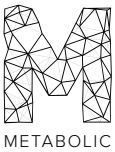
Transitioning
Amsterdam
to a Circular City

CIRCULAR BUIKSLOTERHAM

Vision & Ambition


METABOLIC


DELVA Landscape Architects


Studioninedots


amsterdam
smart
city


new
energy
docks


BSH


PAKHUIS DE ZWIJGER*


de Alliantie
hart voor wonen


waternet


Gemeente Amsterdam
Ontwikkelingsbedrijf

TABLE OF CONTENTS

ABOUT THIS DOCUMENT

This report contains the final results of a study on Buiksloterham's potential to become a leading example of Circular City development in Amsterdam. The study was commissioned and executed by a consortium of local stakeholders who are active in the area of Buiksloterham and see its potential as a global example for a new kind of sustainable urban development.

The results presented in this report are the outcome of an interactive process of analysis, modeling, and stakeholder consultations. In a first stakeholder session, held in September 2014, key stakeholders co-created a shared vision for a Circular Buiksloterham and defined interventions for transition. In a second session in October, a group of decision-makers gathered and aligned around an Action Plan with interventions options for bringing the vision into reality.

Here we present the conclusions of this process: an ambitious vision for Buiksloterham to transition to a Circular, Biobased, and Smart neighborhood. The scope of the proposed ambition is broad, ranging from targets in energy and material management to socioeconomic development and wellbeing. This breadth is essential to maintain a truly systemic and integrated approach. It is also a long-term vision designed to unfold over several decades; the goals are not meant to be achieved overnight. To embed the commitment, the vision and ambitions are translated into a manifest which is signed by local parties and Aldermen of the Municipality of Amsterdam in March 2015.

The only way to achieve this scale of change is through a long-term, committed transformation strategy. This will require incentive structures, policy interventions, and commitment from many different parties. The exemplary Action Plan in this report provides a framework for this longer-term transformation strategy and key immediate steps. The interventions proposed in this report are prioritized in terms of their potential impact and provide further insight into the potential pathways for achieving the vision.

FOREWORD

A joint effort

Cities are the future. There are many reasons to rethink their development and management. The Circular Economy provides one useful perspective for rethinking urban development, but it can be an abstract concept that remains difficult to apply. The vision and actionplan presented in this report for the transformation of Buiksloterham provides a tangible interpretation of the Circular Economy for a part of Amsterdam.

With a better understanding of the notion of a Circular Economy, practical applications of the concept become possible. By combining thorough understanding of a circular city and in-depth knowledge of the development of Buiksloterham, it becomes possible to paint a picture for a Circular Buiksloterham. The actionplan in this study gives us a guide as to which interventions need to be taken now, which ones requires further research or pilotting.

Over the past six months, the plan for Buiksloterham has come to fruition. After growing commitment from a diverse and involved network of individuals and organizations, we are now ready to take focused steps to transorming Amsterdam to a circular city. We proudly present this vision and actionplan for a Circular Buiklsoterham as a constituent of this process.

Endorsing the Circular Buiksloterham vision and actionplan is not open-ended. It requires innovative solutions and a new approach to addressing metropolitan challenges. An approach in which we value different perspectives and challenge the status quo. An approach in which we look beyond boundaries of acceptance and feasibility. An approach in which setbacks are transformed into new solutions. And finally, an approach in which different parties respect each others' qualities while being aware of risks and consequences. In doing so, all the parties show the audacity and willpower to define the future of Buiksloterham.

This vision and actionplan provides a long term plan. The road to this vision is a road that can be adjusted along the way to accommodate new insights. A combination of subjects, timelines, matters of scale and involvement of different parties turn this plan into a complex but unique trajectory to transform Buiksloterham into a living example of a circular city.

Any road to change requires its first steps. For Buiksloterham, we now have a solid vision on how to take the first steps. We would like to invite all participants to expand on these steps and to help accelerate the development of a Circular Buiksloterham.

Amsterdam, March 5th, 2015

On behalf of the partners and the clients for this study: De Alliantie, Gemeente Amsterdam and Waternet.

EXECUTIVE SUMMARY

Cities are a key leverage point for transitioning the global economy to a sustainable state

As human impact on the environment accelerates and we continue to make very uneven progress on achieving most of the United Nations' Millennium Development Goals,[1] cities have come into sharp focus as a key intervention point for change. We must re-imagine how cities function. While they occupy only 3% of global land surface, cities consume 75% of global resources and produce 60 - 80% of global greenhouse gas emissions.[2] Cities must transition from their status as "global resource drains" to circular, biobased, smart, productive, ecologically- and socially-integrated hubs. This is arguably one of the most essential steps in transitioning the broader human economy to a more sustainable state.

Buiksloterham is a unique neighbourhood within Amsterdam that can serve as a living lab for Circular, Smart, and Biobased development

By most quantitative measures, Amsterdam is a small city in a small country. Though it is the largest city in the Netherlands, its municipal population numbers only around 813.000 residents, placing it in 432nd place of the world's largest urban agglomerations.[3] Despite its small size, Amsterdam is global in character. Its role in shaping history through the development of international markets and trade, its contribution to innovation, its creative sector, and its progressive social policy have solidified it as a historical and cultural landmark, attracting almost 13 million tourists per year.[4] Amsterdam is looked to internationally as a positive example for urban governance, development, and policy.

Buiksloterham, a neighborhood in the north of Amsterdam, is in a unique position to serve as both a living test bed and catalyst for Amsterdam's broader transition to becoming a circular, smart, and biobased city. Within Amsterdam, Buiksloterham is a rare case: though it has been treated as a functionally peripheral district because of its industrial past, it is located just five minutes from the old center of Amsterdam across the IJ river. Unlike most other centrally-located neighborhoods, Buiksloterham is a comparative blank slate with many empty plots and almost no monumental buildings. This status creates space and flexibility for new development.

Buiksloterham shares many features with other post-industrial neighbourhoods worldwide

Though Buiksloterham is unique in Amsterdam, it also has many features that make it a good case study for the transformation of other post-industrial neighborhoods in cities around the world. It is near to, but somewhat physically and socially disconnected from, an old city center. It has scattered property ownership. Many of its plots are highly polluted, creating prohibitive cost barriers to development. These are common features of many areas that were once peripheral to city centers, but have grown closer through the process of urban expansion.

In the vision and Action Plan presented in this report, we conceive of Buiksloterham as an engine for the broader transition of Amsterdam. Its polluted lands and open spaces can become the center of the implementation of new clean technologies and a hub for the closure of urban material cycles. The activities needed to close these local material flows can be used as a driver for local industry and the strengthening of local social networks. IT-based interventions can smartly connect local residents with one another and boost the efficiency of resource flows. Urban biodiver-

1) The Millennium Development Goals are a set of targets published by the international community for global sustainable development. Recent progress reports indicate uneven progress on the MDGs, particularly on environmental sustainability targets.

2)United Nations Development Programme Statistics

3) 2013 Population Statistics

4) Amsterdam Economic Board tourism figures

sity and climate adaptation measures are conceived as a core strategy to bring long-term local resilience to the area. As such, Buiksloterham can serve as a blueprint and live experiment for how such formerly peripheral areas worldwide can be transformed into a motor for change and regeneration in cities.

Intervening in the development of Buiksloterham to realize sustainability objectives is urgent

Buiksloterham is part of a larger re-development plan of the northern banks of the IJ river. Though sustainability has been mentioned as an ambition for the re-development of the area and has been used as a performance metric in some tendering procedures, there is no central sustainability plan or directive. This poses the risk that sustainability as a development objective will be de-prioritized because of the unusually market-driven and bottom-up approach the municipality has taken with the area's redevelopment.

Not taking advantage of the transformational potential of neighborhoods like Buiksloterham would be a massive missed opportunity. New construction offers much more flexibility and lower costs for sustainable design than retrofitting. In order to move towards a more sustainable state, these former industrial areas need dedicated creative thinking, investment, and vision as they are redeveloped.

Buiksloterham is now on the cusp of a rapid transformation. In the coming three years alone, around 84.000 m2 of new residential construction is scheduled, representing an increase of almost 30% over the current built area in the neighborhood. Recognizing the urgency for a clear strategy, stakeholders including the development office of Amsterdam's Municipality, Grond & Ontwikkeling, the local water utility, Waternet, and an important local developer, social housing corporation De Alliantie, pooled together resources to make the development of this vision and Action Plan for Buiksloterham possible.

An Urban Metabolism Scan was the foundation for co-creating a future vision and shaping interventions for a Circular Buiksloterham

The foundation of this report is an Urban Metabolism Scan, which was used to understand the full workings of Buiksloterham from an integrated, systemic perspective. The topics investigated as part of the study included energy and material flows, biodiversity, environmental conditions, socio-economic data, an assessment of local stakeholders, policies and strategic plans, and factors that may influence the health and wellness of individuals living in the area.

Insights developed during the analysis were used as input to the co-creation of the Circular Buiksloterham Vision with a group of key stakeholders at a session in mid-September 2014. This session resulted in several hundred proposed interventions for transitioning Buiksloterham towards a "circular state." These interventions were refined and evaluated using the material flow model that was built as part of the metabolism analysis. The intervention options form the basis for both the vision and the exemplary Action Plan for the area.

A second stakeholder session in early October 2014 brought together key decision-makers to commit to further supporting and implementing the Action Plan that has been developed on the basis of the vision and interventions.

Circular, Biobased, & Smart are core underlying paradigms for the Circular Buiksloterham Vision

Over the last decade, the terms "circular," "smart," and "biobased," have begun to frame a new paradigm for urban and, more broadly, economic development. These three terms refer to complementary trends in sustainability practice, and form the basis for the vision and approach we have crafted for Buiksloterham.

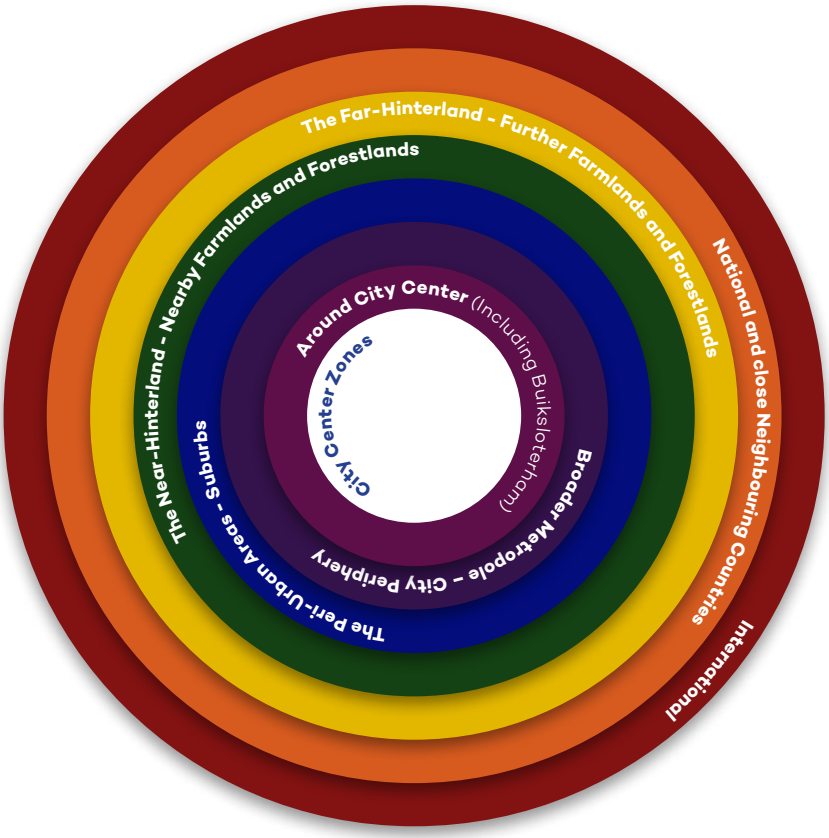
A Circular Economy is one that is "regenerative and waste-free by design." In a Circular Economy, materials are indefinitely cycled at high quality, all energy is derived from renewable or otherwise sustainable sources, and natural and human capital are structurally supported rather than degraded through economic activities. Though it may appear that the primary focus of this philosophy is on material recycling and an energy transition, achieving a Circular Economy requires systemic redesign of our modern industrial system with a great deal of focus on how it relates to both ecological and human systems.

The overarching concept of the Circular Economy is well complimented by the development goals of "biobased" and "smart" cities. The shift towards biobased resources, when executed properly, can reduce our dependency on non-renewable sources of value. A primary objective in transitioning to a biobased economy is the beneficial reuse of biological waste streams (e.g., nutrient recovery from organic wastes) and the use of bioprocessing to replace conventional industrial functions (e.g., soil phytoremediation instead of standard mechanical-chemical cleansing).

Smart Cities are those that maximize social and environmental capital in the competitiveness of urban areas through the use of modern infrastructure, highly efficient resource management, and active citizen participation. One of the drivers behind the Smart City concept is to move away from viewing the development of cities as a purely hardware-related activity to recognizing the importance of "software" elements within the city context: people, knowledge, data flows, and civic engagement. The human and programmatic elements of an urban development stand central in successfully achieving any more technically-oriented goals.

Even within a perfect "Circular Economy," not all resource flows should be closed on all spatial scales of development. The Circular City Model, as developed by Metabolic, translates how Circular Economy objectives should be applied in physical space, particularly in relation to cities. The schematic model provides rule of thumb guidelines for where certain flow types should optimally be closed.

The more costly it is to move a flow (losses, expense around transport) and the more spatially ubiquitous that flow is (for example, energy and water in the form of sunlight and rain), the higher the priority for closing that flow locally. The specific scale at which flows should be closed is based partly on calculations of density of resource demand versus density of availability. For that reason, energy and water are the two top priorities for local flow closure or supply. This is not possible in city centers, but becomes increasingly possible in areas just outside city centers like Buiksloterham. After energy and water, the next priority targets for local material cycle closure are



Circular City Framework

The Circular City Model provided guidelines for which material flows should be preferentially closed within the geographic borders of Buiksloterham

fast cycling and high volume material streams like food waste and other local organic wastes from which nutrients can be recovered. The more complex or scarce a material, the less of a priority there is on closing that material cycle locally.

The intervention options and exemplary Action Plan for Circular Buiksloterham have been developed with this schematic model in mind and based on the following general order of action priorities for managing local resources:

- Reducing the volume of local flows (demand-side management)
- Finding local supply synergies (heat cascades, material cascades)
- Supplying local flows in a renewable fashion

Based on this approach, our priorities for Buiksloterham on the level of managing physical flows have been to focus on the energy, water, and nutrient cycles (in that order of priority).

Results: Circular Buiksloterham Study

The primary outcomes of this work include:

- an Urban Metabolism Scan of Buiksloterham;
- a Vision and Ambition for a Circular Buiksloterham;
- an exemplary Action Plan & roadmaps;
- a list of possible interventions;
- commitment from key parties.

These outcomes are briefly described in the following sections.

Urban Metabolism Scan results

The Urban Metabolism Scan consists of three components: a context, stakeholder, and metabolism analysis. A detailed overview of the results can be found in the Urban Metabolism Analysis chapters at the end of the full Circular Buiksloterham report.

Physical Metabolism

Buiksloterham's current material metabolism is still dominated by its industrial character. This is readily evident in the local distribution of energy and material demand. Because there are currently only 252 registered residents in Buiksloterham, typical domestic material flows (food, household products, water, and wastes) are still relatively low. The majority of these residents is young (under 40), non-immigrant, and low-income. The development plan for Buiksloterham includes a scheduled increase of 700.000 square meters of usable space over the current 300.000, with primarily residential and office functions in the planned expansion. When all of the area's development plans are complete, the number of residents is projected to go up by approximately 25-fold and the number of offices is projected to go up by over four-fold. This will dramatically change the resource demand profile of the neighborhood and reduce the dominance of industry.

If Buiksloterham continues on a "Business as Usual" path, our model concludes that despite projected improvements, Buiksloterham will follow the typical pattern of an urban "resource drain." Below is an overview of how some key parameters may look in Buiksloterham under this BAU path.

Energy:

- The total energy demand will be 992 million MJ (or 992 Terajoules) per year, largely resulting from the area's heat demand (32%), followed by energy for mobility (21%), and operational energy for remaining industrial activities (13%);
- By 2020, the electric grid is projected to supply 12-14% renewable energy to Buiksloterham, little of which little will be generated locally;

Infrastructure & mobility:

- In 20 years, the district heat network will be the primary source of supply for the area's large heat demand. This heat will mostly be produced by the incineration of municipal waste at the waste-to-energy plant;
- The area will have an additional 5.000 parking spaces based on the parking standard of one

spot per household and 1/125th parking spot per m^2 office space;
- The fuel use for vehicles (residents, commuters, transport of goods) will result in 14.016 tonnes of CO_2 emissions per year (23% of total projected CO_2 emissions for Buiksloterham) and significant NO_x and PM emissions.

Water & nutrient cycle:

- Stormwater will be traditionally managed through underground stormwater sewers. The neighborhood will have a dominant percentage of non-permeable surfaces. Most rainwater will not be usefully applied or buffered;
- There will be no recovery of nutrients like nitrogen and limited phosphate recovery (10-20%) at the waste water treatment plant (WWTP) in West Amsterdam.

Material cycle:

- 3.500 tons of municipal and commercial waste will be incinerated annually in the waste-to-energy plant; only 14% of the municipal solid waste will be separately collected and recycled;
- Excluding industrial inputs, construction materials will be by far the largest material flow by mass (490.000 tonnes) into Buiksloterham over the coming twenty years. This flow will be dominated by reinforced concrete, a traditional building material with only low-quality recycling options.

Ecosystems and biodiversity:

- The polluted plots in Buiksloterham cover over 15 hectares, or around 15% of the total area.
- Under a standard approach (ex situ mechanical remediation), these soils would cost up to an estimated 20 million euros to remediate;
- As a result of the high projected cost, most of the polluted grounds will remain empty and fenced off for the coming years.

Socio-economic:

- Buiksloterham runs the risk of becoming a standardized and monofunctional neighborhood. This can be avoided if sufficient room is given to organic development and explicit steps are made towards integration with existing users and neighboring areas, as well as a planned diversification of functions.

Health & wellbeing:

- As a result of increasing mobility and remaining industrial functions, local emissions may pose a risk to healthy air quality. Noise and odor pollution will be a continued nuisance.

Snapshot overview: Current vs. +20 projections for Buiksloterham

- Overall energy demand will increase almost 3-fold;
- Heating demand will increase 5-fold;
- Electricity demand will increase almost 2-fold;
- Vehicle fuel demand will increase almost 6-fold;
- Water demand will increase almost 4-fold;
- Food demand will increase 9-fold;
- Waste production will increase almost 3-fold;
- Household good demand will increase by 170-fold.

Circular Buiksloterham Vision and Ambition

The vision of a Circular Buiksloterham is of a neighborhood with exemplary performance on a set of systemic measures of urban and environmental quality. It is an area of continuous innovation and experimentation. It is a neighborhood with a tight-knit local community, strong civic engagement, and a resilient local economy. All energy comes from renewable sources. All products and materials are recovered for reuse, repair, and recycling. The area is biodiverse and features attractive and human-scale streets and buildings. These holistic performance criteria for a Circular Buiksloterham have been summarized in eight overarching goals for the neighborhood's development.

The results of this modelling have informed the development of the Circular Buiksloterham Vision and the proposed Action Plan.

Overarching Ambitions for Circular Buiksloterham in 2034:

A more detailed description can be found in the Vision and Ambition chapter of the full report.

- Energy: Buiksloterham is energy self-sufficient with a fully renewable energy supply
- Materials & products: Buiksloterham is a zero waste neighbourhood that with a near 100% circular material flow
- Water: Buiksloterham is rainproof and has near 100% resource recovery from waste water
- Ecosystems and biodiversity: Buiksloterham's ecosystems are regenerated and its base of natural capital is self-renewing
- Infrastructure & mobility: infrastructure is maximally-used and local mobility has zero emissions
- Socio-cultural: Buiksloterham has a diverse and inclusive culture, and a high quality, livable environment
- Economy: Buiksloterham has a strong local economy that stimulates entrepreneurship and encourages the creation and exchange of multiple kinds of value (social, environmental, cultural)
- Health & wellbeing: Buiksloterham is a healthy, safe and attractive environment with recreational activity space for all residents

Proposed Action Plan

The high-level performance ambitions for Buiksloterham as a circular neighborhood could apply to most urban developments worldwide because they represent generic standards for a "circular neighborhood" or city. The challenge lies in designing an Action Plan that translates these ambitionss to the context, challenges, and opportunities of a specific area. Some of the unique features of Buiksloterham include: a rapid increase of new housing developments, a rapid increase in mobility and energy demand, large amounts of surface water and rainfall, and a high percentage of polluted grounds (15%).

The proposed Action Plan for a Circular Buiksloterham is where these and other contextual features are translated into an approach for achieving the higher-level ambitions in Buiksloterham. This plan was developed by prioritizing interventions based on their urgency, the magnitude of

their impact, and their specificity to the context of Buiksloterham. Our understanding of magnitude, urgency, and contextual relevance was shaped by the Urban Metabolism Analysis.

Because of the long-term scope of this project, it is not advisable or possible to propose specific technical interventions for fully achieving each goal over the coming 20+ years. New technologies will emerge, the price of existing technologies will change, and the range of opportunities and solutions will evolve over time. Specific technical recommendations risk becoming outdated in even short time-spans. For this reason, it is essential to have mechanisms in place to continue steering towards the desired outcomes (the goals), while leaving the specific means of achieving the goals flexible to maintain optimal efficiency and reduce bureaucracy.

That said, because Buiksloterham is developing quickly, with a great deal of construction planned in the upcoming few years or already underway, there are some technical interventions that need to be made now, based on our current understanding of the situation.

The need for both near- and short-term actions has resulted in an Action Plan that identifies two types of interventions: systemic and technical. The systemic interventions are process-oriented and the technical interventions are focused on more immediate actions that are prerequisites for reaching certain milestones. They are summarized below, and further detailed in the Action Plan chapter of the full report.

Systemic Interventions options

The proposed systemic interventions will create the necessary structures to sustain a long-term transition process in Buiksloterham. We have identified five types of such interventions that we see as prerequisites for further development. There are five primary systemic intervention categories proposed in the Action Plan:

Designate Buiksloterham as an official experimental zone or Living Lab.

A Living Lab status is necessary for establishing the overall character of the neighborhood as a place where new technologies and management approaches can be applied and learned from. It is also instrumental in releasing developers and residents in the area from some legal restrictions that currently prevent the use of new materials and clean technologies in construction.

Develop an inclusive governance and management structure for Buiksloterham.

