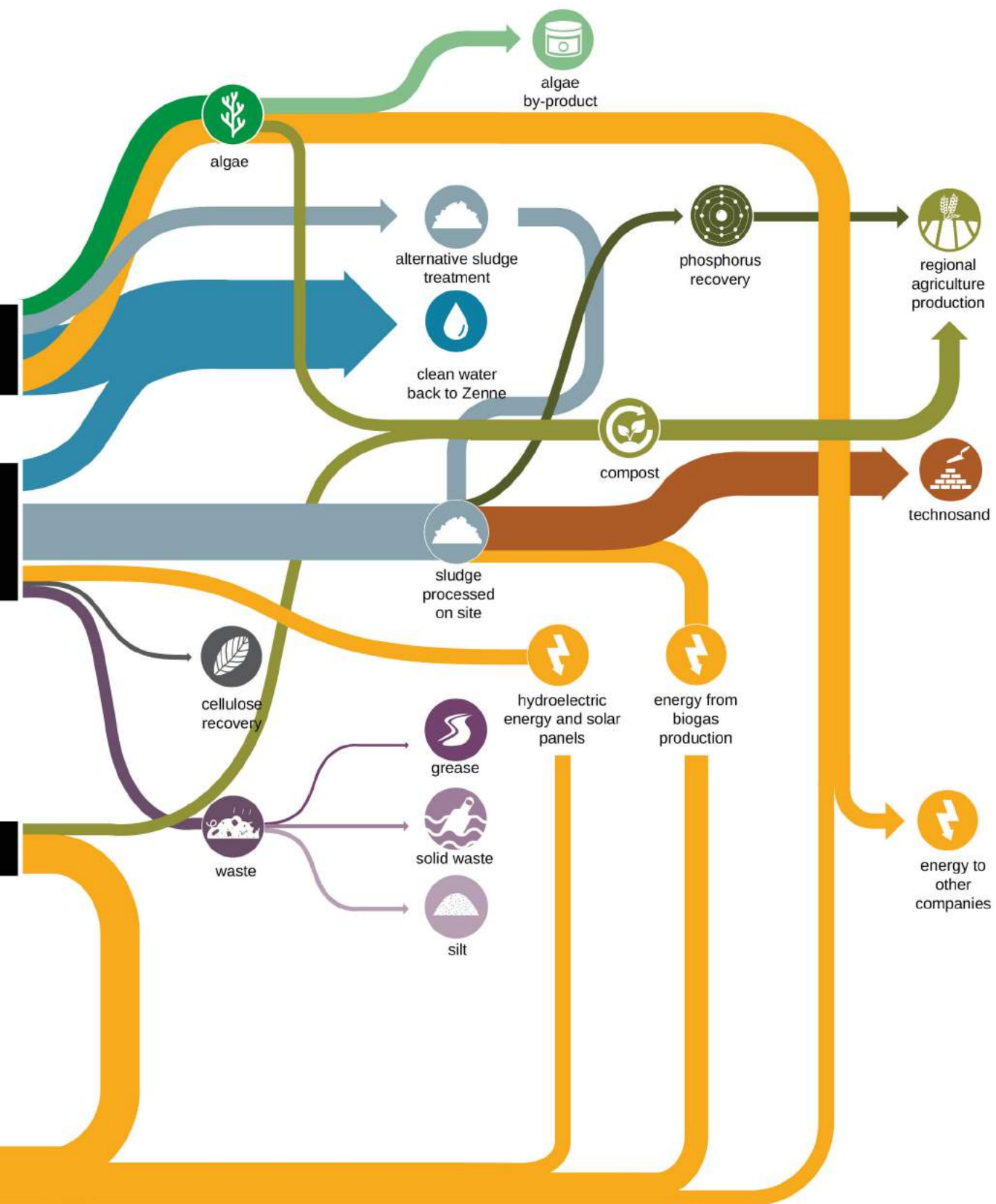
First, at the output side of the diagram we see that Aquiris produces a number of materials that can be considered as new secondary materials, such as unprocessed sludge and Technosand. Technically speaking it makes sense to not only look at Aquiris as a company that produces waste while filtering sewage water, in fact Aquiris is also a producer of new raw materials. At the moment though, these raw materials are hardly used, certainly not locally. This is a missed opportunity, especially when it comes to the production of energy. Currently the activities of Aquiris cost more energy than it produces.





Knowing that the purification process takes energy, and that currently only a small part of that energy is generated while processing substances extracted from the sewage, we can identify new opportunities.



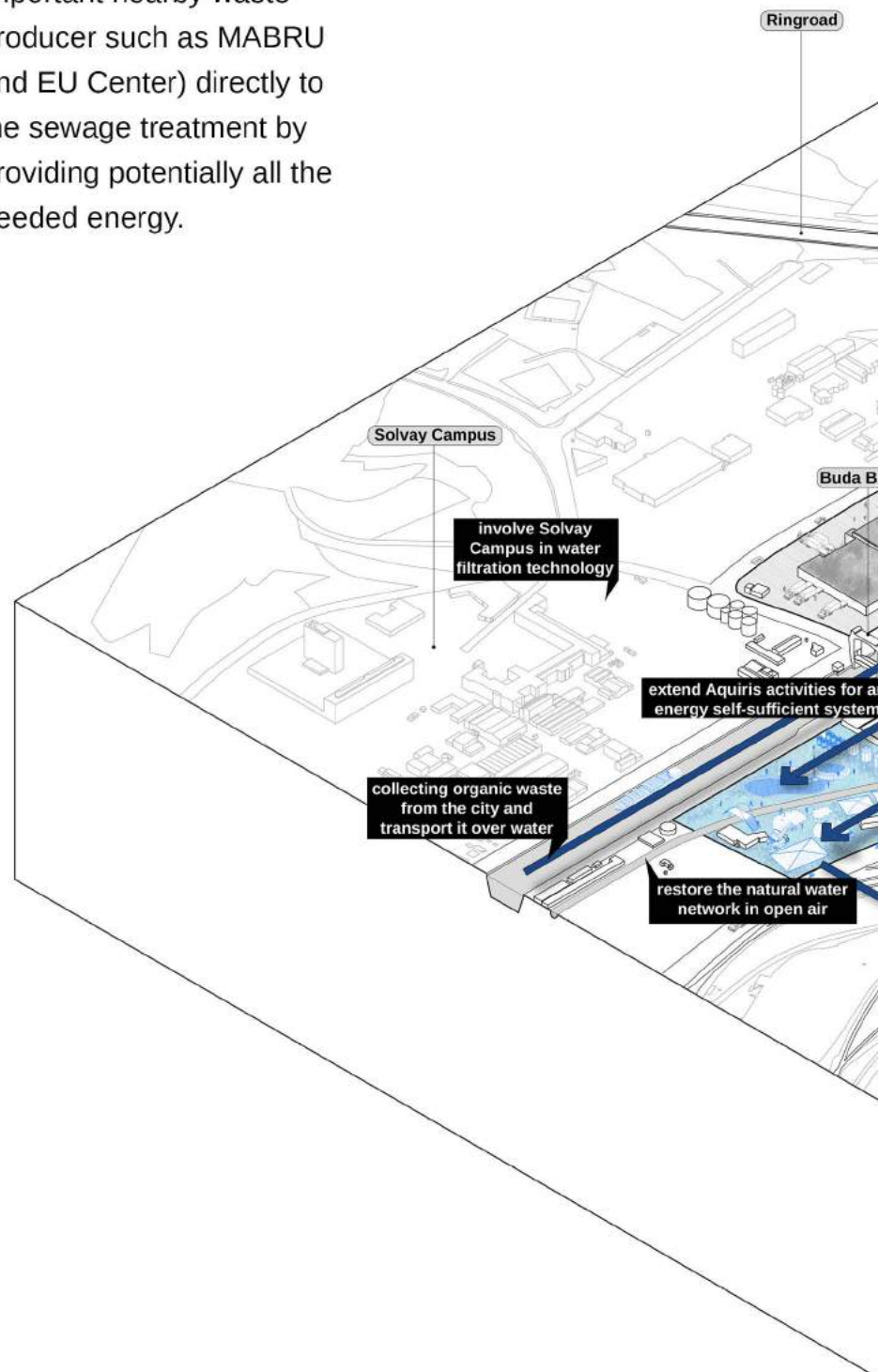


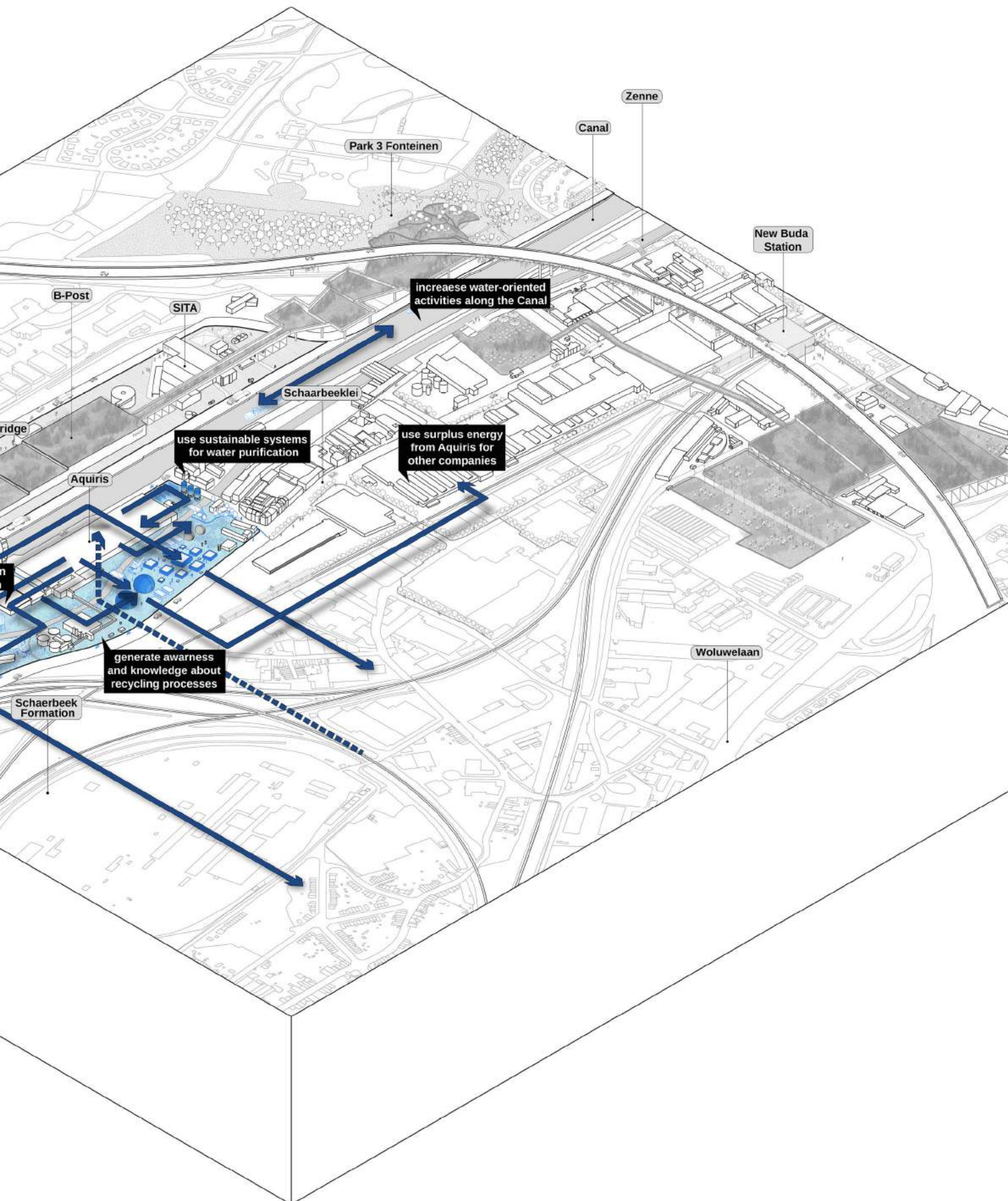


A BIOREFINERY FOR WASTEWATER TREATMENT

The introduction of a bio-digester in Buda would have a positive effect on Aquiris. The bio-digester could, like examples in nearby countries like Holland and Switzerland proof, meet the total power consumption of the plant. The water treatment plant of Apeldoorn (NL) for instance captures all methane gas that is produced in the filtering process, providing enough energy to heat and cool all offices of the plant plus the houses of a nearby neighbourhood. As a 'side product' this treatment plant also produces 900 tons of fertilizer each year! Also from another energy perspective the introduction of a bio-digester in Buda offers interesting possibilities. A bio-digester in Buda would create the possibility to link the organic

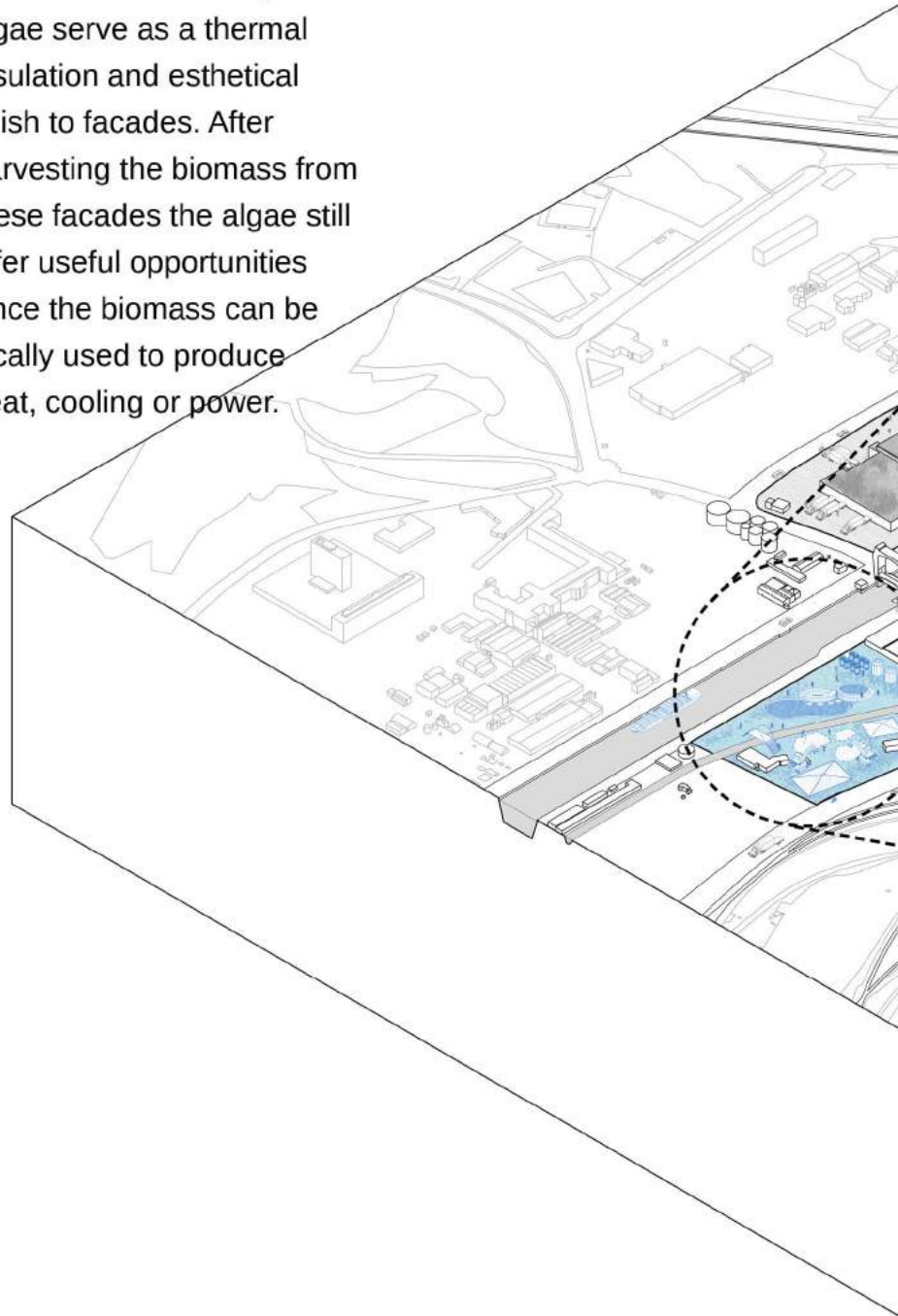
waste coming from the city (or even just from an important nearby waste producer such as MABRU and EU Center) directly to the sewage treatment by providing potentially all the needed energy.

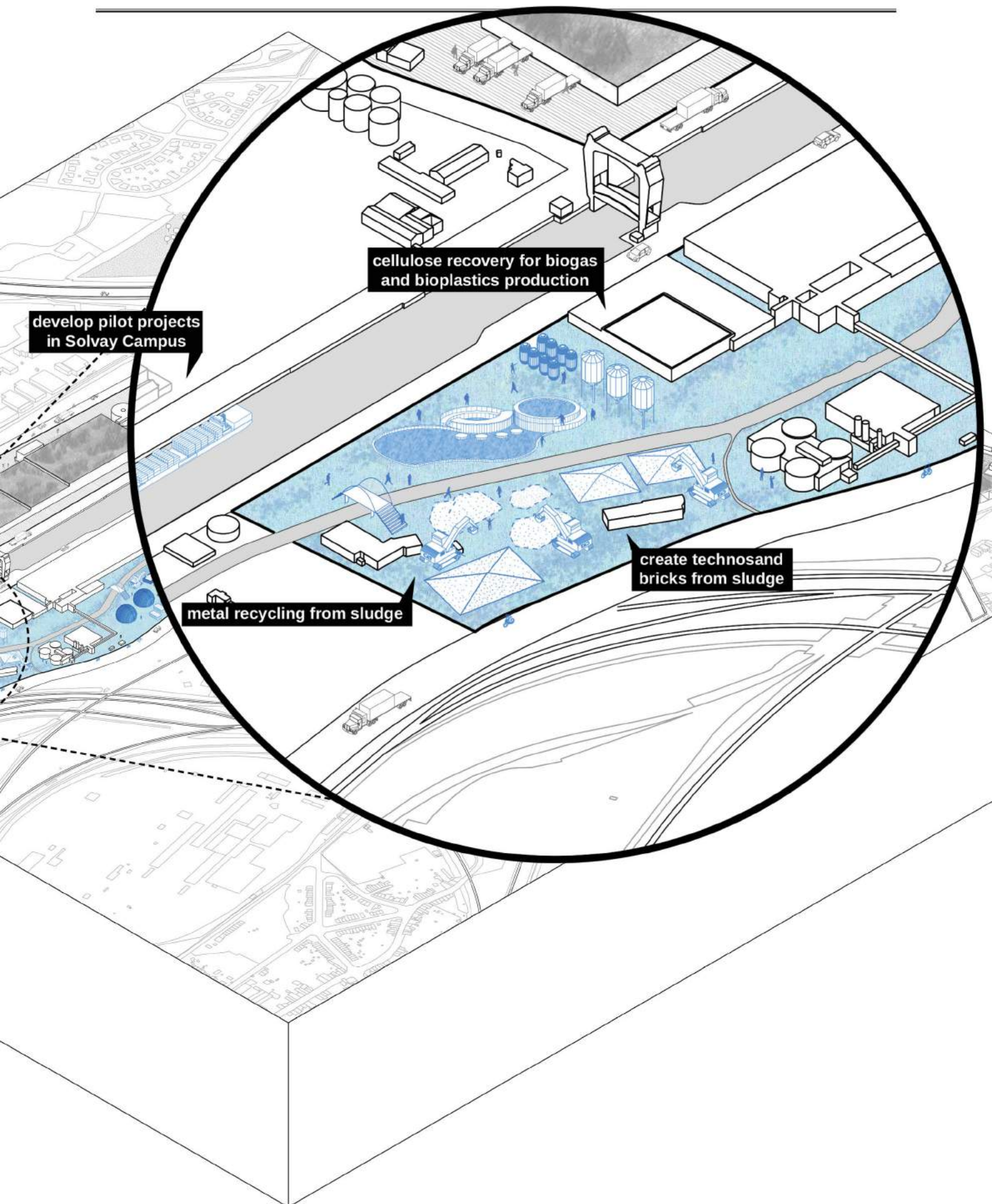




Besides being more careful with what we consider waste from the filtering process, also the process of filtering itself could be done in a more sustainable way. In this case additional treatment processes based on the organic filtration capacity of algae will have a dual effect for Aquiris. They can meet higher standards while taking more substances out of the sewage. One of these substances is phosphate. Since global stocks of phosphate are finite, just as stocks of rare metals, it becomes increasingly important to recover phosphate from waste water treatments using proven techniques. At the same time algae filtration offers good changes to broaden the range of products produced at Aquiris. The spectrum ranges from biofuels to cosmetics. Especially the range of cosmetic related products offers an interesting opportunity for Aquiris to better connect to the general public. But also the algae while

being used for filtering, offer connections to people. For instance, experiments have been conducted in which glass tubes containing algae serve as a thermal insulation and esthetical finish to facades. After harvesting the biomass from these facades the algae still offer useful opportunities since the biomass can be locally used to produce heat, cooling or power.

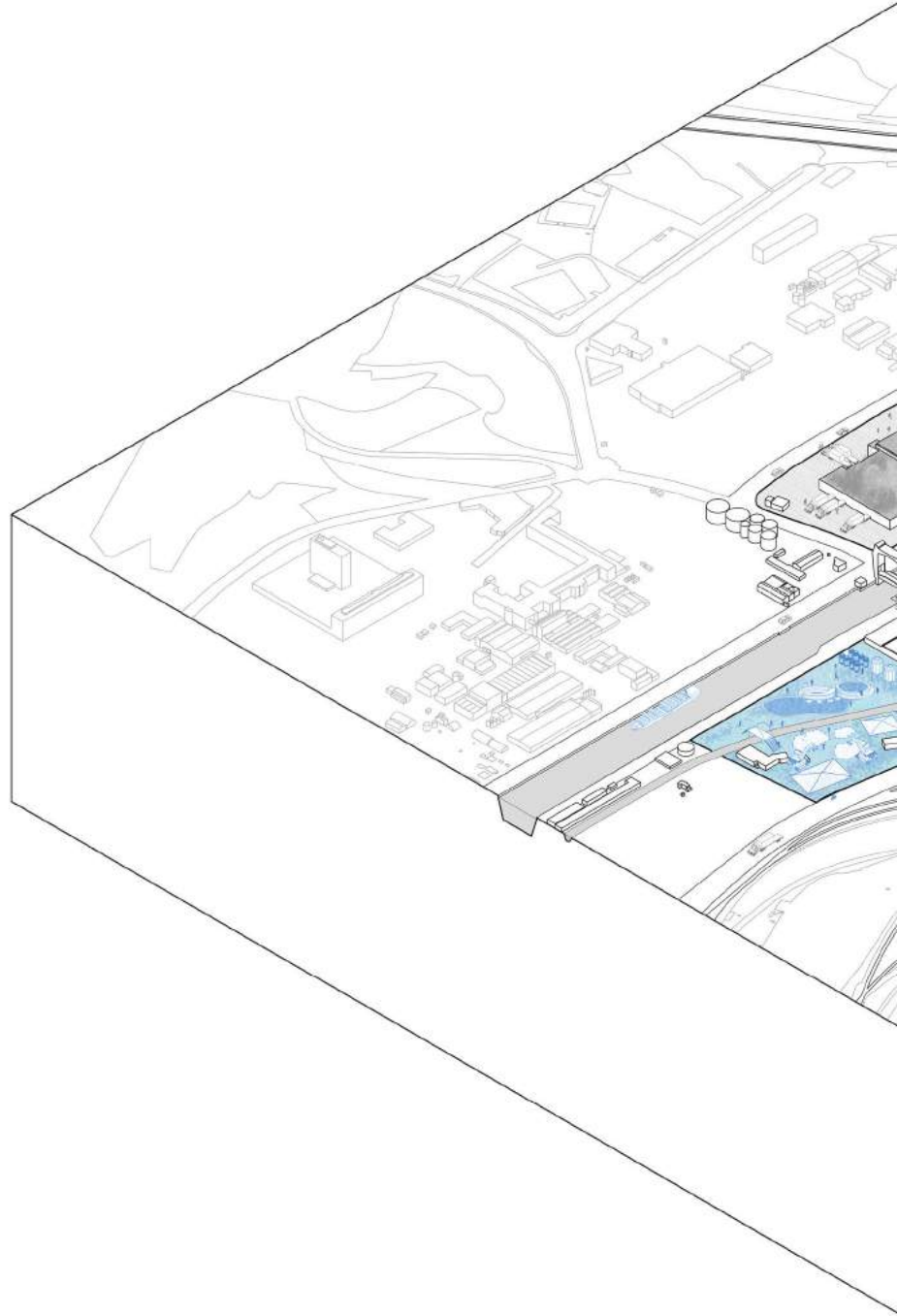


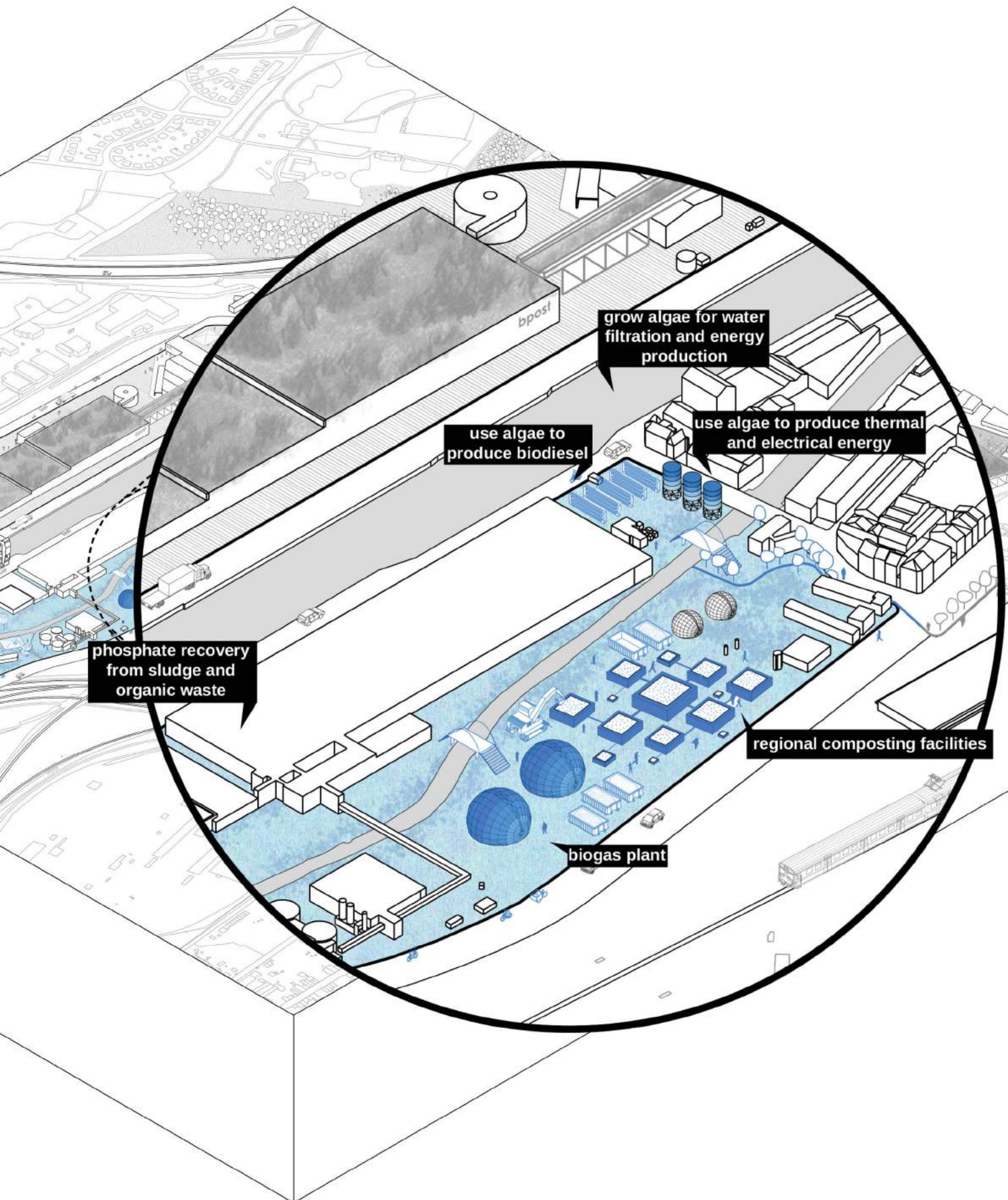


Also on a more systemic level algae create new opportunities since they can serve to produce biofuels. Reasoning from this perspective Aquiris would get a more central position locally as the producer of fuel that can be used in a local network by a series of clients.

Through the outcome of its new filtering processes that become relevant on a regional scale, Aquiris also locally connects manufacturing and producing raw material or providing bio-fuels. Aquiris thus becomes a central link in a cluster of purification activities that we call bio-hub.

Last but not least, with these new products, Aquiris will also get a more public side.

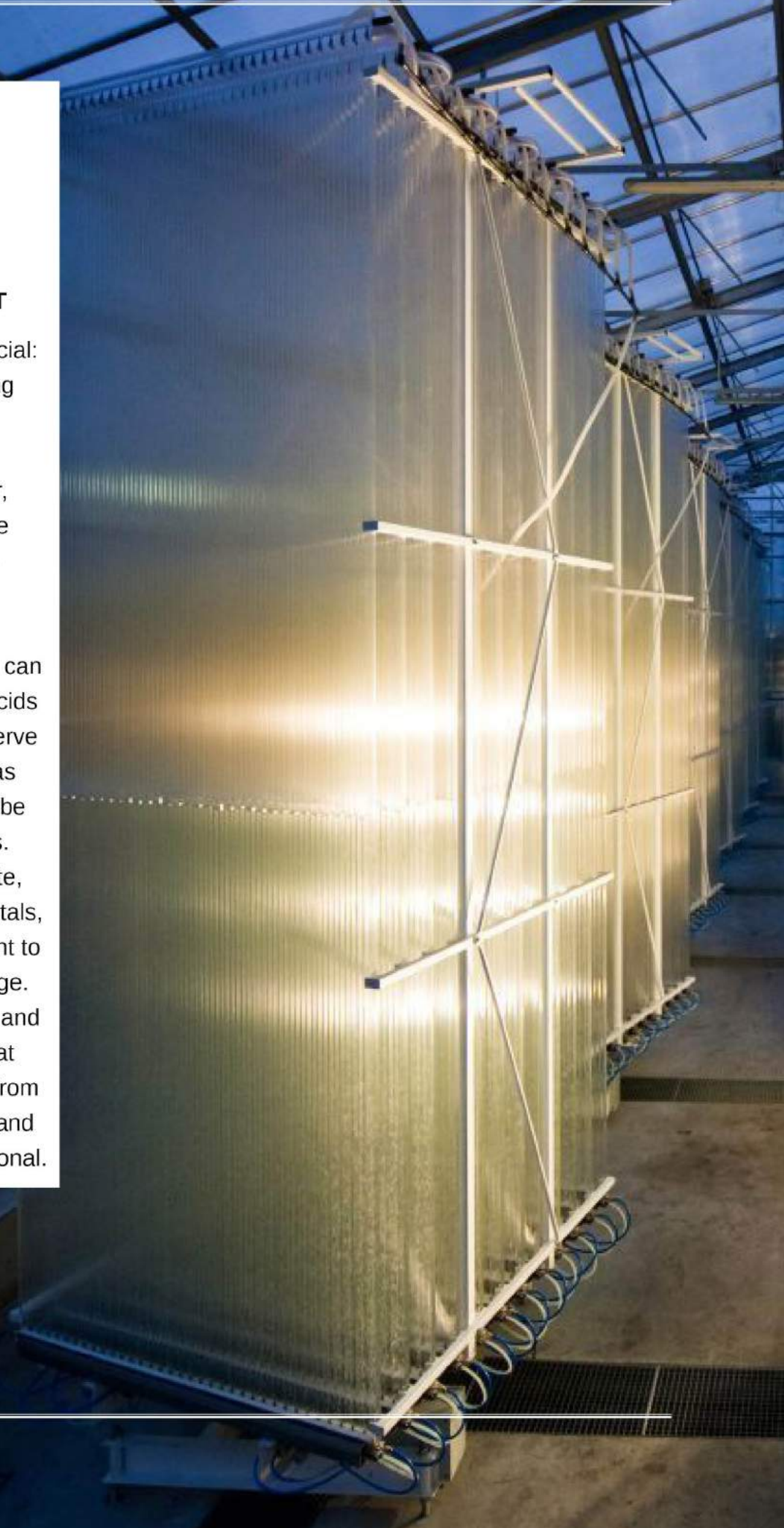






REFERENCE PROJECT

Algae seem nothing special: they are at most annoying as they grow too much in your pond or in our surface waters. However, for the industry, algae are very interesting because in presence of sunlight and CO₂ they start the photosynthesis and they can produce proteins, fatty acids or enzymes that could serve as food, chemicals and as bio-fuels. Thus they can be used to recover nutrients. Since phosphate are finite, just as stocks or rare metals, it is increasingly important to recover them from sewage. Globally, there are more and more tests conducted that are about to transgress from the experimental phase and will become truly operational.