A local governance structure should give responsibility and authority to local stakeholders in collectively managing and enforcing progress towards the long-term goals. Such a structure will be essential for implementing the Circular Buiksloterham vision while giving citizens and other stakeholder groups a consistent and significant voice in the process.

Create new incentive structures and financial vehicles. The transition plan to a Circular Buiksloterham requires sufficient capital for investment and appropriate incentive structures (such as tax or credit schemes) that will provide guidance and enforcement of key directives. New vehicles for investment that take into account the broader ambitions of the area in addition to considering financial returns are a prerequisite for successfully achieving the vision. Several options for such financial vehicles exist, such as a rotating “Circular Investment Fund.”

Build capacity for urban sensing and open data. Urban sensing and open data infrastructure are critical for monitoring progress towards the goals, enforcing key directives, and for purposes of research and communication. Investments in the data infrastructure should be made early on in the process to create visibility and buy-in for the local activities, and facilitate the communication of results.

Implement a Circular Neighborhood Action Plan. The Circular Neighborhood Action Plan is a set of resources for local residents and developers that is needed to provide the translation of higher-level goals into everyday activities. This Action Plan will provide up-to-date guidelines for all residents, developers, and other local stakeholders active in the area and provide a vehicle for internal communication. The Action Plan can include a community web portal, household purchasing guidelines, developers guidelines, and other accessible resources.

All of these proposed systemic actions are urgent; they provide the fundamental infrastructure for the execution of the long-term vision.

Technical Interventions

The overarching Circular Buiksloterham ambitions have been translated into five urgent areas for technical intervention focused around: local renewable energy production, natural water management, soil remediation, smart mobility, and local material cycling. Under each of these categories, we have detailed additional specific action points.

Fully Renewable Energy Supply: To achieve the first of the technical objectives proposed for Buiksloterham, urgent action needs to be taken around the construction of new buildings. Instituting Passive House construction as a standard in new buildings and an electric efficiency guideline are essential pre-requisites for supplying the area with locally-generated renewable energy.

Water Innovation: This objective includes two primary elements: making Buiksloterham stormwater-sewer- free through natural rainwater management, and recovering nutrients and resources from wastewater.

Alternative Mobility. To reduce local emissions, energy use and the need for parking spots, an alternative mobility plan should be introduced. The focus should be on reducing passenger miles overall, facilitating low-energy, zero emissions alternative modes, and increasing shared use of vehicles.

Soil as Natural Capital. Many of the plots in Buiksloterham are polluted and require intensive and costly remediation. Bioremediation combined with temporary use can transform these areas into an societal asset while progressively rebuilding local biodiversity.

Close the Loop. Closing the loop revolves around making Buiksloterham's short, medium and long term materials recoverable and reusable in their highest quality form possible. Setting up source separation programs and circular building principles are most crucial first steps.

The most urgent actions in these categories are those which directly impact new development and infrastructure investments. The most important of these include:

- Reducing the structural energy demand of new buildings by implementing stringent energy and insulation standards, such as the Passive House standard and energy efficiency plans in all

new constructions;

- Designing roof real estate in all new buildings to handle access and extra weight for water collection and buffering, green roofs, and solar infrastructure;
- Building flexible infrastructure capacity in both buildings and underground, which should include a range of connection options for future expansion. This should ideally include different sewer lines for different water quality types (grey, yellow, and brown water). It should also include both AC and DC lines for in-building electric grids. Underground infrastructure should be collectively planned and coordinated between a number of utility partners for optimized installation cycles. A district heat network should be installed, but the requirement for new constructions to connect to it should be dropped, allowing for developers to solve supply side issues using a broader range of energy technologies;
- Reducing mobility demand by releasing developers from the high parking requirements currently in the area, and investing in additional alternative and shared mobility;
- Planning for and executing natural and above-ground water management techniques.

In addition to these most immediate areas of intervention, some others that should ideally take place over the coming 1 - 5 years are included in the plan. These action points are further detailed in the examplary Action Plan and Interventions sections of the full report.

Research Areas

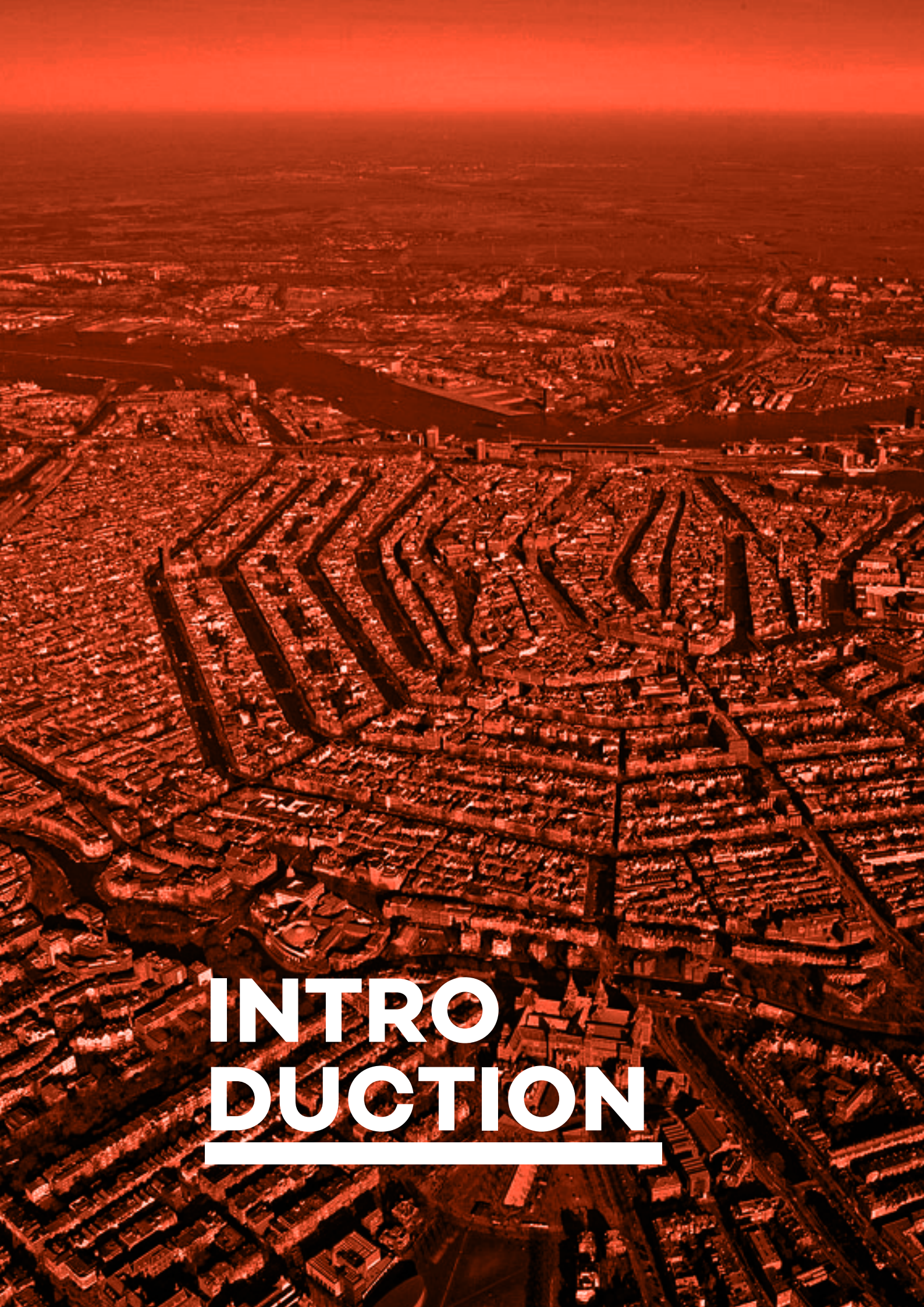
It is clear that many additional research areas remain to work out further long-term aspects of the development plan. Some of the most urgent ones include questions around water infrastructure and separate piping, above ground rainwater management, optimized use of underground infrastructure, nutrient recovery systems from wastewater (local biorefinery), and optimized grid management (AC and DC combined smart grids).

Because some technical decisions need to be taken before full clarity is available on key research questions, we propose erring on the side of designing for flexibility. Though this may lead to some overcapacity of infrastructure in the near-term, it will also preserve essential opportunities for transition to other types of technological solutions as they become available in the future.

Conclusions and Next Steps

In the Vision and Action Plan presented in this report, we conceive of Buiksloterham as an engine for the broader transition of Amsterdam.

A unique development like the one proposed for Circular Buiksloterham requires continuous effort and support from all stakeholders: from residents to research institutes, utilities to developers. Political support and commitment for the ambitions will create a guiding framework for all individuals and organizations active in Buiksloterham; to this end a signing moment with Amsterdam's aldermen and other decision makers will be organized in March 2015. A governance structure should be created as soon as possible to ensure continuous development of the project. Bridge financing will need to be secured from local parties to support the process until larger amounts of funding are secured. A communication plan and online website will help generate traction and transparency about the development. Research and development agendas of stakeholders and institutions like AMS (Amsterdam Institute for Advanced Metropolitan Solutions) should be connected to leverage knowledge and research. Attracting additional funding for the process and interventions will be key to the success of Buiksloterham.



INTRO DUCTION

Buiksloterham has been on the Amsterdam Municipality's radar as a key redevelopment area for over a decade. It is currently slated for large-scale redevelopment from its historical status as an industrial zone into a mixed use area combining industrial, commercial, and residential functions.

The area is five minutes from Amsterdam Central Station on the other side of the IJ river, connected by a free ferry service. The construction of the new "North-South" metro line, which will link the historic center of Amsterdam with the northern side of the river is scheduled for completion in early 2016 and will provide an important means of additional access.

In 2003, the Municipality published a masterplan about the general restructuring of the northern bank of the IJ river towards a mixed-use urban area. Four key neighborhoods including NDSM, Overhoeks, Buiksloterham, and Hamerstraatgebied were targeted under this plan, each of which was slated for very different re-development mechanisms. Notably, the masterplan was never formally approved because of the high costs it would have incurred for the municipality. However, the plan has continued to provide the foundation for the re-development of the area in the four selected neighborhoods.

Overhoeks, which makes up part of the Buiksloterham polder and occupies the former terrain of the headquarters of Shell, is undergoing traditional development. The municipality acquired all 20 hectares of the terrain, which were then fully developed into upscale housing by a private project developer. The neighboring, newly demarcated Buiksloterham area, by contrast, has been designated to undergo a gradual and organic transformation process that leaves room for both small and large actors to invest in development.

This organic approach is experimental in many regards, since the Netherlands has a strong history of integral, top-down, large-scale develop-

1. Stadsdeel Amsterdam-Noord, 2003


Buiksloterham
Nieuwe Houthaven
Houthaven
Oude Houthaven
Floradorp
Sportpark Elzenhagen
Westerdoksdijk
Het IJ
IJ-TUNNEL
Jordaan
DAMRAK
de Wallen
ROKIN
Amsterdam
AMSTEL
Marineterrein
Kattenburg
Wittenburg
Oostenburg
Artis
UvA Roetersteeland
MAURITSKADE
Oosterpark
Rijksmuseum
Amstelcampus
Onze Lieve Vrouwe Gasthuis
Oost
STADHOUDERSKADE

ment. The traditional development approach practiced historically in the Netherlands is very well suited to greenfield developments typical of urban expansions. As the character of development has been shifting towards more re-development, the top-down approach presents several downsides, including higher costs. The current global financial downturn also makes it difficult for government bodies to take on costly and high-risk projects without access to solid financial backing.

A second important shift has been the demand for and perceived need to facilitate bottom-up initiatives. Some express dissatisfaction with the traditional Dutch development model citing the fact that it that leaves little space for individual and small-scale initiatives.[1] This perception has increased with the financial crisis that has stalled many large projects.

The selected approach is inherently more hands-off than what has typically been practiced, and gives different market players a great deal of flexibility. Rather than a typical strict zoning and development plan, the approach for Buiksloterham includes a set of "game rules" for what they wish to develop as long as they follow general guidelines. In this process, pieces of the area are gradually re-developed by actors of varying sizes (from housing corporations to private single-home projects).

This approach poses several legal challenges of its own, as the city is faced with conflicting sets of guidelines regarding encouraging development on the one hand, and enforcing environmental codes on the other.

The 2007 economic crisis had the effect of slowing some of the development plans in the area, as property owners held onto their lots and rental contracts, waiting for better days to invest. The last two years (2012 – 2014) have finally seen a re-emergence of interest in the development of the area after some targeted impulses provided by the municipality (distribution of self-build plots, the temporary easement of some areas to creative industry developers).

As the pace of development looks to be picking up, and interest has continued to grow in sustainable approaches to urban development, the focus on Buiksloterham gained critical mass. On April 11th, 2014, an event on water-related innovation in the city was hosted by Waternet at the Pakhuis de Zwijger, a Amsterdam-based podium for citizen participation. At this event, Buiksloterham was proposed as a key innovation zone for circular urban development in the city. A petition was publicly signed by workshop participants. This led to the current project approach and a desire to develop a more comprehensive sustainability vision and strategy for Buiksloterham.

Project Team

This Urban Metabolism Analysis and Circular Strategy development for Buiksloterham has been commissioned and executed by a consortium of local parties who see great value in using the re-development of this neighborhood as a learning and showcase opportunity. The commissioning parties for the project include:

- De Alliantie, a housing corporation active in the area;
- Waternet, the local water utility;
- Grond & Ontwikkeling, the development agency of the Municipality of Amsterdam.

The executing parties include companies present or active in the area:

- Metabolic
- DELVA Landscape Architects
- Studioninedots
- New Energy Docks
- Amsterdam Smart City
- Frank Alsema

1. Van der Krabben, 2011

Buiksloterham, summer 2014


ZONE


THEIR


DIXI

PROCESS

The Urban Metabolism Scan process.

Urban Metabolism Analysis as a foundation

In this study, we have taken the lens of Urban Metabolism as the foundation for developing a comprehensive understanding what is happening in Buiksloterham and Amsterdam at large. For this purpose, we have used Metabolic's Urban Metabolism Scan methodology, complemented with architectural and landscape analysis conducted by Studioninedots and DELVA landscape architects, and stakeholder interviews conducted by Metabolic, New Energy Docks, and Amsterdam Smart City.

In biology, the term "metabolism" refers to the entire range of biochemical processes that occur within a living organism, including the conversion of food into energy, the chemical facilitation of all activities required for life, and the processing and elimination of wastes. Cities have many parallel functions to a living organism: they also consume and process materials and eliminate wastes. In an Urban Metabolism Scan, we take a detailed look at the inputs, stocks, and outputs related to an urban area. We examine what is driving these flows, the impacts these flows are related to, and how the size and rate of flows is projected to change over time. Beyond just considering physical flows, we also examine socioeconomic flows, like money, data, and the movement of people.

These types of stocks and flows are clearly not the only factors of importance to consider within a complex urban system. However, they are a useful lens for getting a comprehensive picture of an urban area. Most impacts of concern, from social to biological, can be traced in some way to flows of material or value. Even though we are looking through the perspective of materials, we come to understand opportunities for systemic interventions that also relate to socio-economic and ecological factors within the area under examination.

Process steps

The purpose of an Urban Metabolism Scan is to

understand the full workings of an urban area from an integrated perspective. This includes energy and material flows, biodiversity, environmental conditions, socio-economic factors, an assessment of local stakeholders, policies and strategic plans, and the health and wellness of individuals living in the area. There are three overarching analysis steps included in the Urban Metabolism Scan process:

- Context analysis: what are the current activities, strategies, plans, initiatives, goals, policies, and other relevant aspects already at play within the area? What are the financial and demographic elements at play?
- Stakeholder analysis: understanding the stakeholders in an urban area – who are they, what are their interests, what are their points of ownership and investment, what is their vision for the area in question, how are they interested or able to participate in proposed local activities?
- Metabolism analysis: what are the current and projected energy, material, ecological, and socioeconomic flows and conditions in the area? What is the local natural and human capital available for transforming the area to a different state?

We have conducted this analysis for the "current state" of Buiksloterham. We have also projected a +20 scenario taking into account how the area will develop with current plans in place. In some cases, we have also analyzed more near-term changes (+5 years).

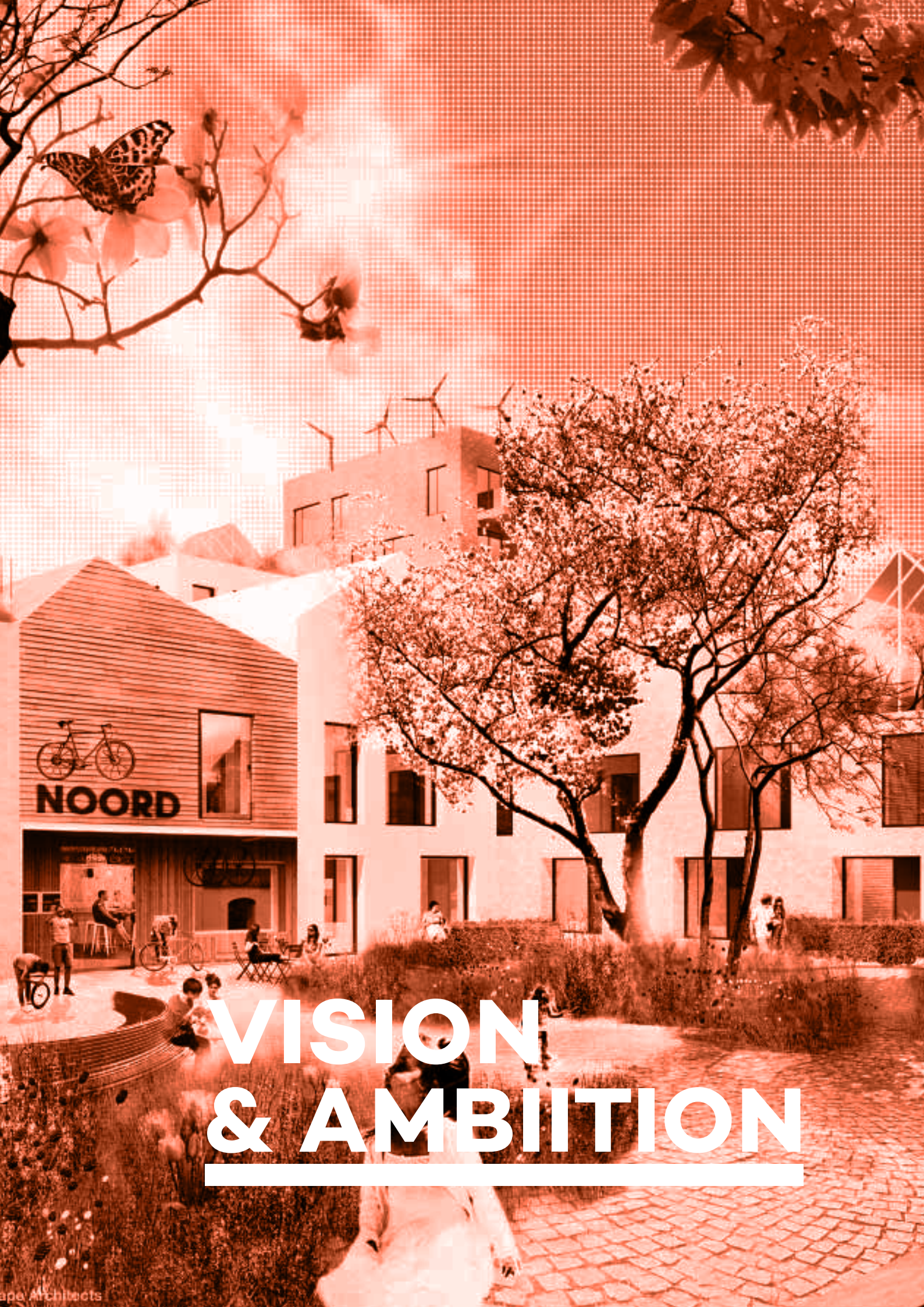
The Urban Metabolism Analysis section of the full report contains the results of the overall analysis conducted for both the current state and the +20 business as usual (BAU) state for Buiksloterham.

Stakeholder engagement

The combined results of the analysis phase were used as inputs for two stakeholder sessions. The first stakeholder session was held on September 16th 2014. Participants were selected based on the results of the stakeholder analysis. Over 40 key stakeholders were invited to participate, including parties that invest in the local area, such as housing corporations and the municipality, local entrepreneurs, and advisory groups. The session offered participants to first brainstorm about five key challenges in the area, after which a selection of ideas was worked out on innovation canvasses. Within one afternoon, this session resulted in more than 300 ideas and 20 worked out plans.

Based on this broad harvest of ideas for a Circular Buiksloterham, the interventions were further worked out by the project team and modeled for their feasibility. A sub-section of these ideas was used to develop the vision and goals for the area.

A second stakeholder meeting was organized on October 2nd, 2014, where twelve key decision makers were present. Here the groundwork was laid for the execution of the vision. The group expressed general enthusiasm for the Circular Buiksloterham project and its direction, and stated the intention to further discuss governance structures and investigate securing full commitment to the long-term goals. The next step is to secure agreement on the scale and scope of ambition as well as the necessary course of action. A manifest will be signed by key stakeholders in March 2015.



VISION & AMBITION

Walking through Buiksloterham in 2034, visitors and residents find themselves in a vibrant, green neighborhood bustling with activity. The area has become one of Amsterdam's tourist hotspots because of its unique architecture, urban experiments, and its pioneering status as a circular development zone. Its designation as a Living Lab has attracted young entrepreneurs and creatives from around the Netherlands and abroad. It is now known for its strong "maker-based economy," which largely emerged because of Buiksloterham's reputation for the freedom to experiment.

The desolate feel of an industrial zone that dominated the neighborhood until the late 2010s has long since faded away, despite the fact that the area now has more industrial activity than it did before its redevelopment. The massive blocks of warehouses progressively filled in with smaller streets full of human-scale architecture, cafes, businesses, workshops, and recreational areas. What used to be fenced-off, abandoned plots were all re-purposed for functions that included bioremediation activities. One of these plots now famously hosts the local Biomakery,[1] a greenhouse-based biorefinery that recovers nutrients and resources from local organic wastes. A large part of this facility is publicly accessible and serves as a covered park.

Hub for innovation and green industry

Though it looks radically different than it did in the past, some aspects of Buiksloterham's industrial heritage have remained through its redevelopment transition. "New-industrial" businesses, like Urbania, Europe's first urban mining center, 3DPrintery, an on-demand manufacturing facility, and ReTex, a local fashion hub using only remanufactured and recycled textiles, have all provided new jobs in the area.