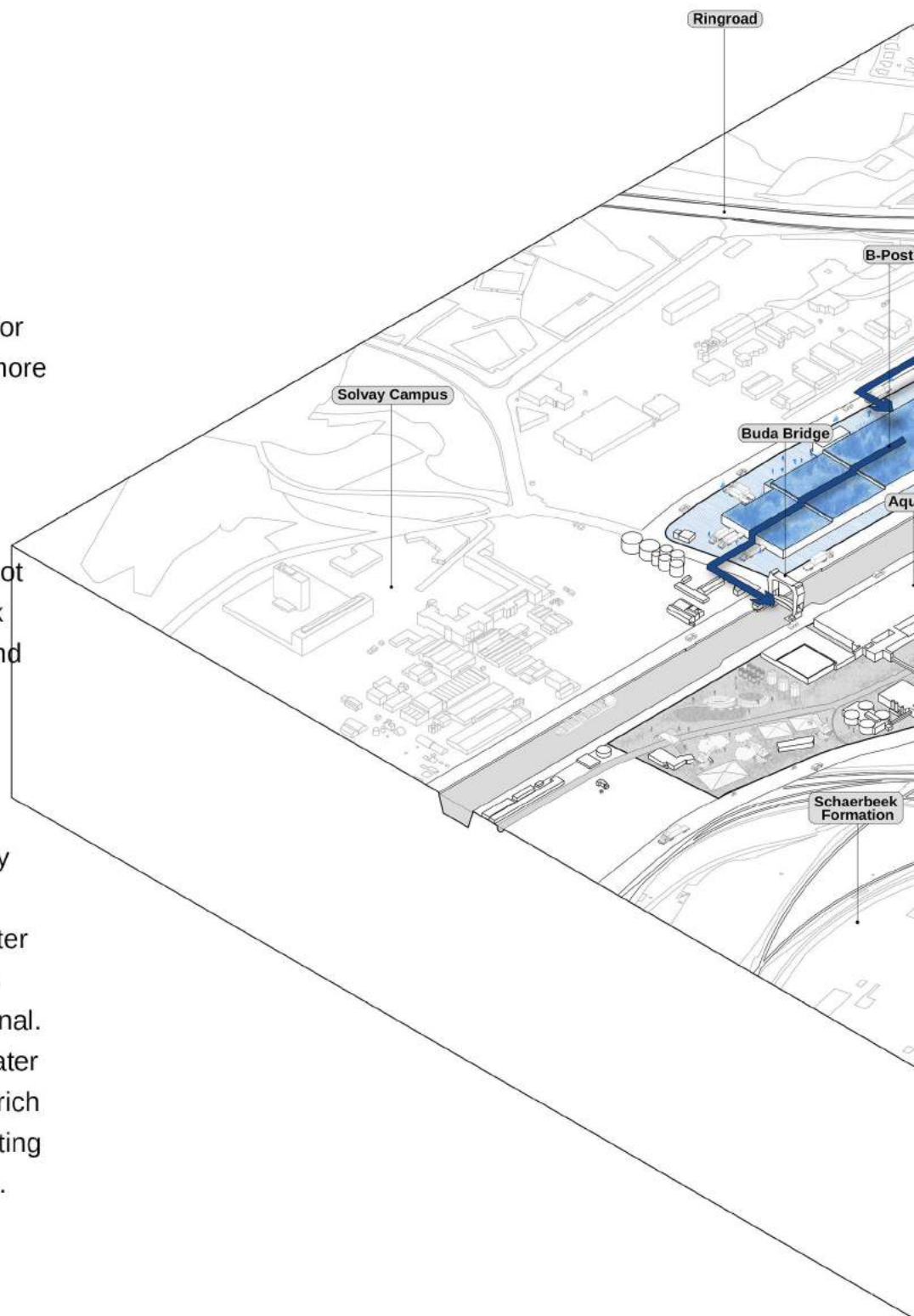


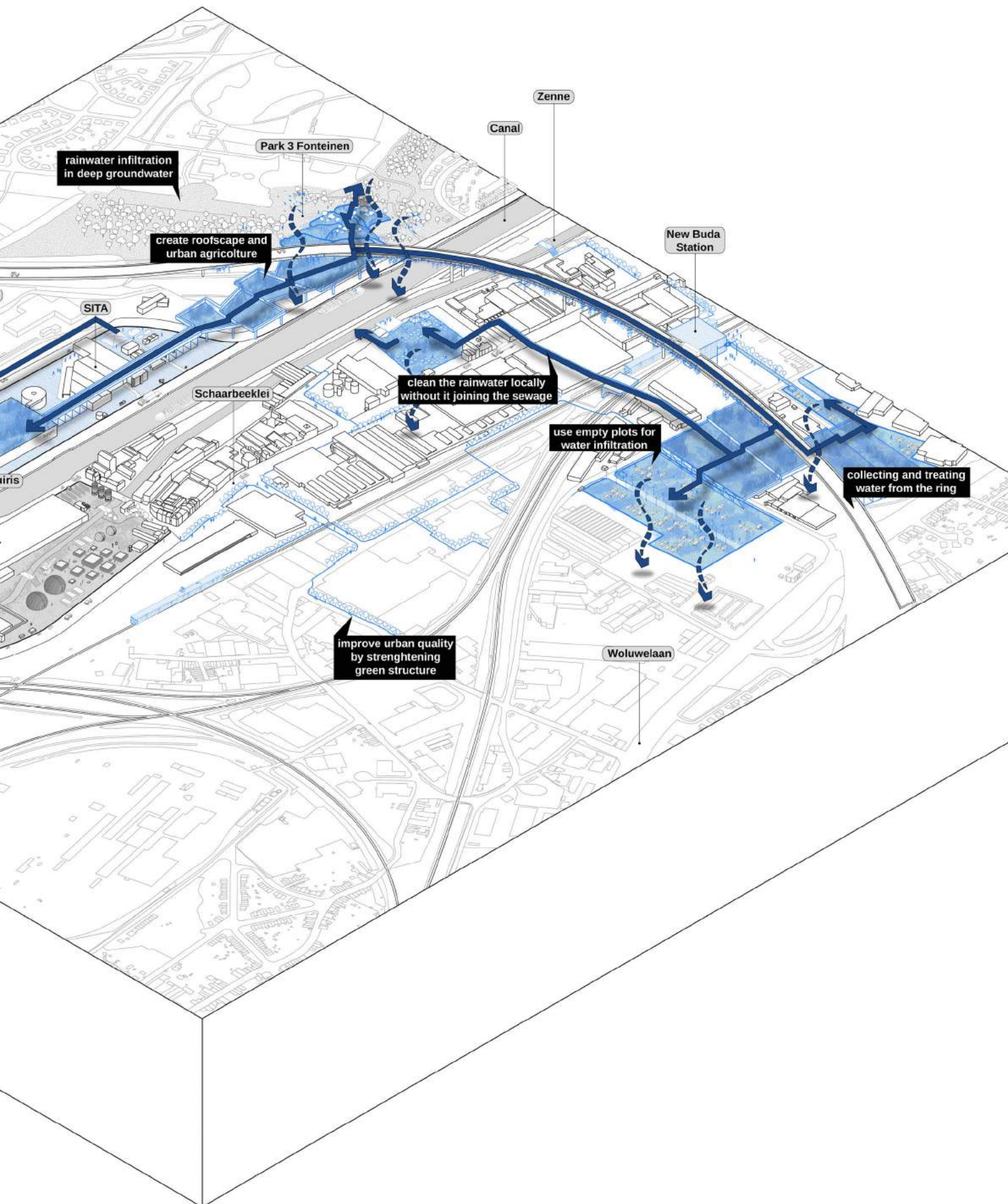


BIOFILTERING RAINWATER

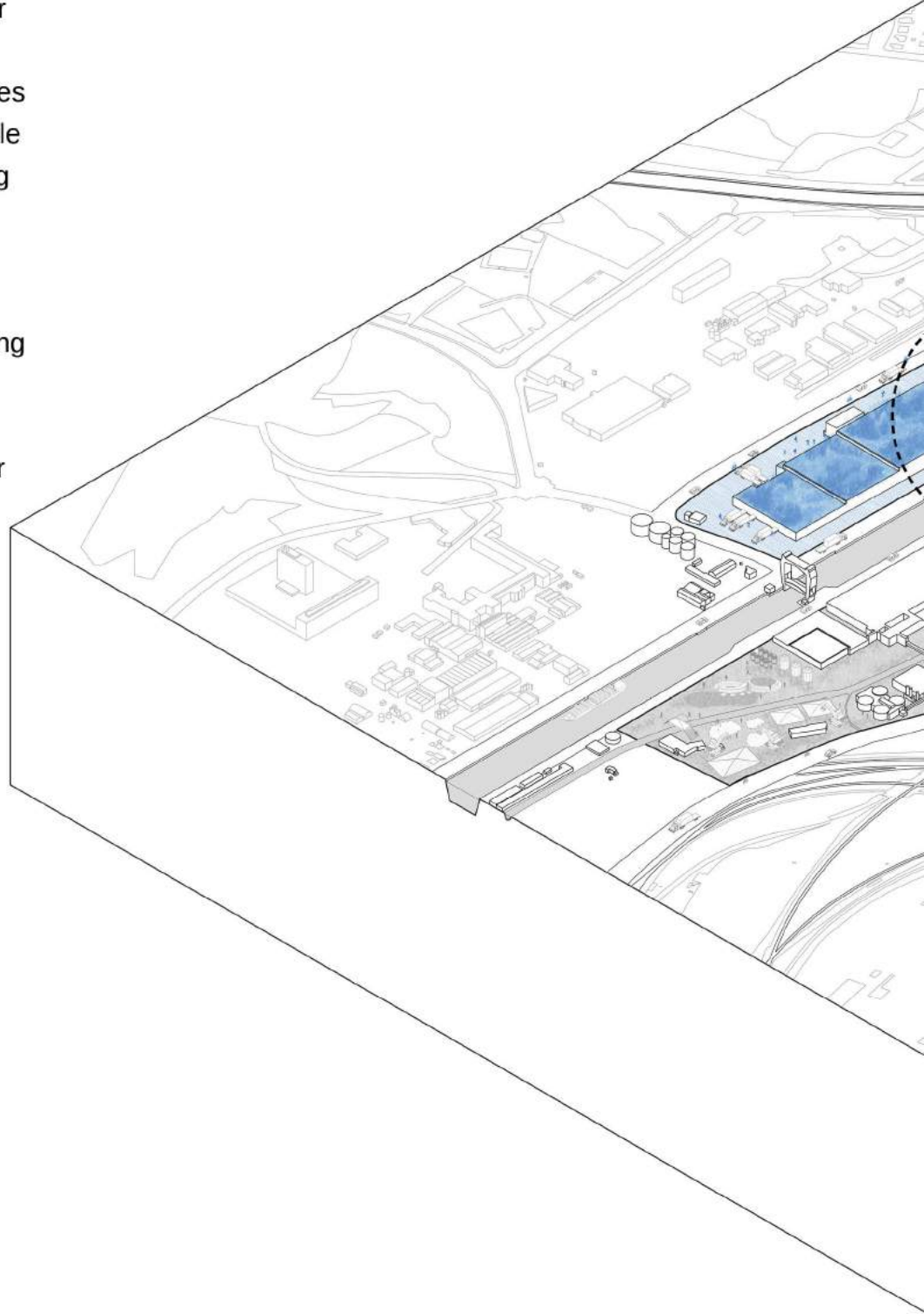
Rainwater represents another water challenge for Brussels in general and more specifically for the Buda area.

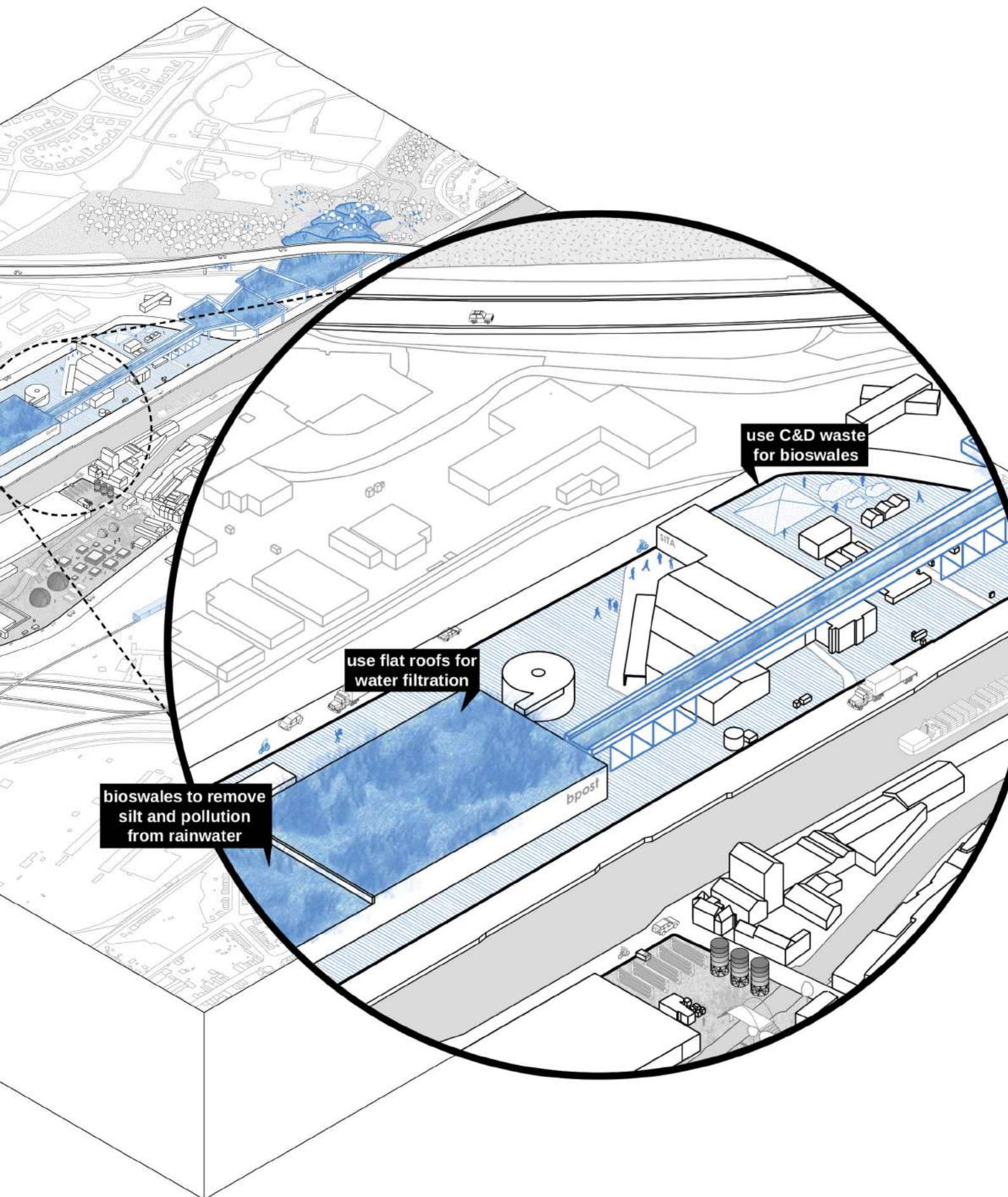
The current sewage system – like most city sewage systems - does not distinguish between black water from households and run off rainwater. Thanks to climate change heavy rains are becoming more common in the Brussels region. During such heavy rains the sewage system can't cope with all the water and thus sewage water is spilled directly into the canal. The untreated sewage water introduces far too nutrient-rich water to the canal, disrupting local plant and animal life.



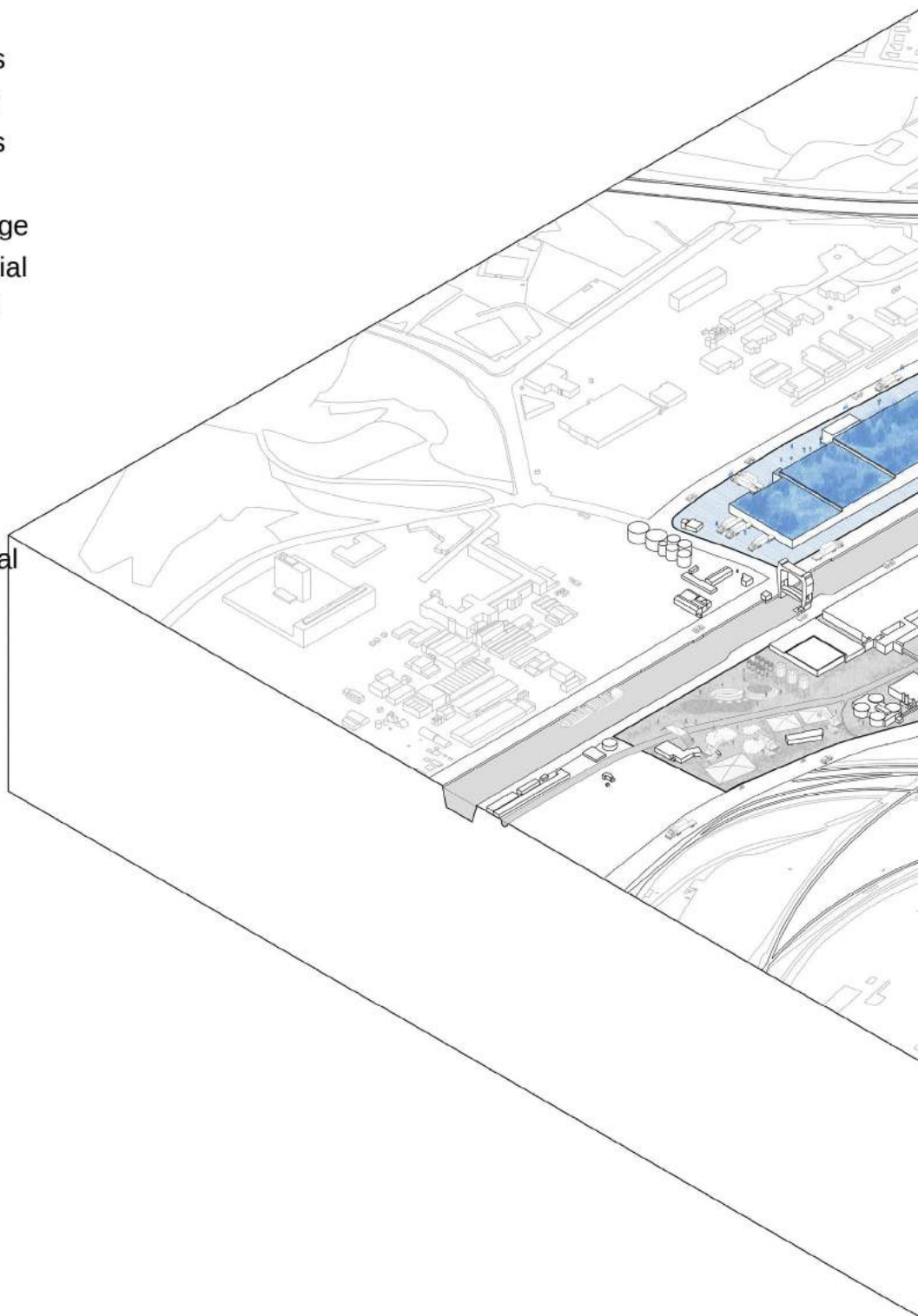


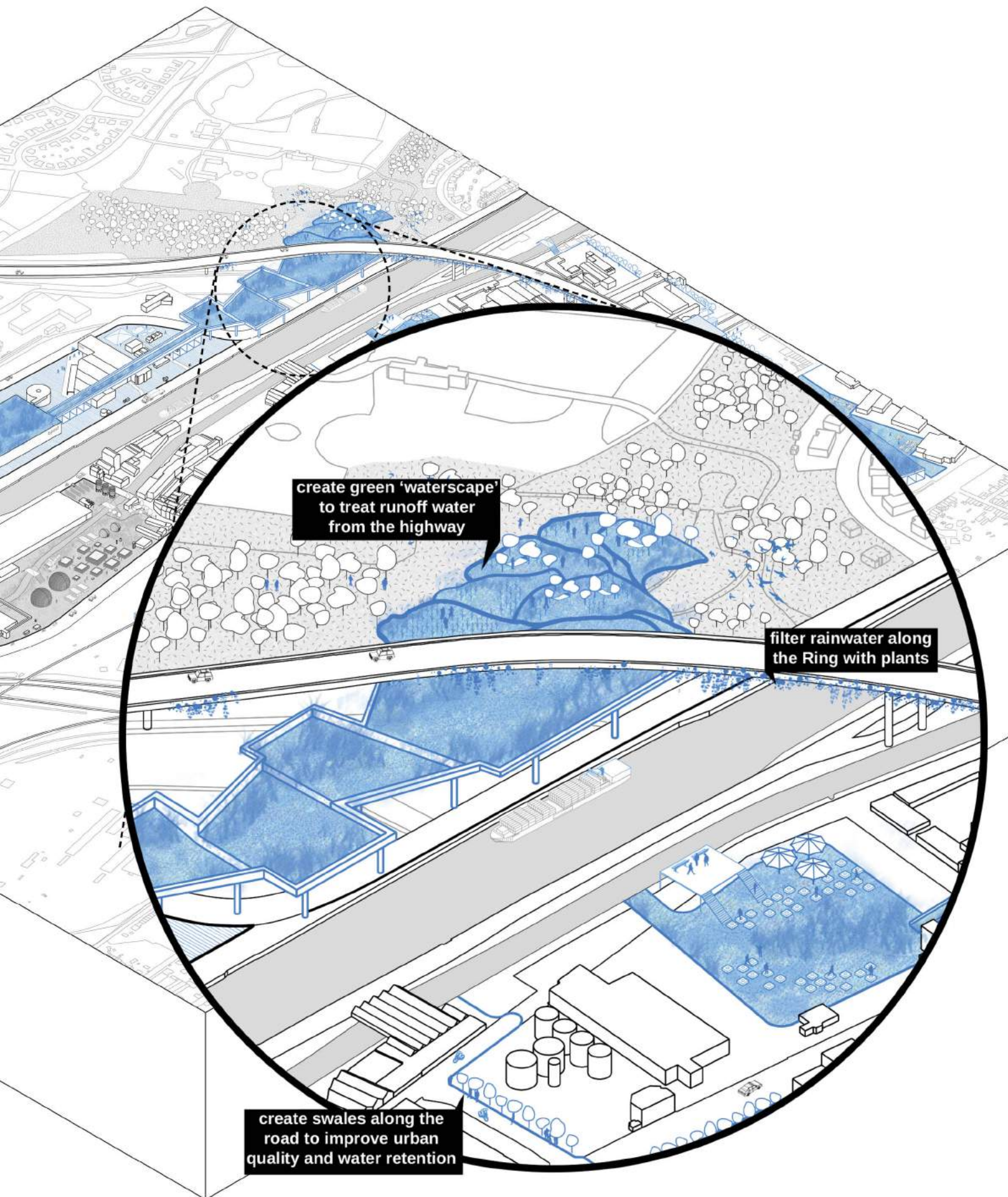
Replacement of the current sewage system into a separate system for black water and run-off rainwater is the most robust solution to this challenge, but it takes decades to renew the whole system. Therefore catching and retaining rainwater by means of so-called city sponges can significantly contribute to reduce flooding of the sewage system without constructing a completely separate sewer system.



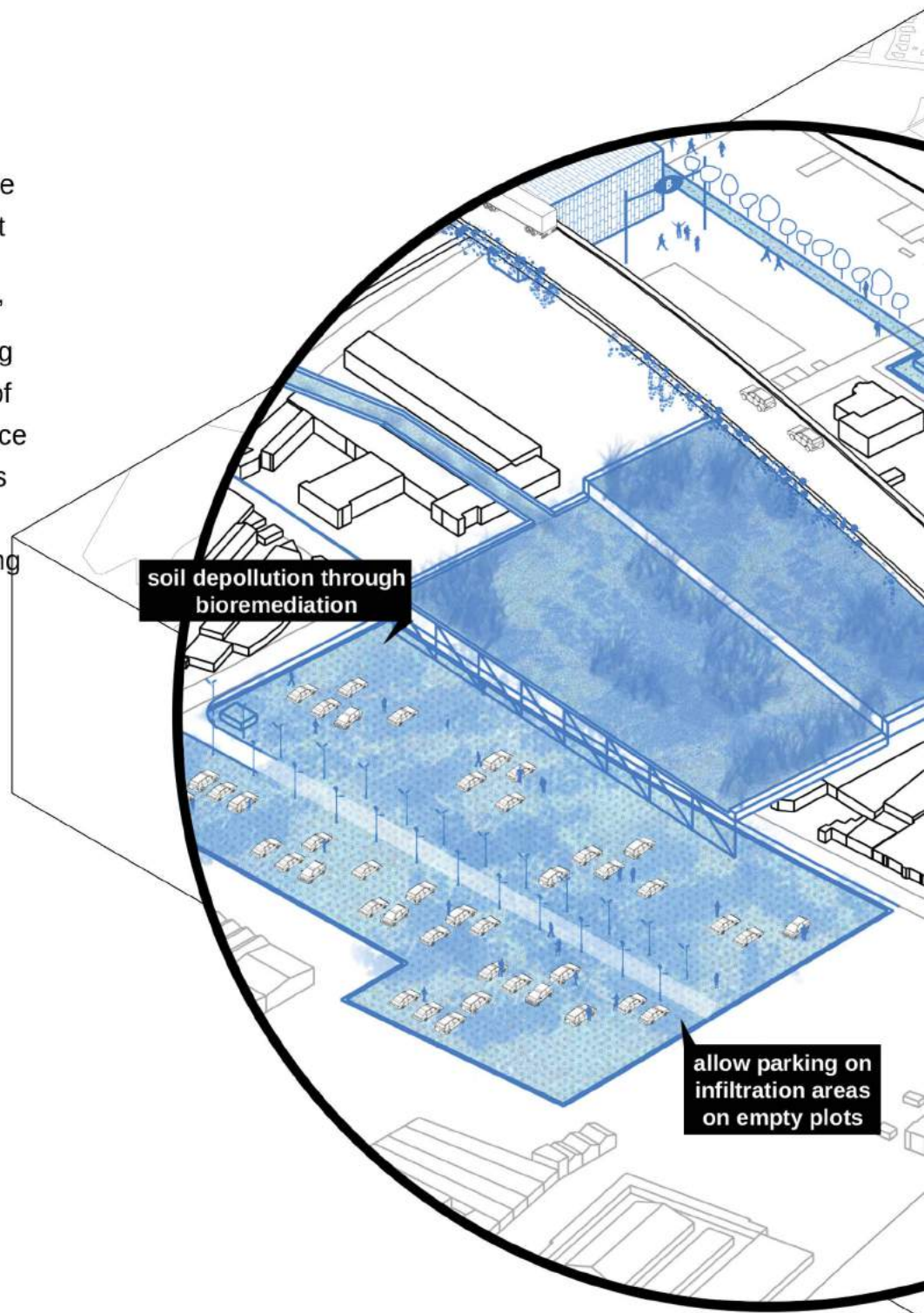


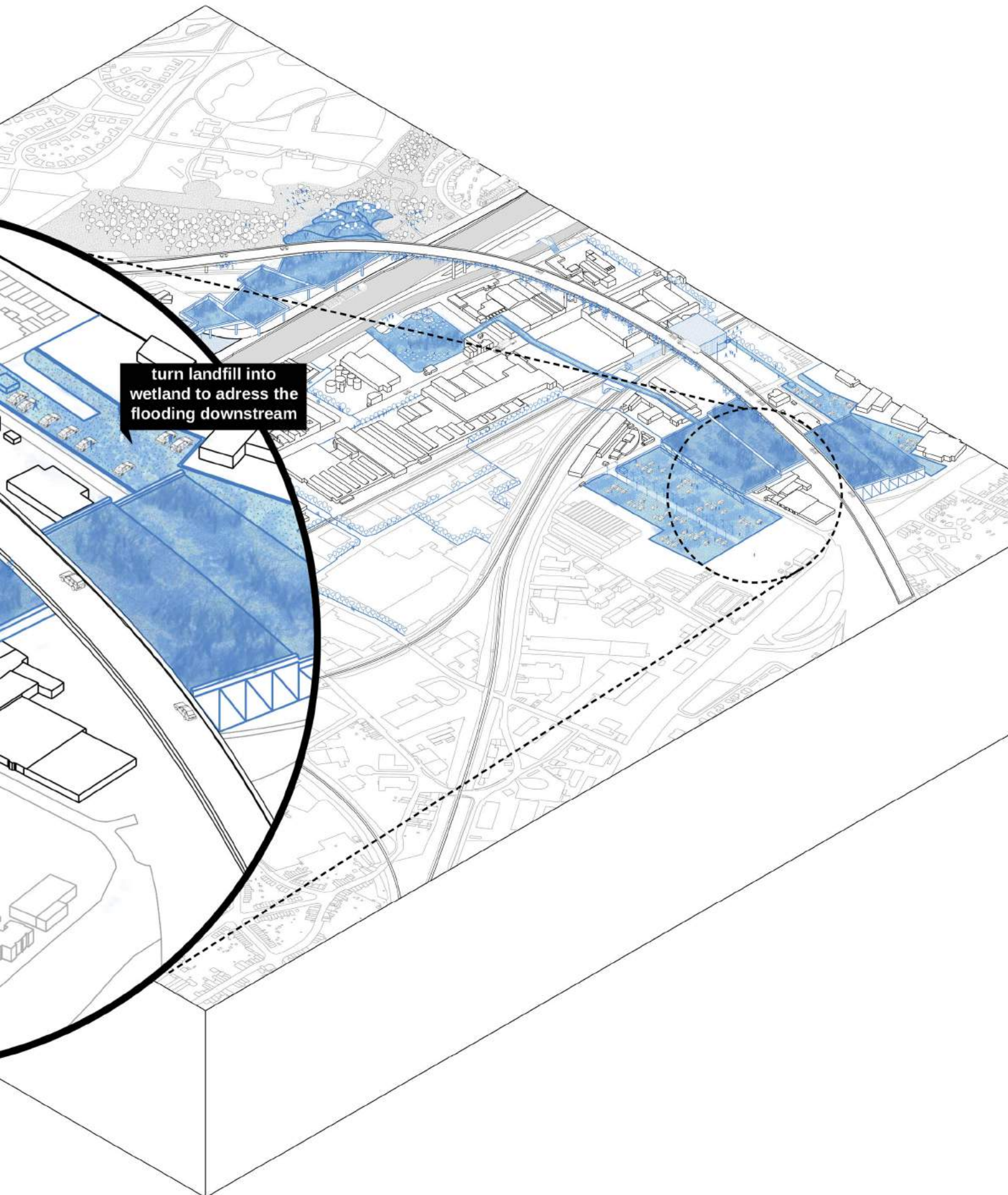
For Buda, this opens new opportunities. Large amounts of run-off water coming for instance from the car infrastructure in this area, now disappear either untreated in surface waters or challenge the sewage treatment plant. But the large roof surfaces of the industrial buildings in this area could be transformed into man-made filtering landscapes. Using ecological filtering processes, rooftops and vacant areas can be connected in an incremental system.





Through these landscapes, the water falling on the ring would by natural decay run down while being purified in several stages before ending in the Canal or the Zenne. The Viaduct Zeekanaal Brussel-Schelde could be considered a pilot project. By providing the viaduct with 'green gutters' that lead to roof-top filtering landscapes at both sides of the canal this hovering piece of infrastructure transforms into a field lab for Aquiris, testing new forms of filtering landscapes.







WATER MANAGEMENT STARTS BY CHANGING THE BEHAVIOR OF SINGLE USERS

conversation with Sybrand Tjallingii

Sybrand Tjallingii is a Landscape Ecologist investigating the role of ecology in urban planning since for more than 20 years. In 1995, with the release of his book *Ecopolis*, he anticipated a systemic vision for water in urban environments that is still a source of inspiration for current urban studies and developments such as our research on the Brussels Region.

When looking at urban planning and development from a systemic point of view, we were pleasantly surprised to discover that you had a very similar approach in your publication *Ecopolis*, which dates back to 1995. As the issue has been growing in the past two decades, how has the situation evolved since then?

It goes up and down, some territories have made some progress in this direction but indeed there was a wave of environmental enthusiasm starting from the early '90. *Ecopolis* originates from a contribution I did to the conference in

Ankara in 1992. Later on we decided to extend it to a national level, and that's why we decided to engage medium size cities in the project such as Dordrecht, Zwolle and Breda. We worked together on practical issues that were relevant at that specific moment and put solutions on the table. This interesting process led us to other commissions where we started integrating the idea of Metabolism in the spatial planning for the next future. It was not immediately embraced but some ideas were actually applied. At that time there was a strong belief in creating a compact city, the idea to build for the need and in direct combination with the cities. We mainly focused on networks as a carrying structure for development. We believed in a green belt not as a barrier to urban development but rather as a green-blue network, together with water infrastructure; on the other side, road infrastructure was the fast lane for economic development. Our vision was trying to find a balance between these 2 essential components but was not aligned with the dominant view of a compact city at the time. Therefore they opted for another scenario, called *Stedeland City*: land of the compact city. I think back then the systemic approach to urban development was somehow integrated in the layered strategy: there is the ground level and the network, which is situated in between the first one and occupation; this system itself was systemic



as well.

What do you consider the reason for this renewed interest towards urban development through a systemic approach, from a flow perspective? Do you think that the awareness of climate change has made clearer the imbalance between cities' consumption and production?

Climate change has indeed stressed the urgency for sustainable development; cities started setting agendas more attentive to their ecological footprint. In the 90's, globalization forces have pushed traffic as never before; economic trends at the time were not exactly in line with our

ideas about system and network planning. But now, after realizing we can't go on this road forever, they're finally questioning the basics of urban development. Back then, the aim for sustainable development, and particularly urban development, faded out in favor of economic growth and the image of the city as a strong, competitive unit. Awareness generates new ideas and principles.

If we look specifically to the water flow, how can we deal with it in a circular way? And where can we start putting it into practice?

If we would suddenly switch to renewable energy sources, it would be a radical

change, too radical for many. But at the urban level, I see many ways of acting in a pragmatic way to experiment without running into political ideology. In your report you really emphasize this process of learning by doing and the three sites you chose are a good example to initiate many other pilot projects. In the early 90's in the Netherlands, with the *Voorbuilt Plan*, a lot of pilot projects were being realized by municipalities and provinces, by stakeholders supported by the national government. Some of these projects are still working and we keep learning from them: like the water sensitive urban development we designed for Drachten, in Friesland and the more recent Van Hall Larenstein School in Leeuwarden where it is also interesting to evaluate how economic factors are still affected by the intervention. When dealing with water flows, you can really create some beautiful designs but it is very hard to change the common practice. Even if the separation between rainwater and waste water is now a principle, the learning process is still long and it is very hard to apply it in existing cities. When we tested the rainwater purification system through helophytes on Erasmusgracht, in Amsterdam, we found out few years later that many people had connected the wrong pipes and wastewater was once again mixed with rainwater. On the other hand, in a recently developed area like

IJburg, it is much easier to integrate these kinds of processes: they collect rainwater and infiltrate it in the sand (on which the city is built), people start gardening on their roof and you have no idea of what is happening underground, everything is invisible.

The challenge is to bridge the gap between general theory and practical issues and complete then the learning cycle. The government can't deal with learning projects on its own, it needs to involve experts, technical engineers... Only by connecting theory to practice it is possible to change the current practice. What is learnt from pilot projects should then be discussed at the policy level by agencies and institutions. And that's where ideas get stuck: institutions have their own ideas and those are not easy to change, you would also need a forum of academic people, researcher, authorities etc... to demonstrate the value of the learning process.

What needs to change in order to enable this process to start? Does Belgian territorial fragmentation facilitates the process in any way?

In a way, probably yes but we need some sort of solidarity between the inhabitants of the valley. If you look at the water flow, many problems could be solved upstream in other regions, but their effect takes

place in Brussels. When it rains, the wealthy houses uphill are unable to collect rainwater because of their old collection systems. The bottom of the valley is where the flooding and the damages occur but if the people living uphill wouldn't pave their garden for instance, part of the problem could be prevented. I am always surprised to see how many initiatives exist in Brussels, unfortunately they are not always efficient because in Belgium, unlike the Netherlands where everything is centrally planned, the bottom-up approach is still the most common.

As you suggested, I think it's a good idea to use territories on the border (like Buda for instance) and use them as experimental zones to test and improve new solutions. There is no need to change the whole system before you start, even putting a new pipe connection in your garden is a small step, and if also your neighbor does it, it starts making a difference. Brussels is a city of valleys, living in the landscape is a carrier for awareness and design of the water system.

In *Ecopolis* we developed an approach made of *guiding principles* and *guiding models*: the first ones show general principles such as recycling or sorting while the models are practical, structured solutions that also have a spatial impact.

In the Netherlands, with the system of polders, it is possible to pump the water and temporarily store it in the polder itself and later feed it back to the water network. In Belgium the situation is different, because of the hills and valleys, you would need a lot of energy to pump the water uphill, but if you manage to retain it upfront and slowly release it in a cascading system it would already make a consistent improvement. You can also think of small local pumping devices that would allow you to use the water for gardening purposes. In this case, the guiding model is different, it's about trying to create some storage at the edges of built areas, use the green network of the valleys for both storage and filtration, like a green/blue structure for urban development. The problem is that in Brussels this model often doesn't apply since the foot of the valley is already fully built.

We developed a guiding model for Moscow, which has a quite similar topography but is not yet as densely occupied. We suggested concentrating the built area on the top of the hill, this way you can open up interesting panoramic views on the edges, where you can store rainwater, slow it down by filtering it along the slopes and collect it in the water streams downhill. This cascading system could be applied in Brussels, in Parc Leopold for instance. As you suggested

in Buda, it's about separating rainwater from wastewater, filtering it and slowly reinserting it in the water system.

How do you imagine to improve the efficiency of the North water treatment plant, Aquiris? Are there interesting out coming products and how can we transform a technical improvement into added value to the citizens and to the urban landscape?

Interesting enough, in Brussels there are many composting sites, also in municipal gardens and parks, but biogas production somehow disappeared from the scene. I actually don't fully understand the reason for this since it is possible to have a combination of bio-digestion first, biogas production and reuse of the remaining sludge as fertilizer. Many water treatment plants adopted this process already for 10-20 years, like the one in Apeldoorn that you mentioned in your study. I picture the situation as a triangle [drawing 3a]: on one corner there is space, which is the landscape ecology in the city, creating social and economic value for urban development. The green structure is part of the economic context as it contributes to competitiveness of the regions, it improves quality of life. I make a difference between landscape and industrial ecology: both can have an attractive character. You start with an industrial process, the functioning of the flows and recycling principles; then you

need to organize and design it, transform it into space, make it work and create an image that people can recognize. Visibility is a very important aspect but synergies are the real challenge: you can start engineering a system with industrial ecological knowledge and then landscape architects can design its esthetical aspects but in the end it has to work in both ways. In the past we've looked at these issues from the wrong corner: it was always too functional or too esthetical.

Where do we start? What should we aim for and what could be the next step?

There are of course different scale levels, overlapping like in a sandwich, from the house at the basis to the neighborhood district up to the regional context. Even a change in the tax system created at the government level affects the behavior of single users. Pilot projects play a role especially at the intermediate levels of urban projects, we tend to forget the relevance of this scale that affects both bigger and small scale. It's important to let inhabitants interact with them and involve at the same time agencies and the government. Perhaps schools can act as catalysts in this process of learning and generating awareness. What is very important is to set a frame: state who will be evaluating, who will be discussing the results and what will be the consequences

for common practices in agencies. As it clearly appeared in the Netherlands, you have to stress the forum in order to create awareness and acknowledgement from common practice.



REFERENCE PROJECT

The conversion of a US Army airfield near Frankfurt shows that man-made landscapes can hold natural beauty and at the same time be useful in water purification processes.

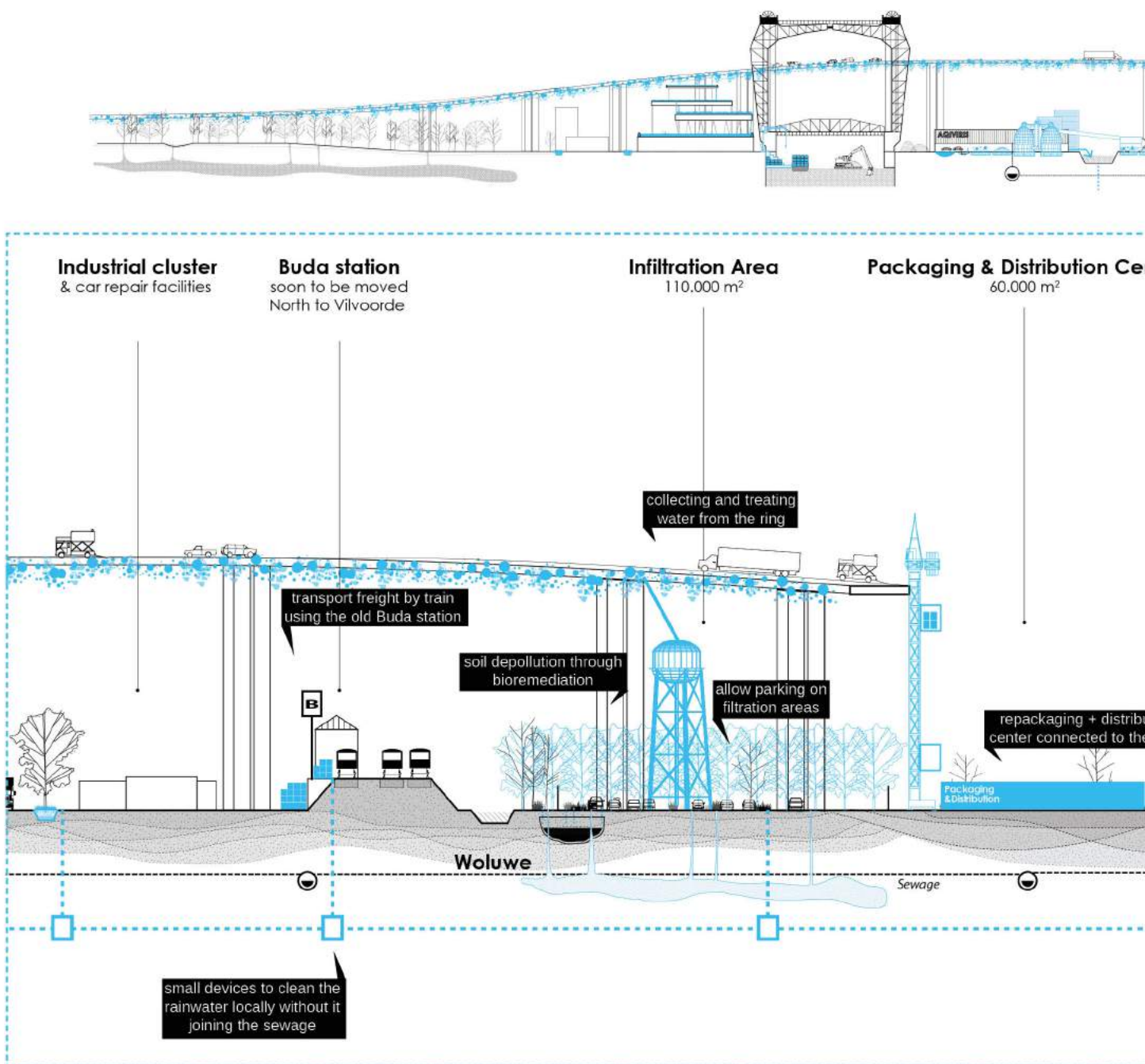
Half of the existing hardscape was demolished, fractionated and built in again in separately selected grain sizes, thus creating a wide amplitude of habitat condition. This hardscape is meant to be used for all kinds of outdoor activities while the biological processes are subject to long term research studies.



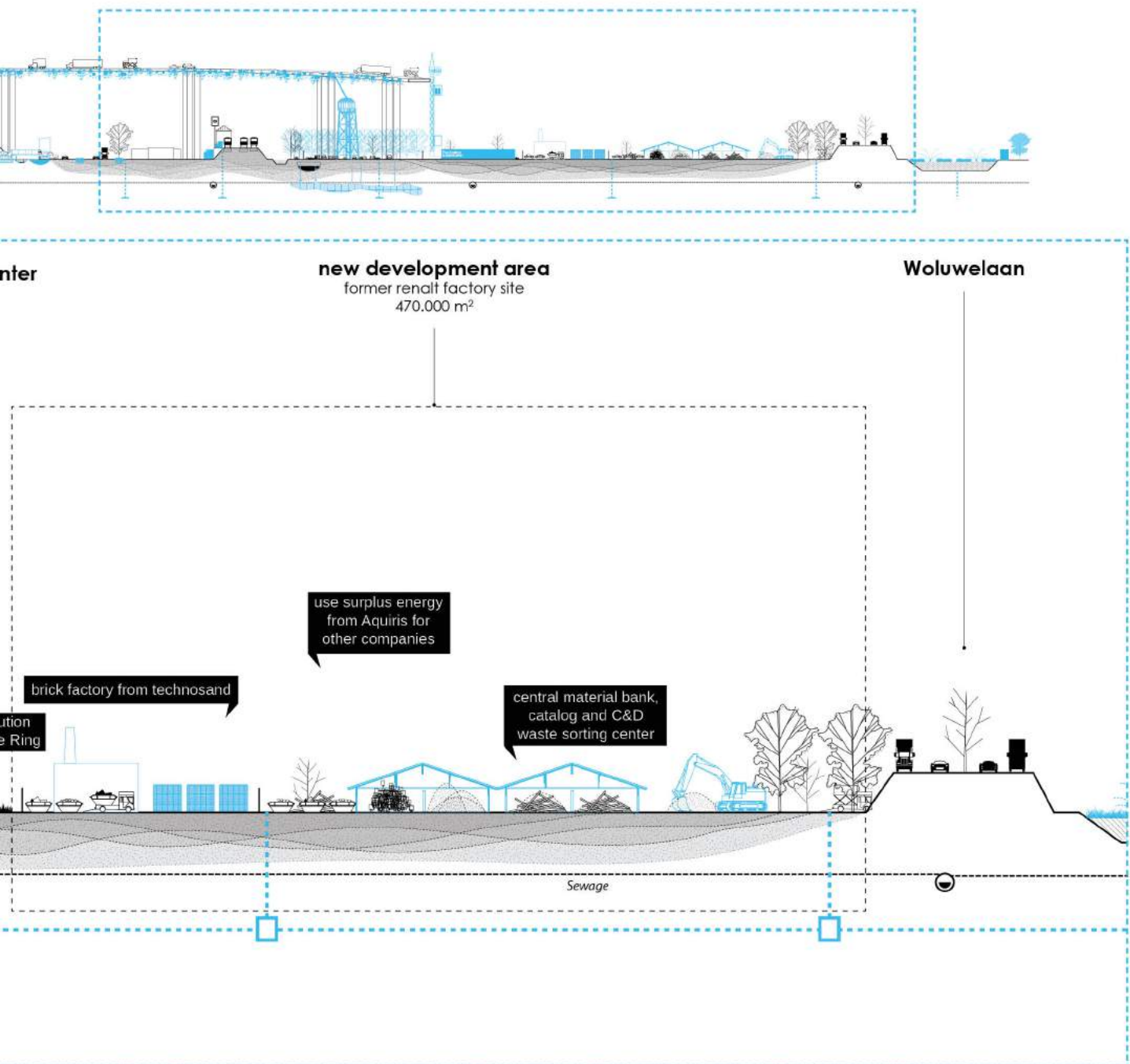


All the previous observations result first of all in a treatment plant that provides its own energy and takes out more valuable substances. Using algae for filtering also diversifies the products of Aquiris, adding bio-fuels, compost and phosphates. In the

SYNTHESIS

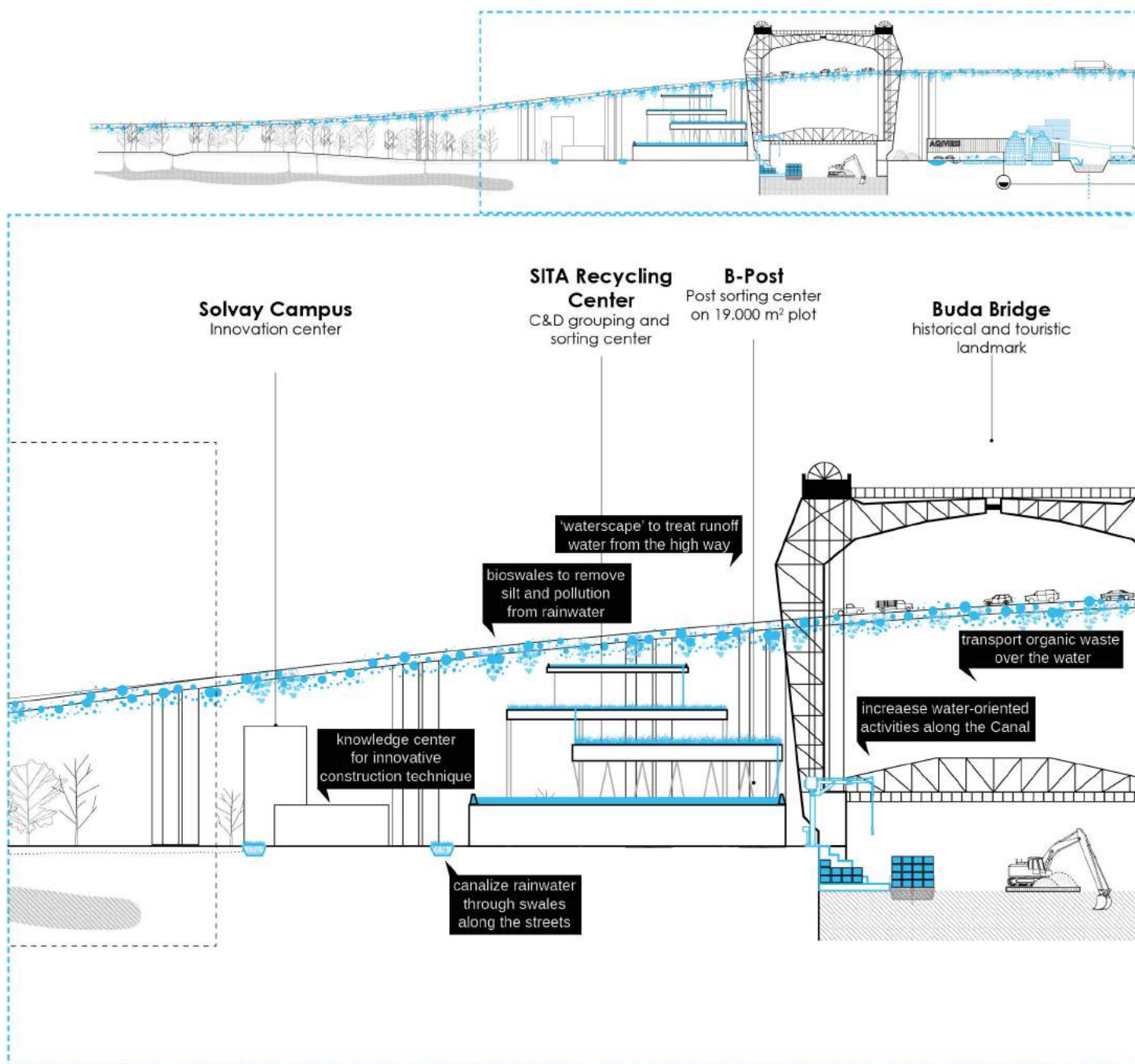


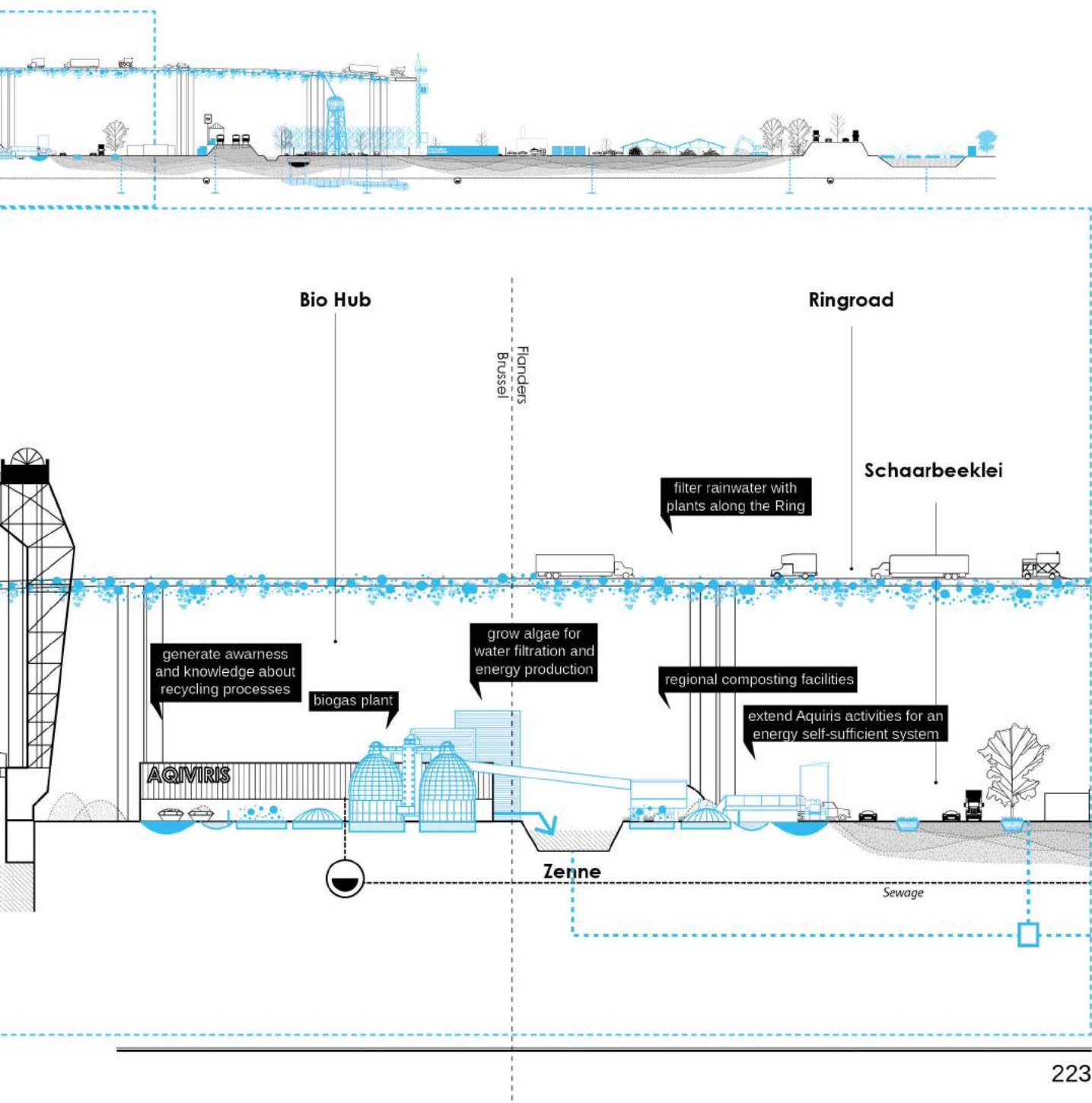
end, this creates opportunities to better connect to adjacent companies making a contemporary version of an industrial ecology based on filtration and its derived products.



Also, it offers opportunities to connect to citizens, creating filtration landscapes that can have recreation value. At this point the flow of sewage also connects to the challenges of rainwater. City sponge strategies in the form of rooftop filtration

connected by bio-swales create green qualities in the area that are now almost completely absent giving back to the city the permeable surfaces that have been occupied by new constructions over time.





05

RESULTS







OPPORTUNITIES

During the present study, the team worked parallel both on a local and on a regional scale, on a selection of four flows at three locations along the Canal. This way of working resulted in some very concrete opportunities for circular economy. Six strategies are identified:

- Developing a new distribution structure based on multimodal hubs at cycling distance from both the city center and the ring.
- Using all fractions of animal waste in a new manufacturing industry around the Abattoir area.
- Re-using food waste by introducing left-over from restaurants, markets and multiplying local composting facilities.
- Extending construction & demolition material recycling industries to a

regional material bank and to e-waste, linking them to a new manufacturing industry.

- Extending the activities of the water treatment plant e.g. with a bio-digester to make the plant function in a more circular way, thus becoming a bio-hub.

- Catch, retain and purify rain-water in a landscape of rooftops and vacant areas, using ecological filtering processes.

More precisely the current linear state of the four flows of freight, organic waste, C&D waste and surface water were imagined circular, evaluating their impact.







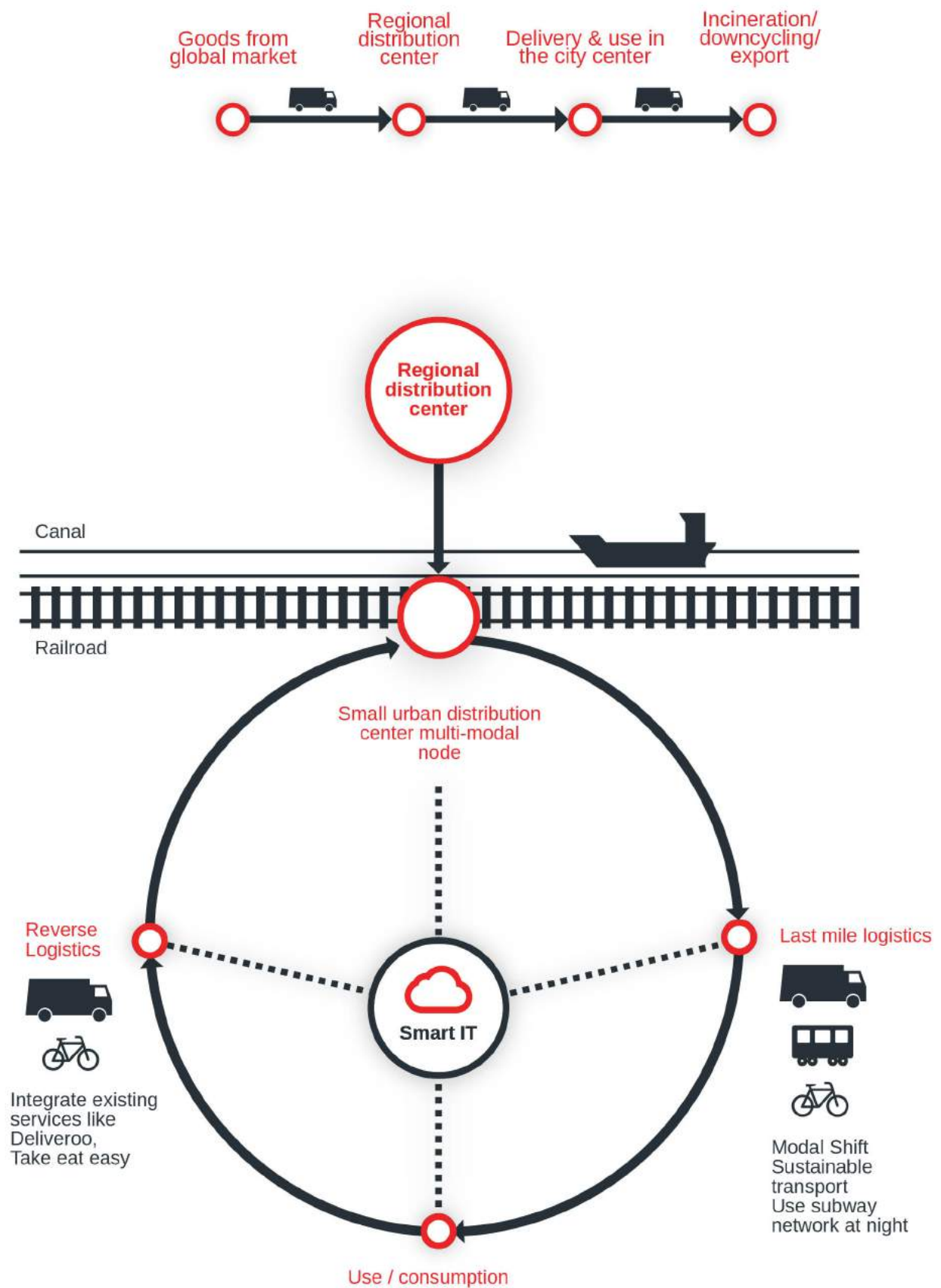
FROM LINEAR TO CURCULAR - FREIGHT

For freight it means moving from the current state:

- Logistics in Brussels is primarily focused on delivering goods as quickly as possible to the customer.
- Large distribution centers around the ring play an important role for the delivery in the city center.
- Trucks are often only partially loaded when entering the city center, while they contribute to the growing congestion and CO₂ emissions.

To a circular state:

- Circular logistics in the city focuses on sustainable last mile logistics and reverse logistics.
- An inner ring of small urban distribution centers, that are strategically placed on multi-modal transport nodes, enables a two-way logistics.
- The transport nodes connect a waterway like the Canal with the metro system or e-mobility solutions like small vans or bikes.