Ever since zero-impact and bio-passive industrial processes became the widely-spread norm, the "new-industry" movement has broadly rein-

1.Biomakery is a term used by Hungarian-based company Biopolus to describe their biological wastewater treatment facilities. We are investigating the feasibility of placing one of BIopolus's Biomakeries or a similar solution in Buiksloterham.

troduced productive industries back into cities. Aside from stimulating the local economy, these types of businesses have also played an integral role in closing urban material cycles. With the presence of a local manufacturing sector, many of the lower-value material waste streams that it would not make economic sense to transport over long distances, can be reused locally.

The dynamic character of the technology landscape in Buiksloterham has also attracted hundreds of small companies to the region. It has been 15 years since BSH Labs opened in 2019. Even in its early years, it was heralded as one of Europe's premier urban innovation programs. With the fastest fiber hub in Europe, it was quickly identified as an attractive destination for ambitious IT companies. Since 2019, it has supported the commercial success of over 500 companies in the fields of cleantech, IT, and biotech applied to the urban metabolism. Visitors and residents experience the Living Lab threaded throughout the neighborhood; experiments in progress are identified by three vertical dots, signifying an Amsterdam in transition.

Zero-emissions mobility

Since 2020, Buiksloterham has been a combustion-engine-free area. What started as a series of experiments around alternative mobility led to a permanent trend on the neighborhood streets: different electric, hydrogen, and fuel-cell powered vehicles are a common sight, and have spread to neighboring areas.

Cyclists flow down from an elevated bike path on their way to work, covered from the rain by solar panels and vegetation. The Zonneweg path, which has become a recognizable symbol of Circular Buiksloterham, connects de Buiksloterweg ferry through Buiksloterham with NDSM and the new metrostop at the Johan van Hasseltweg.

The hydrogen micro-port on the banks of the IJ river is a central logistics hub for transporting biological food into the neighborhood and bringing nutrients and local products back out. It is also used for freight transport for local industries, shops, and restaurants. Construction of the micro-port was an important step without which Buiksloterham could not have become a zero-emissions zone. Canal boats filled with tourists also unload here in the middle of their trip, taking a moment to refuel and giving tourists a chance to explore the nearby bustling market.

Circular Buildings

Since 2017, almost all buildings in Buiksloterham have been constructed based on the neighborhood Circular Building Standard. This voluntary standard was broadly adopted by local developers because of the tax credits that were offered in exchange. The program is generally seen as the single major factor that has allowed Buiksloterham to become fully energy self-sufficient using local renewable energy. Because all new buildings were required to reach Passive House standard, the total energy demand of the area was permanently reduced by over 30 percent.

In Buiksloterham's Circular Buildings, all materials are recorded in a digital passport for easy identification and valuation at the end of the buildings' useful life. The use of standard-sized construction elements facilitates reuse of all building components. Buildings that are refurbished or demolished in the area are harvested for components by the team at The Urbania, the local Urban Mining company, which has a special section for building materials. This practice has led to a 25% decrease in overall material demand in Buiksloterham over the last 10 years.

One of the local developments was designated a showcase testing zone for alternative building materials. The buildings on this plot all feature some kind of unusual construction elements, like walls made of mushroom mycelium (the roots of mushrooms) or new Phase Change Materials used in roofing. In addition, there is a rotating test plot where architects, developers, or other interested visitors, can come and take a look.

Zero-Waste Neighbourhood

One of the most remarkable aspects of Buiksloterham has been its success at closing the loop on nearly all local material cycles. Recycling rates are at near 100%, the use of packaging has been minimized, nutrients are recovered from organic waste, and all buildings are designed for material recovery.

This success was largely, but not only, facilitated by the Circular Building Standard. As part of the Standard, larger buildings were required to offer product sharing facilities with common household items like tools. This led to a reduction in overall product throughput, as people were able to easily share items that they only need infrequently.

Several stores in the area adopted "zero-waste" targets, and a zero-packaging local food

Picture above:
"An Eco-City in Sweden"
Creative Commons BYSA
by La Citta Vita (Flickr)

co-op delivers fresh and healthy food twice a week through the local collection point in the micro-port.

Another key factor in successfully achieving the zero-waste neighborhood goal has been an effective waste management strategy, which has allowed for the very pure recovery of waste cooking oils, plastics, textiles, electronics, metals, and most other recyclable materials.

One of the landmark features of Buiksloterham that has been instrumental in closing the local material cycle is the Biomakery. This greenhouse-covered biorefinery allows for the recovery of almost all the nutrients in locally generated wastewater and organic wastes. Some of the harvested nutrients are locally reused at the new rooftop-based urban farm, which supplies the zero-waste food coop with salad greens.

A final strategy for making Buiksloterham a truly zero-waste neighborhood is that products manufactured locally are all designed for disassembly, remanufacturing, and optimized material recovery. Though manufacturing companies in Buiksloterham do not have total control over the life cycle of the products they put out into the world, they have all signed the neighborhood Circularity Manifesto, which commits them to putting in their best effort at managing the full life cycle of their products.

Regenerated natural capital

Buiksloterham's polluted soils originally seemed like one of the greatest challenges to the development of the area, but have instead ended up becoming one of the largest local opportunities. Different bioremediation techniques have been applied to the polluted plots, and have been used to grow crops for material and energy production while also cleaning the soils. In some cases, the level and type of pollution permitted other temporary activities to take place on the plots while bioremediation continued, opening

up flexible development options.

With ecological regeneration and the use of natural water management as one of the core strategies of the Buiksloterham's development, the neighborhood has become one of the greenest urban areas in Europe. The absence of most non-permeable surfaces and the green buffering of any remaining roads has given the neighborhood a feeling of a natural reserve.

There have been many community tree-planting schemes, with a focus on native and diverse species, which has resulted in a large increase in native birds and amphibians. As a further strategy in the Circular Building Standard, all buildings have multi-functional roofs for both energy generation and water retention. Almost half of all buildings have some form of green roof or green wall for enhanced water buffering. Though these green surfaces are primarily intended to reduce the load on the natural rainwater management system (Buiksloterham has no underground stormwater sewer) they also have the beneficial effect of creating more habitat space.

Because of the high levels of biodiversity in the area, light pollution reduction measures have been applied to avoid interfering with the behaviors of birds, bats, moths, and other nocturnal species. Of all the things that residents cherish about their neighborhood, this is the aspect that is mentioned most frequently in the bi-annual subjective well-being surveys that all residents complete.

Community and civic participation

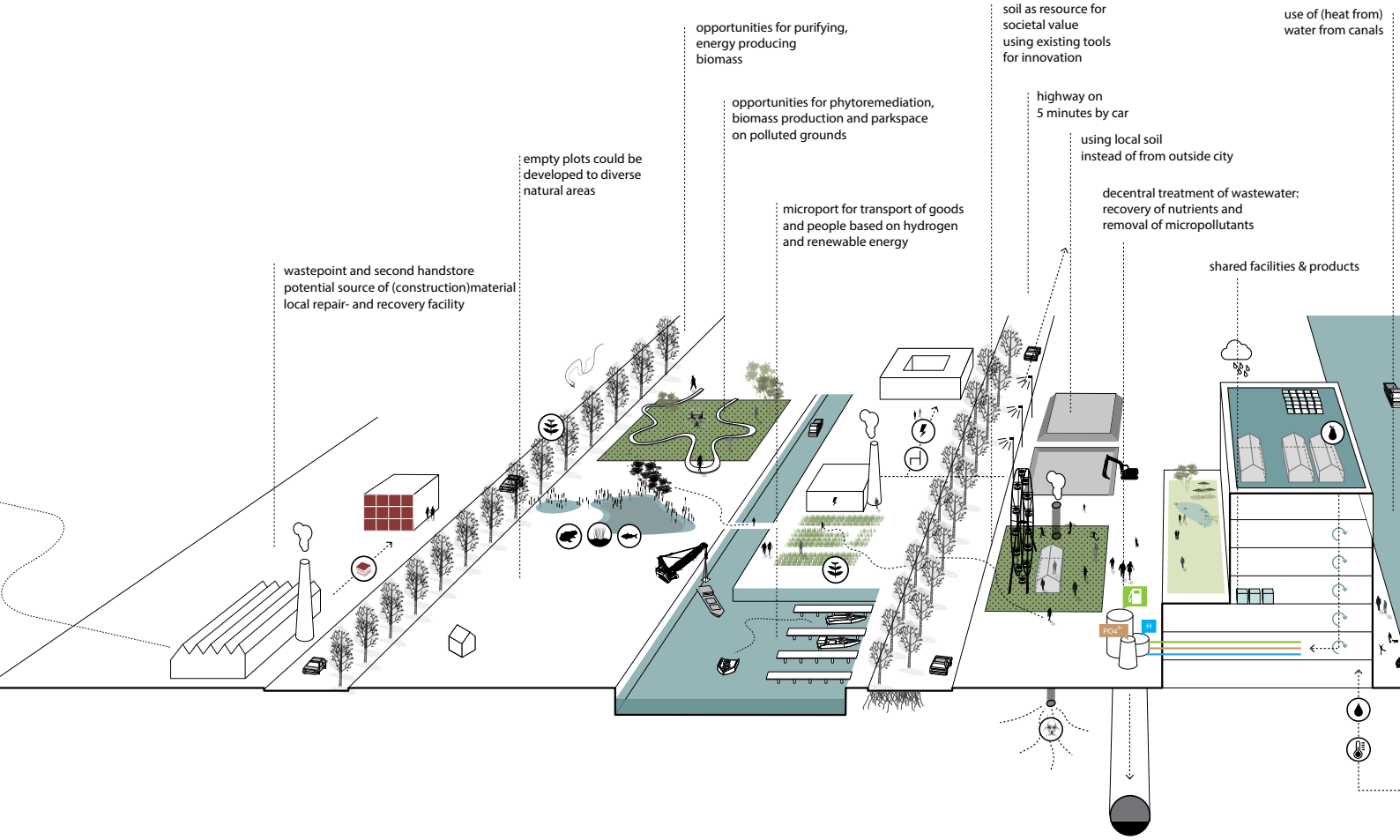
Buiksloterham is well-known for its strong local community; people greet each other on the street, and the communal sitting areas in the trees and parkland are used frequently by groups having evening conversations or children playing. Neighborhood relationships are strengthened through the abundance of shared services and the online community portal, which includes a local time-banking tool. Time-banking has opened up a remarkable parallel economy within Buiksloterham, where people trade skills in addition to exchanging money. Many people partially attribute Buiksloterham's dynamic economy to this local service, because it has given a channel for the essential exchange of expertise between skilled local residents.

Citizens actively participate in the care and governance of the neighborhood. Because of the experimental zone status, anyone with an idea for a new project or use of public space is welcome to submit it. That is how the local currency started, as well as the open repair cafes that are available to all residents. Some younger people in the area have even used these emerging resources as a foundation to start their own businesses. The Handies, a local group of high school students, uses the joint workshop facilities to provide paid repair services for the elderly or those who don't have time to take care of their own repairs. Unlike a formal business environment, the access to these resources create a fluid space for value exchange that does not need large amounts of capital to get started.

International example

From the start of the development, monitoring and tracking of data has been seen as an important objective, which is one of the reasons that a smart water, energy, and air quality monitoring grid was one of the first local investments. This sensor network shows real-time urban data on the neighborhood online portal, and has allowed the entire community to observe and participate in Buiksloterham's progress towards its long-term goals.

Communication has been an essential part of the unfolding story of Buiksloterham. The data collected and lessons learned have become a resource for other urban areas in the midst of similar transitions worldwide.


wastepoint and second handstore
potential source of (construction)material
local repair- and recovery facility
empty plots could be
developed to diverse
natural areas
opportunities for purifying,
energy producing
biomass
opportunities for phytoremediation,
biomass production and parkspace
on polluted grounds
microport for transport of goods
and people based on hydrogen
and renewable energy
soil as resource for
societal value
using existing tools
for innovation
highway on
5 minutes by car
using local soil
instead of from outside city
decentral treatment of wastewater:
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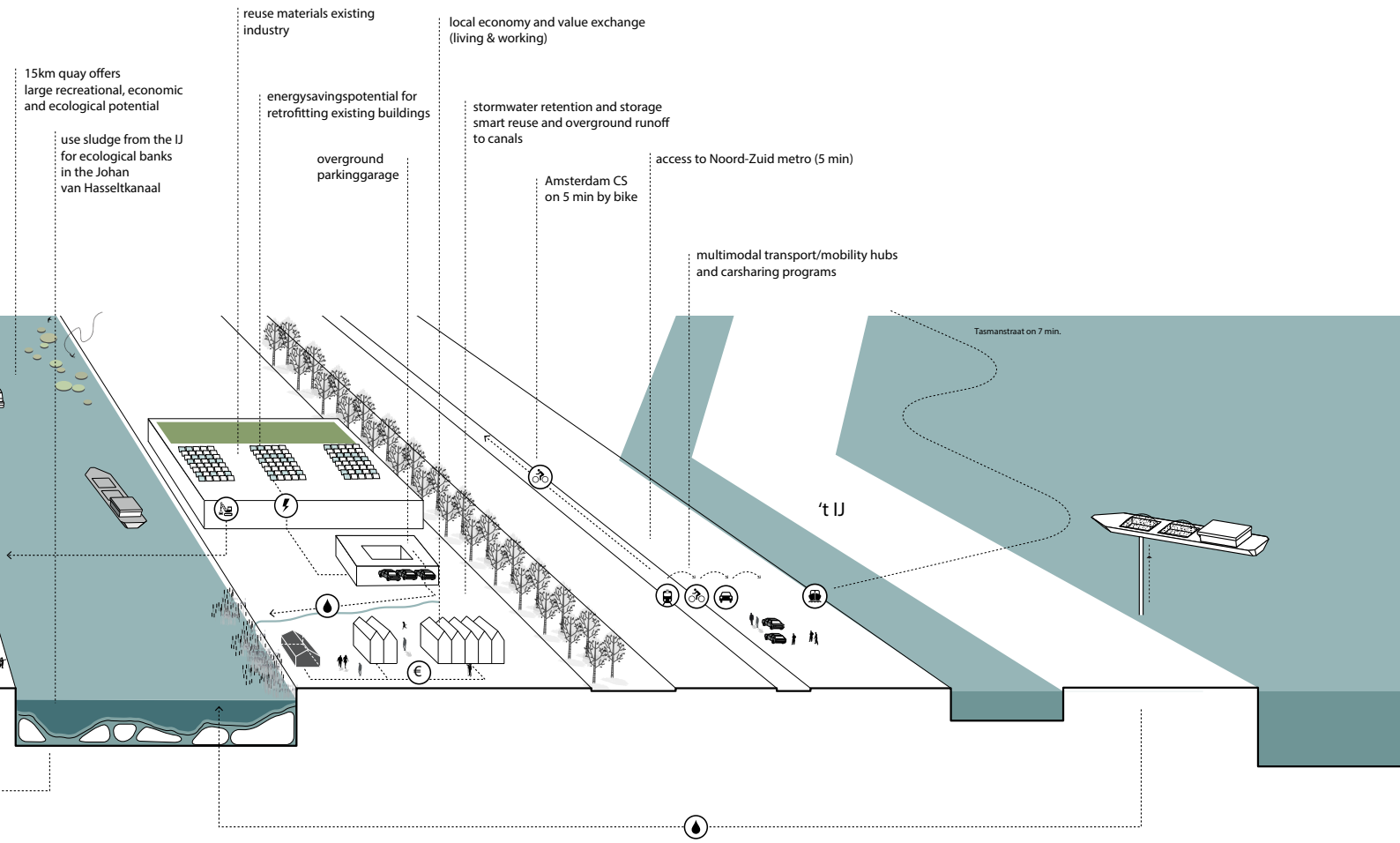
removal of micropollutants
shared facilities & products
use of (heat from)
water from canals


reuse materials existing industry
local economy and value exchange (living & working)
15km quay offers large recreational, economic and ecological potential
energysavingspotential for retrofitting existing buildings
stormwater retention and storage smart reuse and overground runoff to canals
use sludge from the IJ for ecological banks in the Johan van Hasseltkanaal
overground parkinggarage
access to Noord-Zuid metro (5 min)
Amsterdam CS on 5 min by bike
multimodal transport/mobility hubs and carsharing programs
Tasmanstraat on 7 min.
't IJ

AMBITIONS

energy

BUIKSLOTERHAM HAS A RENEWABLE ENERGY SUPPLY WITH MOSTLY LOCAL PRODUCTION

- **Total projected energy demand is reduced by 75%**
  - Projected building-bound energy demand in new buildings is reduced by an average of 60%
  - Projected building-bound energy demand in old buildings is reduced by an average of 30%
  - Projected local mobility energy demand is reduced by 50%
  - Other projected energy demand is reduced by 50% (public lighting, grid losses, etc.)
- **100% of the remaining energy demand is supplied with renewable sources**
- **Local energy production is maximized, reaching at least 50% of total demand**
- **Energy distribution system losses are reduced by 30%**
- **Buiksloterham has a smart energy management system that includes monitoring & feedback, a local smart grid, and the use of electric vehicles for electricity storage**

products & materials

BUIKSLOTERHAM IS A ZERO WASTE NEIGHBOURHOOD WITH A CIRCULAR MATERIAL FLOW

- **Household and office material demand is reduced by 50% over projected numbers**
- **New buildings are designed for near 100% material recovery (Circular Buildings)**
- **Less than 1% of the waste from Buiksloterham is incinerated**
- **Reuse and recycling rates have a target of near-full material recovery (99%)**
- **Products manufactured in Buiksloterham are designed for reuse & recovery**

water

BUIKSLOTERHAM IS RAINPROOF AND HAS RESOURCE RECOVERY FROM WASTE WATER

- **All rainwater is managed above ground with the capacity to handle heavy peak rainfall without flooding or nuisance; Buiksloterham is a "rainproof" part of the city**
- **Domestic & commercial water demand is reduced by 25%**
- **Different quality levels of water are matched to different end uses: drinking water is used intelligently for only high quality functions**
- **Wastewater is mostly source separated; heavily polluted water is not mixed with lightly polluted water (ideally, yellow and black water are collected separately)**
- **Most of the total nutrients and other resources from wastewater are recovered in usable form with a target of full recovery; heat should be recovered from wastewater where possible & sensible**
- **Most of the micropollutants from wastewater are fully removed**

BUIKSLOTERHAM'S ECOSYSTEMS ARE REGENERATED AND ITS BASE OF NATURAL CAPITAL IS SELF-RENEWING

- **50% reduction in soil pollution over 2014 levels by 2034**
- **100% increase in biodiversity (measured through the number of unique species in the area)**
- **Buiksloterham is a zero-emission neighbourhood by 2020**

ecosystem & biodiversity

INFRASTRUCTURE IS DESIGNED FOR FLEXIBILITY AND MAXIMUM USE, AND LOCAL MOBILITY HAS ZERO EMISSIONS

- **100% elimination of combustion engines by 2020**
- **Buiksloterham has a flexible infrastructure plan that can grow and adapt to increasing user demand without overcapacity**
- **Overall energy demand for vehicle-based transport is reduced by 50% over BAU**
- **Projected parking spots are reduced by 50%**
- **Underground infrastructure is implemented at minimum and only when necessary**
- **Utility parties combine efforts, improving the efficiency in construction, maintenance, and operation wherever possible**

Infrastructure & mobility

BUIKSLOTERHAM HAS A DIVERSE AND INCLUSIVE CULTURE, AND THE NEIGHBOURHOOD RANKS HIGH ON LIVABILITY METRICS

- **Streets are lush with vegetation that increases ecological and economic value**
  - Sufficient number of trees per 100m to enable hydrological buffering and ecological corridors
  - High green surface per m2
  - Vegetation monitoring is implemented through remote sensing
- **Low crime rates (Popsicle index)**
- **Cost of living is affordable for all residents**
  - Housing and transportation make up less than 40% of a household budget
  - Housing and Affordability Index: Families earning medium income should be able to afford a median-priced home.

socio-cultural

economy

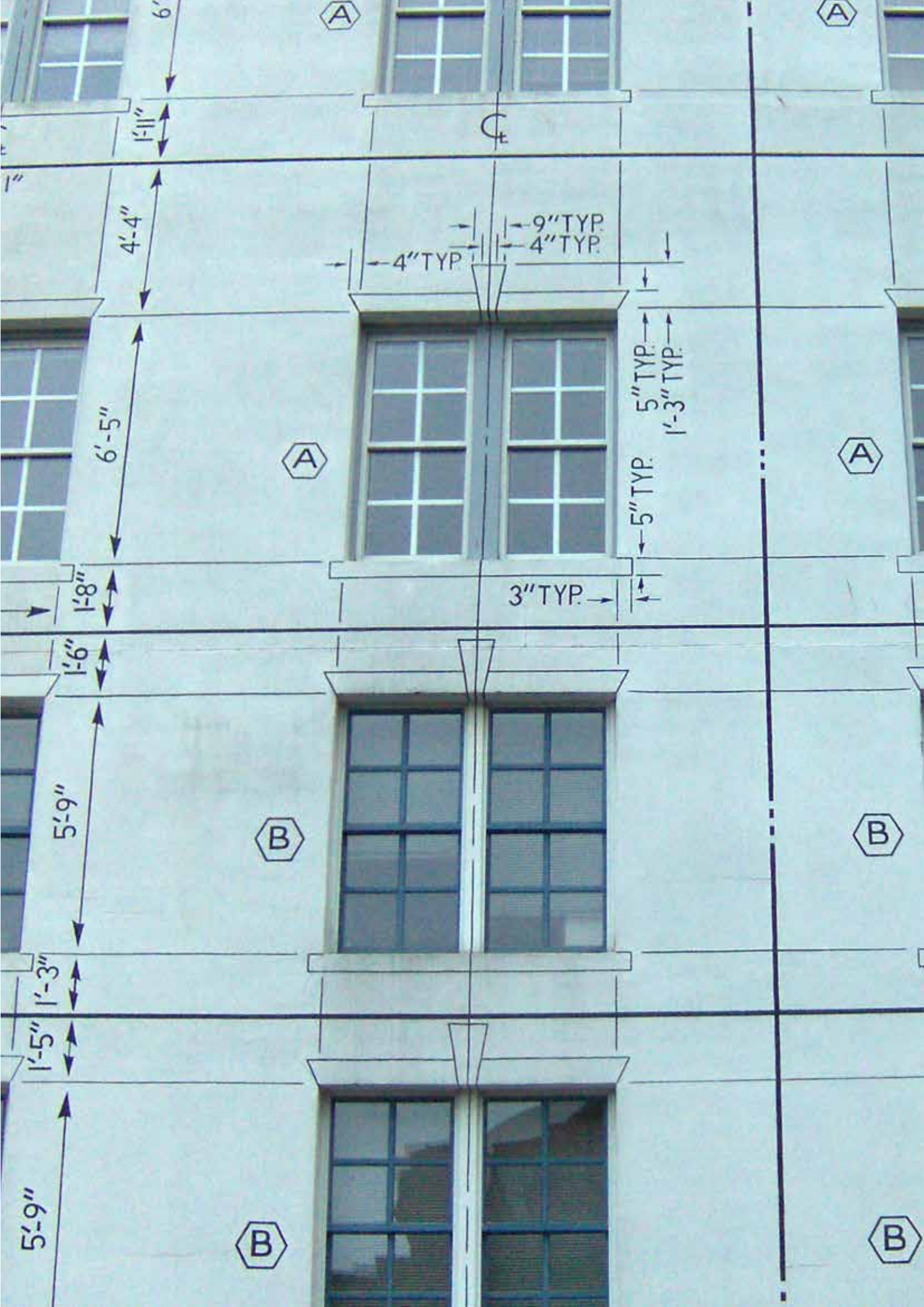
BUIKSLOTERHAM HAS A STRONG LOCAL ECONOMY THAT STIMULATES ENTREPRENEURSHIP AND ENCOURAGES THE CREATION AND EXCHANGE OF MULTIPLE KINDS OF VALUE (SOCIAL, ENVIRONMENTAL, CULTURAL)