FROM LINEAR TO CIRCULAR - ORGANIC WASTE

For organic waste it means moving from the current state:

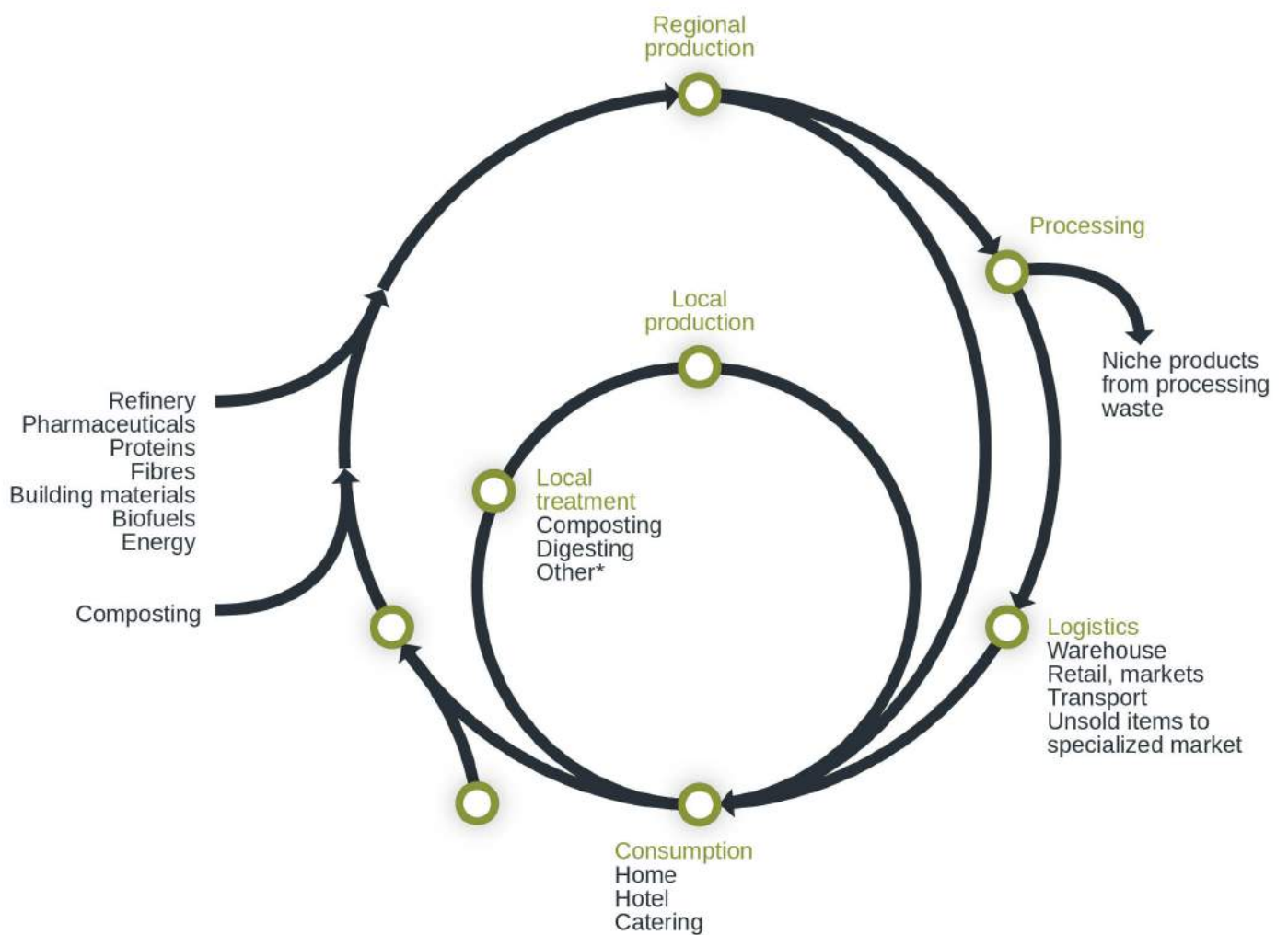
- Organic waste in Brussels is mostly sent to the incinerator due to limited sorting by consumers and companies.
- Only green waste from public areas and a limited amount of organic waste is composted.

The organic waste flow also contains many nutrients. Some of these nutrients (e.g. phosphates) are essential for our survival but, like fossil fuels, are exhaustible.

With the incineration of household waste valuable nutrients are removed from the nutrient cycles that are needed for the production of food, feed, fibers and (bio) fuels.

To a circular state:

- Organic waste is collected and treated separately.
- Nutrients and other valuable materials are optimally recovered through composting, digestion, gasification and further bio refining strategies.
- Local and regional cycles of nutrients then allow for low-impact production of food, feed, fibers and (bio)fuels.



*Insect farming; mushrooms on coffee grounds



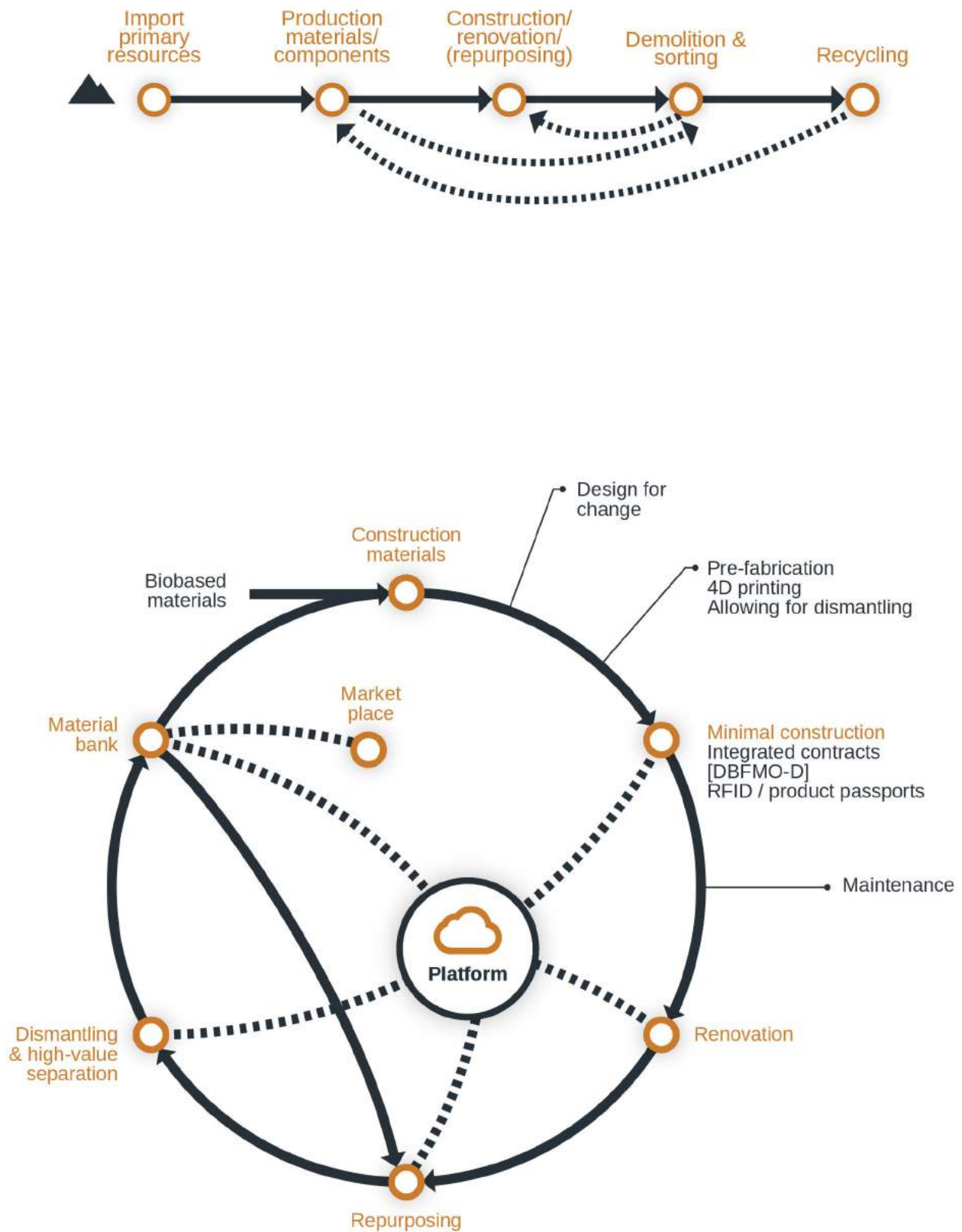
FROM LINEAR TO CIRCULAR - C&D WASTE

For construction & demolition waste it means moving from the current state:

- In Brussels most of the construction and demolition waste is already being recycled.
- A large part, however, is down-cycled or exported out of the city region and even the country.
- Raw building materials continue to enter the city for new construction projects.

To a circular state:

- In a circular state, the construction of new buildings is minimized. Old buildings are repurposed. In both cases, resources from demolition sites or bio-based materials are used.
- If a new building is constructed, its design takes into account easy renovation, repurposing (e.g. from school to hospital) and dismantling for high value reuse.
- Building components and materials are traced through material passports and stored in material banks.





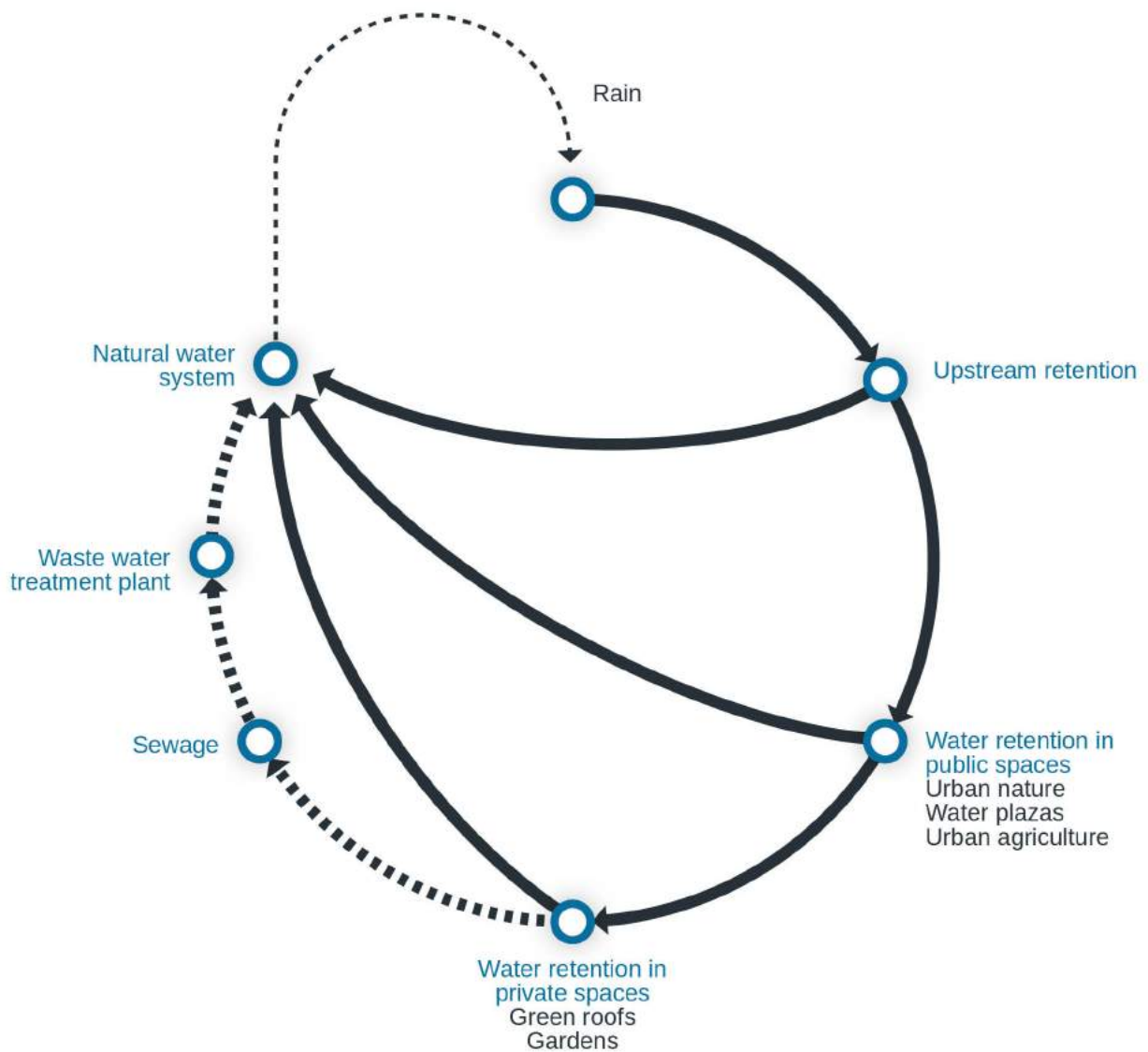
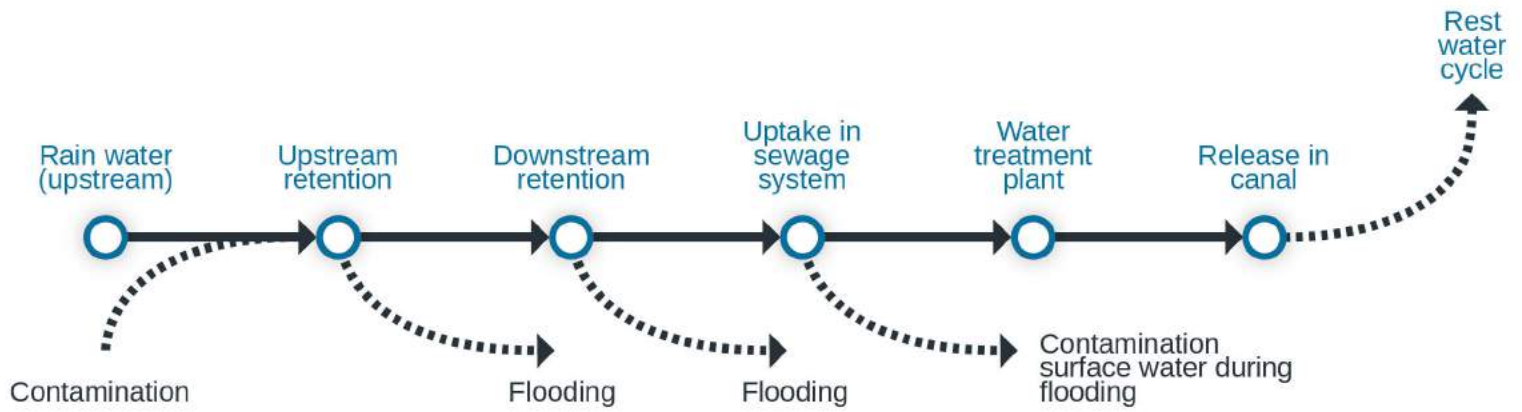
FROM LINEAR TO CIRCULAR - SURFACE WATER

For surface water it means moving from the current state:

- Frequent floodings cause sewage systems to overflow in different parts of Brussels.
- Surface waters thus become contaminated.
- The two wastewater treatment plants are not designed to cope with the excess amount of rainwater entering the sewage system.

To a circular state:

- Natural water cycles are closed and rainwater is treated as valuable resource e.g. for plant production or energy generation.
- Rainwater is retained upstream, in the hills south of the city.
- In the city, rainwater is collected in both public and private areas, through green infrastructure (e.g. green roofs, urban agriculture) and other urban tissues like water plazas. This allows for a gradual release of water in the natural water system, through evaporation or seepage in the ground.

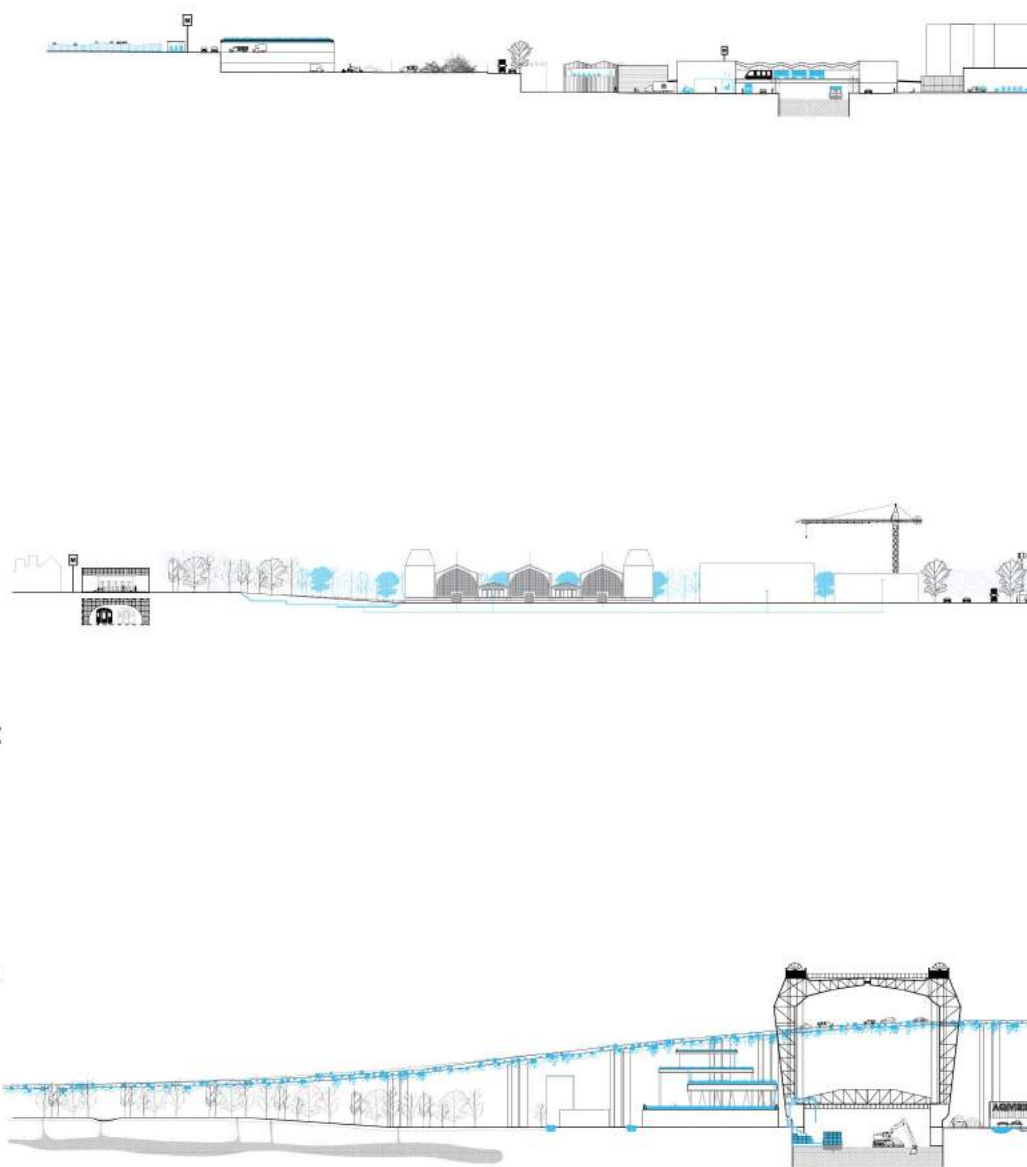




NEW DIRECTIONS

With the introduction of the six strategies, the analyzed locations could change considerably, setting examples resulting in new urban transects. But these examples are often not restricted to the studied locations. What started as a search for losses from isolated flows, thus become new directions for the city to further explore, ranging from:

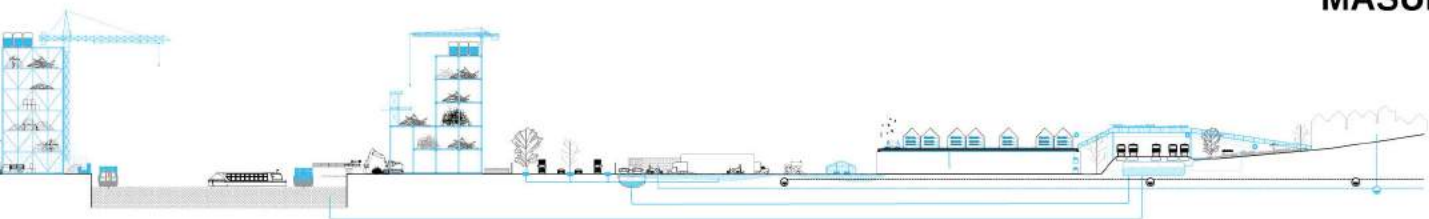
- Re-thinking city logistics,
- Extending recycling and optimizing the use of organic waste,
- Extending recycling and optimizing the use of construction and demolition waste,
- Capturing and utilizing rain water and optimizing the treatment of waste water.



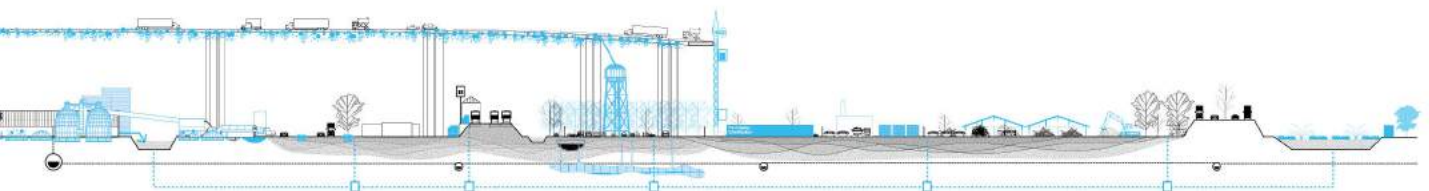
BIRMINGHAM



MASUI



BUDA





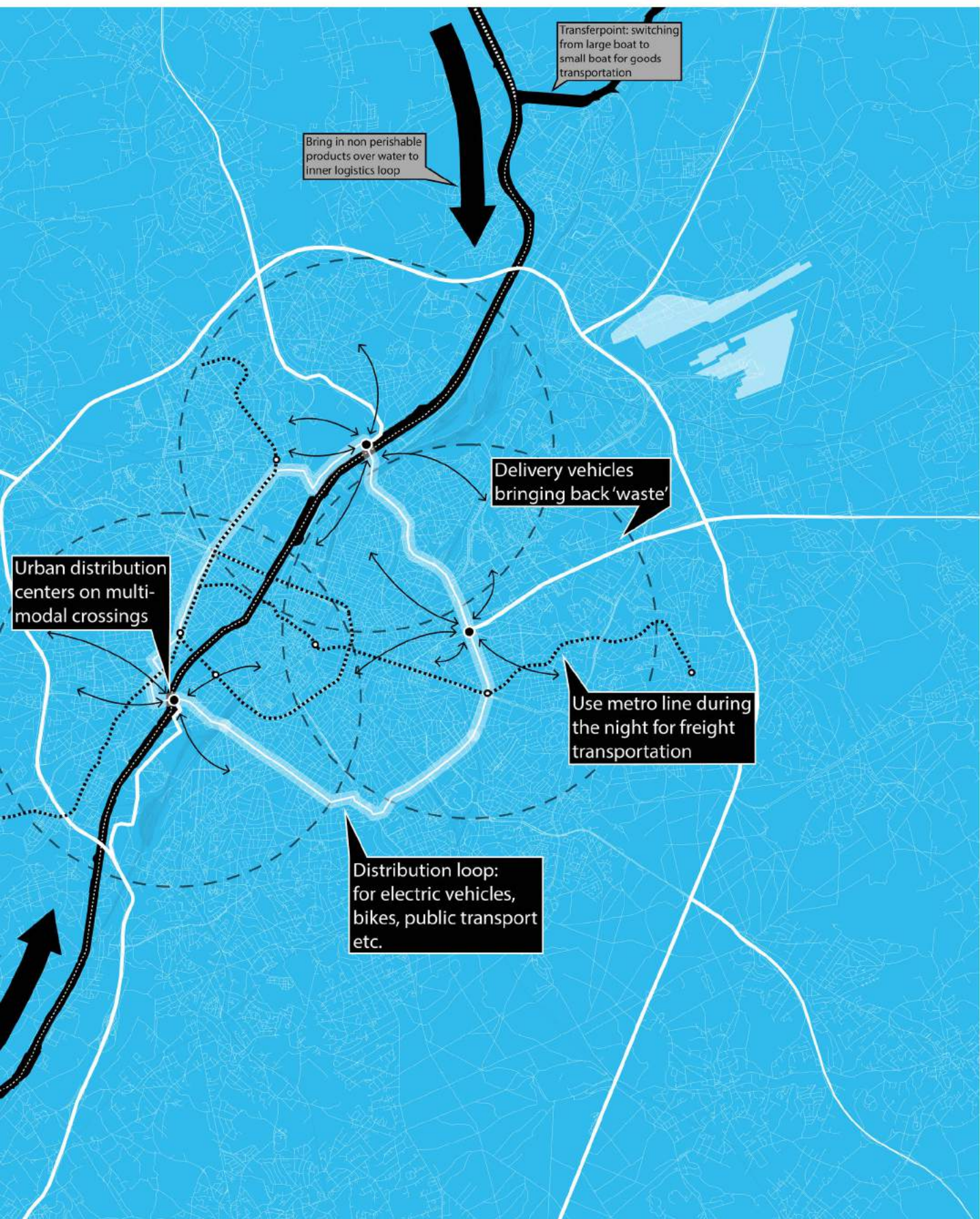
BLUE CARD FREIGHT - RE-THINKING CITY LOGISTICS

Weaving a ring for sustainable transport – an e-loop - through the city will for instance create the conditions in many more places than Birmingham to make a modal shift, saving many hours now lost in congestion.

Envisioned as a ring the e-loop is not only functional if the ring is fully completed. The principle behind the e-loop is based more on dividing the area between the center of Brussels and the ring road, creating two zones in which all destinations are within cycling distance. In the current logistical system most goods are transferred around the ring, leaving a traveling distance to end consumers that is too big to bridge with 'human powered modalities. However, when the distance is halved by applying an inner ring - built from existing connections - this can be done. The idea of the e-loop thus is to identify an area halfway to the center and

the ring in which through the upgrading of existing streets a new high quality route for electric transport can be created. If these routes are also used to improve connections between existing hubs for public transportation a multimodal network for logistics without local emissions is created. This not only has an effect on the extreme congestion that Brussels is experiencing. The e-loop will also have a positive effect on local air quality and thus ultimately on the life expectancy of people.







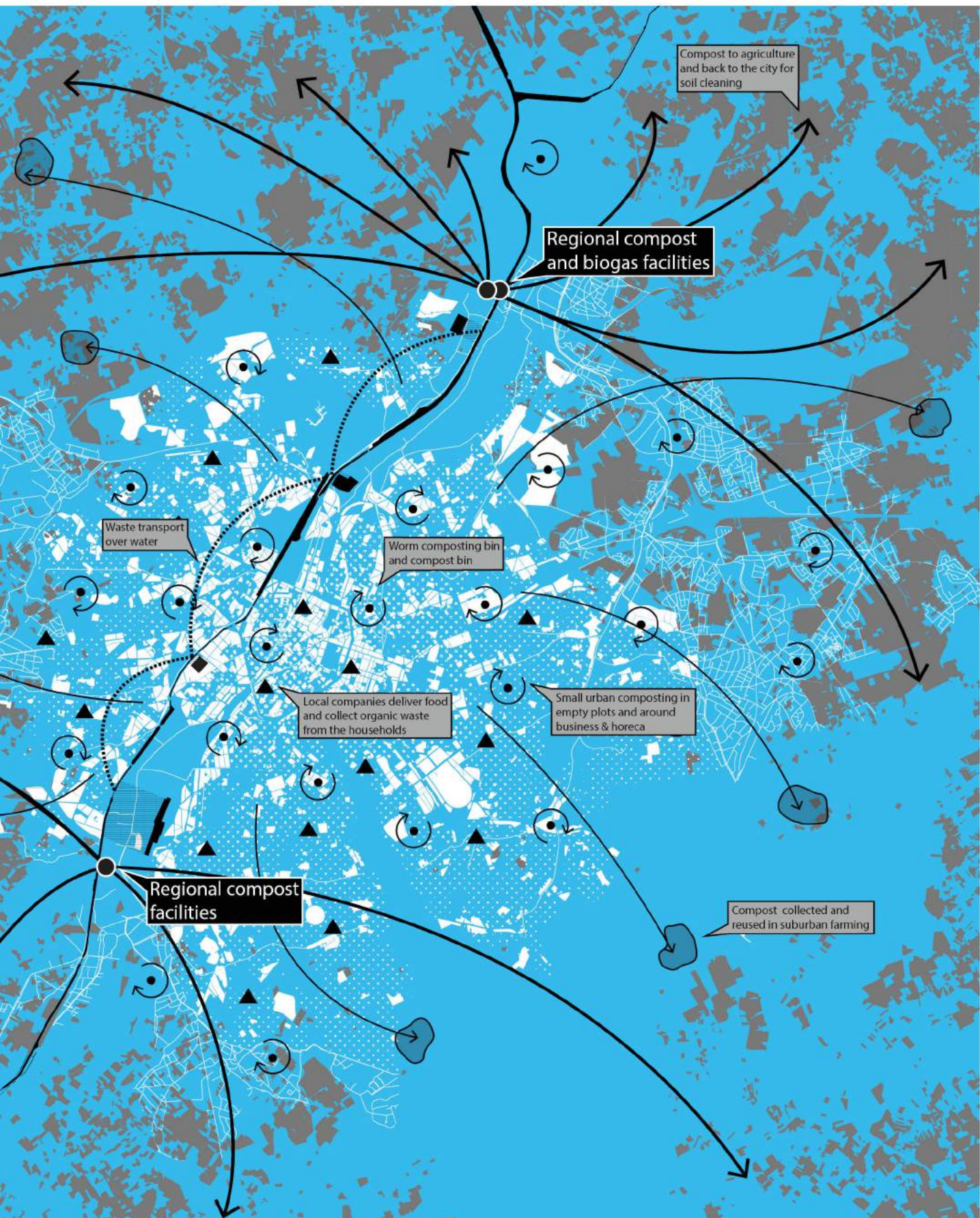
BLUE CARD ORGANIC WASTE - EXTENDING RECYCLING AND OPTIMIZING THE USE OF ORGANIC WASTE

The role of Abattoir as an urban catalyst for transforming Heyvaert Street can be repeated in the city. The search for new chains of production activities around existing actors to reuse existing urban fabric as a strategy can be successful for more than just the food chain. Also a combination to knowledge and education is interesting, especially when it comes to applied training. Thinking about new urban clusters in this way has analogies to the medieval guilds creating clearly distinct areas of the city. Rethinking that concept for the contemporary city offers interesting opportunities to start mixing working and living in many different fabrics.

Introducing local left-over from restaurants and farms, multiplying composting options and creating collective facilities for digesting or

refining will guaranty that all sorts of organic waste are used instead of systematically incinerated. Locally, this means that the options for MABRU and EU Center to give a new impetus to their isolated position and improve their relationship to neighboring neighborhoods grow tremendously. Taking advantage of the fact that the market only functions until 11 in the morning, in the second half of the day and the evening more public activities 'parasite' on all that is thrown away. The effect of this local intervention goes beyond improving the relationship with the immediate neighbors. The range of products that MABRU and EU Center can produce when they work on the systematics separating and recycling of organic waste broadens enormously. In the future it will not inconceivable that EU Center -fertilizer or MABRU-beer become well-known concepts in Brussels and beyond.





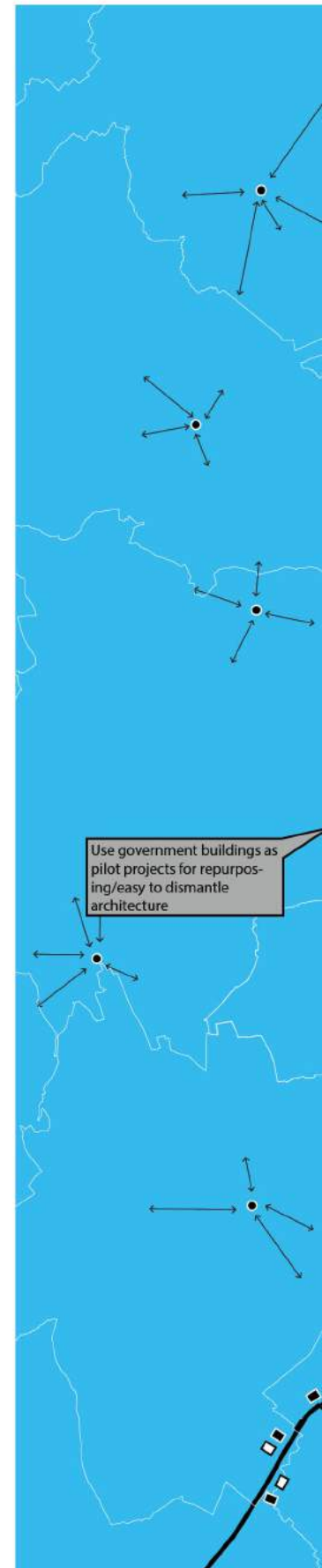


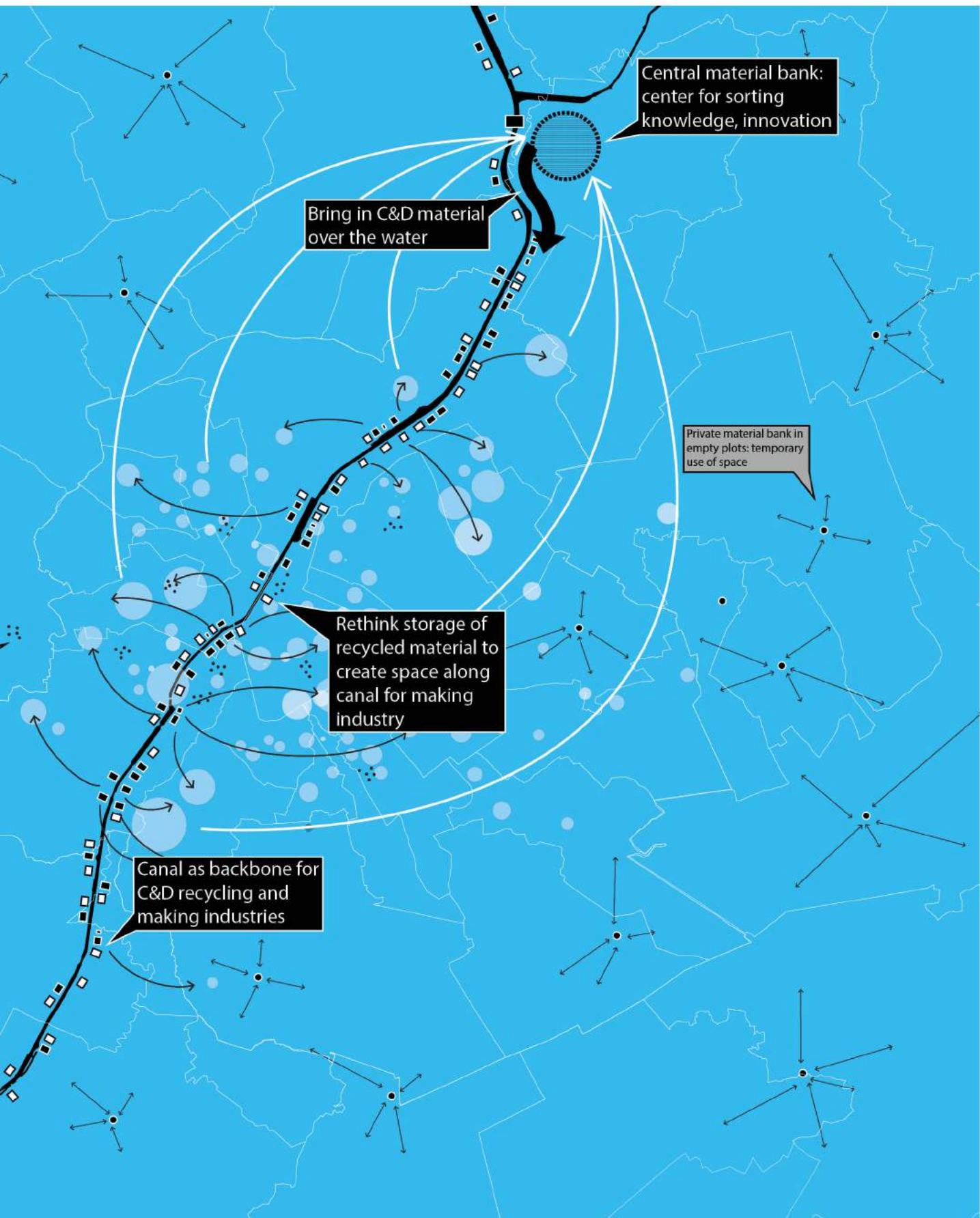
BLUE CARD C&D WASTE - EXTENDING RECYCLING AND OPTIMIZING THE USE OF CONSTRUCTION AND DEMOLITION WASTE

Extending recycling activities in Masui and linking them to new manufacturing industries, will strengthen the canal as a backbone for raw materials made of old materials. Instead of continuing to use the canal for discharge of scrap, and the supply of finite resources, the canal could transform to the backbone of a system of endless reuse. Based on the idea that materials never lose value the canal can become a vital connector between large-scale recycling operations around the metropolitan material bank, and small production activities around Bassin Vergote.

In time, it is even conceivable such a system also could be installed in the south of Brussels, so that eventually the whole city profits from the most sustainable way of dealing with the raw materials

that are needed for urban development. Zooming in at the proposed northern material bank just outside the BCR that feeds this new system, the effect will be a significant improve the match making between production and demand on a regional scale.







BLUE CARD WATER - CAPTURING AND UTILIZING RAIN WATER AND OPTIMIZING THE TREATMENT OF WASTE WATER

The presence of a Bio-Hub in Buda will have a dual impact: creating a national knowledge center for water purification around Aquiris, and at the same time transforming the area around the North part of the ring into a green testing ground.

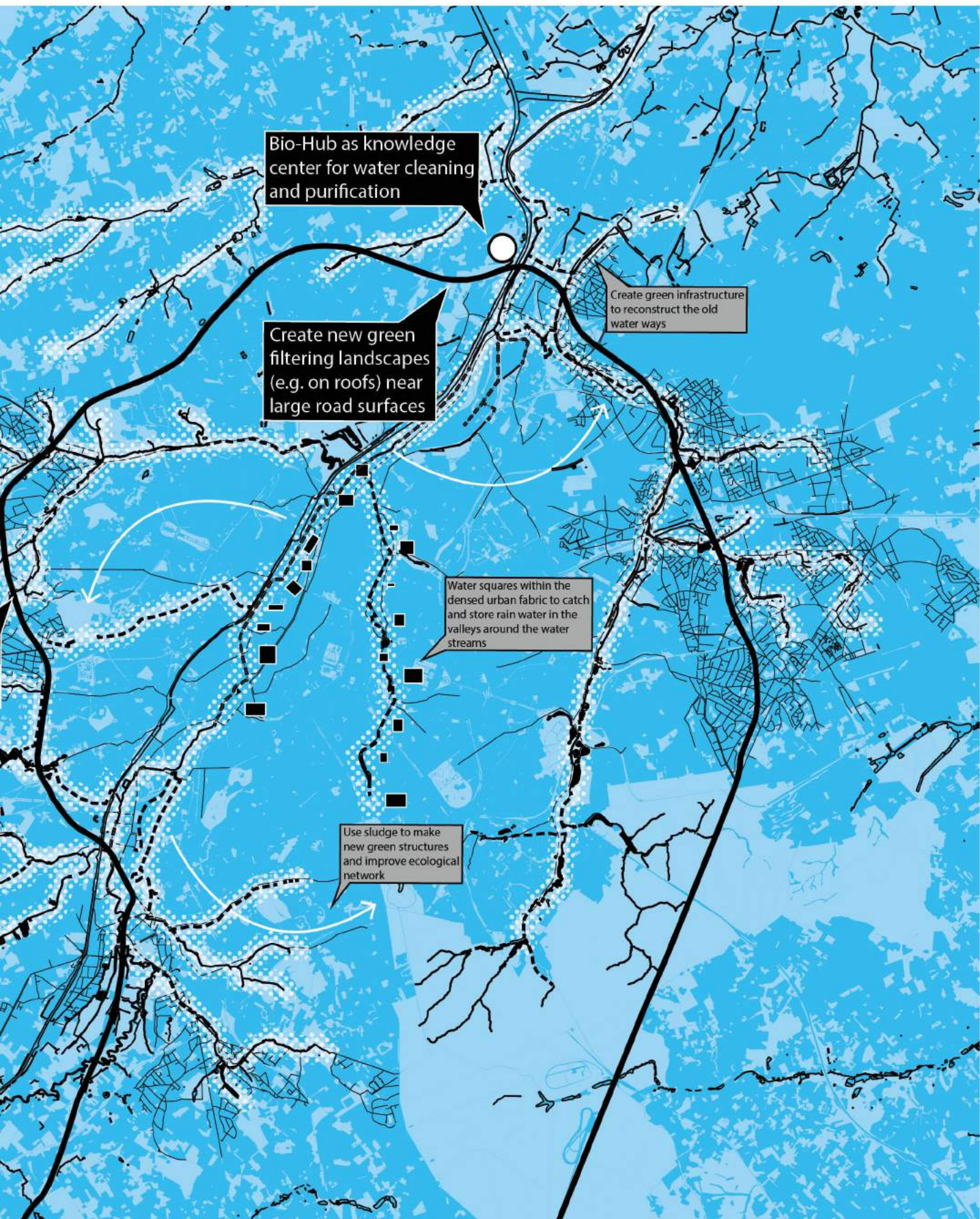
The importance developing knowledge around water treatment based on organic filtration methods using algae is interesting because algae are the basis for a wide range of products, from biofuels to cosmetic products. In addition to broadening the products of purification processes, these products are also able to connect more directly to a wide audience, which results in more support for the activities of companies like Aquiris.

The development of filtration landscapes on roofs of industrial

buildings helps in achieving important climate targets. Because filtration landscapes are not only helpful in easing run off water, preventing the sewage system is not overloaded, but these landscapes also have a cooling effect on their environment with which local «heat islands» can be combated.

The possibilities to connect filtration landscapes to recreational landscapes in the case of Buda offers interesting opportunities. The proposed filtering landscapes can become be part of a large 'neckless' of greens recreational spots along the canal.



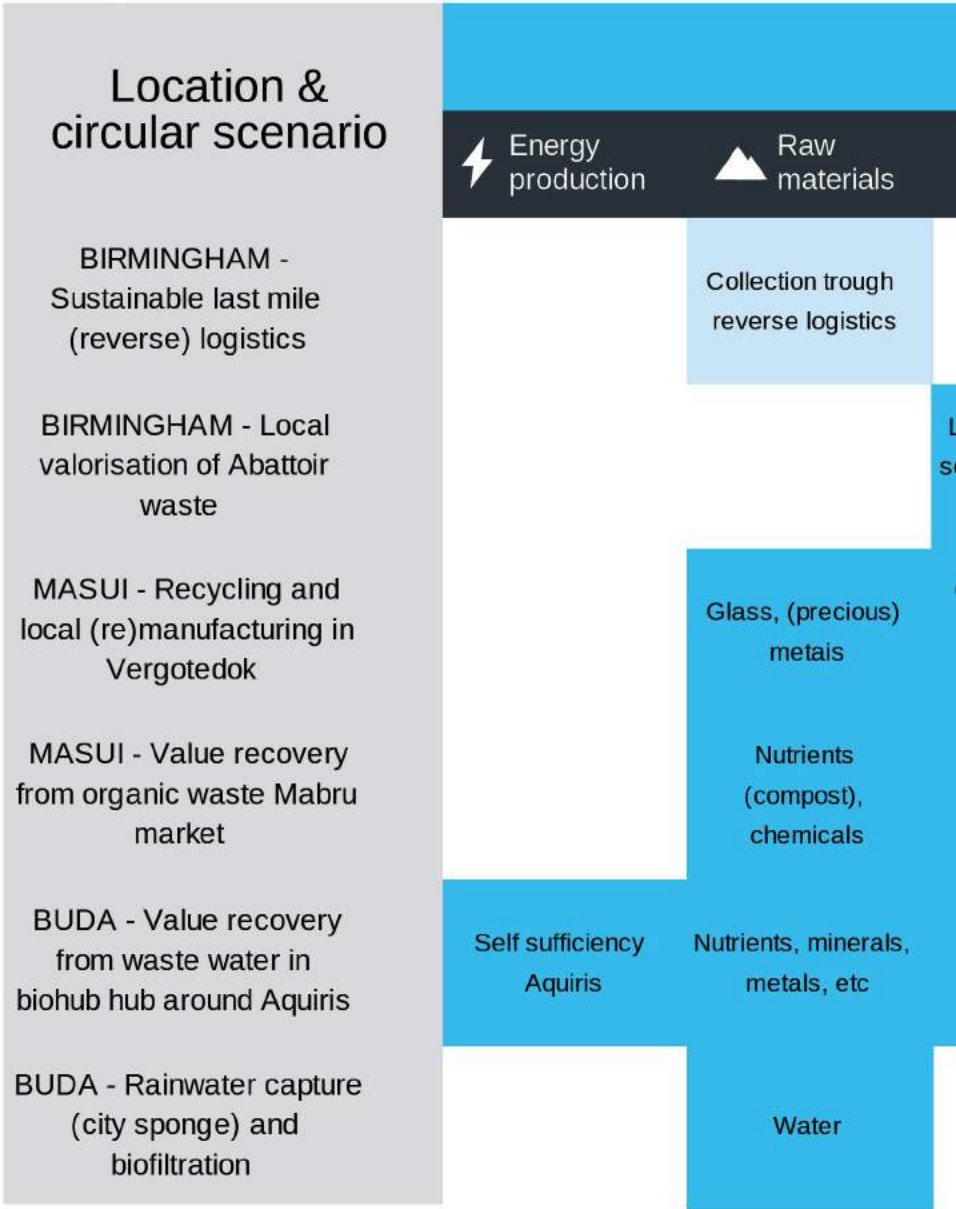




grow or retain Technical knowledge, for instance regarding food production, water purification or the production of leather by-products
raise Public awareness about the circular economy in the city.

IMPACTS

To get a better insight on the circular impacts per location, the effects of the proposed strategies are estimated in a qualitative way.
The darker the blue is, the stronger will be the impact.
Judging the following impacts:
produce energy from waste streams (Energy Production)
create new Raw materials or New products from waste streams, such as nutrients from compost and Technosand bricks from the sludge
cut CO₂ emissions by reducing or improving transport, or by growing biomass
create new Jobs
create New social space, for instance by using the existing urban fabric to bring together people around urban farming or remanufacturing boulevards



Each one of the impacts of these strategies is perhaps not substantial when considered as isolated. However, when considered together and simultaneously, these strategies could yield important economic and quantitative benefits.

The first estimations on the combined effect are an educated guess to be considered as a starting point for initiating concrete projects, especially in the case of Abattoir and the reuse of Technosand in Buda.



Beyond mere economic gains there are more lessons to be learned from this exploration into flows and their circular opportunities.

The present study was very ambitious as it aimed at working at different scales (that cover two different regions) and flows simultaneously in order to propose circular economy strategies moving from the current linear state. Therefore, a number of

challenges arise especially related to data collection and availability (very important number of administrations, stakeholders, inexistent data). In addition, a great number of initiatives already exist both in Brussels and Flanders concerning circular economy. However, as they are financed by a myriad of administrations it is very difficult to keep track of all of them and to centralize those who can dilute or duplicate the effort done.

60.000.000 KM
DISTANCE TRAVELED

using biofuel produced from
algae grown using waste water
nutrients



608 T OF CO2
EMISSIONS LESS

by switching to
reverse-logistics strategy

Most of the metabolic flows are trans-boundary and can come from either a national or international hinterland. Due to this fact, the origin and the final destination of each flow is often outside of a regional boundary. Therefore, when talking about circular economy it is important to think at different spatial scales as circularity might not be achieved at a local scale but on a larger one. For this reason, all the actors/

administrations at different spatial scales need to be simultaneously mobilized in order to obtain the recircularization of a flow. As of consequence, not only governments should agree on implementing coherent and similar policies but also companies should collaborate with other ones that are outside of their territory in order to achieve a circular economy.

30 TONS POTATES

cultivated with compost produced
from organic waste of Mabru
Market

400.000 TOILET FLUSHES SAVED

from catching rainwater
from the ringroad
across Buda



MIN. 10M EUROS GAINED

by recycling e-waste from
households of Brussels



URBAN METABOLISM

DOESN'T EXIST

conversation with Dirk Sijmons

We talked with Dirk Sijmons before his masterclass in the Designing with Flows series in Brussels. Sijmons is a Dutch Landscape Architect and one of the three founding partners of H+N+S in 1990. He developed the concept of Urban Metabolism for the International Architectural Biennale of Rotterdam that he curated in 2014, titled Urban by Nature.

Cities are very successful inventions of mankind, but on the other hand they are also a threat to our way of inhabiting the environment. I think cities are not automatically the solution; they are rather places where we have to look for solutions. Environmental problems have very often urban roots but we tend to look only at the built environment instead of considering the whole artifact, the real footprint. There are American studies that are completely redrawing the maps of the world. If we think about the maps hanging in our classrooms, are the vegetation zones still there? You have to look at the occupation, not only in cities but also in

rural areas. Urbanists need to look at ecosystems (or nature based solutions) to get a grasp on what it takes to solve world's environmental problems and make liveable cities at the same time.

In the International Architecture Biennale in Rotterdam that I curated in 2014, Urban by Nature, we made an explicit invitation to look at the city as a whole. When we are talking about urban landscapes, they have a scale that transcends administrative borders. The North-West European metropolitan area is one whole territory; Anderlecht vs. Ajax is in a way a regional derby. But how can we link this to the modern ideas of governance? The only way I see is to conceptualize the relationships between these loose areas. There might be configurations of all these elements that can be more attractive than others. Rethink the relationship between these different parts is a form of mix between urbanism and landscape architecture.

As a planner, one of the angles you can take is to study the infrastructure of the different flows. This influences the spatial order, indirectly and very slowly. That's why in the old days American planners said: don't bother too much about where the line is, it will be in the right place, after some time. Somehow the spatial order adjusts to the line and

this is a very strong weapon we can use. Working with infrastructures could be a fantastic way to address issues in cities where urban growth is really viral, where masterplanning is unthinkable. When talking about the nexus, food, energy and water are strongly linked together. We can measure the energy contained in our food, we can consider what we eat as oil and only the 2% of sweetwater is for human consumption while the rest is used for production. You can define each of the three in terms of the other. This being true at a global scale, it is very hard to pinpoint it in an instrumental way, when only talking about one city or one region, it tends to remain an abstraction. Some scales seem to be the right ones to address the problem and others are not. In designing with flows you have to keep this in mind. Urban metabolism is a strange metaphor for our industrial society given that my t-shirt comes from Indonesia and my trousers are sawn in Italy: it is a global game. Talking about UM is, in a way, reducing the problem. You have to be aware that these problems can scale, that you are working with a metaphor, with a codex of something that in reality doesn't exist.

The metaphor explains a systemic way of looking at things but does not help to prioritize, these priorities will be different each time. As a discipline, we

are reinventing a very old metaphor; if we would be physicians we would be still in the trial phase. But we are already testing it on real cities and a lot has to be discovered and developed. It is good to work with real stakeholders and to generate real results. You could also do it on a computer and make simulations in-silico before you use them in-vitro. It is important for the commissioner to know that some things are still being tested.

In the late '80s it became apparent that Greenhouse Gases were a problem for the climate and the environment. In a strange way this observation transformed climate as a big manmade artifact, a hybrid between natural and anthropogenic processes. From the '90s on, with the Kyoto Protocol, the problem was framed (in a wrong way) as air pollution. In order to solve it, an inspiration was found in the CFKs: by addressing one particular industry producing this gases influencing the Ozone layer and by banning its activity. This strategy worked in that case but in our century, after the Copenhagen Conference, there was a reframing of the problem as an energy issue. You can't even imagine how wrong we were 20 years ago in framing the issue and thinking about real solutions. That being said, if you look at energy, we can be very proud of humankind's achievements. There was an enormous tailwind because of the use

of fossil fuels. We have been burning up a stock of fossil biomass accumulated over almost 400 million years, in only 400 years. If we look at the current energy consumption, we use half a zetajoule of energy per year but there is almost 10.000 as much of solar energy available. So we are probably just not smart enough to harvest that energy, but if we'll ever be able to, we should make sure not to cause another ecological disaster.

In a quantitative way, we could say that there is enough energy; but somehow what we use is four times as much as the total stock of tidal energy that the Moon and the Earth produce together. And we only use half of the geothermal energy

available. So the amount of energy we use is humongous. The actual challenge will be to make the transition of all the energy we use into sustainable renewable energy sources. With the Paris Agreement, we promised to reduce by 2050 the CO₂ emissions by 80-90% in order to maintain the world's temperature below 2°C. If we keep those promises, it will influence our societies profoundly. It is a very wise policy not only to aim at the transition to renewable energy but also to raise ambitions on energy saving. This doesn't mean adding layers of polyurethane to isolate the building but also reducing the energy demand. For every petajoule we produce only 1/5th of it is translated into real labor. Reducing the demand is



by far the most effective way to reduce emissions in the atmosphere. There is an interesting experiment at ETH in Zürich: the 2000 Watt society (where 2000 W is the actual energetic budget available for every earthling). This project is piloted by a number of cities including Basel. We need to adjust to a future in which not everything can continue growing. Without using any negative term such as 'shrinkage', we have to find 'a prosperous way down', as H.T. Odum would say.

Looking back from the late '70s until now, we live in the ideological consensus that it is possible to cut the link between economic growth and the growth of the ecological footprint but that consensus is not borne out by the facts. In the new era we have to look for new ways to work together because the old way will not be working for much longer. In the Eo Wijers competition we've started elaborating on this concept. We tried out a radical idea of putting a real price on CO2 emissions and change the taxation system so that a VAT is transformed in a carbon added tax. If you would actually do it, you would spurn real innovations at every level of society. Technology is not automatically moving in the right direction. For instance, when the LED lights were introduced everybody was relieved by the idea of reducing the energy consumption. But what happened is that, as every other time, LED lights were

discovered for very different uses, such as façade lighting, electric advertising, etc... It is a rebound effect but in the end the amount of energy we use was not reduced but raised. You see that happening again and again in the history of mankind.

Another example is the Volkswagen Beetle, as it evolved from 1947 until today. Both versions (the original and the new one) use 1 liter of gas for 14.7 kilometer. This doesn't mean that in all these years there hasn't been any progress though. Moreover, the new Beetle weighs almost three times as the old one! The truth is that the progress has been made in favor of comfort and safety. I think that in order to make technology work in the right direction you have to put green gloves on the invisible hands of the markets so that producers make the right choices. By changing the taxation system for instance, we can make also redraw the match of the world determining what kind of industry will be placed where. As designers, we need to design the second and third order effects of this transition. As a discipline, we are now approaching new fields, as spatial solutions are not enough anymore to shape cities.



FINDINGS

What started out as broad question by OVAM, the team of FABRIC, ULB and Circle Economy reformulated into a focused explorative research into opportunities for circular economy in the Brussels Region concerning 4 flows. The outcome is a 'urban impression' that portrays the flows of Water, Organic Waste, Construction & Demolition Waste and Logistics as they are present on three sites along the canal.

This impression aims to face the social, environmental and economic challenges of the region through the understanding of the flows at different scale levels. After analyzing the flows at the 3 different locations the team developed strategies to transform the current linear uses of the flows into more circular processes. The proposed strategies are then translated back into spatial impact on the 3 selected sites: Birmingham, Masui and Buda, creating concrete opportunities for local actors and stakeholders and providing spatial qualities as a result of circular gains.

To disseminate the outcome of the research in a wider public a number of follow-up actions have been undertaken. First a number of experts were consulted

to test their reactions to the proposed strategies. Ranging from international experts like Dirk Sijmons, to local entrepreneurs like the people from Stevens & Co. They are all interviewed to capture their reactions and advices. These interviews are inserted in this report. Secondly the study and its findings were placed within the context of three important current policy document namely the Gewestelijk Programma voor Circulaire Economie, the T.OP Noordrand and the Plan Canal (Book 1 & 2). The complete analysis can be found in the appendix to this report that explains the similarities between the scope and territory considered, but also discuss what learnings can be transposed from one realm to another and what are the opportunities to apply circular economy in the Brussels Metropolitan Region.

Thirdly the results are shown at the Productive Metropolis exhibition at BOZAR in the fall of 2016. Since OVAM and the research team believe that the urgency of this new approach towards a more sustainable urban development doesn't only concern the Belgian capital but also the surrounding municipalities of Flanders and the rest of the country a masterclass series was organized. The aim of the 'Designing with Flows' masterclasses was to get an audience of professionals familiar with theory and practice on the concepts of urban metabolism. Moreover, with the masterclasses we aimed to initiate and stimulate the development of a metabolic

agenda. An agenda which is not limited to a particular urban area but needs to be shared at different levels.

The combined effect of the research, interviews, comparison with policy documents, the exhibition and master class is multiple. Firstly, a significant translation step has been made. More or less known data about, for example, the total amount of organic waste in household waste -144 Kton - or the amount of building materials that annually enters Brussels - 2.4 Mton- have been collected and translated into more understandable numbers. To understand the magnitude of the challenges it is simply better know that 144 Kton of organic waste waste equals more than 7,000 trucks full. Or that 135 M m3 of rainwater is equal to 54,000 Olympic swimming pools full of rain. The real understanding of the urgency of the urban challenges came when these quantities are also spatially translated. Per stream therefore maps of the current size, direction and the infrastructure per flow were made. These maps show directly the limitations of the current approach to urban development based upon a object approach instead of a good understanding of the underlying systems. This brings us to the first important finding of our study:



**URBAN METABOLISM
SHOWS WHY IT DOESN'T
MAKE SENSE TO KEEP**

**LOOKING AT PROBLEMS
IN AN ISOLATED WAY.
IT REVEALS PROFOUND
RELATIONS BETWEEN
BRUSSELS AND FLANDERS.
FOR INSTANCE,
WASTE FLOWS
TRAVERSING BRUSSELS
INDICATE THAT THE
INTERDEPENDENCE WITH
FLANDERS IS PARTICULARLY
BENEFICIAL.**



Testing the proposed strategies both with experts and stakeholders in most cases resulted in interesting moments of acclaim and recognition. First the challenges that are identified by the research team usually were fully recognized. But also the direction in which solutions are sought could count on support. Or as Tom van Lier (MOBI) - expert on logistics in the Brussel area – stated it in his reaction to develop a new logistics structure for Brussels: “I find the idea of an e-loop quite interesting. It would be great to have urban distribution centers nearby the city center, well connected to the water and road infrastructure. [...] Spatial design is crucial to make cities more sustainable. There is still a lot of unused capacity in the transportation system such as using the public transport during off-peak hours or improving the use of waterways and rails [...] It's a constant attempt to optimize the available space.”

This brings us to our second finding:

“ **MOVING FROM AN OBJECT-CENTRED APPROACH TO A SYSTEMIC APPROACH, ALLOWS SPATIAL DESIGNERS TO ENGAGE FLOWS, ACTORS AND PLACES INTO THEIR PROPOSALS FOR URBAN TRANSFORMATION.** ”

The public elements in the follow up phase of the research have shown that the ideas of Urban Metabolism not an abstract theoretical approach that only scientists believe. Especially during the masterclass in which professionals municipal planning authorities, environmental experts and interested people participated, showed that approaching urban development from a flow perspective offers a value addition to the existing instruments. Until now urban development to often is only informed by spatial and political agenda's. The concept of Urban Metabolism on the other hand provides an opportunity to really look at the use and performance of a spatial constellation. Hence our third observation:

“ **URBAN METABOLISM IS NOT SUBSTITUTING URBAN DEVELOPMENT. IT IS LOOKING FOR**

OPPORTUNITIES FOR URBAN IMPROVEMENT.



To stay within the competitive framework of time and budget the research team for this study has used a new method. The collective experience of the team shows that the approach of urban metabolism from an overview of the system, is methodologically understandable, but practically very intensive and time consuming. Also the team knows that (sub) systems depending on the scale at which we look often change of behavior. Drafting an overall image which on the scale of the region, on the scale of the city and on the scale of the street is accurate is very demanding. Instead of working on composing a total system for a large number of different flows, the team with OVAM decided to test an inversed way of working. In this research the team thus looked at a limited number of streams from very concrete locations investigated per flow its potential for the development of circular economy. The researched flows and locations are strategically chosen so that they bundle related flows, chains, sectors and themes. Thus, we look for example at the flow of waste water, but that is not entirely separable from the flow of rainwater, from ground and from water for transport. Judging by the enthusiasm with which the proposed strategies have been received and the diversity of the identified

opportunities this hands on approach of urban development through urban metabolism is successful and proves that there is not always a need to first have a good understanding of the overall system. Especially in the explorative phase of matching challenges and opportunities it can be helpful to start small and gradually build up the understanding of the system. Our final finding therefore is:



**URBAN IMPROVEMENT
CAN START RIGHT NOW.
JUST DO IT ...
BOTTOM UP AND
TOP DOWN, BY MEANS
OF PILOT PROJECTS
THAT COULD TEST NEW
METABOLIC ASSEMBLAGES
ON SPECIFIC LOCATIONS,
LINKED TO ONGOING PROJECTS
WITH WHICH THEY COULD
DEVELOP SYNERGIES.**



06

APPENDIX







EXISTING POLICY DOCUMENTS

Within the framework of the commission « Urban metabolism as a carrier for a sustainable transition to a circular economy in the Flemish-Brussels metropolitan region », it was asked to place the study we carried out within the actual policy context.

Three main reports were to be analyzed, namely the Gewestelijk Programma voor Circulaire Economie, the T.OP Noordrand and the Plan Canal (Book 1 & 2). The analysis below will not identify only what the similarities between the scope and territory considered in our study and the three policy reports are, but also discuss what learnings can be transposed from one realm to another and what are the opportunities to apply circular economy in the Brussels Metropolitan Region. In fact, our study not only considers the metropolitan region of Brussels as a dynamic system where flows enter and exit to satisfy its consumption and production needs but also as a conjunction of a number of challenges ranging from socio-economic, to production and consumption patterns and behaviors, from demographic and health challenges to urban, territorial

and strategic planning. In fact, any circular economy and urban metabolism study and report should consider and include all these challenges simultaneously if the understanding and the actions proposed are to be comprehensive.

Gewestelijk Programma voor Circulaire Economie (GPCE) – Programme Régional en Economie Circulaire (PREC)

The Gewestelijk Programma voor Circulaire Economie (GPCE) 2016-2020 was elaborated in March 2016 by the Ministry of Economy, Employment and Professional Training, Ministry of Housing, Quality of Life, Environment and Energy, and the Ministry of Public cleanliness, Waste collection and treatment and Scientific research of Brussels Regional Government.

This policy report wishes to transform the linear economy of the Brussels Capital Region (BCR) that is in conflict with its socio-economic, demographic and environmental challenges. In fact, the transition towards a more circular economy aims to meet the needs of BCR's inhabitants and companies while increasing their quality of life. More practically the GPCE proposes a set of actions that will

- 1) dematerialize BCR's economy and mitigate its environmental impact,
- 2) anchor economic activities that will enhance short economic cycles and implement local jobs,
- 3) increase the local quality of life.

This Programme consists of 111 actions divided in 4 strategic parts (transversal, sectoral, territorial and governance). The most relevant parts for our study are mostly the sectoral and territorial ones (although some specific actions of the transversal part have an intimate link with the results of this study). At this stage it is important to mention that in annex of the GPCE, the Plan of Resources and Waste, Plan of Air-Climate-Energy, the Good-Food Strategy, the Strategic Plan for products transport and the Plan of Innovation also have ties with this study of Urban Metabolism and Circular Economy of the Brussels-Flemish metropolitan area.

Transversal aspect

Within this section there are two main aspects for which our study is of great relevance. These elements are employment and education/training. One of the concrete actions of the employment facet is to identify prospective job sectors that will develop in the future and their necessary skills (EMPLOI 1). Our research can provide valuable insights for this identification as a number of circular economy strategies were proposed for the 4 studied flows namely water, construction and demolition waste, organic waste and logistics. These strategies could practically be translated in very specific jobs that would in turn reflect the necessary know-how required. The last point is also relevant for the education/training aspect (FOR 1). In addition, the study we developed could

provide valuable insights for practitioners either for inspiration or matchmaking purposes (FOR 2).

Sectoral aspect

The strategic part focuses on 5 specific economic sectors/activities, namely Construction, Resources and Wastes, Logistics, Retail and Food. All of these activities are highly interconnected with our study although retail activities were not considered in the research we developed *per se*.