- **The region's General Progress Indicator (GPI) score is positive (> 0)**
- **Local unemployment is below the national and regional average**
- **Ecological footprint per euro generated is monitored**
- **Economic flows are monitored for how much capital is re-invested in the local economy**
- **Value flows are monitored for how much value is traded through non-monetary exchange**

health & wellbeing

BUIKSLOTERHAM IS A HEALTHY, SAFE AND ATTRACTIVE ENVIRONMENT WITH RECREATIONAL ACTIVITY SPACE FOR ALL RESIDENTS

- **Residents have high score on a bi-annual Subjective Wellbeing Survey**
  - The survey gathers the responses of at least half the residents, for example through mobile based messages
  - The Wellbeing Survey measures Eudemonic and Hedonic well-being as well as life satisfaction
- **Residents have a high score on the Gallup-Healthways well-being index**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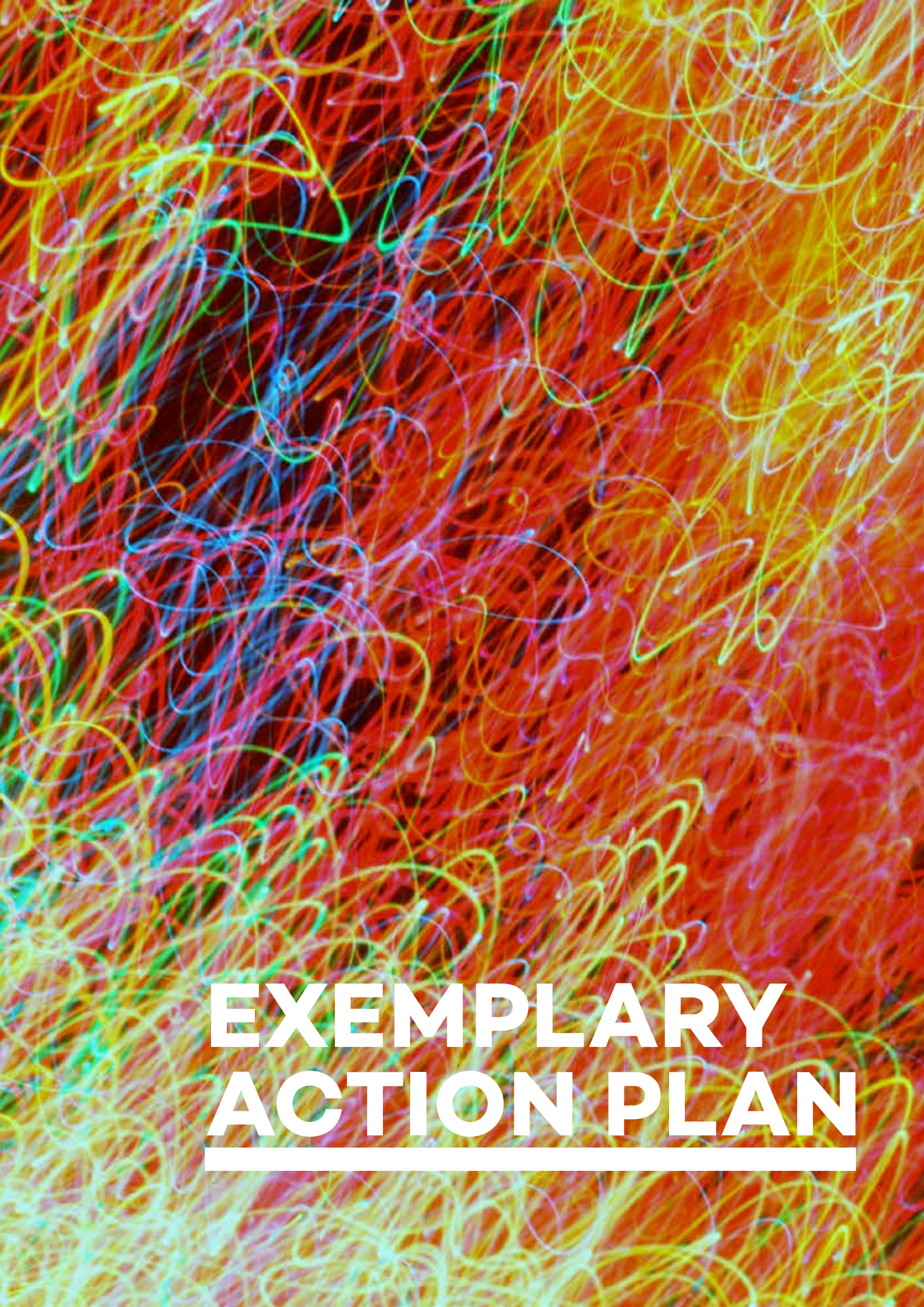

EXEMPLARY
ACTION PLAN

This examplary Action Plan for a Circular Buiksloterham contains an overview of the key activities that need to take place in the near term in order to achieve the vision and high-level ambitions over the longer term.

The high-level performance ambitions for Buiksloterham as a circular neighborhood could apply to most urban developments worldwide because they represent generic standards for a "circular neighborhood" or city. The challenge lies in designing an Action Plan that translates these goals to the context, challenges, and opportunities of this specific area. Some of the unique features of Buiksloterham include: rapid development of new housing, a correspondingly rapid increase in mobility and energy demand, large amounts of surface water and rainfall, and a high percentage of polluted grounds (15%). These, and other contextual features, inform the specific interventions and plan proposed in these pages.

It is important to note, however, that with a long-term development such as Buiksloterham, it is not possible or advisable to provide specific technical interventions for achieving all of the goals over the full development period. The landscape of available technologies will evolve and the costs of existing technologies will fall. The local population will change in its character and needs. Many other factors, from the economy to the local climate, will also change over time. Therefore, specific technical recommendations risk becoming outdated in even short time-spans. That said, because Buiksloterham is developing quickly, with a great deal of construction planned in the upcoming few years or already underway, there are some technical interventions that need to be made now that are based on our current understanding of the situation.

For those technical aspects that require more research, or whose impacts cannot be fully foreseen, there is an urgent need for additional research and modeling (for example: is it feasible to install separate urine collection in new construction?). Because some technical decisions need to be taken before full clarity is available

on key research questions, we propose erring on the side of designing for flexibility. Though this may lead to some overcapacity of infrastructure in the near-term, it will also preserve essential opportunities for transition to other types of technological solutions as they become available in the future. In the case of separate urine collection, our recommendation would be to invest in separate infrastructure to accomodate this, even though it may not be used for several years. Installations of this type during construction can vastly reduce overall investment costs over the full course of the development. Moreover, investing in flexibility now will preserve the experimental character of the area. In general, overcapacity in infrastructure should be avoided to reduce costs, but in a Living Lab context, a premium is placed on the capacity to experiment.

Based on the mix of Buiksloterham's contextual factors, this exemplary Action Plan presents a combination of:

- Systemic intervention options, which address the need for establishing appropriate and long-lasting support structures for the transition to a "circular" state;

- Technical intervention options, which focus on immediate and near-term actions in technology selection that are essential for steering upcoming developments in the direction of the vision.

Finally, though not explicitly included in the proposed Action Plan, we make reference to a number of key research areas, which refer to topics of investigation that should be taken up as part of the further development process. Several knowledge institutes, including the recently established AMS Institute (Amsterdam Institute for Advanced Metropolitan Solutions), are ideal candidates for furthering this work.

The exemplary Action Plan presents an overview of both the recommended systemic and technical interventions. These are described in broad strokes: detailed execution strategies are needed for the success of each one. Some additional detailing and case studies for the proposed actions is included in the "Interventions" chapter of this report.

Systemic Interventions

There are five primary systemic intervention categories proposed in the Action Plan:

- Designate Buiksloterham as an official "Experimental Zone" or Living Lab;
- Establish inclusive governance structures for managing the further development of the area
- Implement new financial vehicles and incentive structures for investment in the long-term goals;
- Invest in urban sensing and open data infrastructure;
- Draft and implement a Neighborhood Action Plan that translates the goals to everyday actions for a range of local stakeholders.

The Living Lab status is necessary for establishing the overall character of the neighborhood as a place where new technologies and management approaches can be applied and learned from. It is also instrumental in releasing developers and residents in the area from some legal restrictions that currently prevent the use of new materials and clean technologies in construction.

There must be an inclusive governance structure with a push and pull mechanism that can drive forward the larger ambition of the development plan. These structures are pivotal for both implementing a circular Buiksloterham and giving citizens and other stakeholder groups a consistent and significant role and voice in the process.

New vehicles for investment that take into account the broader ambitions of the area in addition to financial returns are a prerequisite for successfully achieving the vision. Several

options for such financial vehicles exist, including a rotating "Circular Investment Fund" as well as tax break and incentive schemes.

Urban sensing and open data infrastructure are critical for monitoring progress towards the goals, enforcing key directives, and for purposes of research and communication. Investments in the data infrastructure should be made early on in the process to create visibility and buy-in for the local activities.

The Circular Neighborhood Action Plan is a set of resources for local residents and developers that is needed to provide the translation of higher-level goals into everyday activities. Without such a plan (which can include a community web portal, household purchasing guidelines, and other accessible resources), local stakeholders will not have clear guidance on what daily actions they should take.

All of these proposed systemic actions are urgent; they provide the fundamental infrastructure for the execution of the long-term vision.

Technical Interventions

The overarching Circular Buiksloterham ambitions have been translated into five urgent areas for technical intervention focused around: local renewable energy production, natural water management, soil remediation, smart mobility, and local material cycling. Under each of these categories, we have detailed additional specific action points.

The most urgent of these action areas are those which directly impact new development and infrastructure investments. The most important of these include:

- Reducing the structural energy demand of new buildings by implementing stringent energy demand reduction measures such as the Passive House standard and energy efficiency plans in all new constructions;
- Designing roof real estate in all new buildings to handle access and extra weight for water collection and buffering, green roofs, and solar infrastructure;
- Building flexible infrastructure capacity in both buildings and underground, which should include a range of connection options for future expansion. This should ideally include different sewer lines for different water quality types (grey, yellow, and brown water). It should also include both AC and DC lines for in-building electric grids. Underground infrastructure should be collectively planned and coordinated between a number of utility partners for optimized installation cycles. A district heat network should be installed, but the requirement for new constructions to connect to it should be dropped, allowing for developers to solve supply side issues using a broader range of energy technologies;
- Reducing mobility demand by releasing developers from the high parking requirements currently in the area, and investing in additional alternative and shared mobility;
- Planning for and executing natural and aboveground water management techniques.

In addition to these most immediate areas of intervention, some others that should ideally take place over the coming 1 - 5 years are included in the plan.

Research Areas

It is clear that many additional research areas remain to work out further long-term actions as part of this plan. Some of the most urgent ones include questions around water infrastructure and separate piping, above ground rainwater management, optimized use of underground infrastructure, nutrient recovery systems from wastewater (local biorefinery), and optimized grid management (AC and DC combined smart grids). These are further described at the end of the exemplary Action Plan.

EXEMPLARY ACTION PLAN OVERVIEW

Goal	Intervention Area	Timing
	SYSTEMIC	
	Designate Buiksloterham as an official "Experimental Zone"	t+0
	Establish inclusive governance structures for managing the further development of the area	t+0
	Develop and implement new financial vehicles and incentive systems to support investment	t+0
	Invest in urban sensing and open data Infrastructure	t+0
	Implement a Neighbourhood Action Plan that translates the goals to everyday actions	t+0
	MAKE BUIKSLOTERHAM ENERGY SELF SUFFICIENT WITH A 100% RENEWABLE ENERGY SUPPLY	
	Require all new buildings to reach Passive House Standard or a similar level of insulation	t+1
	Designate 75% of available roof surface area for solar PV (or thermal)	t+1
	Implement electric efficiency standards for all households	t+1
	Retrofit existing office and industrial buildings	t+5
	Develop renewable energy supply, financed by the circular investment fund	t+5
	Pilot a parallel AC / DC smart grid	t+5
	Reduce operational energy demand in remaining industries	t+5
	Actively finance and implement additional renewable energy production	t>10
	MAKE BUIKSLOTERHAM THE SMARTEST AND MOST INNOVATIVE WATER SITE OF THE NETHERLANDS	
	Design and develop above-ground stormwater management systems	t+1
	Implement decentralized water collection and natural buffering zones	t+1
	Install kitchen waste macerators in all new buildings (Neighbourhood Action Plan)	t+1
	Install urine separating infrastructure in all new buildings (Neighbourhood Action Plan)	t+1
	Implement water saving measures in all new and old buildings (Neighbourhood Action Plan)	t+1

EXEMPLARY ACTION PLAN OVERVIEW

Goal	Intervention Area	Timing
	Research the feasibility and potential location of a biorefinery in Buiksloterham	t+5
	MAKE SOIL A COMMODITY FOR SOCIAL VALUE	
	Open the use of polluted ground for temporary functions and bioremediation	t+1
	Selectively raise ground levels for key development areas	t+1
	Design and implement ecological corridors and hydraulic buffers	t+5
	MOBILITY PLAN	
	Reduce the required parking standard	t+1
	Eliminate vehicles with fossil fuel combustion engines in Buiksloterham by 2020	t+1
	Further develop and implement vehicle sharing programs	t+5
	Extend public transport infrastructure over water	t+5
	Strategic bike paths connecting Buiksloterham with NoordZuid metro line	t+5
	Prepare infrastructure for EV charging and other fuel possibilities	t+5
	Infrastructure for zero emission transport of goods	t+5
	CLOSE THE MATERIAL CYCLE	
	Develop and implement appropriate source separation plan & infrastructure	t+1
	Design all new buildings for material recovery and reuse	t+1
	Release the work/residential restriction	t+1
	Implement material recovery programs and repair facilities	t+5
	Implement a zero food waste programs	t+5
	Incentivize zero packaging stores	t+5

SYSTEMIC INTERVENTION OPTIONS

Designate Buiksloterham as an official "Experimental Zone" or Living Lab for applied pilots and ongoing experimentation

Adapting Buiksloterham into a Circular Neighborhood will require a new approach to urban development than the currently practiced norm. New materials, new technologies, new policies, and new kinds of organizational structures will all likely be needed to achieve the ambitious performance goals. There is a broad need to open the opportunity for urban innovation, not only to capitalize on potential efficiency gains, but also to learn and transfer lessons to other urban developments.

Rather than being facilitated, this kind of experimentation and learning is made difficult through the regulatory landscape. Current legal frameworks at the municipal, national, and European level pose significant barriers to adopting new approaches.

Particularly relevant for circular and biobased economy objectives, many such barriers are found around the reuse and recycling of material and waste streams. Many regulations in the Netherlands do not offer a "de minimus" provision, where if a certain activity is conducted at a sufficiently small scale, it is exempted from the heavy restrictions that would apply if it were conducted at an industrial scale. In order to collect and process wastes, for example, companies need to officially comply with industrial waste collection standards, even if the scope of their activities is very small.

An example of where this becomes a meaningful restriction is the use of organic wastes for com-

posting and biodigestion. In the past decade, a number of new technologies have been developed for small-scale biodigestion, a process that allows biogas and nutrients to be recovered from organic waste. Though the appropriate scale for efficient digestion is almost certainly not at a household or even block level, current restrictions make it very challenging for groups like collectives of restaurants, for example, to experiment with the approach. Collecting waste requires specialized industrial permits, the activity classification for a small scale digester does not exist in the environmental code at all, and the storage of biogas beyond a few cubic meters (which has around the combustive capacity of a regular butane lighter), requires further industrial permitting procedures. Most smaller companies or consortia cannot afford or will not qualify for the resulting complex permissions and compliance processes.

Another area of legal restriction is the requirement for new buildings to be connected to certain centralized utility infrastructure systems. Though this law has been instituted for the sensible reasons of ensuring safe and high-quality utility service for citizens, as well as maximizing the use of existing infrastructure, it also reduces the possibility to experiment with alternative neighborhood-scale or smaller solutions. One example particularly relevant to Buiksloterham is the requirement for a large fraction of new constructions in the area to connect to the district heating network. For those wanting to build their buildings to Passive House standard and supply their own hot water through solar heating, eliminating the need for outside sources of heat, this connection to district heating becomes an unnecessary and forced expense.

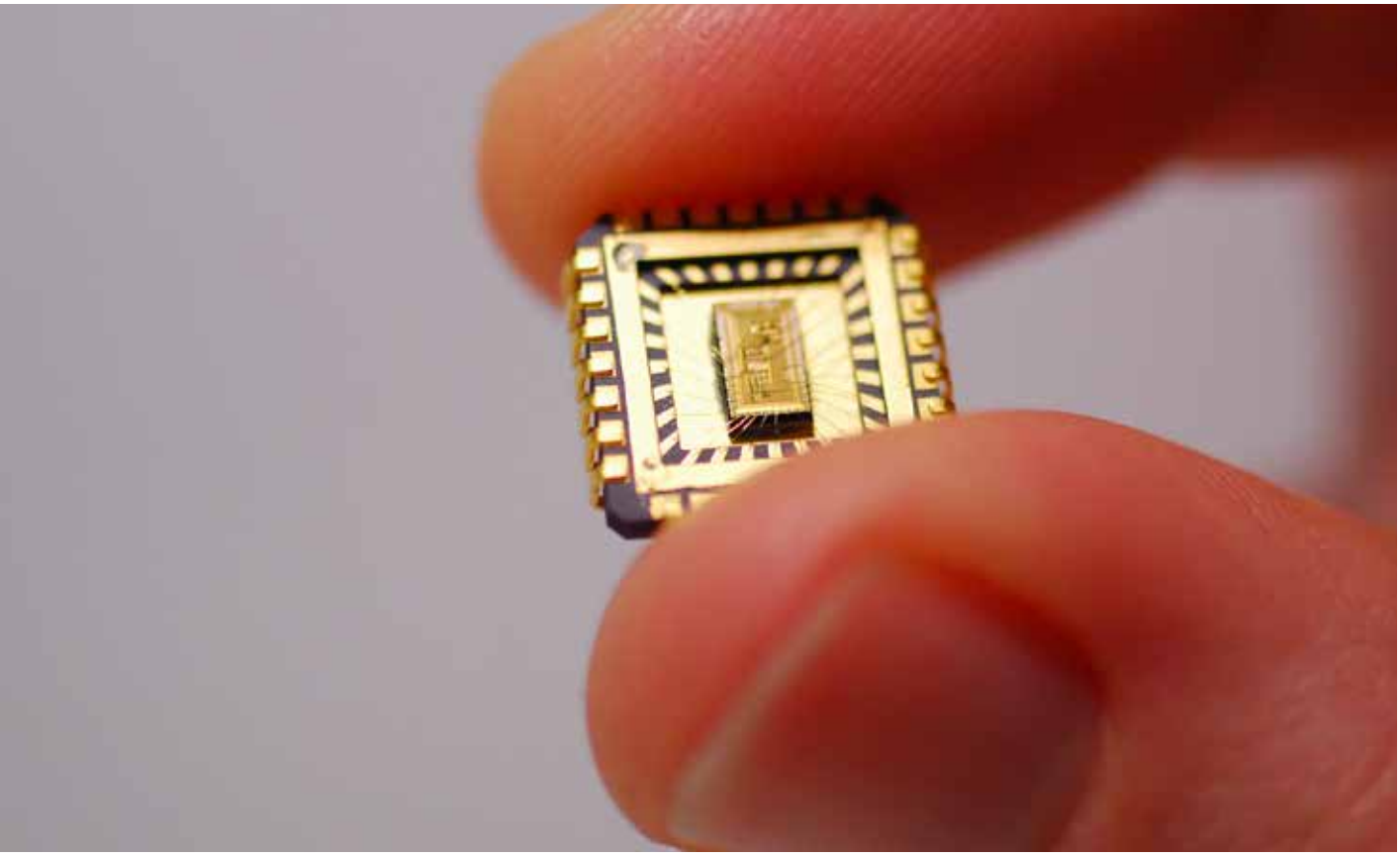
Of course, it is important to uphold the spirit or intention of the law, which largely aims to ensure the safety of citizens. Simply voiding laws in the name of innovation is not a solution. However, it is essential to create an environment that allows for continuous adaptation and experimentation within a framework that respects the original intention of the law.

For this reason, the first systemic intervention proposed here, which is a prerequisite for successfully achieving further goals, is to designate all of Buiksloterham as an official Experimental Zone or Living Lab. The purpose of this designation would be to permit certain activities that have high potential for furthering the circular neighborhood goals and are designated as safe, to be exempt from applicable legal restrictions within the area of Buiksloterham.

There are multiple approaches for achieving this kind of status, and there are examples from around the Netherlands where this has been applied to a greater or lesser extent. The Dutch "Crisis and Herstelwet" is a legal framework that includes a petition option through the Ministry of Infrastructure and Environment (I&M) to allow for innovative experiments. Activating this framework allows for the deployment of specific innovations that contradict the law. A more informal experimental status can be achieved through political support on a local (municipality of Amsterdam) and national level, for example through a Green Deal. These more informal approaches may perhaps be more effective and broad in scope.

The most important aspect of implementing such an experimental status is to ensure that innovation is supported while the original intention of the law is upheld. This means that procedures should be put in place for evaluating the safety and sensibility of proposed experiments. At the same time, the status should be taken advantage of and innovative projects should be encouraged rather than blocked by a new layer of bureaucracy in the form of these evaluation procedures. The knowledge gathered through these experiments should be collected and codified; successful pilots should be scaled in size and copied. To that end, we propose the following possible measures to guide the experimental status in Buiksloterham:

- Develop a simple process through which local stakeholders can apply for a pilot or experiment. Ideally the levels of bureaucracy in this



process should be limited and the decision turnaround time should be fast. Proposed experiments should be evaluated on their relevance to the circularity goals. This process could be open, for example, two to four times per year creating several rounds of evaluation. To encourage experimentation, the process should be well publicized to local stakeholders;

- Put in place an ad hoc safety commission to evaluate proposed experiments. A group of experts from knowledge institutes and local utilities should ensure that the proposed pilots do not pose levels of unreasonable risk. If the project fulfills these safety criteria, then it should be granted legal exemption status from applicable laws. The liability associated with pilots should remain with the organizations or individuals proposing the pilots;
- Create special physical zones where urban experiments can be carried out, evaluated, and visited by the public. This will increase their visibility and encourage knowledge transfer. Not all experiments need to be located in these zones, but this could create an added value for Buiksloterham through creating a visible "testing ground";
- Track and communicate the results of the experiments: identify those that can be scaled. All proposed pilots should have some data collection requirements to evaluate their success'
- Create a process for implementing "policy testing" (for example, a local carbon credit scheme, a local currency). Beyond just encouraging physical interventions, it is interesting to also evaluate policy and organizational innovations. These mechanisms can have even greater systemic impact on the development of an area, and can also yield many copyable approaches. Ideally the local government would take part in this aspect of the experimentation.

Establish inclusive governance structures for managing the further development of the area

Any well-functioning process or organization requires governance. In the case of Buiksloterham, where the responsibility for the develop-

ment is spread over many dozens of stakeholders (largely due to the scattered ownership of the plots in the area), this is particularly important. Another prerequisite for the successful development of Buiksloterham as a circular neighborhood is therefore the establishment of an inclusive governance structure.

The purpose of this governance structure (or structures) should be to maintain oversight, monitoring, and collective enforcement of progress towards the area's goals. The governance system should be designed in such a way that both large and small stakeholders within the area are given a consistent and significant voice in the development process. A key responsibility of the governing body will be to develop both positive and negative enforcement mechanisms (push and pull incentives) for steering local activities towards the goals.

Bottom-up initiatives are an important tool in increasing livability of an area, as residents have insight into what needs improvement and are natural stakeholders of progressive change. Connections between the top and bottom are necessary to achieve the best of both worlds. Left to themselves, bottom-up initiatives can be messy and uncoordinated. Top-down policies should be shaped in such a way that they harbor, nurture, and support the bottom-up initiatives but are able to effectively implement top down policies and broader development strategies. These policies should provide a platform that inspire and motivate citizens to form beneficial initiatives.

A multi-level governance approach would sustain a base for the vision and structure while facilitating effective inclusion of stakeholders who are pushing forward on-the-ground action. There are many ways that such a governance model can be established. One possible set of structures could consist of:

- A steering committee or a similar entity that guards the vision, sets the ground rules, monitors progress, decides on tenders and experiments;
- An area association that includes all stakeholders and facilitates the on-the-ground action;
- A local utility cooperative that can facilitate the investment in larger scale projects for energy production, mobility or nutrient recovery. It can act as a linking pin between residents, utility companies and investment funds to facilitate projects that serve the whole community but require long term investments and have benefits accruing to many different parties.

Develop and implement new financial vehicles and incentive systems to support investment in Buiksloterham's long-term ambitions

One of the most significant prerequisites for a successful development in Buiksloterham is access to capital for investment. Many of the proposed interventions will require both individual and corporate entities to make large up-front investments, particularly in the areas of new building construction, infrastructure, and mobility.
Many of these costs will have good return on investment profiles, but not all. The nature of investing in sustainable and circular initiatives is that financial returns generally have a longer time horizon and a large part of the returns comes back in non-financial form. For this reason, traditional investment vehicles are not necessarily suited to providing the financing for circular development objectives. In order for the Circular Buiksloterham development to be successful, a broader range of financial vehicles needs to be made available. These vehicles should ideally be geared towards longer-term returns, value non-financial returns, and account for externalities (negative external impacts that are typically not valued financially, such as pollution).

The Amsterdam Innovation Fund (AIF) is a good example of a mechanism already successfully employed in Amsterdam that provides very low interest revolving loans to projects that help the

city achieve its Greenhouse Gas (GHG) emissions reduction targets. Within this program, parties can submit project descriptions that include a quantified emissions reduction to qualify for the loan. A similar, but broader approach could be taken with the targets for a Circular Buiksloterham: loans could be given out to projects that achieve a broader range of desired outcomes than just GHG emissions reductions, and include focal areas like natural water management, certain kinds of material recycling, remediation of polluted soils, or increases in local livability standards.

A broader concern within the social investment sphere is the question of how to capture the value of non-financial gains. This is something that can be explored through the Buiksloterham investment program. Just as with GHG emissions reductions, the city has a non-financial goal to achieve a certain level of performance with other social benefits. Because cities or other parties typically pay for these services in other ways, it would be ideal to link these payments to a more decentralized approach. For example, if natural water management requires that individual building owners install green roofs, high-permeability parking terrains, and water buffering systems, it could be logical for a water utility to set aside a budget for these building-level investments. The water utility would otherwise spend money on a centralized water management system to achieve the same outcome: sufficient stormwater management.

It is challenging to find investors with a longer-term time horizon, since even social investors typically look for faster returns. One solution for this problem is to match longer-horizon investments with parties that can potentially them. Partnering with pension funds is an interesting option to explore; they may be able to justify these longer-horizon investments with parts of their portfolio. Development banks that have funds meant to support specific objectives could be another source of capital. Another source of capital for this purpose could be European-level grants for urban development. If such a grant is acquired by Amsterdam, a large part of it could be made available to local stakeholders for investment in achieving the targets. The amount of capital needed to achieve the goals in Buiksloterham is estimated to be quite large. A starting fund of 500 million euros would be a reasonable target amount to begin with, which can be reevaluated as the development progresses.

Aside from providing access to capital, there also need to be other incentive systems, both positive and negative, to help steer the development in the right direction. Rewards of some kind should ideally be provided for measurable progress towards the goals, and disincentives of some kind should be put in place for actions that take the development farther away. An exam-

ple is offering tax credits in exchange for the achievement of measurable targets.

To that end, we propose the following possible actions to create appropriate investment and incentive structures in Buiksloterham:

- Establish a rotating investment fund that can help shoulder the costs of up-front financing for key circular interventions. This fund should be long term focused and allow for the capturing of other types of value. The performance goals of Circular Buiksloterham inform the criteria that are used to select investments. By its nature as a revolving fund, financial capital can be reinvested in new interventions over time. The fund should also be able to carry some risk, which can be achieved by creating a portfolio of interventions with a range of high to low risk profiles and short and long returns on investment;
- Develop and implement a local incentive system that provides rewards and punishments tied to progress towards or away from the circular development goals (taxes, credits, prizes; the exact mechanisms should be further investigated);
- Establish reverse tenders for challenges and goals. Reverse tenders for challenges put forward problems statements that require innovative solutions and allocate a certain budget to achieve those goals. This has been successfully applied around the world to attract innovation, spark civic entrepreneurship, and reduce the costs of interventions (see City Mart and their Barcelona Open Challenge as an example).

Invest in urban sensing and open data infrastructure

Monitoring and communication should be an integral part of the Circular Buiksloterham development. A local sensing and open data infrastructure offers three important opportunities:

- Feedback on intended impacts and a real-time understanding of progress towards goals;
- Behavioral feedback to improve efficiency of services and to make adjusting measures;
- Transparency to Buiksloterham stakeholders and people around the world;

A smart monitoring system should ideally include at least the following elements:

- Building-level monitoring for electricity, heat, and water use as well as indoor air quality
- Waste-generation monitoring either on a building level or at centralized collection points
- Outdoor air quality, light monitoring, and motion sensor stations
- Parking spot sensors
- Energy generation monitoring at all distributed sources (e.g., solar panels) to manage smart power distribution
- Energy storage monitoring at all distributed storage banks (e.g., electric vehicles) to manage smart storage

With this type of network of sensors, smart management systems can be installed over time. For example, street lighting can be dimmed relative to ambient light availability (less street lighting on moonlit nights) or the presence of pedestrians (turn off lights when there are no people within a 200 meter radius). A local app can tell visitors to Buiksloterham where the nearest available parking spot is located to avoid inefficient circling in search of the parking. This kind of monitoring system can become the basis for all kinds of innovative apps that can help better manage the area.

A lack of consistent and high-quality data about the urban environment and its performance is a consistent roadblock to smart urban development. Buiksloterham could also be one of the leading neighborhoods for deploying this kind of data collection. Ideally, this information would largely be made available open source. .Protecting privacy is a matter of aggregating the data so that it can never be viewed on the level of an individual household by anyone but the household's residents.

An online portal such as a Buiksloterham website could host this data, also offering the important function of communicating and tracking neighborhood progress towards the overarching goals (for example, showing real-time data streams of what percentage of local power is coming from renewable sources).

Implement a Neighbourhood Action Plan that translates the goals to everyday actions

Developers, businesses, and citizens within Buiksloterham will continue making decisions on a daily basis that influence progress towards the long-term ambitions presented in the vision. All of these actors will need access to clear and specific guidelines for making these daily decisions in line with the Circular Buiksloterham ambitions. The Neighborhood Action Plan should provide these guidelines.

This Neighbourhood Action Plan can take many forms (physical documents, an online portal with videos, a new construction design tool, lists of local suppliers, etc.). There should be materials targeted at different stakeholder groups that offer specific answers relevant to their situation. For example, the developers' guideline within the Neighbourhood Action Plan should include information on building design and orientation for maximizing passive solar gains, instructions on roof design for water buffering and energy generation, recommendations for electricity-efficient design, and others. It should also explain what access to capital is available for certain types of investments, what types of incentive structures exist, and what goals each proposed action is helping to fulfill. The Neighbourhood Action Plan should be based on this report and the interventions presented here, but should have a great deal of practical detail. We recommend that the most urgent parts of the Neighbourhood Action Plan (e.g., the developers' guidelines), be written and published as soon as possible.

TECHNICAL INTERVENTION OPTIONS

Aside from the systemic intervention options, which form the structural backbone of the circular development of Buiksloterham, we propose five key technical intervention areas that stakeholders in Buiksloterham should commit to acting upon in the near term. They were selected due to their crossover between the following three criteria:

- **High impact:** The business-as-usual development projection of Buiksloterham shows us key areas where we anticipate the highest impacts over the course of Buiksloterham's development. Energy demand in Buiksloterham is projected to be one of the greatest single impacts, and is highly tied to new building and mobility infrastructure design. Much of this impact can be avoided by making different design choices now. Within the Circular City Model, it is also a high priority to close the local nutrient and water cycle for reasons of efficiency and resource preservation. Therefore, another focal area is therefore to design infrastructure that will facilitate nutrient recovery. Building up natural capital by strengthening local ecological function is also essential in the long term to maximize benefits from ecosystems services.
- **Area specific:** Soil pollution, the abundance of water, and the mix of residential, industrial and office spaces are the three most important characteristics of Buiksloterham. They provide unique challenges and at the same time hold the opportunities to change the current and projected path towards a more circular state.
- **Urgency:** To achieve the performance goals for Buiksloterham, a variety of interventions need to put in place. Some require more urgent action than others. To keep things comprehensive and overseeable, only the most important intervention areas have been selected for immediate action. Within each theme, actions are prioritized, from the most urgent actions that need to be implement now to the medium and more longer term actions that need more investigation and support.

This exemplary Action Plan also refers to more fine-grained interventions, which are described in more detail in the technical appendix of the full report.

MAKE BUIKSLOTERHAM ENERGY SELF SUFFICIENT WITH A RENEWABLE ENERGY SUPPLY

A Circular Economy will ideally be based on a 100% renewable energy supply. The shift away from fossil fuels is one of the world's greatest priorities for tackling climate change and creating healthy local air quality. According to the circular city model, energy is one of the cycles that should be closed as locally as possible. Therefore, we should aim for Buiksloterham to be energy self-sufficient with a fully renewable energy supply.

The total projected energy demand for Buiksloterham is 992 million MJ (or 992 Terajoules) per year, which is largely caused by the large heat demand in buildings (32%), followed by mobility energy demand (21%), and the operational energy required by remaining industries (13%). Our calculations have shown that by following an intensive demand reduction program, the total projected energy demand for Buiksloterham can be reduced by 60%. The remaining demand can be largely supplied using local energy generation, though existing technologies will not be able to supply this full density of demand locally; we estimate that solar PV generation will be able to provide up to a quarter of household energy demand. In the longer-term, the goal should be to explore emerging technologies and larger renewable energy installations to fulfill the remaining gap.

Resource management hierarchy

The efficient management of any resource should involve the following general hierarchy of actions, which should be modified based on local context (such as existing infrastructure):

- Reduce: structurally reduce the demand for the resource in question through the design of efficient systems and designs;
- Synergize: make use of available resources and cascades in the area (such as local heat, waste heat, etc.);
- Supply: fulfill the remaining resource demand with renewable and otherwise sustainable sources;
- Manage: implement sensors and monitoring systems for the smart balancing of available resources to avoid waste and provide feedback on usage profiles.

Applying this hierarchy to Buiksloterham, we can clearly see that the largest and most urgent opportunities around achieving this energy-related goal come from taking a different approach to new construction. Second priorities are to reduce the demand for mobility and actively shift to alternative mobility technologies (e.g., electric and fuel-cell-based vehicles) and to optimize energy delivery infrastructure to avoid transmission losses and optimize load balancing.

Performance criteria for new buildings are the highest priority

The majority of the life cycle energy demand of a building is determined in its design phase. Buildings that are designed with their context in mind (smart orientation towards sun and wind, appropriate shading mechanisms, attention to the placement of glazing and openings), can already achieve very large reductions in demand for heating and lighting. Developing electric efficiency plans for buildings (such as efficient lighting plans, passive heat reuse from heat-produc-

ing devices in the home, appliance efficiency guides, etc.) are measures that can further reduce energy demand.

We recommend that the Buiksloterham Neighborhood Action Plan contains detailed guidelines for all developers and self- builders for how to attain maximum energy demand reduction. In particular, moving to Passive House or a similar standard has the potential reduce the total area's projected energy demand by around 30%. For new constructions, building to this standard is estimated to cost around 5% more than a standard construction, which can offer excellent payback times.

New buildings in Amsterdam constructed as of 2015 will already be required to reach "energy neutral" status. However, this does not necessitate all of the demand-side measures that we recommend for Buiksloterham; it requires that energy be supplied from renewable sources, which can also be purchased from the grid. Our recommendations for Buiksloterham include a much stronger focus on demand reduction because of the long-term and structural decrease in impact this implies, and a greater focus on local renewable supply, initially through decentralized solar installations.

Develop a smart mobility plan

The second most significant source of savings over the projected demand is in optimizing local mobility. The most important aspect of this process is to reduce overall personal transport demand through maximizing accessibility to services and ensuring a good mix of living and working zones within Buiksloterham, which can reduce commuter transport. Bike lanes can also be made more attractive by adding green wind-screens and awnings with solar panels that can protect cyclists from the rain.

Vehicle innovation is progressing quickly as battery technology has improved and hydrogen storage for fuel-cell vehicles has been developed. A broader vehicle-sharing can provide on-demand zero-emissions mobility.

Implement flexible energy infrastructure

As with other new developments in the Netherlands, we recommend a natural-gas-free infrastructure. For experimental reasons and in the interest of flexibility, it may still be interesting to lay down a gas infrastructure that could potentially be used for biogas at a later date. The district heating network that is scheduled to be installed in the area can be of great benefit in reducing the impact of energy demand in existing constructions (retrofits may be prohibitively expensive in some cases) and in providing hot water demand. However, we recommend a reduction in the requirement for connecting to the district heat network for new constructions that satisfy their heating energy demand in other passive or renewable ways. The district heat network is primarily fueled by the local incineration plant, and as such does not represent a renewable supply of heat. The infrastructure itself, however, could potentially be used for heat distribution from renewable sources at a later date and for local waste heat reuse.

Another key aspect of infrastructure development is the optimization of distribution and storage. One possible pilot in this regard is the implementation of a parallel DC grid. As generated electricity is converted to AC power, large conversion losses occur. Converting this power back to DC for devices to use presents additional losses. Though it is currently impossible to switch entirely to a

DC grid because most commercial products have now been designed with built-in AC adapters, some equipment, such as lighting and HVAC systems in buildings runs on native DC power. Even just switching these functions, lighting and HVAC, to a parallel DC grid, could save up to 3% of local electricity demand through reduced conversion losses. Solar panels also produce DC power, which could be made available for use with no conversion if such a parallel DC grid is available.

With a broader system in Buiksloterham that includes renewable power generation, electric vehicle batteries, hydrogen generation during peak production times, and a parallel grid, a local smart grid can be designed to optimize transfer between these different system functions.

Significant reduction potential

With the right demand-reduction and energy management strategy, as well as new infrastructure and decentralized energy networks, the demand can be reduced significantly. It is estimated that at least 60% of the predicted energy demand can be reduced for Buiksloterham with proven interventions. The remaining energy should be provided with locally produced renewable energy (wind, solar) on roofs, in public spaces, and within households, as well as alternative, renewable fuel production (hydrogen, biomass, biogas).

energy

Buiksloterham is energy self-sufficient with a fully renewable energy supply

10% TWO 2,5 MW WIND TURBINES INSTALLED

4% 3 HA SOLAR PARKING LOTS CONSTRUCTED

1% 4 KM SOLAR BIKEWAY IS CONSTRUCTED

BSH BIOMAKERY PRODUCING BIOGAS & HYDROGEN

DEVELOP RENEWABLE ENERGY GENERATION PLAN

24% 75% OF BUILDINGS HAVE SOLAR PV +HEAT INSTALLED

40% REMAINING DEMAND SUPPLIED THROUGH OTHER RENEWABLE TECH

DESIGN & IMPLEMENT DC MICRO SMART GRID 6%

DESIGN & IMPLEMENT ALTERNATIVE MOBILITY PLAN 13%

ALL NEW CONSTRUCTION ADHERES TO ELECTRIC EFFICIENCY PLAN 2%

EVALUATE & EXECUTE ENERGY RETROFITS FOR EXISTING BUILDING STOCK 17%

ALL NEW CONSTRUCTION IS BUILT TO PASSIVE HOUSE STANDARD 29%

SYSTEMIC & PROCESS INTERVENTIONS (EXPERIMENTAL ZONE, BSH COOP, INVESTMENT FUND)

2015 2020 2030 2035

TOTAL DEMAND REDUCTION RELATIVE TO BAU SCENARIO 60%

TOTAL RENEWABLE SUPPLY OF REMAINING DEMAND 100%

MAKE BUIKSLOTERHAM A SMART INNOVATIVE WATER SITE

The proposed water strategies for a Circular Buiksloterham include two main components:

- Natural water management and the smart use of collected water
- Effective treatment of waste of wastewater for nutrient recovery and micropollutant removal

Buiksloterham is a neighborhood with many canals and a lot of surface water, meaning that natural water management without underground stormwater sewers should be feasible and economically beneficial. Natural water management can enhance biodiversity and enable rainwater reuse for low-grade applications like irrigation. It requires additional buffering and storage capacity on dedicated public and private surfaces. One challenge for achieving natural water management in Buiksloterham is the nature of the local soils, which are primarily clay-based. This means that they have naturally low permeability. However, this does not mean that natural water management is not possible: it may simply require more surface level management strategies as well as the construction of buffering zones and "water features" that fill up during times of heavy rainfall. One example is Rotterdam's "water square", which serves as a natural water buffering zone while also providing a social recreation space during dry periods. A further, detailed investigation of the total buffering capacity and the possible locations for such buffering zones is a prerequisite step for developing this plan.

Wastewater is a resource containing energy, nutrients, metals, and valuable trace elements. One of the key challenges of the 21st century is to effectively and economically recover resources from wastewater. Micro-pollutants must be removed, which can be done effectively when biologically treating undiluted flows. The technology largely already exists but must be tested and implemented on larger scales. Increasing the nutrient content of water and making source separation easier implies instituting the maceration of kitchen waste and urine separation as key strategies. An objective is to create such a new infrastructure that can support nutrient recovery in preparation for decentralized biorefinery and other infrastructure that enables not only a more effective treatment of waste but the harvesting of valuable resources.

water

Buiksloterham is rainproof & has full resource recovery from wastewater

DESIGN & BUILD BUIKSLOTERHAM
DECENTRALIZED BIOMAKERY / WWTP

RESOURCE RECOVERY &
100% MICROPOLLUTANT
REMOVAL

90%

ALL NEW BUILDINGS HAVE SEPARATE URINE
COLLECTION INFRASTRUCTURE

saves 73.000 m3 water/yr 9.000 kg struvite / yr

ALL NEW BUILDINGS HAVE KITCHEN MACERATORS
OR SEPARATE COLLECTION

662 tons organic waste recovered / yr

BUILD WATER COLLECTION &
NATURAL WATER BUFFERING

rainwater used for low-grade applications

DESIGN & IMPLEMENT
STORMWATER FREE
INFRASTRUCTURE

cost savings & ecological benefits

ALL NEW CONSTRUCTION IMPLEMENTS WATER SAVINGS MEASURES

both water & energy savings

SYSTEMIC & PROCESS INTERVENTIONS (EXPERIMENTAL ZONE, BSH COOP, INVESTMENT FUND)

2015 **2020** **2030** **2035**

RESOURCE RECOVERY
FROM ORGANIC WASTES — 90%

MICROPOLLUTANT
REMOVAL — 100%

25% WATER USE SAVINGS,
WITH 2% ENERGY SAVINGS — 25%

RAINPROOF — 25%

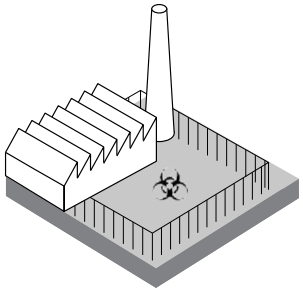
MAKE SOIL A COMMODITY FOR SOCIAL VALUE

Soil is a very slowly renewing resource; it builds up over centuries with the deposition of organic matter, and slowly becomes a living network of organisms. It is the foundation of all terrestrial ecosystems: the origin of all plant life, and a rich ecosystem of its own. Without healthy soils, the basis for biodiversity is undermined, creating a broken link in an essential value chain that includes humans and our food supply. For this reason, it is essential to restore soil as a usable commodity: not just for the coming two generations, but for many to come.