The construction sector is a key component of Brussels economy. It is responsible for 20% of material imports, generates approximately 25% of BCR's waste and is composed of around 12 000 companies. In addition, the construction sector presents an important potential of job creation notably for a labor force with a lower qualifications, an important potential for innovation (BIM, 3D-printing, design for disassembly, lease of materials), and significant flows and stocks that can develop short supply chains and local employment. Our report already proposes practical solutions with local actors that could use/reuse C&D waste such as reusing the Technosand which is a byproduct of Aquiris, for a construction material or locally reusing metal flows that are currently treated by Stevens and Co. Bruxelles Environnement will develop a similar study in order to transpose circular economy principles to the construction section (CD 1). A number of synergies

could be foreseen. In addition, a monitoring tool for the implementation of circular economy in the construction sector will be developed (CD 2). Results from our research could initiate this process and help for its development. Another specific action (CD 4) for which our study could be a valuable asset is to present the different actors of the construction sector the opportunities of circular economy (job, economic, subsidies, etc.). For instance, Bruxelles Environnement will launch a call for projects for construction companies in order to develop innovative solutions (CD 11).

The Resources and Wastes related economic activities are another key sector for implementing circular economy in BCR. In fact, reuse and repairing are in the heart of applying circular economy principles at an urban scale, to create jobs needing a low qualified workforce (mostly non delocalized) and enhancing short cycles. To achieve this, resource and waste observatory will be created (RD 1) and identify the potential and opportunities of reuse and recycling. Our urban metabolism and circular economy study could be helpful to establish a methodology for data collection, analysis, interpretation and for estimating the potential of circular economy strategies. This methodology could be used as a public decision-making tool.

For the Resources and Wastes sector, Bruxelles Environnement will also reinforce a circular management of resources and wastes at a neighborhood and municipality

scale (RD 5). In the framework of the Agenda, 21 calls for projects and different models of integrated management will be defined. The territorial approach developed in our research fits very well this objective as it is not only focused on metropolitan and regional scale, but also at the local scale.

Another action from this economic sector that is very close to the report elaborated by .Fabric, ULB and Circle Economy, is the establishment of a feasibility study for the recuperation of precious metals in wastewater (RD 8). Results from this feasibility could on the other hand also help to better quantify and understand the urban metabolism of BCR and its material stock. In addition, action RD 10 (waste and resource cadaster made by Agence Bruxelles-Propreté) will be a centerpiece in the establishment of BCR's metabolism and identify CE strategies and opportunities. Several elements from our study represent a first step towards this cadaster (both at the regional and local scales) and the latter could also be a significant asset for future UM studies. Actions RD 13, 15, 16, 17 and 23 target the reuse/recycling/deconstruction of construction and demolition materials through different perspectives. The figures obtained by the current study could help to estimate the potential of each of these actions respectively.

Action RD 24 focuses in turn on the analysis of different models of green waste valorization. Some specific examples

were already provided in the developed report and could therefore be of practical relevance.

The Logistics sector constitutes the infrastructure over which most of materials are flowing in and out of Brussels. In order to reduce the environmental impact from this sector it is important to rethink the current modal split (favorise the water and rail transportation (LOG 4)). In addition, the logistics sectors could facilitate the creation of new logistics centers that gather most of entering and exiting flows (LOG 5). Ideally, reverse logistics principles should be applied at the scale of Brussels and particularly in the waste sector (LOG 1 and 2). Most of these actions are already reflected in the developed study.

Finally, for the economic activities related to Food, no specific actions are mentioned in the Programme, as they are already elaborated in the framework of the Good Food Strategy. Nevertheless, some of them include a local production of food to ensure a local supply but also to reduce food waste. Examples for both these actions were once again already defined in the research developed by .Fabric, ULB and Circle Economy.

Territorial aspect

This aspect of the GPCE focuses on the territorial challenges that are necessary to face in order to implement circular economy strategies in the Brussels-Flemish metropolitan Region. These territorial challenges were already confronted or

dealt with in the developed study as it considered Brussels at different scales that have different priorities and face different challenges. At a regional scale, Brussels will face an important demographic pressure on a territory that is spatially and institutionally locked. Nevertheless other spatial scales might be relevant to propose CE actions, such as the scale of the project, masterplan, neighborhoods, the Canal Zone, the metropolitan area, etc. To achieve a full efficiency and adoption by its inhabitants and workers, the CE solutions and actions proposed will need to always keep the territorial realities in mind. In addition, a circular economy for the BCR will only be possible by taking into account its economic, job and residential hinterland (metropolitan area). The research we developed touches upon some of these scales and fully embodies the complexity of a multi-scale and territorial analysis and could once again help to implement some of the proposed actions of the GPCE. Some of these actions include circular economy principles at a neighborhood scale (namely the sustainable neighborhood contracts (TER 1)) but also at larger strategic scales and the Canal Zone (TER 2). Solutions developed in our study at the local scale can provide valuable insights. Finally, a last action mentioned in this territorial aspect of the GPCE for which this study could provide valuable insights is TER 3 (include circular economy indicators in the Sustainable Neighborhoods Guide of Bruxelles

Environnement).

Governance aspect

While most of the governance aspect is not directly related with our study, the Reporting and Indicators section of the GPCE that will be developed by Bruxelles Environnement is however considerably connected. In fact, in order to head further than a punctual study of Urban Metabolism and Circular Economy for Brussels (at any scale) it is essential to establish a dashboard that traces the evolution of different metabolic flows, of their recircularization, etc. (INDIC 1 and 2). Ideally, these indicators should be comparable with other territories and could therefore be based on the ISO 37120 (Sustainable development of communities – Indicators for city services and quality of life).

Conclusion

As a preliminary conclusion, it is important to mention that the Gewestelijk Programma voor Circulaire Economie (GPCE) still struggles to take into account the spatial dimension. While several circular economy strategies are proposed, the link between those and a better quality of life for Brussels' inhabitants is still unclear. In fact, the GPCE is more of an economic policy agenda rather than a spatial development plan. This results to a series of short- and long-term strategies that do not necessarily focus on everyday quality of life and concrete spatial solution actions. Our

study attempts to bridge these two realms by not only providing regional and local urban metabolism balances and circular economy strategies but also providing their spatial implementation. This spatial implementation not only considers new economic activities but also new forms of working and living across the Canal Zone.

T.OP Noordrand

The territorial development program of the Noordrand or Northern Fringe is a document that analyses the challenges of Noordrand, presents the objectives that need to be met, the vision that is desired to be reached and the strategies to achieve it. Four specific strategies (which are « umbrellas » for a series of related actions) and four areas were detailed in this policy document. It was developed by Brussels Regional Urban Development administration, OVAM, the Flemish department of Spatial planning, and the Flemish Brabant administration.

While the links between this document and our study are fewer than with the GPCE, there are still some important connections to be made not only through some of the strategies but also for the locations (Masui and Buda sites that were analyzed in our study are actually part of the Northern Fringe). Finally, some aspects of the T.OP policy document could be valuable insights for the developed report and vice-versa. For instance, both documents bring

together a great number of stakeholders from different professions, disciplines, institutions, administrations, etc. to build a common short- and medium-term vision. In addition, very similarly with urban metabolism and circular economy, this territorial development report takes into account the dynamic aspect of a territory where the challenges and the list of actions that address the former evolve and adjust. The first strategy focuses on a multi-layered mobility network where each layer represents not only different spatial boundaries (from international to neighborhood) but also different scopes. The thought behind this strategy is that the better a place is connected to this network the more opportunities for its development it will create. This idea of connectedness to a network is also essential for circular economy and was also present in our study. In fact, the more an economic activity is connected to a local and global network of material and energy flows, the easier it would be to propose and implement circular economy strategies. In addition, the multi-layered approach mentioned in the T.OP document is also important and relevant for circular economy and urban metabolism (and was somehow exemplified in our report). In fact, not only there are different scales to consider when establishing a metabolic balance of an urban area, but also to develop circular economy strategies. For instance, while cycling, the organic waste flow could be done locally, reusing precious metals flow

is usually done at a national or international scale. Therefore, the transportation networks discussed in the T.OP document are also the backbone in the establishment of circular economy in urban areas and it should be *varied and change oriented*. Within this strategy and alongside the multi-layered mobility network it is also proposed that the spatial development of this area should include spaces that aim for both living and working. Indeed, it is put forward that the space needed to create economic activities should not be pushed further away by the increasing demand for housing (due to the demographic pressure) and the profitability of housing developments compared to productive activities (needing considerable space for manufacturing, stocking, etc.). New type of urban industries should be invented and implemented to fit the future profile of the Northern fringe population. The aforementioned challenges were already identified in the developed study. Indeed, to cycle urban material flows locally, manufacturing activities should not only remain within Brussels boundaries but also should be reinforced. In addition, in the context of circular economy, new innovative and more creative manufacturing processes should be implemented that involve and empower local and future population. These processes should include a full spectrum of employment status ranging from entrepreneurs, to craftsmanship and low qualified labor force (Cleantech cluster in Nossegem,

logistics hub in Schaerbeek Formation, etc.). Indeed, a diverse offer of employment could ensure attractivity for a diverse population and reinforce the identity of this area.

The repair, reuse and recycling activities of this area (also analyzed in our study) could help to develop a vision and identity opportunities and therefore guide its future urban development mixing housing and economic activities.

The second strategy to develop this area is to use open space as a driver for urban development. In fact, the Northern Fringe encloses a diverse mix of areas ranging from green (agricultural, natural reserves and parks), blue (water surface, canal, etc.) and grey (unused spaces from highways, railways, embankments, etc.). While these areas could be extremely relevant for all of the flows considered in our study as well as the circular economy strategies proposed (logistics, C&D waste, organic waste and wastewater flows), in the future there will be a fierce competition for the use of these areas. Ideally, the future activities that will take place should consider a large number of circular strategies simultaneously. In addition, a connection between the circular strategies proposed in our study and the provision of ecosystem services should be considered in the future.

The last two strategies namely the urban development and life quality, and the unused space are not developed here as they do not bring distinctively new features than the two previous ones. In

addition, they are less linked with the urban metabolism and circular economy realms as metabolic flows and economic activities are not explicitly formulated or considered. As a preliminary conclusion, the T.OP Noordrand is a document that clearly sheds some light in the spatial and administrative challenges that this area is experiencing. It clearly shows how this zone spreads over 2 regions and 3 municipalities with different agendas trying to propose a new common vision. However, the strategies proposed are still rather local and do not consider the wider system of Brussels Metropolitan Area as well as its metabolic flows. Thus, while Circular Economy is proposed to be a federating vision for the Noordrand, the wider context is not included and understood enough. In fact, it is important to underline that Circular Economy could only be efficiently and effectively implemented if it takes into account the economic, resource and waste, people, etc. flows of its wider context. As per the previous conclusion, our study bridges two different scales as it provides metabolic balances and circular economy strategies in order to improve the quality of life at two different scales.

Plan Canal - Kanaalplan – Book 1 & 2

The Plan Canal - Kanaalplan (Book 01 and 02) is a policy document developed by Alexandre Chemetoff and Associates. This plan was commissioned by the Brussels Capital Region government, the

Bruxelles Développement Urbain – Brussel Stedelijke Ontwikkeling and the Agence de Développement Territorial – Agentschap voor Territoriale Ontwikkeling. It is considered as an action plan that wishes to transform Brussels Capital Region along its most important articulation: the Senne valley and the Canal. After determining the domain over which this action plan will focus its energy (around 300 hectares), this plan proposed a *new philosophy* of project/city planning. The Canal Zone holds a strong industrial and commercial heritage which will serve as the basis for the future developments and activities. Taking into account its historical and geographical context will enable Brussels to transition towards a more sustainable future while remaining faithful to its industrial past and its current population. In addition, this zone is a major connection between Brussels Capital Region and its national and international hinterland. For the above reasons, the Canal Zone can be considered as a key area for implementing circular economy in the metropolitan area of Brussels. In fact, it comprises not only the canal and the port which are key elements for logistics, stocking and manufacturing activities but also more natural aspects that could activate cycled and shortened organic flows. Finally, the three local areas examined in our study are part of the four pilot sites of the Plan Canal - Kanaalplan (Abattoirs, Vergote and Buda).

As such there is an important overlap

between the objectives of the Plan Canal - Kanaalplan and the analysis from the developed study not only theoretically (analysis of flows and economic activities at different spatial scales) but also practically (circular economy solutions and strategies for specific areas and companies). In the case of the Plan Canal urban logistics, warehousing and urban mining activities are proposed in a similar fashion that our solutions. Therefore, each of the circular strategies developed in our study could become a pilot project adopted by the Plan that would enable to tackle socioeconomic, demographic, urban planning and resource and waste management and supply simultaneously and in a resilient way. For the Birmingham case study, the industrial activities of the STIB/MIVB are to be reorganized and renewed. The land that will be freed could host the circular economy strategies developed in our report (for instance using organic or animal waste from the Abattoirs). This area also offers several depots and warehouses that could serve as construction materials depots coming from selective deconstruction/construction sites.

The Vergote bassin site (that is identified as Masui in our study) gathers economic activities that come in direct contact with the basin's water (which allows a two-way transportation). These activities include several construction materials manufacturers (Holcim cement factory, Inter-Béton, CCB cement factory), metals recycling (Stevens & Co) and logistics

activities (TIR and TACT). Similarly to the strategies/actors analyzed in our study, the Plan Canal focuses on how cement factories, logistics, and metal recycling activities could mix in an efficient way. Therefore, not only an overlap between these two visions seems to exist but the solutions developed within our studies could enable to implement and operationalize the Plan Canal until 2025. As a conclusion, the Plan Canal argues that in order to move towards a more sustainable future, Brussels should not only be the product of construction processes but also to put into practice principles of an inventive economy (which is fully embraced in our study). In addition, a mix of developments should be implemented in order to cover the mix of present and future situations that will take place in the Canal Zone. In practice, a mix of the circular economy solutions should be considered in order to offer a diverse and redundant mix of economic activities and employment opportunities. Therefore, the series of actions proposed in the Plan Canal are not only in line with our study but the latter could fuel its evolution and implementation. However, it is important to mention that in contrast with the Gewestelijk Programma voor Circulaire Economie (GPCE), the Plan Canal is almost solely focusing on urban development and not on economic activities and physical flow strategies. Once again our study manages to address simultaneously economic and urban development challenges in order

to improve the economic, environmental and quality of life aspects of Brussels inhabitants.

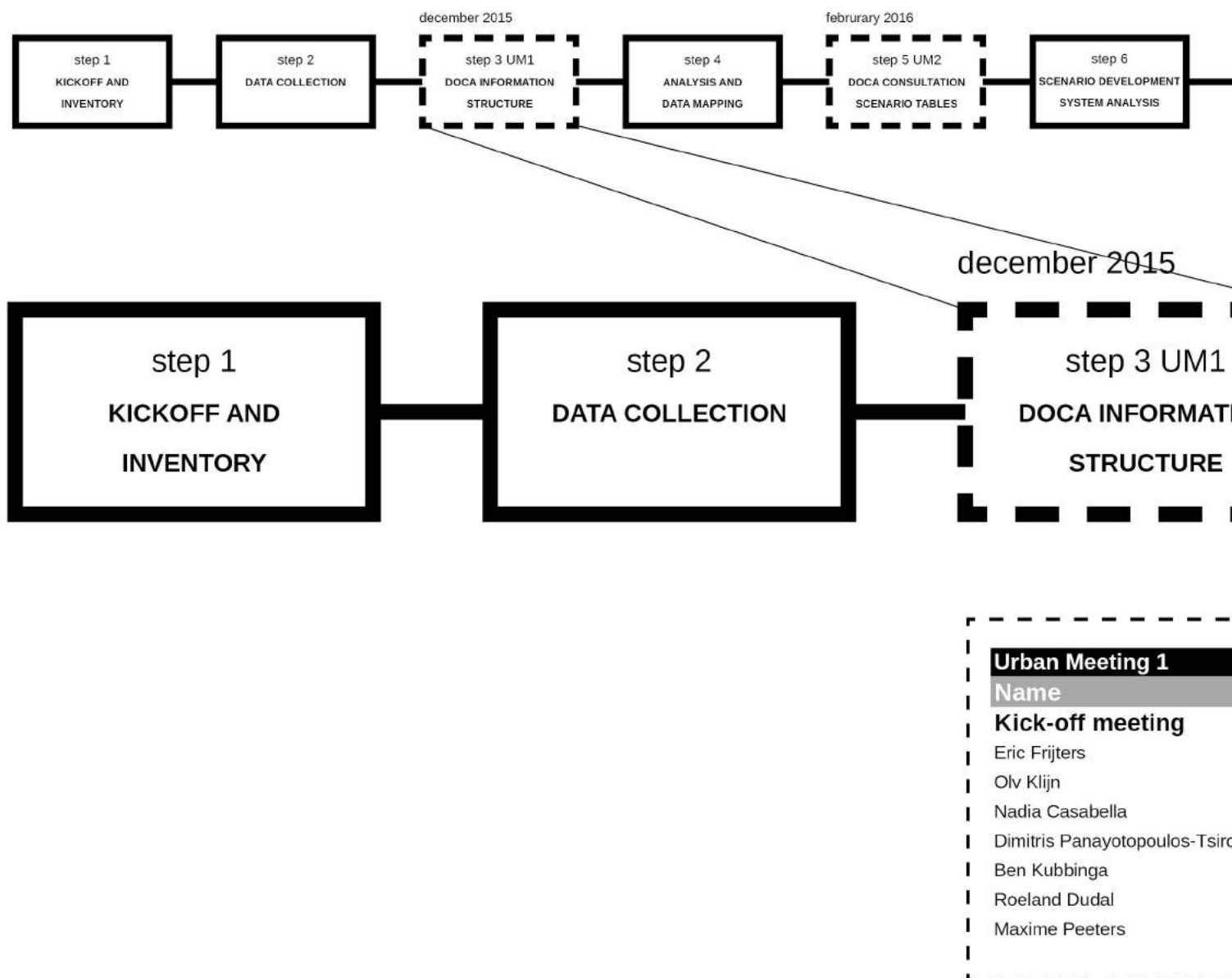
Conclusion

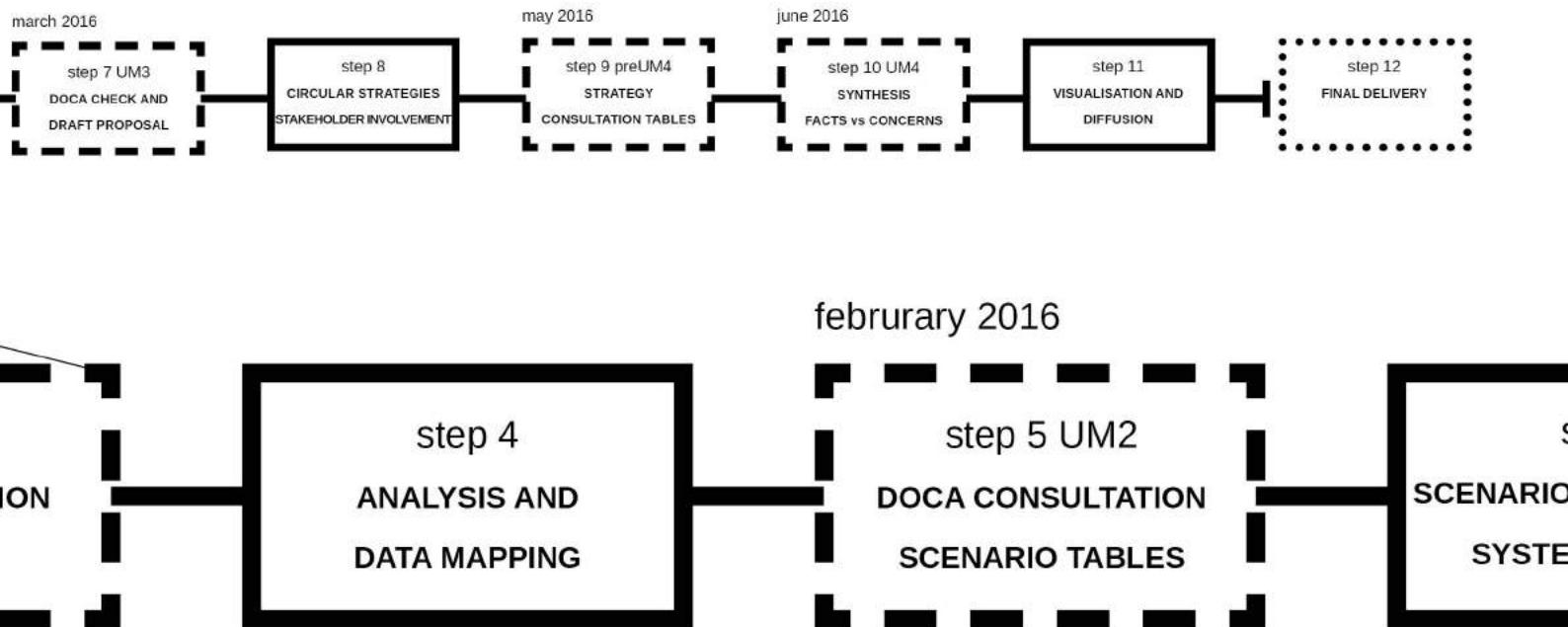
The three policy documents analyzed here above all present a vision for a specific territory of Brussels Metropolitan region and a number of actions to achieve this vision. All three documents agree on the need for a shared vision that gather efforts from a great number of local, regional and metropolitan stakeholders to transition towards a sustainable and resilient future. In addition, there is a mutual agreement that the territory holds an important heritage and resources that should be used and activated in order to achieve this vision. Furthermore, the future shared vision should combine new forms of living, working, producing and consuming where inhabitants are active players. In fact, all plans agree that the shared vision should (at least in part) be territorial and address the specific challenges of Brussels simultaneously :

- a socially and economically precarious local population (while Brussels Capital Region has one of the highest GDP in Europe),
- an important share of structural unemployment and low qualified labor force,
- a high dependence of imported natural resources

- a very high share of waste incineration
- a demographic pressure
- a very high competition of land use
- an institutional complexity and thickness

The study developed by .Fabric, ULB and Circle Economy on applying the Urban Metabolism framework in Brussels in order to identify and propose circular economy principles could partly help to present a single and unified solution for most of these challenges and overarch the three policy documents. In fact, our study wishes to create a metabolic and circular economy vision of the spatial development for Brussels Metropolitan Area. This vision could offer valuable insights for all three documents but could also further be enriched and evolve thanks to them. In fact, a metabolic vision of Brussels Metropolitan Area could ensure a coherent and comprehensive way to transition towards a more sustainable future. In conclusion, while each of these reports either focuses on urban development or on economic strategies, our research attempts to bridge by providing an analysis and results that focus both on design and economic strategies. Our study takes into account the physical basis of the economy and proposed design strategies in order to make Brussels more resilient and with a higher quality of life.

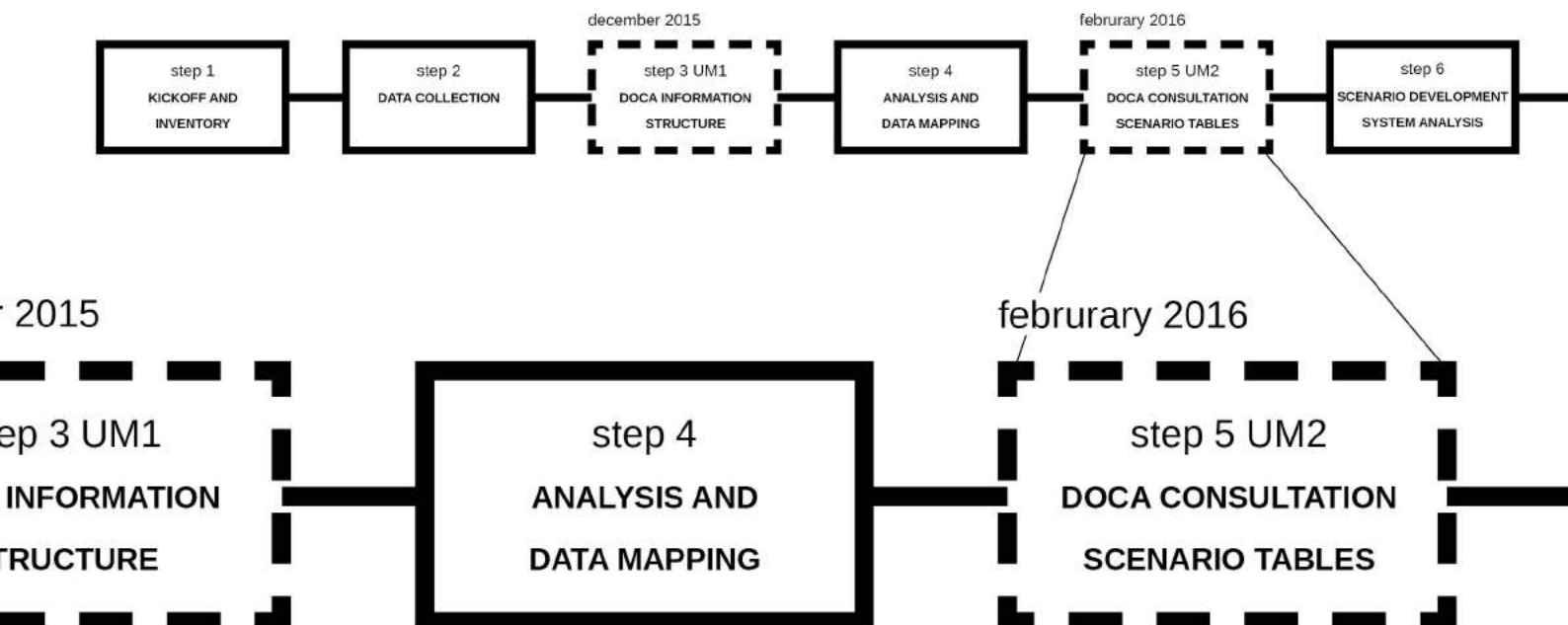




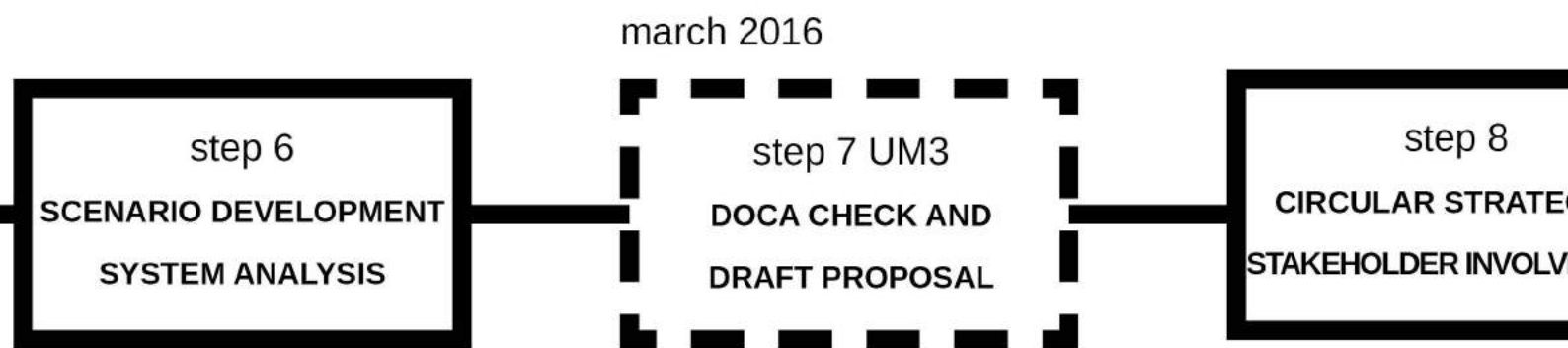
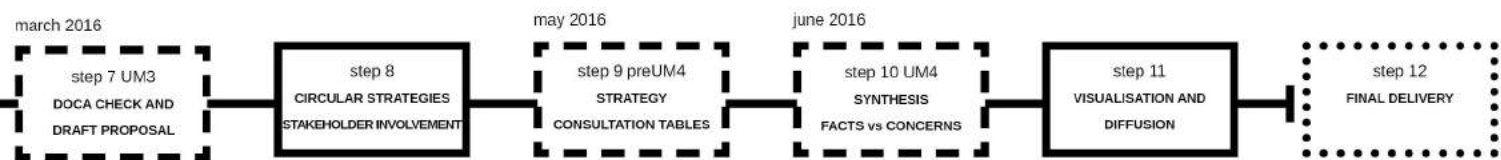
Brussels 18-12-2015
Organisation

Fabric
Fabric
ULB
ULB
CE
AWB
AWB



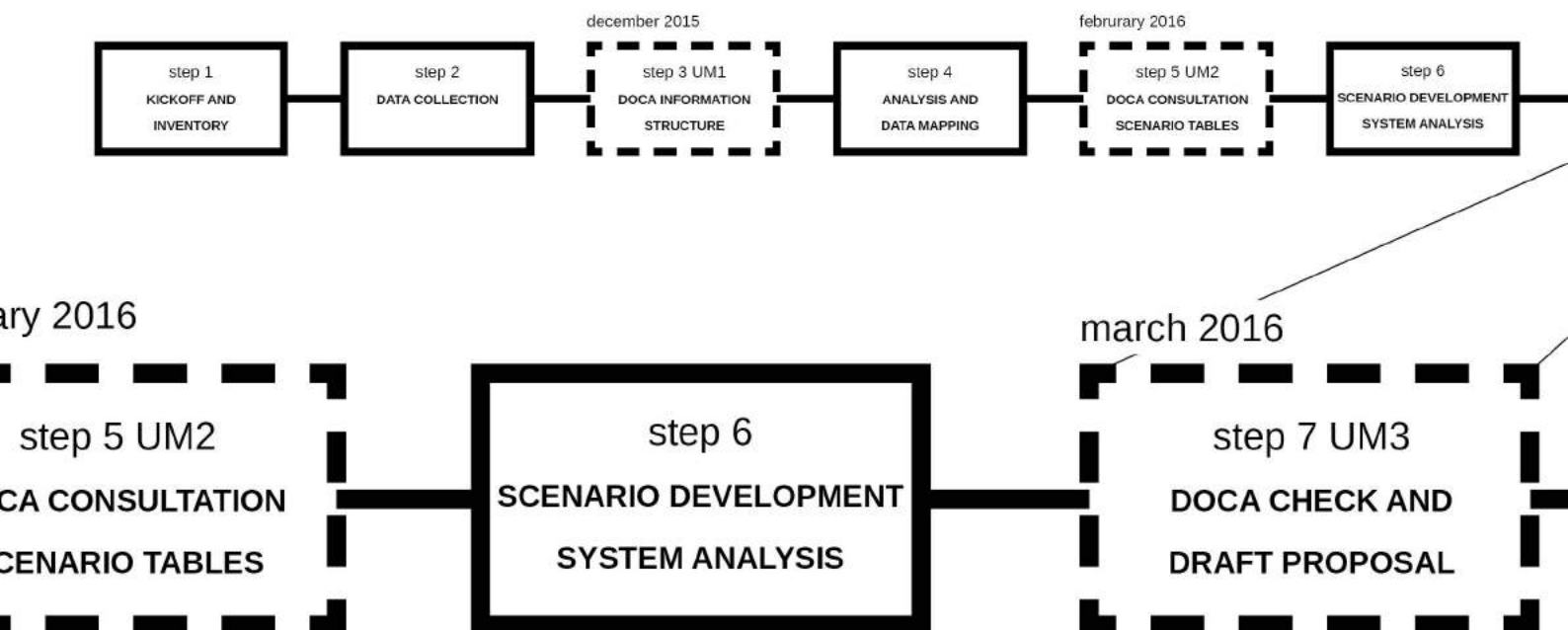


Urban Meeting 2		Brussels 4-2-2016	
Name		Organisation	
Waste experts			
Erik Grietens		BBL	
Nicolas Scherrier		IBGE / BIM - Leefmilieu Brussel	
Bart van de Wiele		INCOVO & INTERZA	
Frank Nevens		UGent	
Kristel Vandenbroek		VLACO vzw	
Pieter Herthogs		VUB	
Steyn Van Assche		Bral	
Jan Leyssens		Plan C	
Logistics experts			
Christophe de Voghel		Bruxelles Mo	
Philippe Lovens		CityDepot	
Laurent Vanden Broeck		Haven van B	
Eddy Wille		OVAM	
Steve Sel		VIL	
Philippe Lebeau		VUB	
Steyn Van Assche		Bral	
Jan Leyssens		Plan C	
Sybrand Tjallingii		urban ecolog	