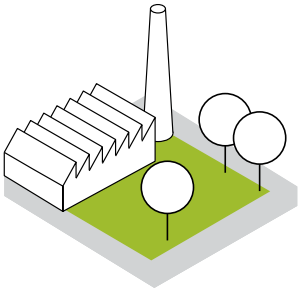
The polluted grounds of Buiksloterham are a key characteristic of the area. Conventional engineering-based remediation techniques are expensive, energy intensive, and result in displaced toxicity. Many areas in Buiksloterham are closed off by fences because of their polluted soils. These will either be capped or mechanically remediated. Within the plan for a Circular Buiksloterham, it is essential for these polluted soils to be returned to a long-term usable asset for both people and other local species. The currently vacant lots can also be given temporary functions that combine remediation with other socially valuable activities, or become areas for biomass production for energy and products.

In this plan we recommend selectively opening up certain polluted lots (ones with less dangerous pollution to people), for activities that combine social or business functions alongside biological treatment. Different kinds of in-situ biological treatment for soils exist, and more are emerging through research. Though phytoremediation (the use of plants to clean soils) is one of the better-known biological treatment techniques, it is a very slow process. More effective and faster methods include mycoremedation (the use of fungi to clean soils) as well as various forms of bacterial remediation using selected bacterial strains. Phytoremediation can be interesting when used on less-polluted soils and combined with biomass production. For example, certain lots can be used as bamboo or willow production zones for either fuel or even building materials. This can remove pollutants from the soil while also producing additional valuable products. The pollutants contained within the plants themselves will depend on the nature of the contamination as well as the types of plants used. The life cycle of the toxins should be managed: if they end up in the plants, then the removal of ash after combustion should be part of the management plan.

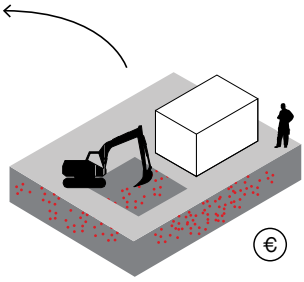
A challenge around the use and recovery of these polluted soils is the scattered ownership of the plots. A first step would be to make a comprehensive plan around the temporary use of the different lots, and engage the plot owners in the process. If properly executed, the combined bioremediation and temporary function approach can provide benefits to all parties: local residents, plot owners, as well as the city.



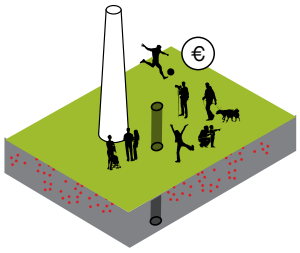
Polluted grounds are inaccessible and take a lot of space



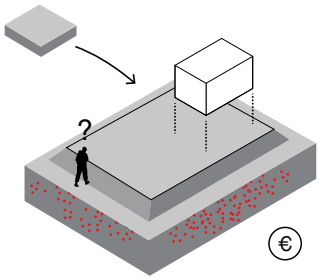
Phytoremediation or biological treatment in combination with biomass production



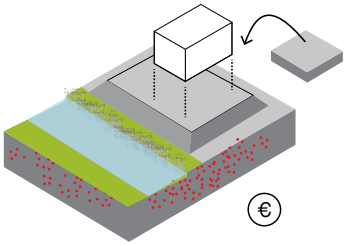
Traditional remediation: the soil is dug away or covered



Creating societal value through tendering for innovative concepts



Traditional development brings clean soil from elsewhere to heighten ground and cover pollution

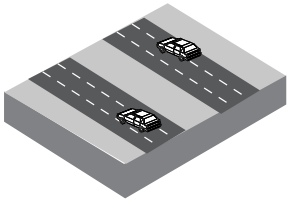


Selective raising with clean soil from within Buiksloterham

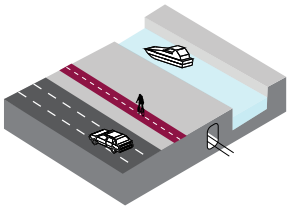
PLAN FOR SUSTAINABLE MOBILITY

Under the +20 business as usual scenario, motor vehicles (cars and trucks) create the second highest energy demands in the area. Mobility in Buiksloterham is the result of the demand for transit from residents, but it also includes people who commute to Buiksloterham and live elsewhere, and the shipment of goods. Aside from the energy use, such a large mobility demand results in significant infrastructure such as the large amount of parking spots, up to 6.000 in total.

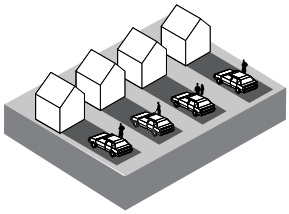
In a circular Buiksloterham, mobility demand from traditional vehicles should be reduced significantly, and energy efficiency per passenger mile is improved strongly. Vehicles are transformed from a pollution emitting nuisance into a beneficial energy storage bank. A focus on alternative mobility aims to reduce 50% of the energy demand of transport and by 2020 the objective is to move to an entirely zero-emission Buiksloterham with the infrastructure in place for low-energy zero emissions alternatives for mobility. These goals compliment a focus on human health (particulates and hydro-carbon emission should no longer be emitted at ground level).



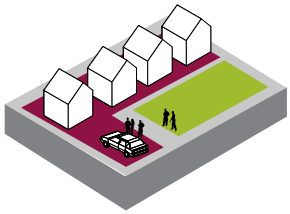
Without measures, the area will have high energy use for mobility



Individual car ownership leads to significant parking



Developing alternative transport modes with multimodal connections is key



Cars are shared, less space is used

CLOSE THE MATERIAL CYCLE

Within Buiksloterham's material flow, three levels of material cycles can be identified: short- medium- and long-term. The short-term flow is dominated by food, nutrients and packaging (over 13.500 tonnes on annual basis), the medium-term stock by furnishings and appliances (over 9.000 tonnes per several years) and the long term-stock by construction materials (375.000 tonnes for building the projected m2 of space). The most significant annual material flow is that of local industries: 130.000 tonnes per year.

The aim of making Buiksloterham a zero-waste neighborhood by closing 100% of its material cycles does not imply that all material cycles have to be closed within Buiksloterham. The overall material throughput should be reduced through sharing, reuse, repair, and a reduction in unnecessary consumption (e.g., reducing food waste). Dispersion of materials should be avoided. The complexity of products and materials should be preserved as much as possible with repair, remanufacturing and recycling. The proposed interventions should be directed at the short material cycle, the medium and the long term cycle.

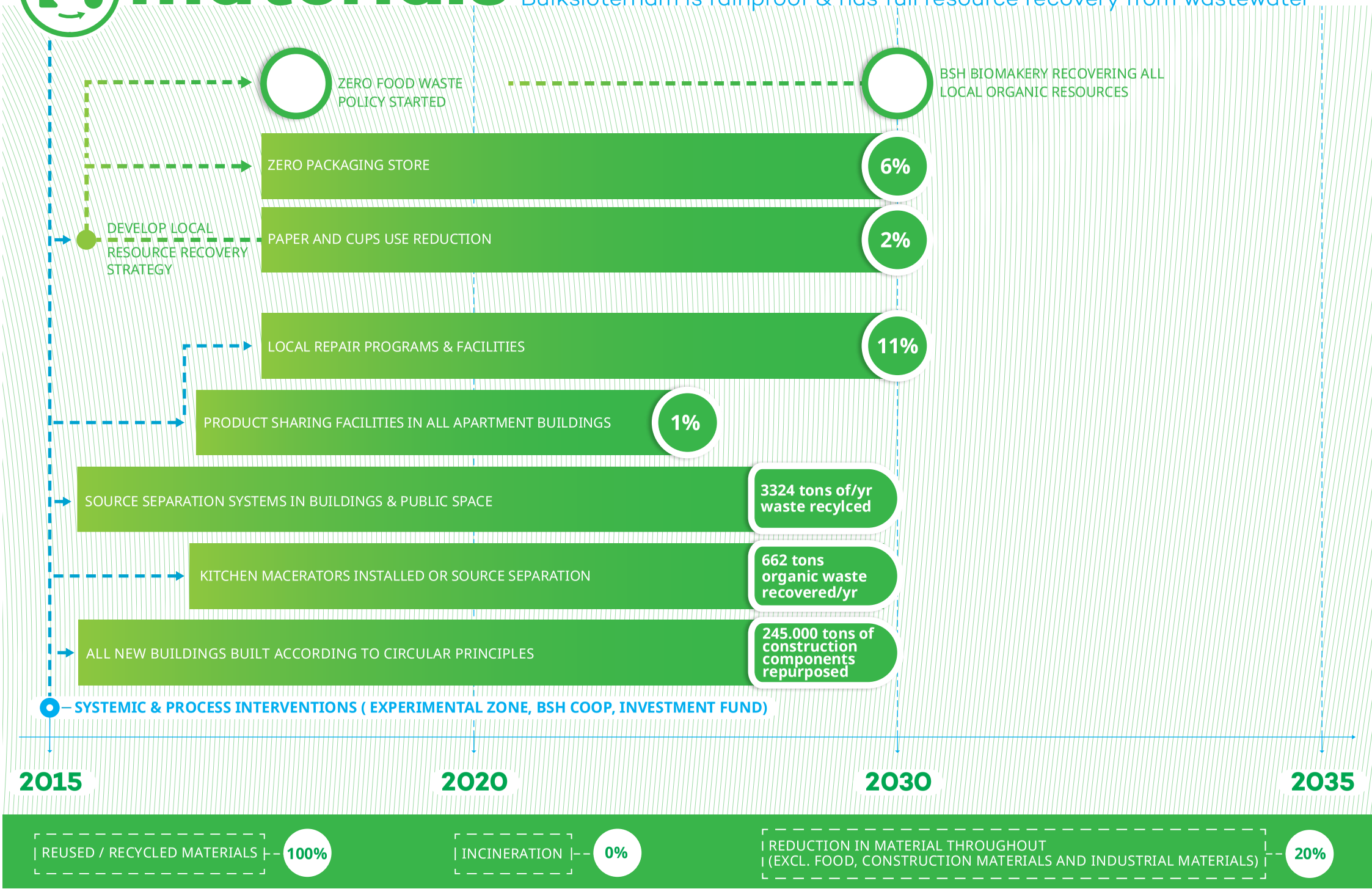
The short term nutrient cycle is the most important material cycle to close in Buiksloterham. Creating infrastructure in Buiksloterham to recapture all short term materials takes primacy. Closing these cycles locally is a second step: Buiksloterham now requires infrastructural interventions now that can prepare it later for full material cycling. The industrial and residential zoning mix does not only make this possible but it could also enable Buiksloterham to offer nutrient recovery services to local neighborhoods.

To cycle the medium term flow facilities like the second-hand stores that are already present in the area could play a significant role in the recycling and upcycling of this material flow. After local repair cycles, the reversed logistics should be organized in such a way that valuable components and resources can be recovered elsewhere.

Buildings and infrastructure are a large portion of the long term material stock in the neighborhood, and should be designed for optimal material recovery, preserving the structure and individual components instead of downcycling to granulate level for low grade applications. Guidelines for circular building design should be included in the Neighborhood Action Plan.

materials

Buiksloterham is rainproof & has full resource recovery from wastewater



| REUSED / RECYCLED MATERIALS | 100%

| INCINERATION | 0%

| REDUCTION IN MATERIAL THROUGHOUT | (EXCL. FOOD, CONSTRUCTION MATERIALS AND INDUSTRIAL MATERIALS) | 20%

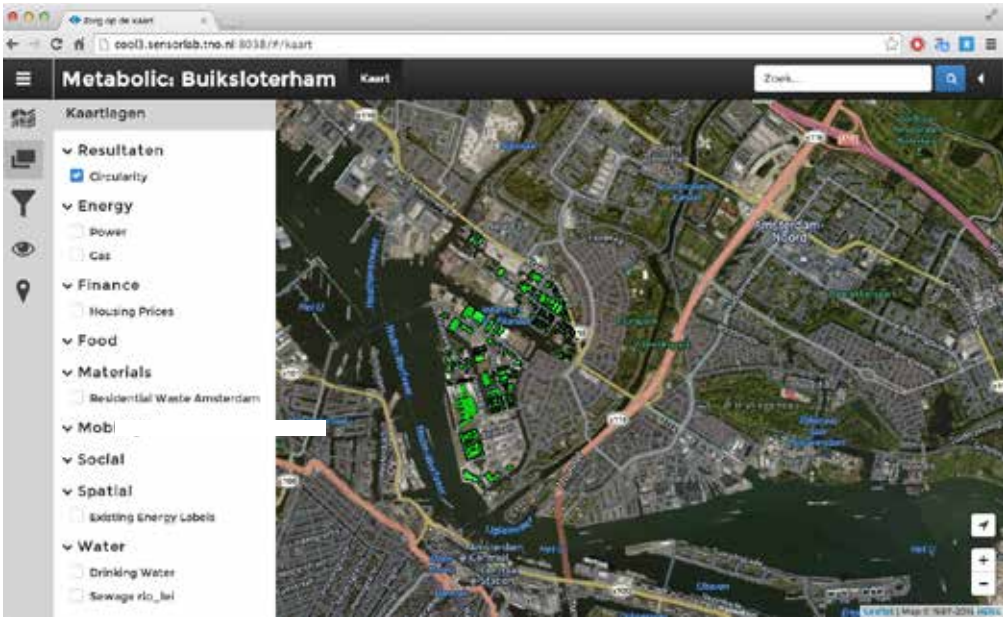
NEXT STEPS

The most important steps towards realizing the Circular Buiksloterham vision have been described in the Action Plan above. Without the systemic interventions, which structure the process for the coming years, it will be unlikely that any of the goals will be met. These systemic interventions are the financial, organizational, political and legal support structures that are needed to successfully achieve the goals. There needs to be support on a political level for the overall ambition and commitment from all stakeholders on the most urgent priority actions.

Some of the immediate next steps include:

- In March 2015 a signing moment is organized during which a manifest for the continuation of the Circular Buiksloterham will be signed by alderman of the municipality of Amsterdam and the main stakeholders;
- Launching a communication campaign. The results of the study and the process should be communicated widely through a targeted communication strategy;
- Raising funding for and setting up a governance structure to push forward the project in the first year;
- Setting up national Green Deals with the ministry of I&M could provide further support for the development;
- Creating a working group (now under the worktitle of 'Tafel van 20') that involves all developers who are currently in the process of designing or preparing for the construction of new buildings; as many building-related circular interventions as possible should be executed in these upcoming constructions;
- Setting up a website portal for Buiksloterham brings the project to life. It should function as a central hub in the development containing amongst others: resources for developers and builders about the circular building principles interactive spatial maps that allow planners and investors plan;
- Attracting more funding by applying for national and European grants for circular and smart cities will be an essential step towards realizing the systemic or technical interventions. Similarly, attracting (international) partners will make the development process more successful: from financial partners to international agencies, to major frontier companies like Tesla.

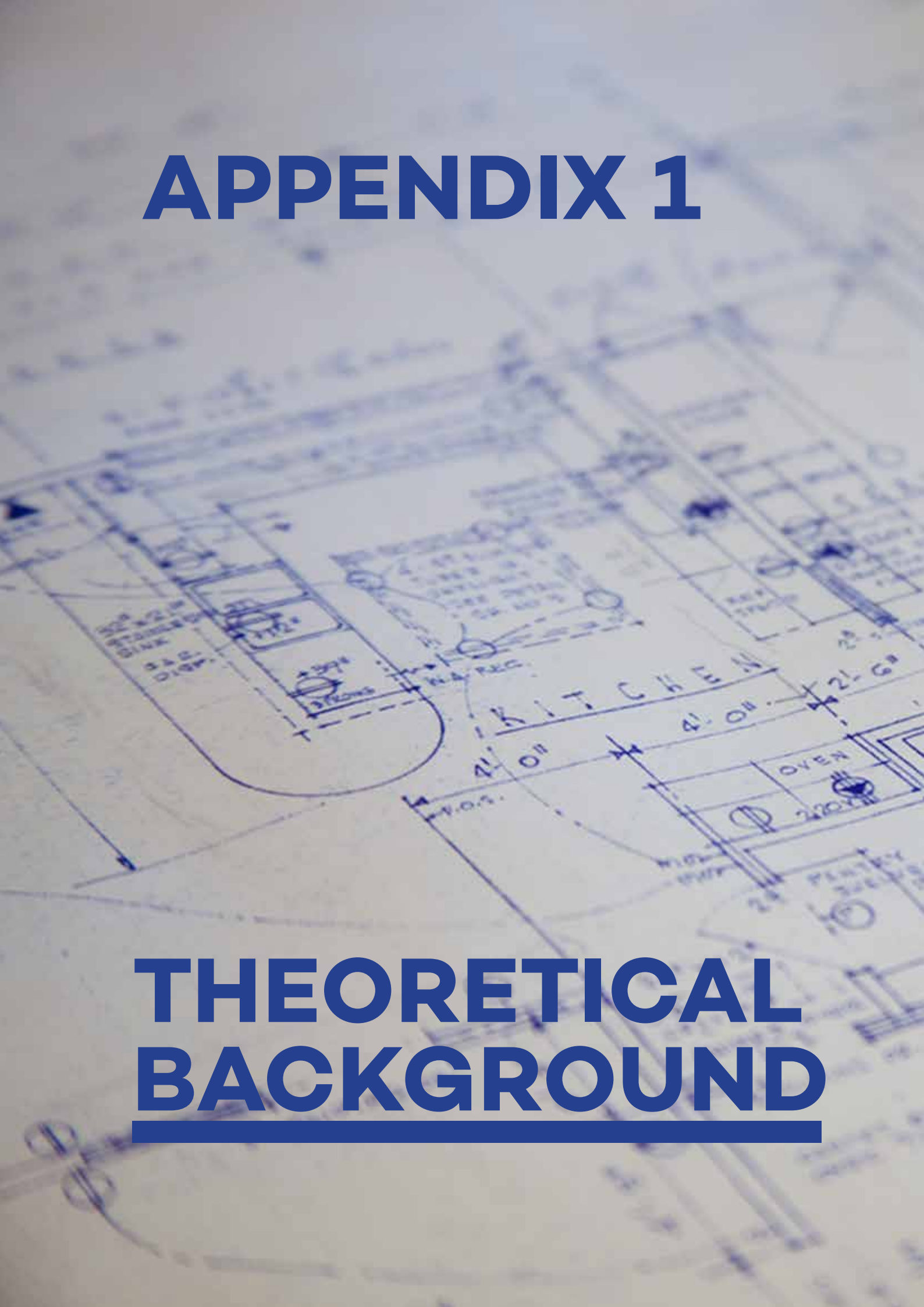
Circular Buiksloterham Interactive Metabolism Map



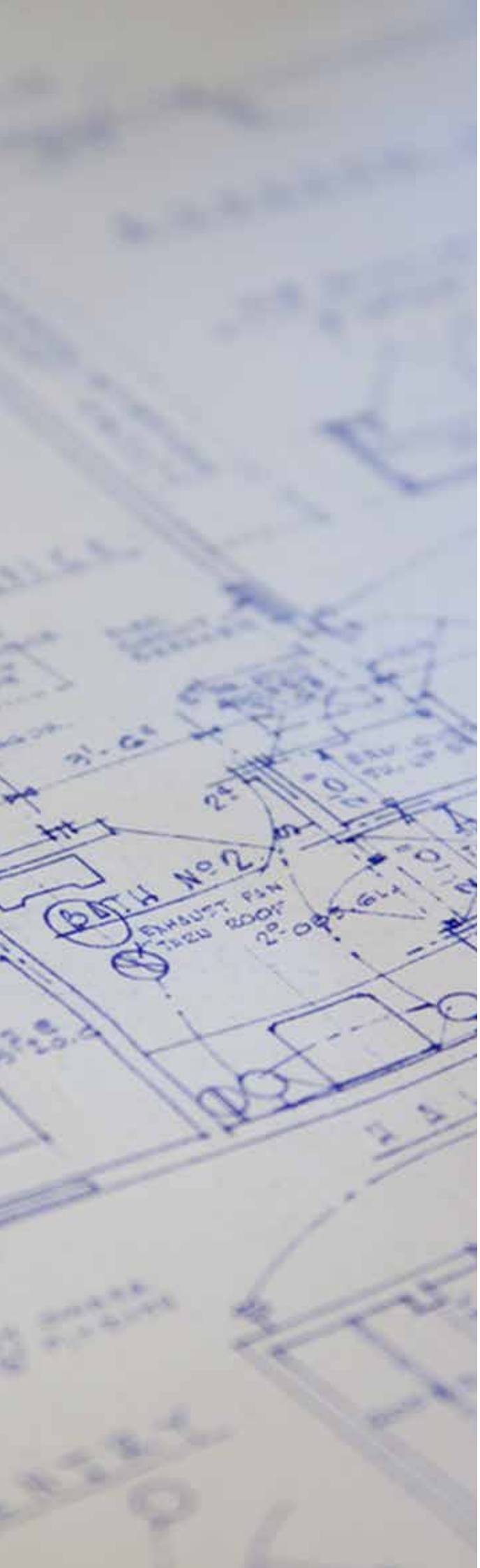
In order to provide an overview of all the data referring to the area of Buiksloterham in a comprehensive way it is important to provide an interface that will communicate the information hidden in this data in a common language. The way to do this is through interactive maps which not only project static information about the area but are constantly updated with live on-site measurements and give the user the opportunity to interact providing feedback on different options. In order to achieve there is a close collaboration with institutions like TNO that are specialised in Big data handling and visualization and together we create a 'circularity' grading system that will reflect the efficiency of the buildings and potential interventions in this direction.

The goal is to improve transparency and engage citizens and stakeholders directly through an interactive map that will be designed and accessible through an online portal. This map will contain data on resource and material use per building along with scores of 'circularity' that will be derived from these data. Residents will be able to access the portal and learn more about the circularity of the area. They will also be able to 'drag-and-drop' their own custom interventions to see how these could improve certain scores of certain buildings or areas.

APPENDIX 1



THEORETICAL BACKGROUND



Cities have become the beating hearts of globalized human civilization. They are the drivers of global economic activity, teeming centers of human creativity, and home to the majority of the human population.

Cities are an accelerator: of innovation and productivity, but also of consumption. Global urban residents earn more and consume more per capita than their rural counterparts. Though our cities only occupy around 3% of the world's land surface area, their residents consume 75% of natural resources and account for 60 – 80% of humanity's greenhouse gas footprint. The global trend towards urbanization is projected to continue, with the global urban population rising from 54% currently to over 60% by 2025. This increase in urbanization is driving the expansion of city borders, an increase in infrastructure demand and development, and a growing demand in product and service consumption within cities.

Understanding these statistics, we can see that cities are one of the most critical intervention points for reducing human impact on the environment, creating sustainable local economies, and increasing the average quality of human life. It is essential for us to radically re-imagine how cities currently function and to develop transition strategies for urban areas to evolve to a more sustainable state.

Cities

- Occupy 3% of global land surface
- Produce 80% of global GDP
- Produce 50% of global waste
- Consume 75% of natural resources
- Account for 60 to 80% of global GHG emissions

From Resource Drains to Circular, Smart, Bio-regions

Cities now function as global resource drains. They import food, energy, and materials from outside of their borders. These resources are consumed and despite growing rates of recycling, most still re-enter the material cycle as wastes or downcycled materials, contributing to the "linear" structure of our economy. Within cities, increases in personal vehicles have led to congestion and poor air quality. The vast swaths of concrete, steel, and asphalt that form urban infrastructure result in heat island effects, low water permeability, and a fragmentation of surrounding ecological habitats. Cities also have

many endemic social problems. The image of a bustling, lively city almost always also conjures associations of pollution, crime, and social segregation.

The goal of this study is not to itemize or fully delve into known urban problems; this has been done extensively in academic literature. Our primary objective is more pragmatic in nature: we are looking for systemic solutions and leverage points within the functioning of the city where many of the known, diverse challenges can be tackled at once. The goal is to avoid the path of incremental improvement and truly discover leapfrog opportunities for moving towards a radically new kind of sustainable development.

Within this search for intervention points, we are also focused on opportunities for value creation that provide incentives for local residents and other stakeholders to invest in urban transformation. These opportunities for value creation can include financial returns, but also many other forms of value such as increases in local resource security, improvement in social cohesion, progress on environmental targets, and increases in quality of life.

Our overarching objective is to develop a plan that can drive Amsterdam's transition away from the model of the city as a "resource drain" towards the city as an essential node in circular material flows, a socially-connected hub facilitated by smart systems and IT, and a strong base of natural capital. This will require changes in the hardware of the city (infrastructure, building technology, structure of green spaces, implementation of sensors and monitoring), but also the software (social program, investment strategy, policies).

The first part of this project involved understanding Buiksloterham through a comprehensive Urban Metabolism Analysis. This analysis gave stakeholders the necessary inputs to develop:

- a vision for a Circular Buiksloterham;
- an Action Plan and roadmaps defining key immediate and longer term steps;
- a package of interventions that can be used as part of the Action Plan.

Circular, Smart, and Biobased

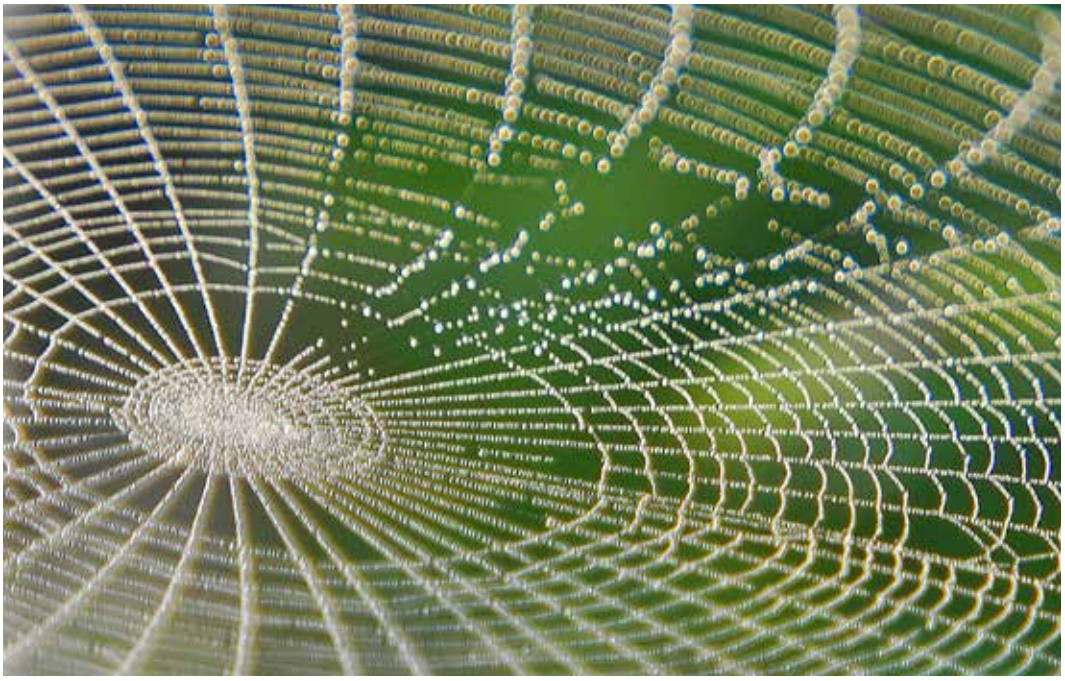
Over the last decade, the terms "circular," "smart", and "biobased", have begun to frame a new paradigm for urban and, more broadly, economic development. These three terms refer to complementary trends in sustainability practice, and form a foundation for the vision we have developed for Buiksloterham. Achieving a Circular development in Buiksloterham is the leading goal, though the other two terms provide important additional perspectives.

Circular Economy

Our current economy has been described as primarily "linear", from the perspective of its material metabolism. Materials are extracted, processed, used, and then disposed of. Though recycling rates are increasing globally, a large fraction of key materials is still dispersed or downcycled. The term "downcycling" refers to forms of material reuse that are lower in quality than the original function of the material and that don't offer opportunities for further material cycling later in the chain.

Europe as a region has shown significant improvement in material recovery over the past decade. In 2004, 33,9% of materials within the EU-27 were recovered for non-energy reuse. This rose to 45,7% in 2010, the last year for which data are available on Eurostat. Overall waste generation has also shown a slight decrease, reducing from 2,6 billion tonnes in 2004 to 2,5 billion tonnes in 2010, despite an increase in population. This translates to 5.349 kg per capita in 2004 versus 5.008 kg per capita in 2010.

However, achieving a circular economy goes far beyond simply increasing the global rates of material recovery. The overall material through-



put of our economy remains unmanageably high and economic productivity still remains strongly coupled to material use, which means that we continue to consume materials at too high a rate for our planetary resources. Our energy and material system contains enormous inefficiencies due to the essential nature of product, building, and infrastructure design. We are also rapidly depleting our natural capital (biodiversity and ecosystem health) and perpetuating materials cycles that are hazardous to both ecological and human health through the use of toxic materials. A truly Circular Economy would address all of these issues, creating a system that is "waste free and regenerative by design".

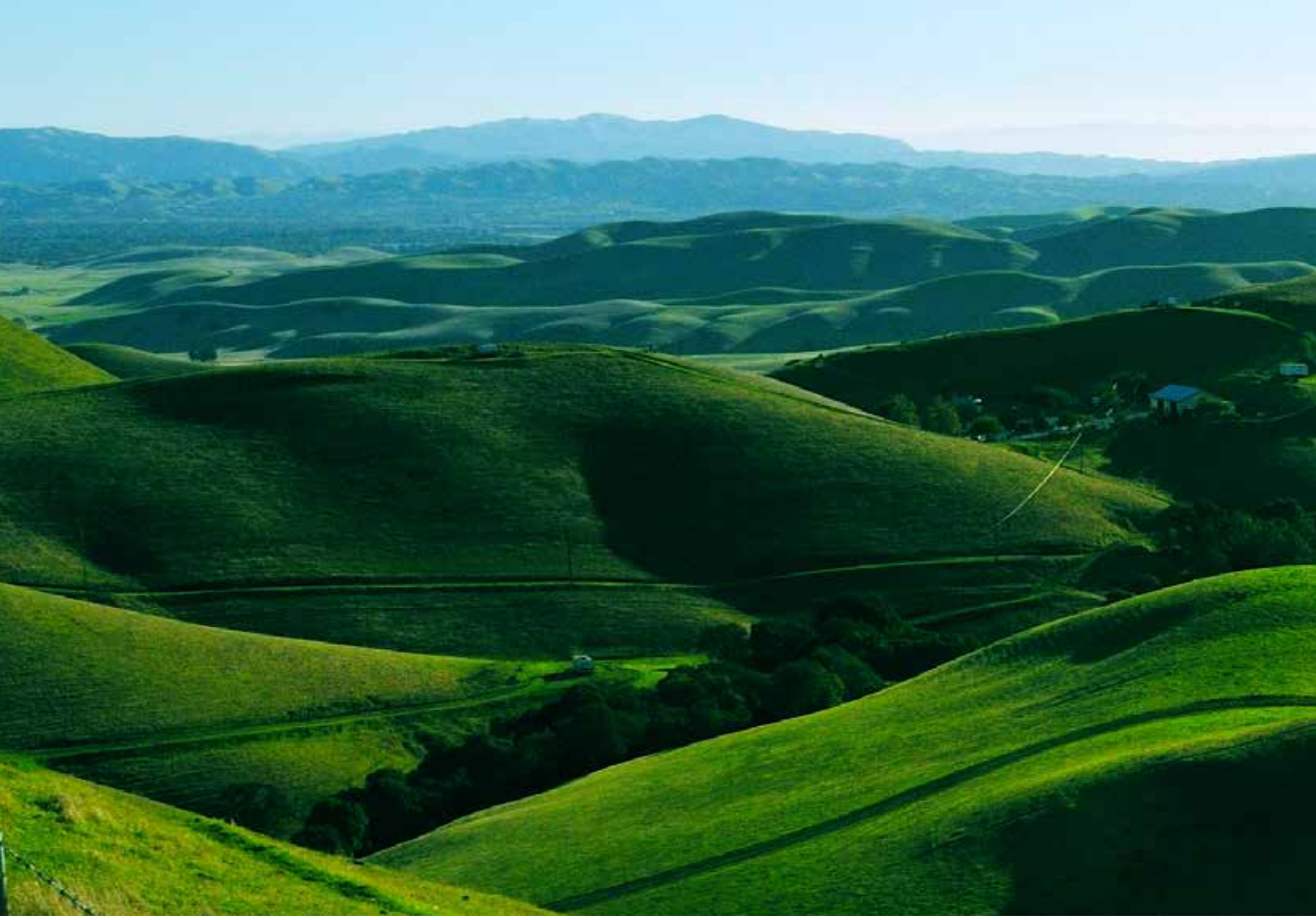
Beyond just handling material and energy cycles, a Circular Economy is one that is designed with the understanding that the world we live in is part of a complex system that faces unexpected changes. As such, a Circular Economy is also designed to be adaptable and resilient. This is achieved through the development of genuine capacity for adaptation, by preserving diversity, preserving natural capital, and strengthening the networks of knowledge and social ties among people.

In a later section of this report entitled, "A Circular City," we elaborate further on how circular economy principles may translate to an urban area like Buiksloterham.

Biobased Economy

In recent years, a call has emerged in the developed world to move towards a "biobased economy". The general idea behind this objective is to begin re-integrating the human industrial complex with the biological metabolism already prevalent on the planet. There are several drivers behind this trend. One is the directive to move towards a higher percentage of renewable material resources within the economy, in parallel to the shift towards renewable energy. Another is the understanding that biobased alternatives can provide solutions that are more efficient and less inherently hazardous than many of our current industrial solutions.

The fundamental logic behind this shift is sound. The efficiency of biological systems is unparalleled by any human invented ones. The Biomimicry movement often cites the fact that nature has had "3,8 billion years of R&D" to devise intelligent solutions. There is a claim in the field of cellular biology that each cell in a human body



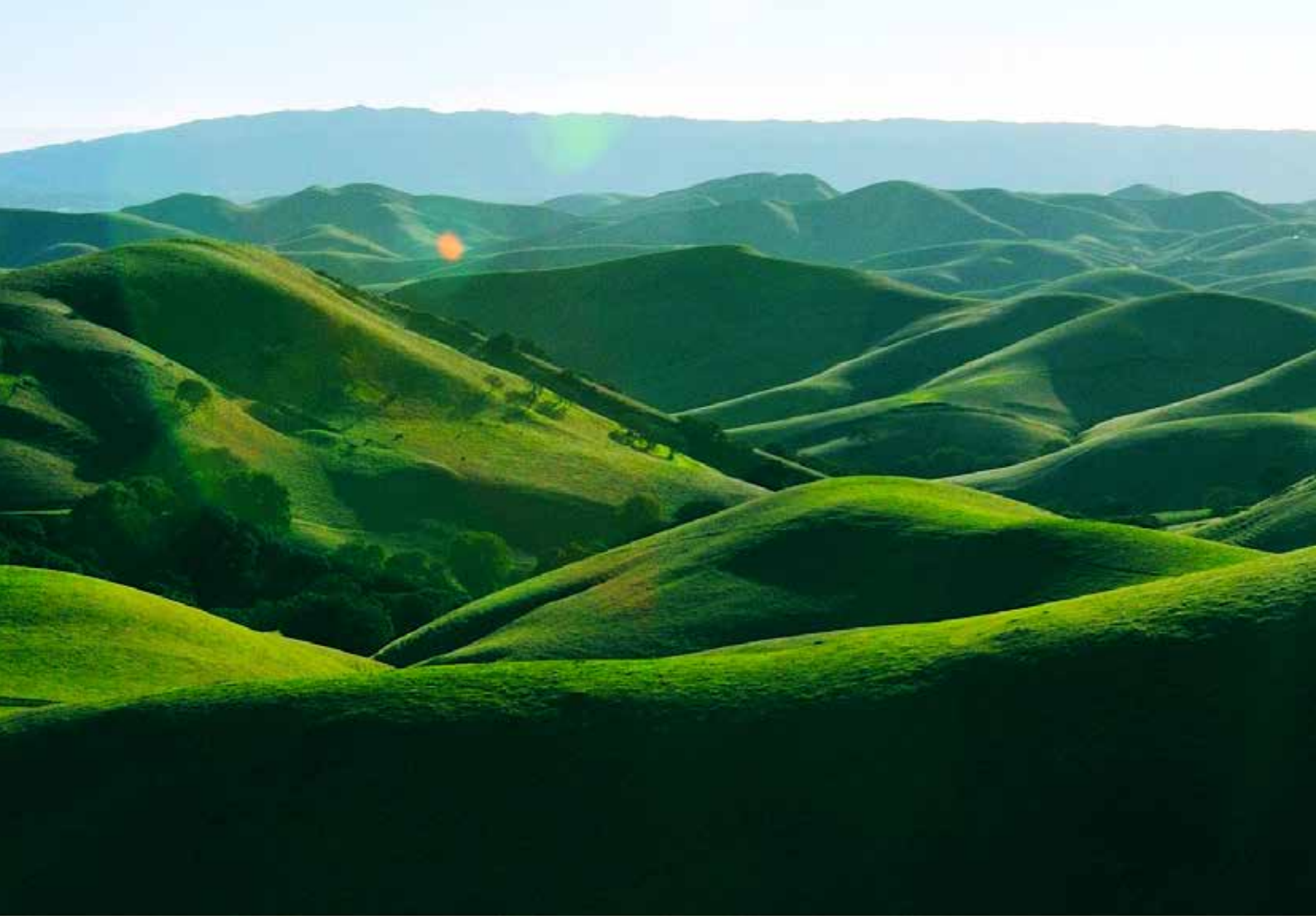
successfully completes more chemical reactions in an hour than all of the factories in the world complete in a year. Moreover, human industry is only able to complete these reactions with the use of massive amounts of energy, pressure, and chemicals, whereas biological cells are able to achieve this with comparatively tiny amounts of energy, using ambient temperature and pressure conditions, and using materials that are non-hazardous and biodegradable. Cells are able to do this because they make use of ingenious nano-machines called enzymes, which are able to lower the energy required for each reaction and cascade materials in very efficient ways.

By understanding how biological systems function and the different properties they have, we are theoretically able to effectively upgrade the human industrial complex into a system that is seamlessly integrated with the biosphere, but still provides the same quality and type of services humans need and allows for creativity and innovation.

However, there are some important challenges and risks to address in facilitating a transition to a biobased human economy. The primary one of these is that the extraction of biological resources is highly impactful to the biosphere. Though biological materials only account for around 27% of global material extraction, their cultivation and production are contributing to many of the transgressions on known planetary boundaries, such as biodiversity loss and nutrient cycle imbalance.1 Therefore, a wholesale shift to basing our economy on biobased materials is not advisable: we must focus on efficiency gains and on the recapture of biological waste streams as a top priority.

Smart Cities

Over the last decade, there has been a strong policy shift towards encouraging "Smart" development, particularly within the European Union's policy frameworks. In particular, "Smart Cities" are sometimes framed as the next evolutionary model of cities, moving beyond the indus-



Rolling green hills in the East Bay Area, California

trial and manufacturing era.

The term "Smart City" has multiple definitions, though all of these share some common elements. Smart Cities, broadly speaking, are ones which:

- Maximize social and environmental capital in driving the competitiveness of urban areas;
- Use modern infrastructure design (mobility, ICT) to fuel sustainable economic development and high quality of life;
- Achieve high levels of efficiency in natural resource management through active citizen participation and new kinds of governance.

One of the drivers behind the smart city context is to move away from viewing the development of cities as a purely hardware-related activity to recognizing the importance of "software" elements within the city context: people, knowledge, data flows, civic engagement. Smart cities are typically assessed and ranked along six main dimensions of performance: transport and ICT, economics, natural resources, human and social capital, quality of life, and citizen participation in governance. Another key element of smart cities is the focus on building capacity for innovation and problem solving. The notion is that a truly smart city will be able to adapt to challenges and changing circumstances, based on its own internal resilience, much of which is developed through strengthening its citizens and enhancing their connectivity, using new measures like ICTs, but also through the education of local populations and attracting creatives and highly-skilled professionals.

Though the term Smart City is commonly associated with primarily ICT-based innovations, like wireless sensor networks that can transmit key data in real-time to citizens and governing bodies, these innovations are in fact just a tool towards achieving the broader concept. As such, the Smart City approach can be considered instrumenctal in the development of adaptive capacity and social innovation within the bigger concept of a "Circular City" development.

CIRCULAR CITIES

The Circular Economy is a term that has been gaining increasing popularity within business and development circles. The definition of "circular economy" as has been popularized by the Ellen MacArthur Foundation is an economy that is waste free and regenerative by design. This definition is constructed in contrast to the features of our current economy, which has been described as a linear "take, make, and dispose" system. Within the literature on the Circular Economy, there is therefore a great deal of focus on the closing of material cycles. However, beyond general guiding principles for how to move towards such a state, there hasn't been a firm vision of what a truly circular end state might look like for the economy at large or for cities in particular.

In partnership with Dutch foundation, Circle Economy, Metabolic has been developing the Circularity Framework, a shared vision and set of guidelines for decision-making for moving towards a circular economy. The development of this circular economy vision has been based on our joint work with dozens of international companies and several public actors within the Netherlands. The definitions and principles proposed within the Circularity Framework are useful to apply as a foundation for the Circular Buiksloterham vision.

The circular economy is a paradigm for managing scarcity and sticking to within the safe operating space of key planetary boundaries while ultimately upholding the highest goal of allowing life, in all of its diversity, to flourish.

Key principles for moving towards a circular economy that help decision-making about trade-offs include:

- Prioritize based on avoiding the most essen-

tial impacts: don't violate any key planetary boundaries or get close to tipping points;
- Preserve complexity: especially, don't destroy things you can't recover;
- Be efficient – match quality, match scale, match time-demand, do not use resources if not necessary;
- Allocate resources intelligently (we don't have infinite anything).

Because we are far from achieving a circular economy as described in the performance goals above, there are clearly transition scenarios needed. Not all activities need to match with this end vision immediately, but it is important to know that they are at least heading in the right direction. Particularly in the early stages of a transition to a circular economy, trade-offs will need to be made between these different principles, since our resources are limited and decisions must be made within short time spans.

When making decisions about trade-offs, it is important to have a shared logical value set. What is proposed in the Circularity Framework as a core directive is the overarching principle to preserve complexity: don't destroy what you cannot recover easily, which particularly applies to what has evolved through the costly investment of nature's evolutionary mechanism. Natural diversity brings resilience, and it is one of the most fundamental sources of our long-term protection. It is our truest form of capital. The priorities in the face of trade-offs faced in the short-term, are therefore ranked above with 1 being the most important and 5 being the least. So we see, that even though discussions about the circular economy generally focus on energetic and material cycles, the optimization of these cycles is truly done in service of the higher-level goals of enhancing natural and human capital.

So how do these broad performance principles for a circular economy translate to a city or regional level? Working with a limited geography poses interesting questions for developing a circular economy, because one of the first issues that emerges is the question of scale.

It's clear that not all the performance characteristics for a circular economy should be applied within the scale of a neighborhood. However, the activities and design of the neighborhood should not violate the broader possibility of achieving a circular economy, and should support it in as large an extent as possible.

Circular City Principles

If we apply the principles of a circular economy to cities, we must start translating high level and abstract performance goals to a more concrete spatial and temporal scale.

It does not automatically follow from the idea of a circular economy that every unit of geography must fully comply with the bigger principles. In other words, not every city or region must be "circular" when looked at in isolation. Indeed, if we wish to continue having an economy that includes a global supply of tropical fruits and the continued proliferation of personal electronic devices, then complete regional self-sufficiency is not the desired outcome. Regional circularity in a global economy will look quite different from autarky.

The key question then, is how to design regions and cities in such a way that they support and fit into the larger picture of a global circular economy.

Below - City of Lights. Photo of Toronto at night. Picture by Paul Bica, under Creative Commons License.