	Water experts	
bilité	Carl Verhamme	Haven van Brussel
	Eddy Wille	OVAM
russe	Nele Bal	OVAM
	Peter Van den Bossche	Witteveen en Bos
	Steyn Van Assche	Bral
	Jan Leyssens	Plan C
	Sybrand Tjallingii	urban ecologist
gist		



**Urban Meeting 3****Brussels 15-3-2016****Name****Organisation****Birmingham**

Andrea Bortolotti

ULB (organic waste)

Charlotte Claessens

IBGE / BIM - Leefmilieu Brussel

Francois Taquin

CityDepot

Sarah de Boeck

VUB

Simon de Jaeger

KU Leuven

Sven De Bruycker

BSO

Christophe Boogaerts

VLACO vzw

Masui

Jean Lievens

Stad Brussel

Laurent Vanden Broeck

Haven van Brussel

Lionel Devlieger

Rotor

Patrick van den Abeele

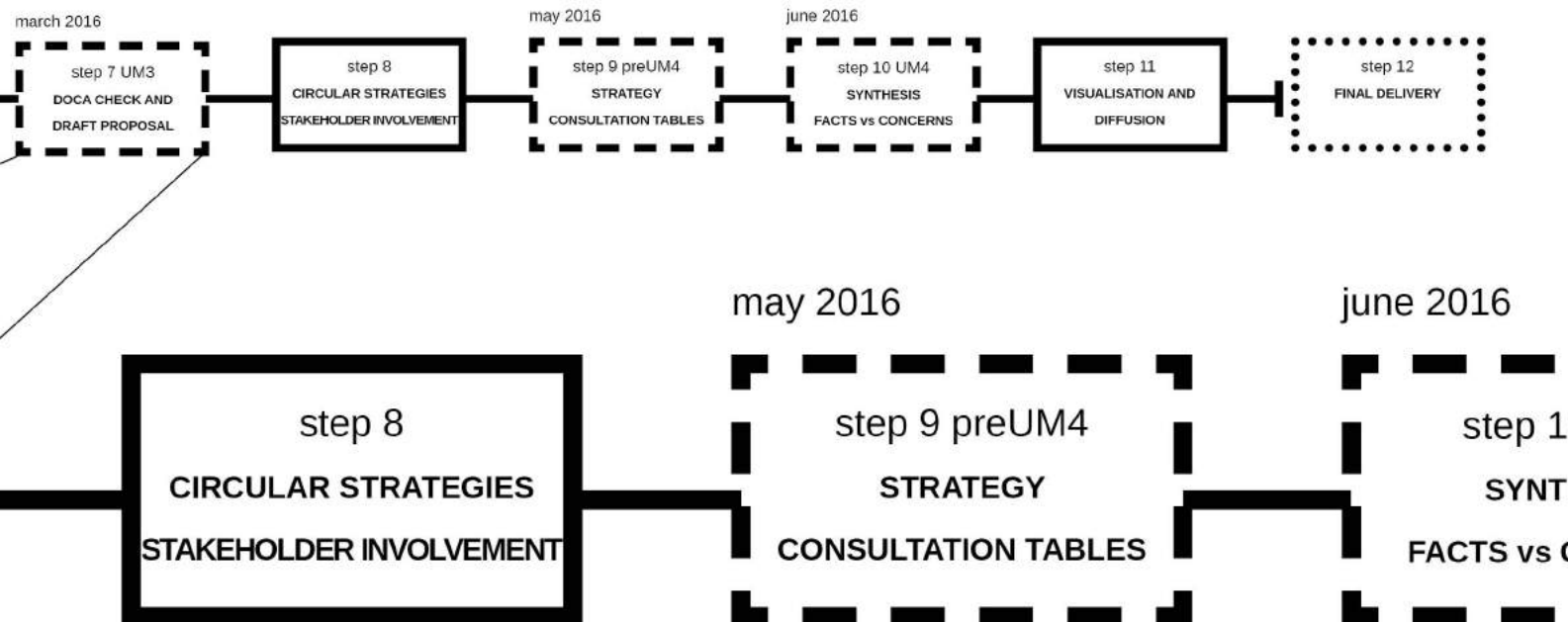
IBGE / BIM - Leefmilieu Brussel

Philippe van de Velde

OVAM

Steyn Van Assche

Bral

**Buda**

Sybrand Tjallingii
Goedele Vanacker
Jan Zaman
Mieke van den Broecke

urban ecologist
OVAM
Ruimte Vlaanderen
VUB

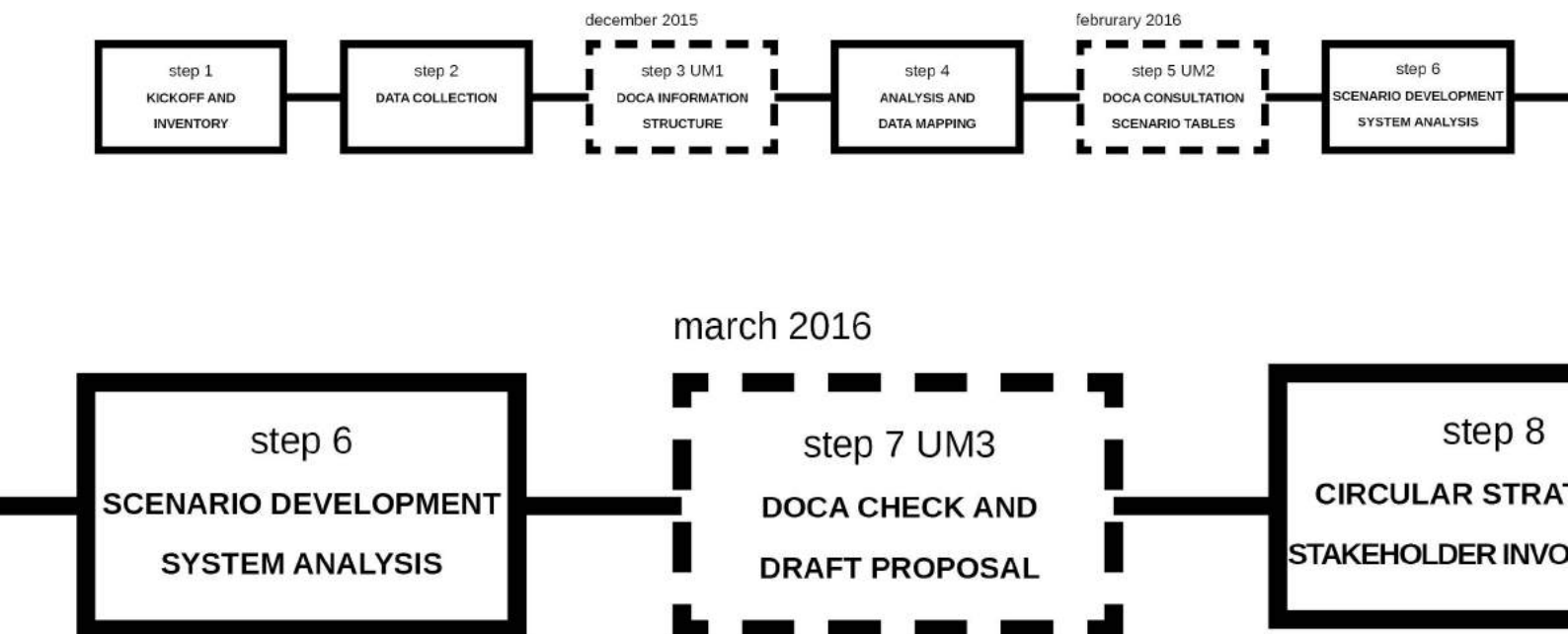
Nik Zegels

VMM

Olivier Schmit

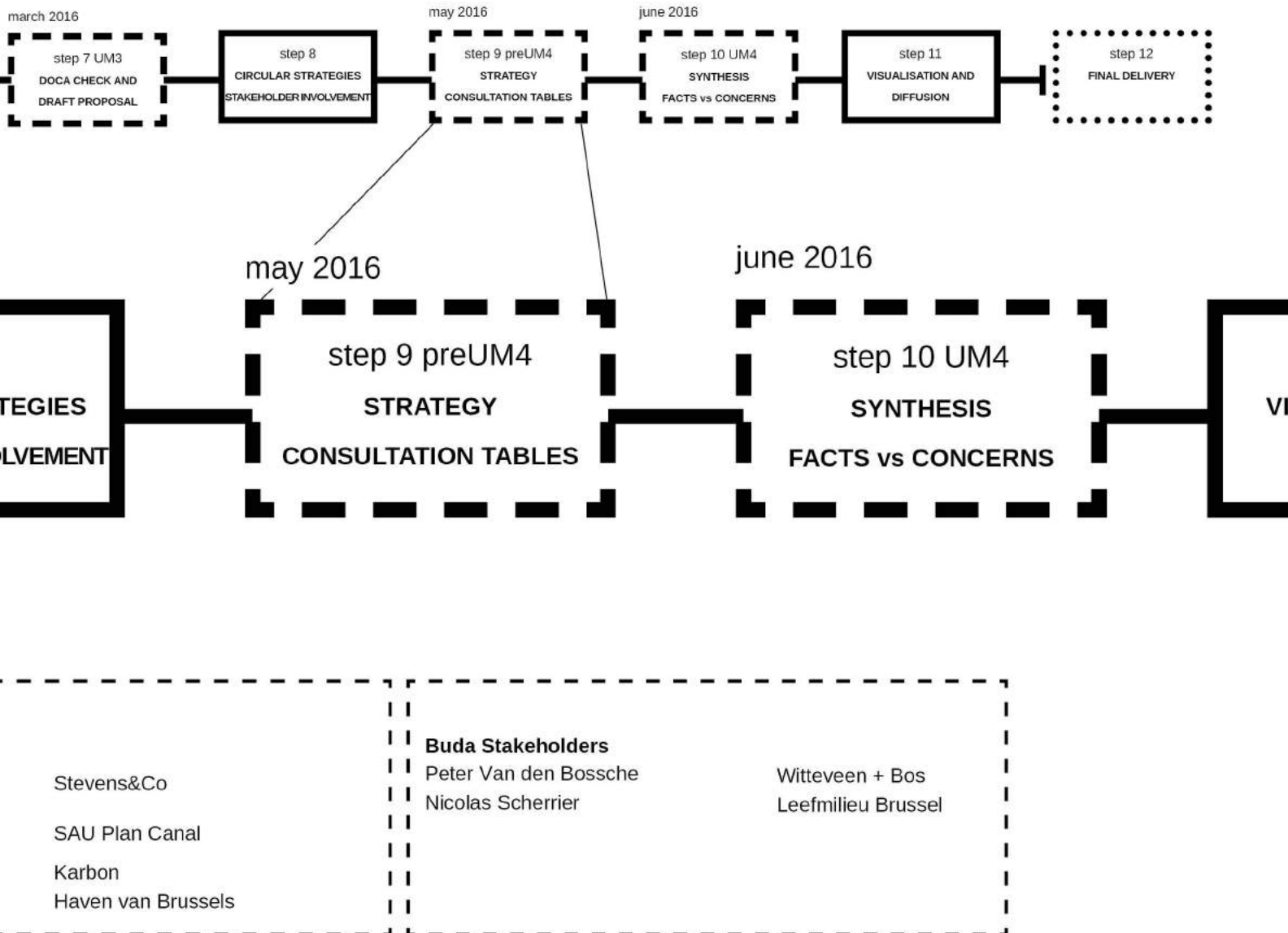
BIM

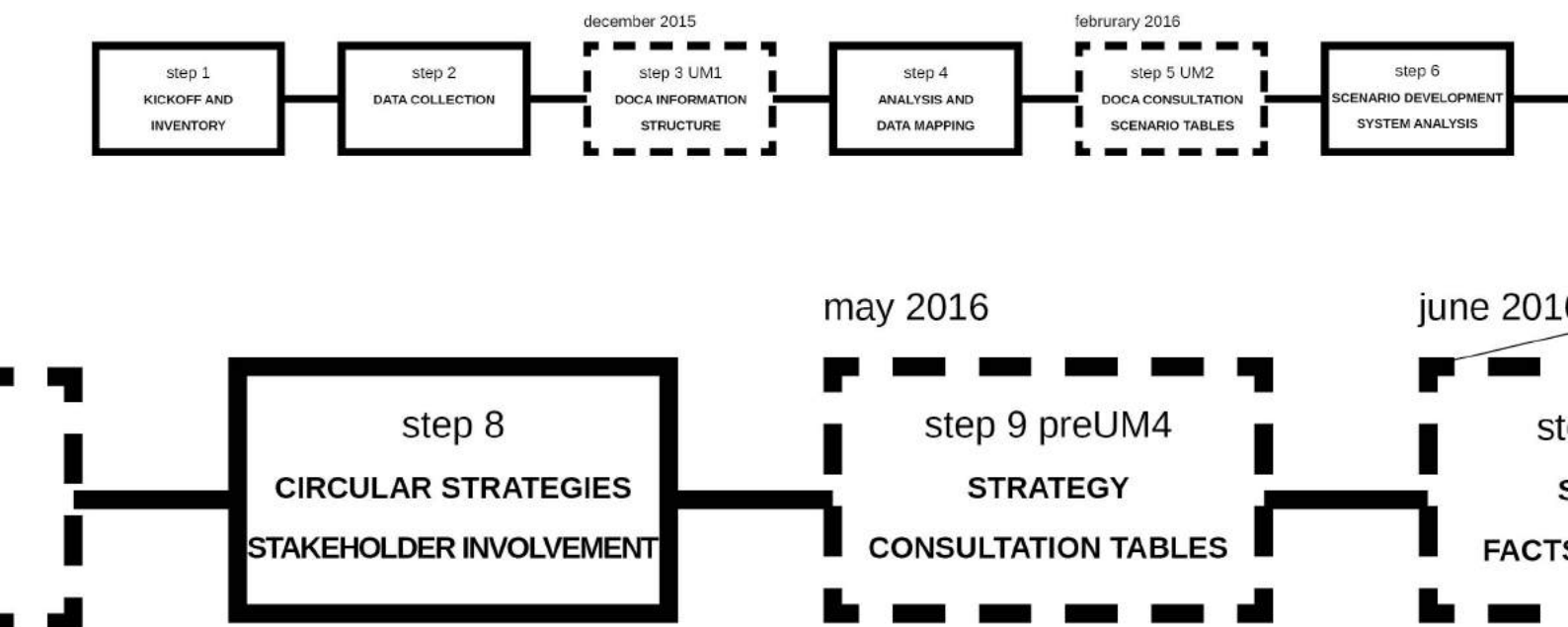


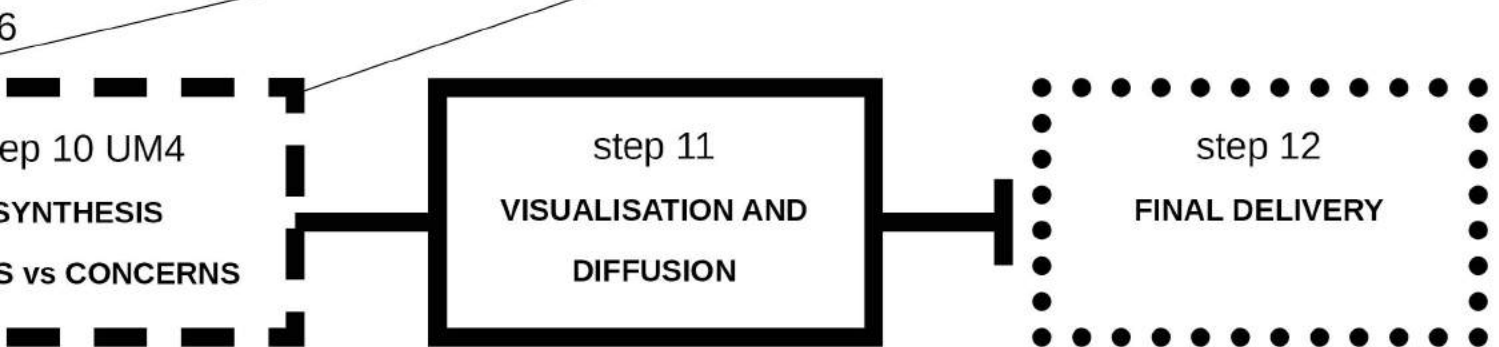
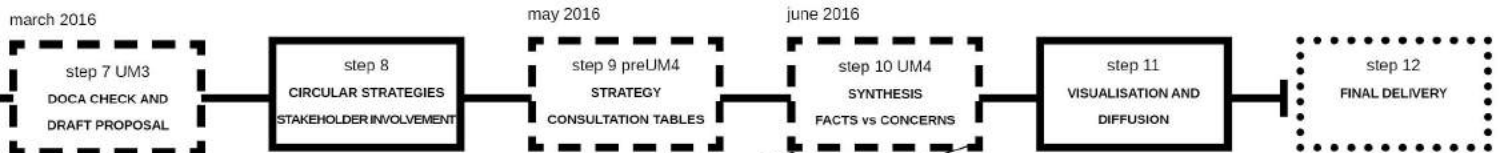


Pre-Urban Meeting 4		Brussels 24-5-2016	
Name		Organisation	
Abattoir Stakeholders			
Cataline Senechal		Forum Abattoir	
Olivier Menalda		SAU Plan Canal	

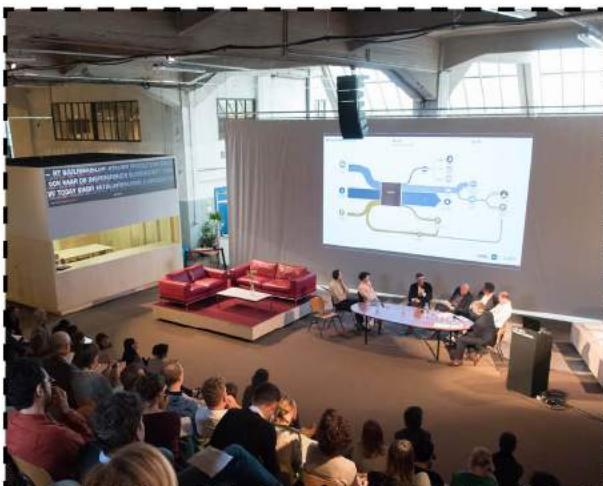
Vergotedok Stakeholders	
Stephanie Thomaes	
Charlotte Kokken	
David Brokaert	
Valerie Tanghe	







Urban Meeting 4	
Rotterdam 2-6-2016	
Name	Organisation
Debate @IABR	
Mark Brearley	Atelier Master/Cass Cities London
Kristiaan Borret	Master Architect Brussels
Marco Broekman	IABR-Atelier Rotterdam
Olv Klijn	Fabric
Nadia Casabella	ULB
Radim Louda	Central
Yves Malysse	URA
Ward Verbakel	Plusoffice architects
Joachim Declerck	AWB



DHL, Amsterdam (NL)
Freight delivery by boat

The boat makes its way from distribution centers outside the city through the canals and three bike couriers take packages to the final distance, houses and businesses. They load up 10-15 items in a bakfiets.

The boat and bike operations replace five delivery trucks. They don't get stuck in traffic and can navigate the streets faster than their boatless competitors.

**Heineken, Rotterdam (NL)**
Electric truck delivery

In 2013 Heineken Netherlands proudly rolled out Europe's largest electric truck in the port city of Rotterdam. The 19-tonne truck, with a load capacity of 9 tonnes and a range of 200 kilometres, provides 22 tonnes of CO2 emissions savings annually. Furthermore, electric transport limits the exhaust of small particles such as SOx and NOx.



UPS, Basel (CH)**Electric cargo bike**

The electric cargo bike for delivery and pickup of packages is active in downtown Basel. UPS is exploring the economic and ecological viability of this alternative mode of transportation for city-center delivery over a period of four weeks.

The battery-supported tricycle has a capacity of 1.5 cubic meters and can carry loads weighing up to 150 kilograms.

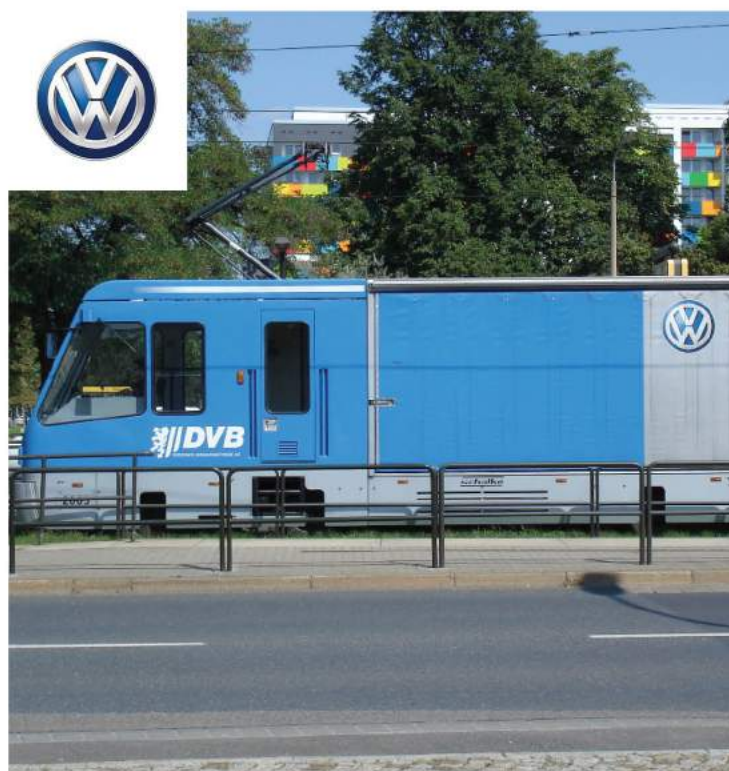
**Albert Heijn Supermarket (NL)****Electric grocery delivery**

Albert Heijn launched a trial in Amsterdam in which groceries are delivered with a bicycle or an electric delivery vehicle. The delivery bike with electric pedal assistance can carry thirty full groceries crates. The driver fills his bike in a warehouse on the outskirts of the city, after which he drives into town.



CarGoTram, Dresden (DE) **Volkswagen's components delivery by tram**

The CarGoTram is a freight tram in Dresden. It supplies Volkswagen's "Transparent Factory" with parts for their automobile production. CarGoTram runs every hour. If necessary, it can run on 40 minute cycles. Total capacity is the equivalent of three motor trucks (214 m³ or 7,600 cu ft).



HelloFresh (NL) **Fresh food home delivery**

Hello Fresh helps you to put healthy, homemade meals on the table. By purchasing the abonnement to their weekly box, they will delivery directly to your door fresh food and easy recepies to consume it in the best way. You never have to worry about what you eat during the week on groceries or fast yet healthy solutions to this problem.



Mail Rail, London (UK)
Minimize companies waste

The Post Office Railway, also known as Mail Rail, is a 2 ft (610 mm) narrow gauge, driverless underground railway in London that was built by the Post Office with assistance from the Underground Electric Railways Company of London, to move mail between sorting offices. Inspired by the Chicago Tunnel Company, it operated from 1927 until 2003.

**Pic Nic Supermarket (NL),**
Online supermarket with free delivery

The new online store will deliver free of charge and without delay. People buy their groceries via an app and then get a free home delivery at an agreed time. "We can sell groceries at a low price and deliver it for free because we do not do 'taxi' and have no stores," says serial entrepreneur Michiel Muller. "This saves cost and benefit goes back to the consumer."



Hovenring, Eindhoven (NL)
Bike connection

The Hovenring is a suspended cycle path roundabout in the province of North Brabant in the Netherlands. In order to improve the flow of traffic and improve safety, it was decided to completely separate motorized and bicycle traffic. In addition, it was decided to transform the roundabout for cars into a regular crossing of streets, to improve the flow of traffic.

**The Bike Snake, Copenhagen (DK)**
Suspended bike lane

The Bicycle Snake is completing the journey over the Bryggebro Bridge, offering Copenhagen's cyclists a fun ride along the harbour and past its tower blocks at first-floor level. As part of Copenhagen's strategy to be one of the best cycling cities in the world, the new cycle bridge will guarantee cyclists improved accessibility and connection to the city.



**DHL Parcel (DE)
Delivery lockers**

DHL Parcel has launched a pilot programme with Deutsche Annington, to install parcel boxes within apartment blocks. The parcel lockers are free for residents – all they'll have to do is register online to receive a unique digital key for the parcel lockers in their building. Delivery staff place parcels in the parcel lockers, and recipients receive a notification of the delivery in their usual mailbox.

**Vert chez Vous, Paris (FR)
Freights sorted on boat
and delivered by e-bike**

Packages enter the city on a boat from distribution centers in peripheral areas of urban center.

The freights are sorted while approaching the city center and they are then transferred to cargo bikes at specific spots that will deliver the goods to the single customers. The logistics proposed by the company is 100% electric and produces 0 emission.



Mil-Tek, Bruxelles (BE)**Minimize companies waste**

Mil-tek specializes in technical solutions designed to compact recyclable waste from companies, large or small. Mil-tek balers & compactors reduce their cost and minimize waste. Mil-tek assures our earth remains green and clean.

Mil-tek can accommodate its balers and compactors to fit any size of business.

**Green Logistics,****Groningen (NL)****Return logistics policy**

Green Logistics Groningen not only looks after the stock levels of your business, it can also remove clean and sorted waste such as paper, plastic, cardboard, clothes hangers and other similar waste. This provides more space in your retail unit and more time overall. By returning your sorted and clean waste you are contributing to a cleaner environment.



CityDepot, Brussels (BE) Reverse logistics project

The idea for the 'reverse logistics' project was conceived and developed within the grant opportunity for innovative projects involving sustainable materials management selected by OVAM.

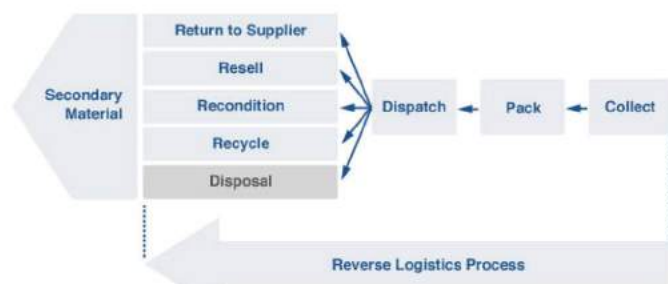
By making use of the City Depot model, in Hasselt will start a development program for urban waste to capture and enhance it in innovative ways.



Reverso Logística (PL) Organic and solid waste reverse logistics

Reverso Logística is a high performance logistics company, specialized in reverse logistics of organic and solid waste.

The company manages the solid, improper and organic waste of your enterprise, in the following steps: collection, transportation, transshipment, separation and final destination of the solid waste.



Food Village, Amsterdam (NL)
Urban Pig-Farm

There proposal is to transform an old asylum seekers building into bed and breakfast where you can wake up to the sound of the cockerel crowing, pigs snorting and bees buzzing. An initiative to bring communities closer to the food production process. It aims to stimulate the local economy, provide employment, teach children and adults about sustainable agriculture.

**Bristol Fish Project (UK)**
Community supported aquaponic farm

Our work is an experiment in the commercial viability of community-supported aquaponics. We want to see if urban aquaponic farming can be a viable livelihood, to explore how aquaponic farming can help to close urban material loops, and to build community through innovative, collaborative local food systems.



De Zwammerij + Superuse Studios, Groningen (NL)

Oyster mushroom from coffee waste

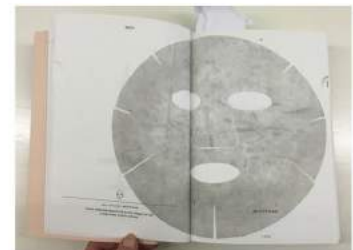
Re-use of a waste cycle inside the new office of DUO and Belastingdienst at the Kempkensberg in Groningen: 400 kilograms of coffee-grounds per day! De Zwammerij uses coffee-grounds to cultivate oyster mushrooms, which not only can be tasted during the exhibition, but will finally be part of the menu of the 'cruise ships' company restaurant.



PIG 05049 by Christien Meindertsma,

Pig by-products

Christien Meindertsma has spent three years researching all the products made from a single pig. Amongst some of the more unexpected results were: Ammunition, medicine, photo paper, heart valves, brakes, chewing gum, porcelain, cosmetics, cigarettes, conditioner and even bio diesel.



**CRAFTICA Formafantasma,
Amsterdam (NL)**

Furniture from animal waste
Studio Formafantasma utilized discarded leather left over from the Fendi manufacturing processes, as the foundation of the collection. In addition, the designers selected a range of leathers obtained from fish skins discarded by the food industry, vegetal processed leather using natural substances from tree bark, cork leather extracted from cork trees.



Yarn from slaughterhouse waste, ETH Zurich, (CH)

ETH researchers have developed a yarn from ordinary gelatine that has good qualities similar to those of merino wool fibres. The unique method deviates from other natural fibre products, because it originates from gelatine or waste that is generally found inside a slaughterhouse. It combines the organic solvent isopropyl with the heated gelatine from animal skin and bones.

**Qmilk, ETH Zurich (CH)
Fabric made from milk fiber**

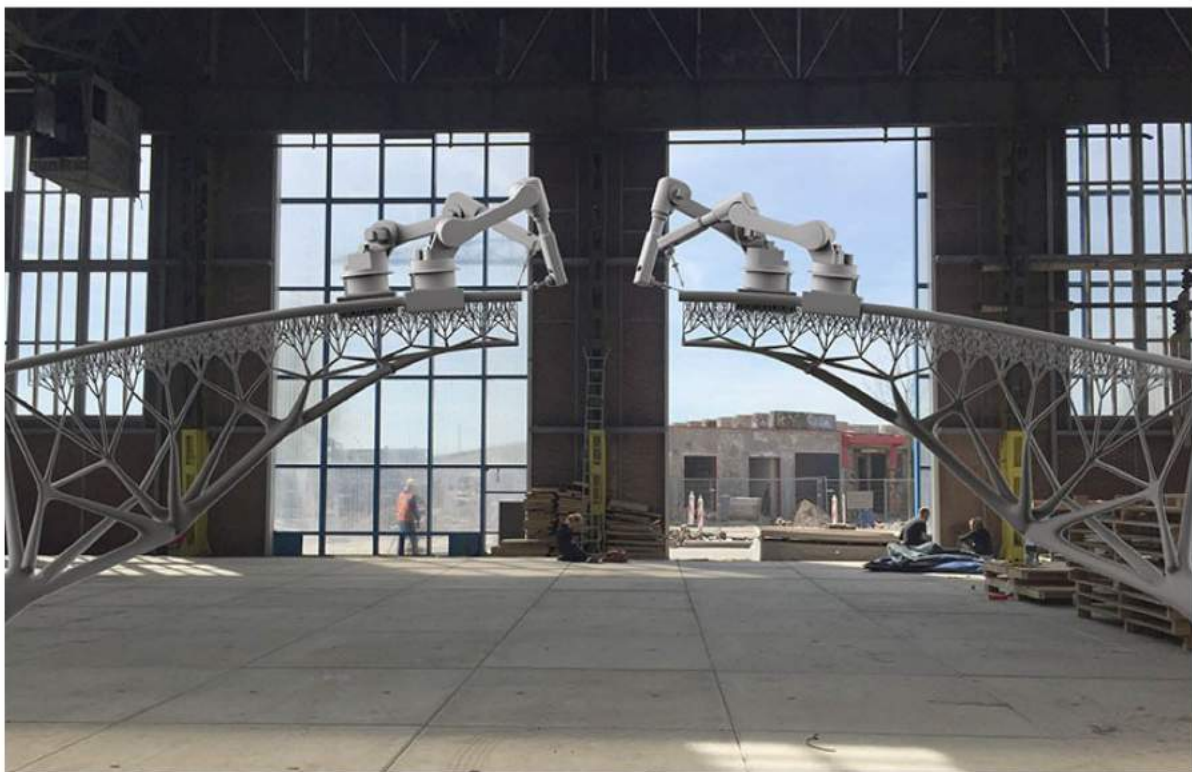
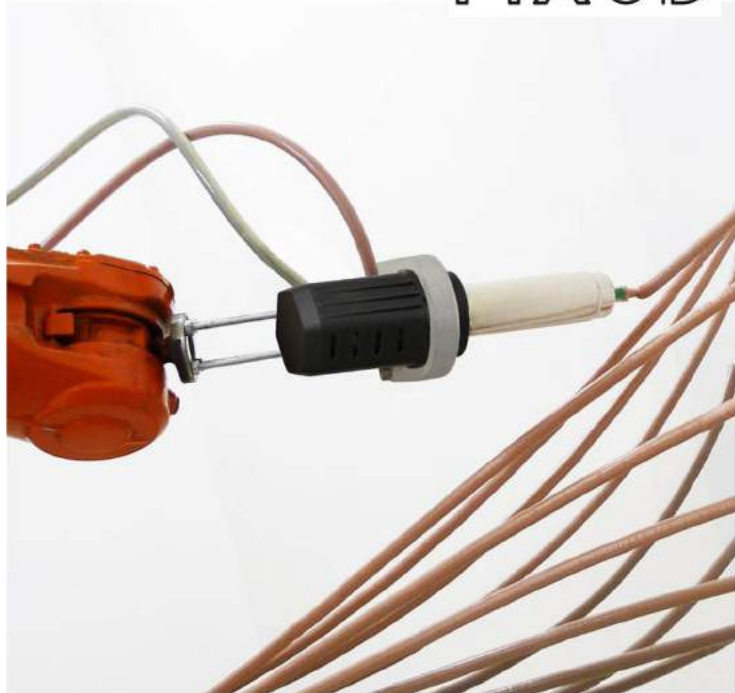
The newly developed Qmilk fiber does not only convince by offering a clear environmental advantage, but also outstanding functional properties for all clothing ranges: An admixture of only 20% of Qmilk fiber is sufficient to improve the quality of yarns and fabrics made from conventional fibers significantly. Fabrics made of Qmilk fiber are very soft and provide a comfortable fit.



**MX3D Bridge by MX3D,
Amsterdam (NL)****3D printing lab using metals**

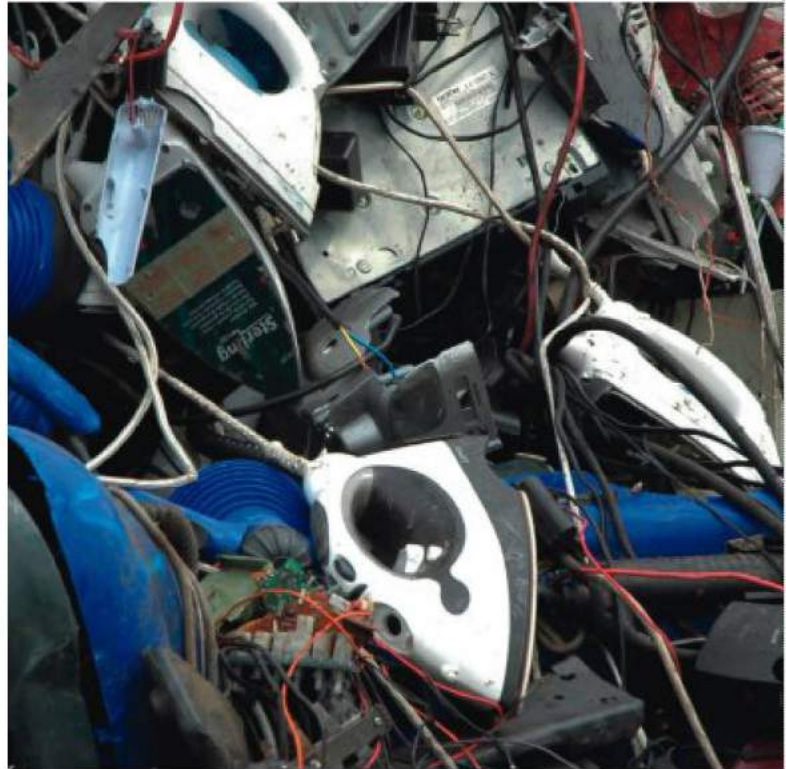
We are going to 3D print a fully functional, intricate steel bridge over water in the center of Amsterdam to showcase our revolutionary technology. MX3D equips industrial multi-axis robots with 3D tools and develops the software to control them. This allows us to 3D print strong, complex and gracious structures out of sustainable material – from large bridges to small parts.

MX3D



Galloo, Menen (BE)
E-waste recycling

Every year, Galloo processes 50 per cent of all WEEE collected in Belgium, which equates to 30,000 tons of household WEEE and 250 tons of professional WEEE. After being collected, registered, sorted and purified in specifically created departments, the appliances are processed through the shredder and separated into ferrous and non-ferrous metals.

**Repair Café, Brussels (BE)**
Domestic waste repair café

In this café people gather and learn how to repair their "domestic waste" for free instead of throwing it away. Some technicians are available to supervise and help everyone. It's a knowledge hotspot and meeting point at the same time.



Research Michigan State University, US

Waste glass as cement

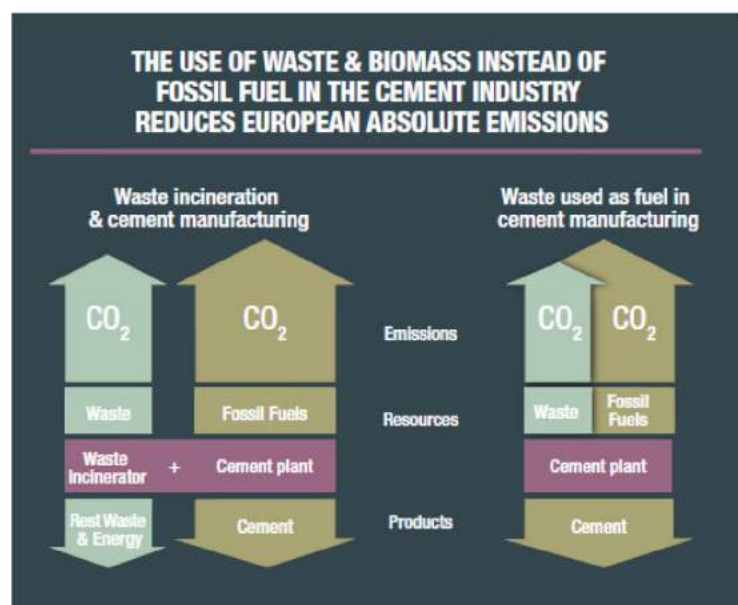
The chemical composition and the pozzolanic properties of waste glass are encouraging for the use of this waste in the cement and concrete industries and to provide an environmental friendly solution for the glass and cement industries in order to reduce greenhouse gas emissions, intensive energy use and exploitation of natural resources.



CEMBUREAU, Brussels (BE)

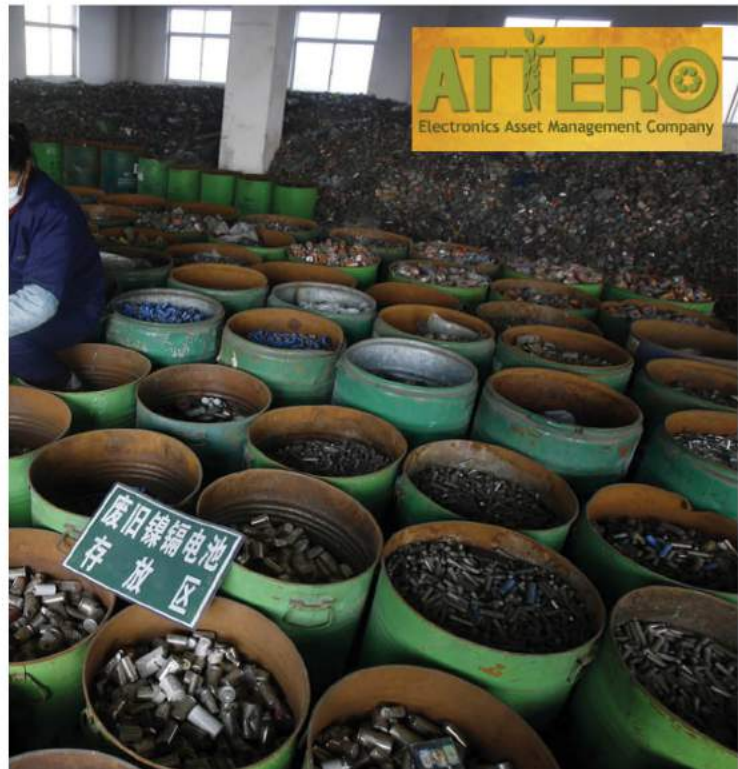
Sustainable cement production

The high calorific value of the rubber is used to substitute primary fuels and the inert ingredients substitute the raw materials. The ENCI (NL) has been working together with the Limburg Purification Board, receiving pre-treated sludge from their water treatment plants. 80kt/y of dried sludge are co-processed annually in a kiln with a capacity of 865kt/y of clinker.



ATTERO, Noida, India
E-waste recycling

Attero is now collecting and processing about 1,000 metric tons a of e-waste a month from over 500 cities in India, and extracting precious metals like platinum, gold and selenium from the trash. Annual revenues nearly quadrupled over two years to \$15 million in the fiscal year that ended this March, and they eked out their first profit that year.

**Perpetual Plastic Project, Rotterdam (NL)**
3D printing from plastic waste

We get used to throwing plastics away but the material quality however is just as good as it was before the usage. By recycling the plastic step by step into a new product we make visitors realise how valuable it can be. We let people transform their throwaway drinking cups with 3d-printer in new products they care about.



ReGen Village, Almere, NL
Self sufficient neighbourhood

The neighborhood will be the first ReGen Village, a new type of community designed to be fully self-sufficient, growing its own food, making its own energy, and handling its own waste in a closed loop. Any household waste that can be composted will feed livestock or soldier flies. The neighborhood will grow many times more food than a traditional farm of the same size, with fewer resources.



**Kraeutergarten, Metro
Supermarket Berlin (DE)
Vertical microfarm**

At the end of the produce aisle in the Metro supermarket in Berlin, an indoor farming company is testing the ultimate in local food: Greens and herbs are growing inside the store itself. The greens grow inside glowing modular boxes, in a design that Infarm (that designed it) says is so efficient that it can finally make vertical farming affordable on a micro scale.



**‘Ecco-Jäger Früchte und
Gemüse AG’, Bad Ragaz (CH)
Rooftop Aquaponic farm on
grocery store**

In spring 2015 ECF Farmsystems, a Berlin based company, completed a 1000m² greenhouse on the roof of the swiss fruit and vegetable shop Ecco-Jäger. Underneath the greenhouse edible fishes grow in an aquaculture. Ecco-Jäger sells the own produced edible fishes, salads and herbs in the shop on the ground floor.



**Hackney Brewery,
Toast Ale, UK
Waste bread for beer prod.**

Toast ale, made entirely from surplus bread from bakeries, delicatessens and supermarkets is the brainchild of Tristram Stuart – who has linked up with Hackney Brewery to produce the new ale. Stuart, which campaigns to end food waste, was inspired by a Belgian brewer and wants the model to inspire the UK's home brewing community.



**Instock restaurant (NL)
Restaurant reusing
organic waste**

At Instock our chefs create dishes with products that otherwise would go to waste. These products are collected every morning, with our electrical food rescue car. Therefore it is always a surprise what the 'harvest of the day' will be in our restaurant. We stand for good and inventive dishes because we want to enjoy food instead of wasting it.



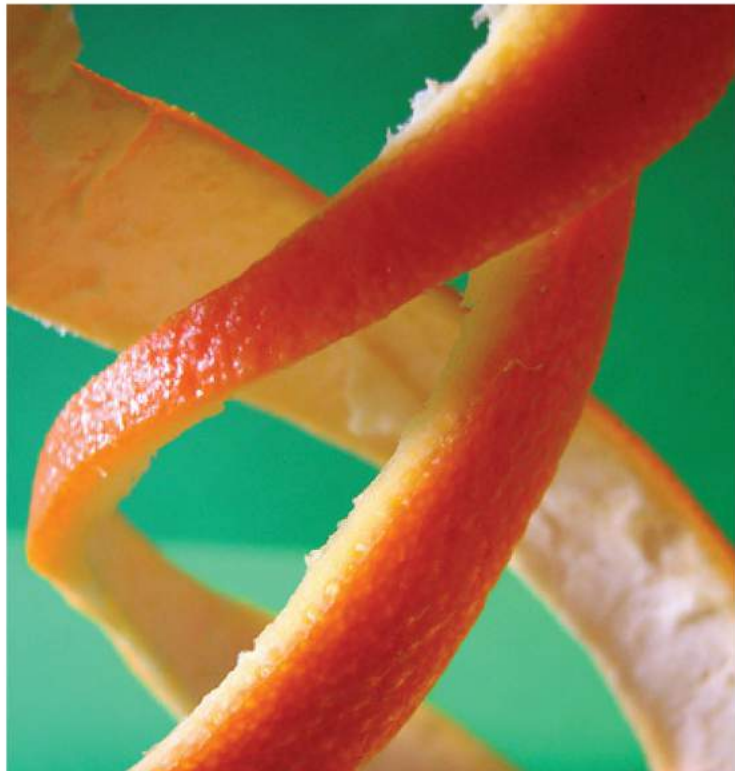
Uit Je Eigen Stad (NL) **Organic urban farm and restaurant**

UJES wants to reconnect city dwellers with the food that ends up daily on their plate. They created a place where citizens can see the production, experience the ambient and taste the food. With a vast field, farming food is brought to town again. After that, the harvest is processed in its own restaurant and sold on the Off You Own City Market.



York University (UK)
Reuse of orange peel

The orange peels are exposed to high-intensity microwaves at low temperatures that transform many components of the orange peel into liquid that can be later collected and from which useful products are obtained. What remains is cellulose, which can be used as a food additive or a thickening agent or be converted into a solid biofuel.

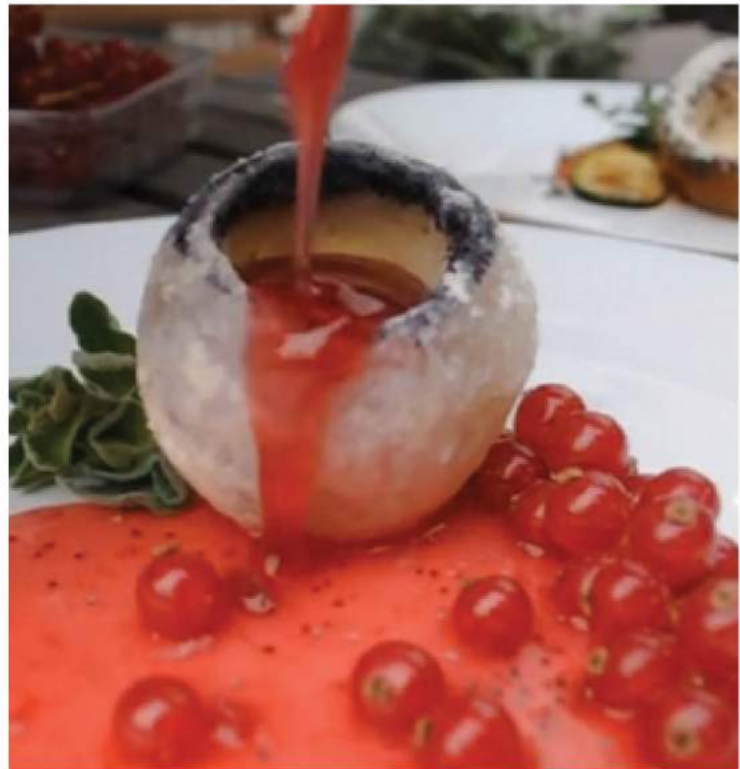
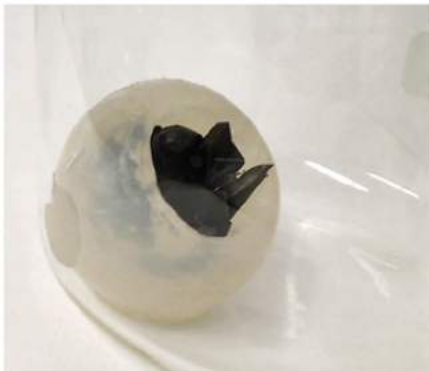
**Flinders University, Australia**
Chemicals from organic waste of citrus fruits

This substance is capable of removing mercury from both soil and water, it is made from renewable, recycled, organic waste, and provides an efficient and sustainable way for continuous mercury pollution removal. The key ingredient is sulfur-limonene polysulphide, which is created from sulfur and limonene – a substance found in the oily skin of citrus fruits.



Livin Studio Vienna (AT) **Growing food on toxic waste**

Livin Studio and Utrecht University have developed a new fungi food product grown on (plastic) waste, a prototype to grow it and culinary tools to eat it. Fungi Mutarium grows edible fungal biomass, mainly the mycelium. Fungi is cultivated on specifically designed agar shapes. Agar is a seaweed based gelatin substitute and acts, mixed with starch and sugar, as a nutrient base for the fungi.



Werdhölzi, Zurich (CH)
Self sufficient water treatment plant

The swiss water treatment plant collects the gas, which is released during the drying process of sewage sludge, for producing energy in cogeneration units. Biomass is collected from allotment gardens surrounding the treatment station to produce energy.



Stadt Zürich
Entsorgung + Recycling



Apeldoorn (NL)
Energy-sufficient water treatment plant

Excess heat from the treatment of water is used for heating houses and water (as biogas). Methane gas is produced from the sewage treatment.

Offices of the RWZI are heated during the winter and cooled during summer with energy coming from the sewage.

900 tons of fertilizer per year are produced.



**ENG-THERMIE 1,
Copenhagen (DE)
Biogas & Compost Plant**

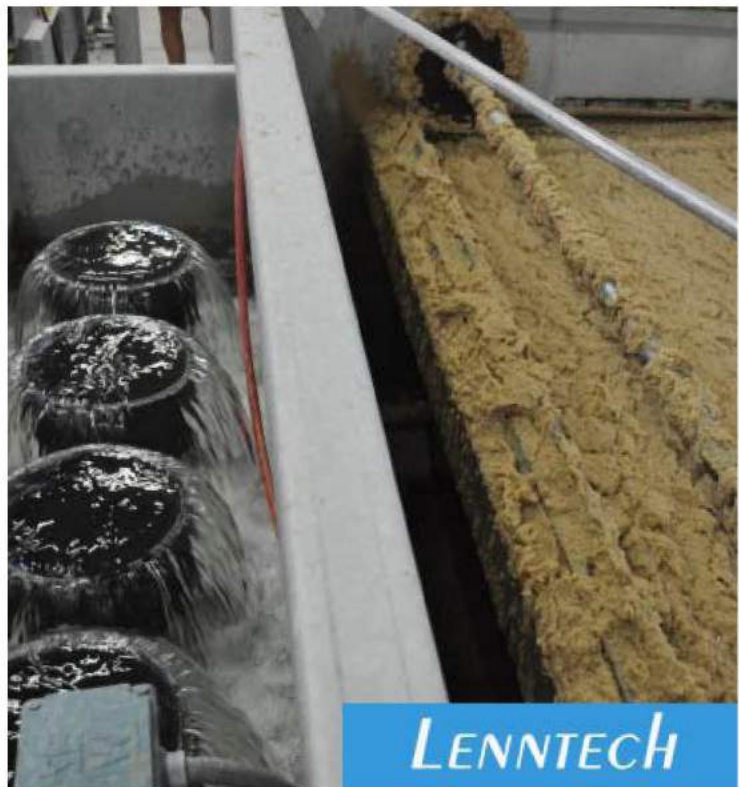
The aim of the Project is to demonstrate a new energy and environmental concept for a combined biogas and compost plant for organic waste. The concept is based on the following principles: minimize energy consumption and loss of nutrients, optimization of energy output and nutrients recycling, maximization of recycling and minimization of residues.



**Lenntech, Delft (NL)
Phosphorous removal from
wastewater**

Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest is inorganic. The main phosphate removal processes are:

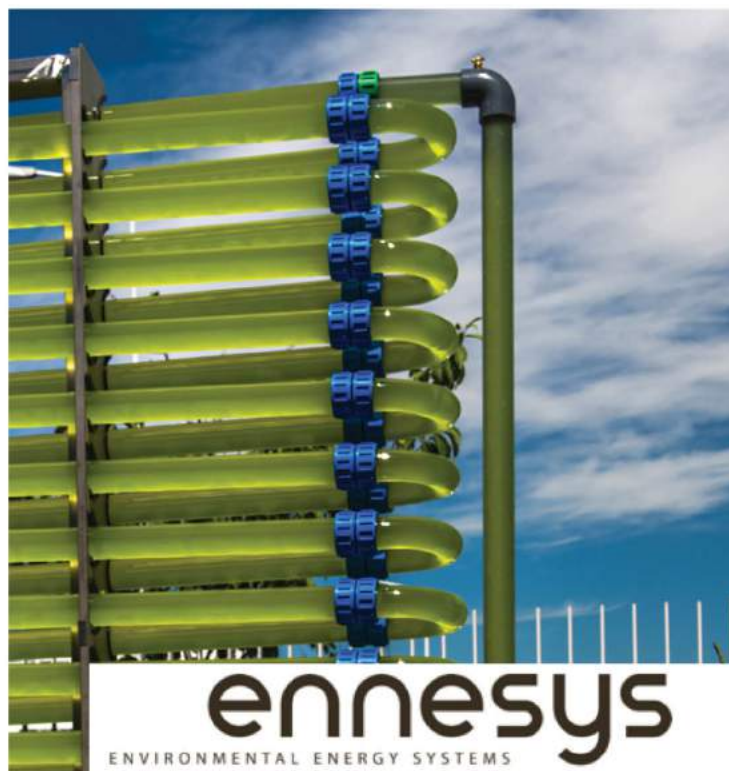
1. Treatment of raw/primary wastewater
2. Treatment of final effluent of biological plants (postprecipitation)
3. Treatment contemporary to the secondary biologic reaction (co-precipitation).



Ennesys, Paris (FR)**Algae Clean Energy and Wastewater Treatment**

Ennesys' biomimetic solution uses microalgae for the triple advantage of wastewater remediation, clean energy generation, and thermal insulation of buildings.

Pollutants are assimilated and increase biomass production. After harvesting, the biomass can be transformed locally to produce power, heat, or cooling, and the water is cleaned.

**Oceanwell, Kiel (DE)****Cosmetic company using algae for facial cream**

Oceanwell opens up a new dimension in algae-based cosmetics. Oceanwell has been developed by marine biologists who passionately and skilfully cultivate, tend and harvest Laminaria algae on the Baltic coast off Kiel. The active ingredients extracted from these algae impact in full through this new range of marine cosmetics.



Proviron, Hemiksem (BE)
Biofuel company from
algae cultivation

Proviron developed a controlled, simple and cheap way to grow algae. The photo bioreactor is one big, translucent, plastic bag filled with water. The bag contains multiple vertical panes. The algae grow in these panes while CO₂ rich air is bubbled through. The plastic foil is specially designed.



Algaelink (NL)
Algae bioreactor for food,
feed, fuel

Extensive research over a number of years has proven that algae is a high-value commodity and extremely beneficial for use in a large number of markets, including the Food (e.g. nutraceuticals, food additives), Feed (e.g. aquaculture feed) and Fuel industry. Algae farms offer great solutions for CO₂ and Waste Water emission problems too.



**Algae House, BIQ
Architects, Hambourg (DE)**

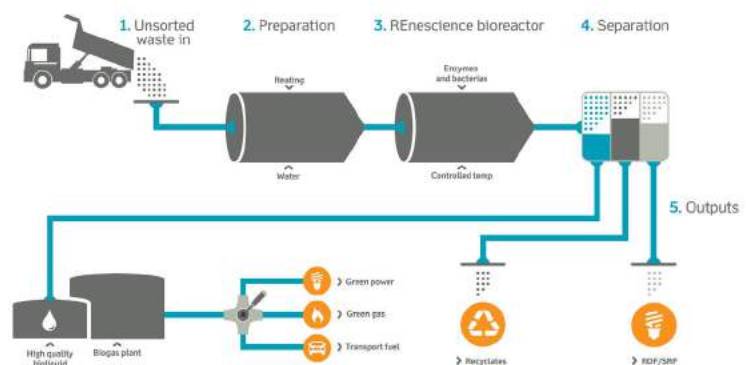
Algae Facade bioreactor

Thanks to the hybrid functionality of its algae façade, this building combines various processes of regenerative energy production to create a sustainable circulation system: solar heat, geothermal energy, biomass and a fuel cell together form three storable energy sources in the form of heat, electricity and biogas.



**DONG Energy, Northwich (UK)
Unsorted waste treatment**

The new bio plant set to be built near Manchester will be able to treat unsorted household waste without prior treatment by using a special enzyme treatment. The groundbreaking technology has been tested at a demonstration plant in Copenhagen since 2009, and will allow for a greater part of the UK's waste to be recycled and converted into biogas.



Eco-Domaine Ferme de Bouquetot (FR)**Spirulina algae farm**

Eco-Domaine Ferme de Bouquetot, has four 50m² algae ponds, heated, covered and insulated to retain warmth. The heat pump with heat network is connected to the digester and ponds, with press and solar dryer, and a laboratory.

The goal of the digester is to grow spirulina organically using cow and horse manure as main inputs.

**Linde Group (BE)
Volker-Wessels (NL)
Algae Biofuel**

OCAP supplies greenhouses between Rotterdam and Amsterdam with carbon dioxide that a Shell refinery nearby had previously emitted into the atmosphere. Large-scale algae farms could produce this important industrial raw material in large quantities. Bioethanol, for example, can be used to fuel motor vehicles.



**Biesbosch Museum Island,
Studio Marco Vermeulen, (NL),
Water purification roofsystem**

Sanitary wastewater is purified through a willow filter. Willows absorb the wastewater and the substances it contains, among them nitrogen and phosphate. These substances act as nutrients and help the willow to grow. The purified water is discharged into the adjacent wetland area and flows from there into the river. Once the willows are dried, the wood can be used as fuel.

**OpMAAT, Amsterdam (NL)
Horizontal helophyte filter**

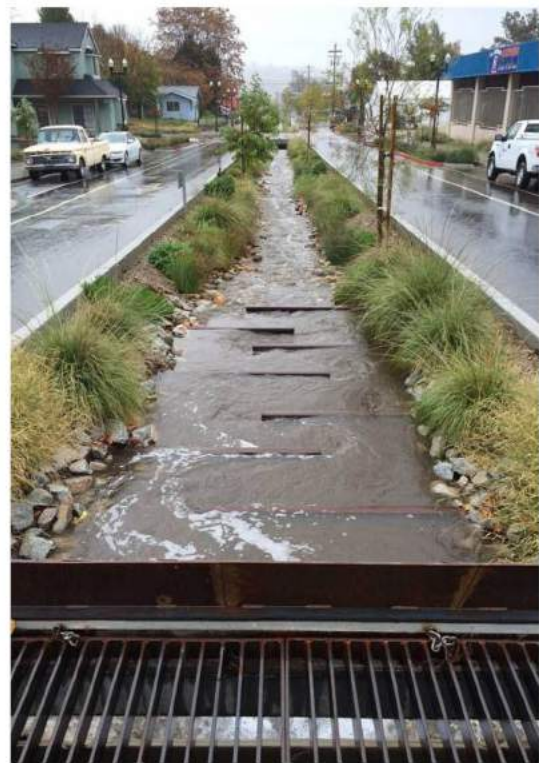
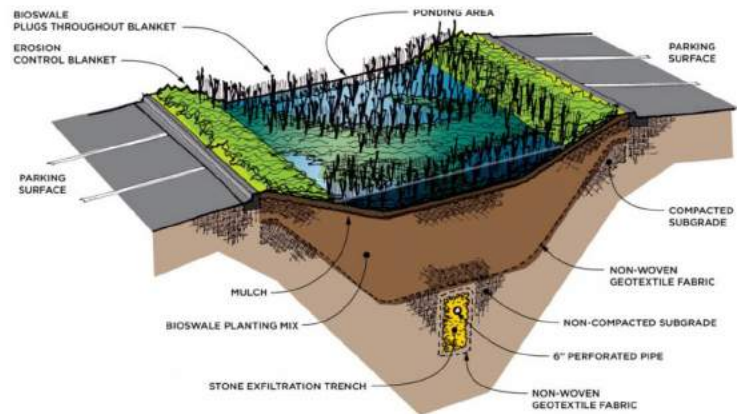
In the Erasmusgracht in Amsterdam is a pilot project realized with a constructed wetland with sedimentation by Waternet in 1993. The rainwater drains an area of 2.37 hectares & is connected to this system. After flowing through the wetland rainwater is discharged into the canal. The decentralized treating of rainwater yields better results than the application of a separated system.



China's sponge cities, Stanford University

Bioswale for removing pollution from rainwater

Scaling rainwater harvesting up to large apartment towers and office blocks would be best accomplished with rooftop gardens. At ground level, bioswales, naturally collect and filter rainwater. That water can then either be allowed to seep into the soil to replenish the groundwater or be collected in underground cisterns.



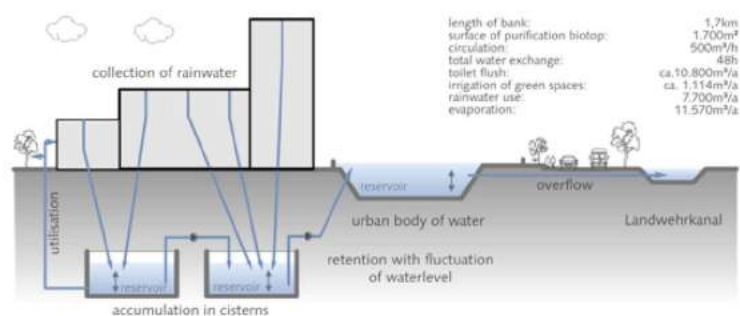
**Rain(a)way Garden,
De Urbanisten & Fien
Dekker (NL), Permeable tile**

Each of these tiles responds to and manages water in a different way. EBB for example is designed to direct water, much like a gutter, into gardens or flowerbeds. The Flood Open is intended for water filtration and storage. The Flood 'Doorlatend' Tile, allows water to seep slowly back into the earth. The Flood Closed Tile allows for slow drainage through wall joints in the tile.



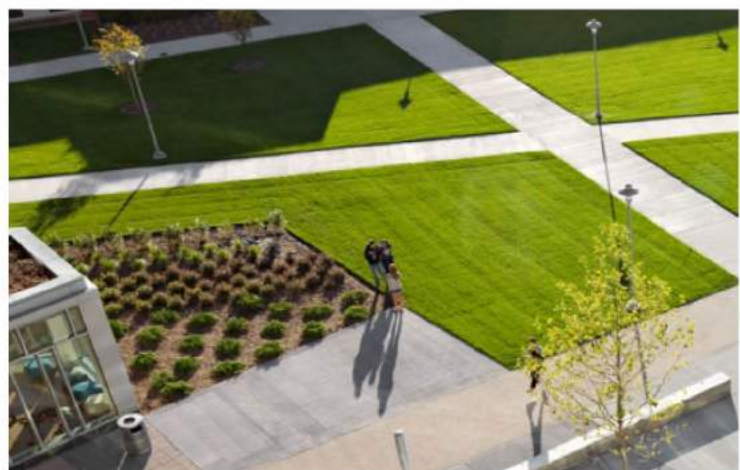
Potsdamer Platz Berlin (DE), Water purification through willow filter fed by nutrients

The large water surfaces are fed entirely by rainwater. The water features improve the urban climate, since the water slightly lowers the ambient temperature in summer, binds dust particles and humidifies the air. The rainwater from the roofs of the surrounding buildings is captured in large underground cisterns. It is used for topping up the pools, for flushing toilets in offices and for irrigating green areas.



State University, Salem (USA) Stormwater filtration

Stormwater from the project is sent to a large, linear bio-swale with native grasses to be filtered and given the chance to percolate back into the ground. The bioswale is lined with stone-filled gabions and extends through a new quadrangle giving an architectural expression to a natural process and educating residents to the process of treating stormwater.





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