In a circular economy

Materials are incorporated into the economy in such a way that they can be cycled at continuous high value and are never dissipated into the environment in unrecoverable form. A priority is placed on preserving material complexity (the "power of the inner circle"), by cascading materials in their most complex form for as long as possible (e.g., as products rather than components, and as components rather than materials). The length of materials cycles is matched to material scarcity: scarce materials are preferentially cycled at shorter intervals so they can be recovered sooner for reuse. Material cycles are designed to be as short as possible (geographically-speaking), which varies depending on the ubiquity of the material. Density of material consumption should optimally be matched to the density of material occurrence. Materials can be recovered in energetic form when the energetic cost of transporting and processing them is higher than the embodied value of the material itself (this will generally not apply to scarce, non-renewable materials). However, the system is designed to avoid the recovery of materials as energy. Materials should not be mixed in ways that they can no longer be separated and purely recovered, unless they can continue to cycle infinitely at high value in their mixed form (and even then, this is preferentially not done because it limits choice). Materials should be used only when necessary: a preference for dematerialization of products and services. ***Trade-off priority level: 4***

All energy is based on renewable sources. The materials required for energy generation and storage technologies are designed for recovery into the system. Energy is intelligently preserved (waste is avoided), and cascaded when lower values of energy are available for use (e.g.,heat cascading). Density of energy consumption should ideally be matched to density of local energy availability to avoid structural energetic losses in transport. Conversion between energy types should be avoided. Avoid transport of energy. The system should be designed for maximum energy efficiency without compromising performance and service output of the system. ***Trade-off priority level: 5***

Biodiversity is structurally supported and enhanced through all human activities in a circular economy. As one of the core principles of acting within a circular economy is to preserve complexity, the value of preserving biodiversity is one of the highest values within the circular economy. Habitats, especially rare habitats, should not be encroached upon or structurally damaged through human activities. Preservation of ecological diversity is one of the core sources of resilience for the biosphere. Material and energetic losses are tolerated for the sake of preservation of biodiversity. ***Trade-off priority level: 1***

Human society and culture are preserved through human activities. As another form of complexity and diversity (and therefore resilience), human culture is important to maintain. Activities that structurally undermine the well-being or existence of unique human cultures should be avoided at high cost. ***Trade-off priority level: 1***

The health and well-being of humans and other species should be structurally supported through the activities of the economy. Toxic and hazardous substances should ultimately be eliminated, and in the transition phases towards this economy, minimized and kept in highly controlled cycles. Economic activities should never threaten human health or well-being in a circular economy. ***Trade-off priority level: 1***

Human activities should generate value in measures beyond just financial. Materials and energy are not currently available in infinite measure, so their use should be intentional and meaningful contribution. ***Trade-off priority level: 3***

Drawing from the circular economy performance objectives described earlier in this document, Metabolic has developed a schematic approach for understanding and measuring the functioning of a circular city. Some excerpts of this work are presented here (the full description can be found in Metabolic's forthcoming publication, The Circular City Model).

How should Circular Regions and Regions Work?

Cities have several types of zones of activity based on land use type, the economic value of land, density of living and working, and the intensity of different types of activities. We have defined 8 "zones," for which we have assigned general activities and characteristics for functioning within a circular city. These are guidelines rather than hard rules, but they start to translate how circular economy principles could function in the dynamic spatial environment of a city. The zones are arranged in a concentric circle, representing distance from the city center, which is located in the middle. It is possible for cities to have multiple functional "centers" based on the density characteristics that they have in different neighborhoods.

The further one gets from a city center, the more material cycles should be closed locally; space and activity restrictions cease to be as much of a constraint as they are in cities. The areas surrounding cities can also handle more complex activities for material recovery. Based on their spatial ubiquity and the cost of their transport, water and energy should have the shortest cycles of extraction and use. Food and nutrients should have the second shortest cycles of use. The more complex, rare, or specialized a material, the longer the permissible spatial cycle of that material (the further away it can originate from or be shipped to for recovery). The reverse is true of temporal cycles: the more complex, rare, or specialized a material, the shorter its duration of use should ideally be to improve the reuse potential of the material.

On the right - Circularity Framework. Metabolic, 2014

The further away from the city center we move, the shorter the local material cycles should get as areas are better able to provide from themselves and have lower density of demand. Even in this context, regions and cities will retain their own character due to the local biology, climate, and culture. What emerges is a global network of bio-cultural regions that are self-supporting for key resources, but actively trading with one another for scarce or geographically specialized products.

Some basic principles for applying circular economy thinking to cities include:

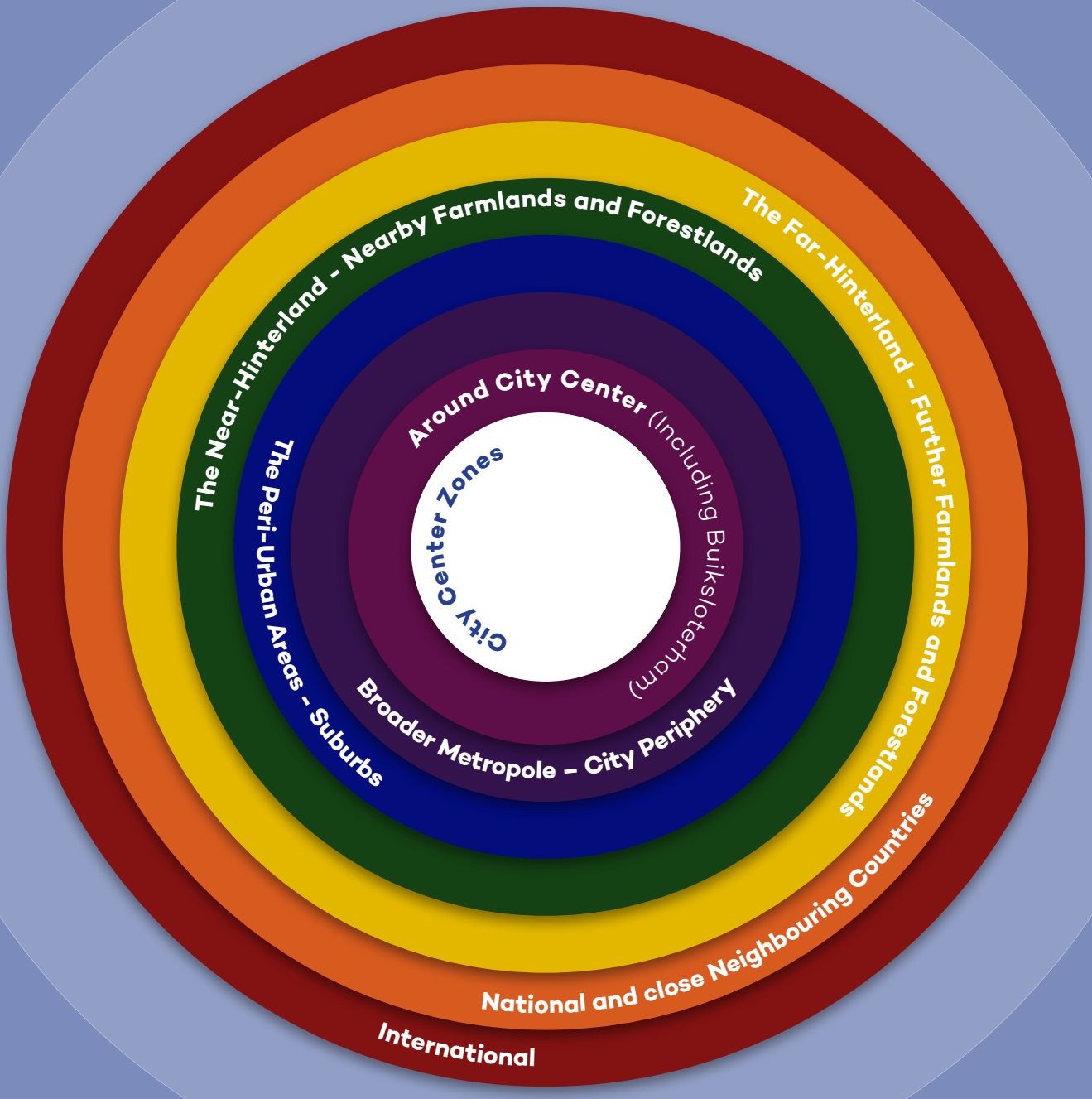
- Optimize for Geographically Short Material Cycles;
- Optimize the Time Scale of Material Cycles for Material Demand;
- Match the Quality of Resource Availability to the Type of Demand;
- Preserve Complexity and Diversity in Social, Ecological, and Physical Flows;
- Balance Overall Material Input and Output of Ecologically Relevant Flows;
- Focus on Key Impact Reduction as a Priority (for example, health impacts in dense zones).

These approaches for a circular region design then begin to translate to the eight zones that we have identified for a circular city. With this study, our primary focus is on the Purple Zone (the second from the center), because this is the category that Buiksloterham belongs to. Below we describe some of the proposed features of the first two zones within the schematic circular city characterization:

1. White Zones (City Center Zones)

The White Zone refers to the most central part of the city where there is the highest density, highest property values, and often the least flexibility for reconstruction or technical interventions. Because of the nature of these zones, very few material cycles are closed within their borders. A large focus is on health and green space: because these zones have very dense habitation and working populations, this is the

circular city framework



Metabolic, 2014

Chicago aerial view.

area where cities can gain the largest benefit by investing in good air quality and stress-reducing green areas. Likewise, this is where some of the largest benefit from applying smart monitoring and sensor feedback could be achieved. Though energy, water, and food will need to largely be important from the adjacent zones, it is still preferred if as much local production is occurring as feasible.

Some proposed characteristics for the White Zones include:

- As much local energy as possible (energy import still occurring from adjacent zones 2 - 4);
- As much local water use as possible – e.g., grey water use matched where possible to lower quality water use functions (import of drinking water generally occurring from zones 2 – 3);
- Local rainwater management to prevent stormwater overflow;
- Only zero-emissions transport to protect local air quality (preferably all city zones 1 - 3 will have zero emissions transport, but central zones are the highest priority for intervention due to the number of people living there);
- Defined green areas for air quality, heat, and human health management;
- Product reuse and light product repair should occur within these zones. Facilitation of product sharing should also take place to reduce total throughput and demand for materials.

2. Purple Zones (Around City Center) (Buiksloterham)

Purple Zones are the areas located just around the city center, which have very good connectivity with the central areas, but slightly lower density. This is the type of zone where we find Buiksloterham. Many formerly industrial areas that were on the outskirts of cities are now located in these zones as city centers have expanded, though this varies significantly by the development patterns of specific cities. In some cities, this zone will only be located many kilometers outside of the center-most-zone because of the size and expansiveness of the urban center.

The Purple Zones provide an important point of connectivity or transition between the very dense center and the broader metropolitan area

beyond them. They tend to have more flexible buildings and infrastructure, and, as in the case of Amsterdam, fewer monumental buildings. There is more opportunity for these zones to be fully self-sufficient in renewable energy supply because of the lower density of demand, particularly if they are designed differ.

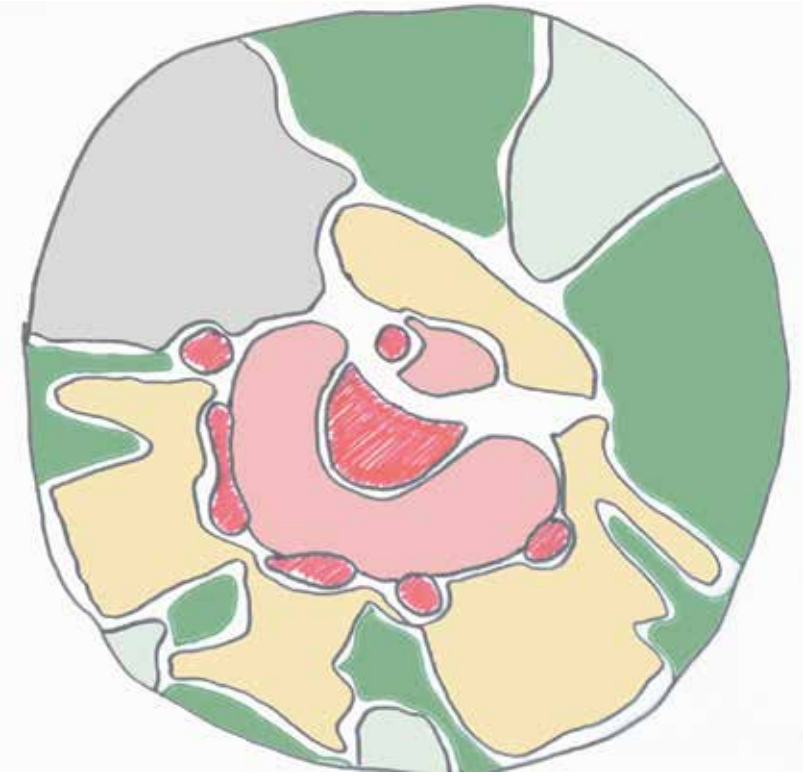
Some proposed characteristics for the Purple Zones include:

- Aiming for fully self-sufficient for renewable energy (some import may still occur from zones 3 – 4);
- Aiming for largely self-sufficient for water resources (drinking water import may still occur from zones 3 – 4);
- May contain key transport nodes between city center and outer zones for materials sorting and management;
- May have more materials and product repair facilities (for larger-scale and more specialized repairs);
- Can host new "circular industries" - that are inherently non-polluting and less noisy than traditional industries.

Applying the model to Amsterdam

In applying this model to Amsterdam, we begin to get a clearer picture of how resource cycles may be differentially handled in different parts of the city and on different spatial scales.

Another approach to the Circular City Model that produces a comparable result is the "cell model," which is used by Studioninedots in their urban development work. This is a specific elaboration of a vision as expressed in the book Ökologisches Bauen by Detlef Glücklich. The cell model attempts to translate the concept of ecosystems to the city. Cities can be divided into its systems of different cells (for example, density, age and function). The cells have different structures and differing ecological performance. The goal is not to solve all challenges at any location in the same way, but to shape the cells in such a way that in conjunction they provide a good urban ecosystem. Resembling a natural system that evolves and improves over time, the modern city should also be evolving into a socially and environmentally sustainable situation where water and energy management, the use of materials and landscaping are better organized. This process requires continuous iteration. This city will not only consume, but also produce. The cell model was used from 2009 performed in the analysis of several urban development projects such as Transvaal district in The Hague, the Food Center in Amsterdam and the Lagoon in Basel.



The cell model as applied to Amsterdam, produced by Studioninedots.

CONTEXT ANALYSIS

Despite its proximity to the city center of Amsterdam, the neighborhood of Buiksloterham has been largely ignored by the municipality for urban development. In the past it was treated as a site for undesirable uses or polluting industries. Industrialization of the area began in the mid-19th century and after 1900 it became the primary industrial location in Amsterdam. In recent years the city has been expanding rapidly adding approximately 10.000 new people and 5.000 new houses per year. Buiksloterham has naturally been turned to as a prime area for new housing and densification.

This first section of the Urban Metabolism Analysis contains the highlights of the analysis of Buiksloterham's local context. It includes the summarized results of dozens of stakeholder interviews, development plans, demographics, ecological conditions, and many other factors.

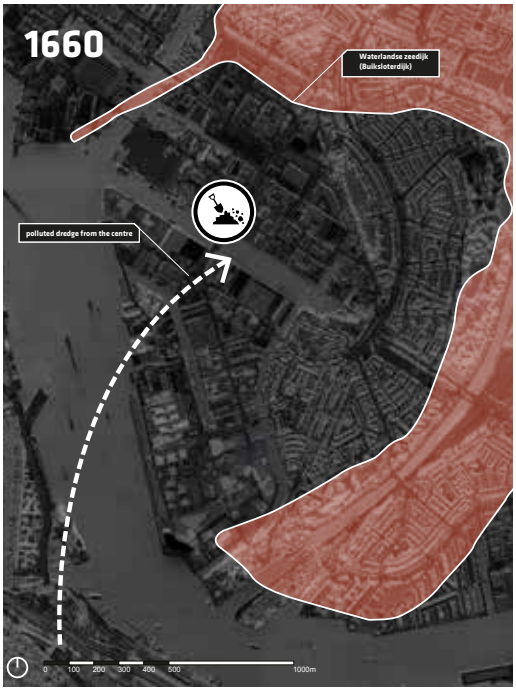
HISTORY

Buiksloterham is a polder in Amsterdam North that was constructed from deposited dredge material from other parts of Amsterdam (Bestemmingsplan Buiksloterham, 2009). Once a part of the IJ ('Den Ham'), the dredged materials slowly filled up the water. In 1886 the area was officially dammed and became Buiksloterham. For several years after the origination of the polder, it was used for light farm activities. Around 40 farms were located in the area raising livestock and producing grain and potatoes.

Major industrial activities did not emerge until around the start of the 20th century. An absence of rail and road infrastructure and a close connection with the IJ facilitated a growth in mainly water-based industries. New ports and waterways were constructed to accommodate the industrial activities. Examples of early industries located in Buiksloterham were the Bataafsche Petroleum Maatschappij (former Royal Dutch Shell) and Fokker Aviation industry. In 1918 two municipal utilities – the waste incineration plant and the municipal power plant – moved to Buiksloterham and would remain active until 1982 and 1993 respectively before moving to the Western Harbour District.

Buiksloterham, as most of North, originally did not belong to the municipality of Amsterdam. North was comprised of smaller municipalities like Landsmeer, Niewendam and Buiksloot – Buiksloterham belonged to the latter. It was only after the construction of the North Sea Canal that disputes around land rights were settled and Buiksloterham became part of the Municipality of Amsterdam.

Around World War One, the municipality commenced with the construction of municipal housing for industrial workers migrating to the city from the hinterlands. This led to the construction of the neighborhoods Disteldorp (1918), Asterdorp (1926) and Tuindorp (1927). For most of the 20th century, Buiksloterham has remained an industrial site. In the eighties, the municipality started reconsidering the function and zoning of Buiksloterham. Over the past two decades, industries have slowly moved away or were actively relocated, resulting in the Buiksloter-



Buiksloterham 1660

Buiksloterham 1900

Large-scale waterrelated industry. Transport of raw materials and products went largely over the water. Roads were limited and where often dead ends by a lack of bridges.

Buiksloterham 1970

New forms of business, mixed functions and intensification ask for better connections by land and water. Roads and bridges were built to make Buiksloterham more accessible.

ham as we know it now: an industrial area in transition to combined residential-working area. In 1998 a spatial vision for land development was drafted for all of Buiksloterham. The municipality of Amsterdam invested approximately € 39 million, mainly towards acquiring large industrial properties

CURRENT STATE BUIKSLOTERHAM (2014)

Buiksloterham is around 100 hectares, of which around 300 000 m2 bruto floor surface (BVO) is currently built and mostly in use.

It is characterized by little (dedicated) public space and green space. Aside from the current users (offices, facilities, some residential), there are many empty brown-fields which are symbolized in the current zoning plans. Interestingly enough, these provide for a relatively large amount of greenspace, although remain inaccessible due to contaminants.

There is a combination of small and large plots, as well as privately owned (or developed) and municipal owned. A characteristic of the area is the combination of 1/3 municipal grounds, 1/3 lease (erfpacht) and 1/3 privately owned grounds.

As a result of the current industrial functions, a large percentage of the overall surface is paved.

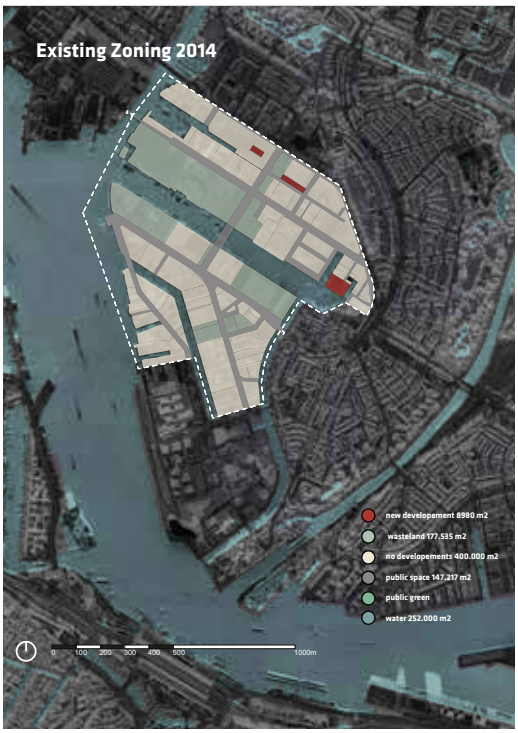
Demographics, users, and facilities

The current area is characterized by brown-fields from industries that have already retracted out of the area, an industrial zone around Asterweg where some of the large industries still remain, small to medium sized office buildings and some light-industrial functions such as car garages and print shops. Most of the retail is concentrated around the Klaprozenweg at the North side of

Buiksloterham and mostly consists of DIY and furniture stores. Because of the many brownfields, the area has an impoverished image.

Most of the current remaining users of Buiksloterham are offices, retail, light industrial functions and some larger industries. Buiksloterham has little inhabitants: in 2013 there were only 252 residents. In this analysis, a lot of unique data was collected about the current companies and facilities present in Buiksloterham. Both at a central city level and Stadsdeel Noord, incomplete information was available about the active organizations and their activities. Overall, Buiksloterham currently comprises an interesting mix of organizations: see a full breakdown in the list below:

- 28 residential housing buildings;
- 9 co-working buildings;
- 3 schools (primary education and one special education);
- 3 other schools: martial arts-, dance-, cookingschool;
- several industrial bakeries;
- 1 safe house for drugs addicts;
- 11 cultural/leisure facilities;
- 12 large retail stores;
- 1 creative office park (broedplaats);
- 5 abandoned plots;
- 19 buildings for rent;
- 135 offices;
- 2 second hand stores;
- 10 restaurants;
- several antique shops;
- 21 car garages;
- 43 light industrial;
- 2 churches (catholic);



Map on the left:
Existing Zoning 2014

Map on the right:
Typolosy Housing 2014

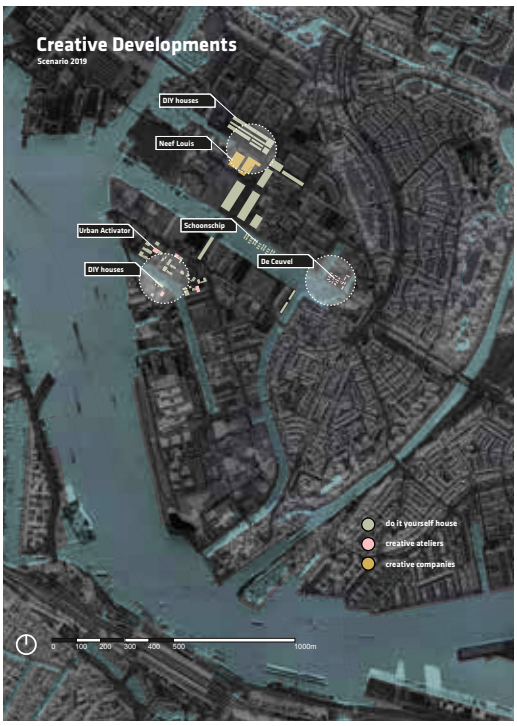
- 1 campsite for camper vehicles;
- 1 squatted building;
- 1 waste point;
- 10 food related (restaurant, catering);
- 2 parking lots;
- 2 sports facilities;
- 2 day care facilities.

Unusual and undistributed mix of facilities

Noteworthy is the amount of retail stores and companies that are aimed at the recycling, repair or collection of used products and materials. There is a high concentration of second-hand and antique stores and a large amount of car repair companies. There are no supermarkets,

Self-build plots

The self-builders mark the start of the transformation of Buiksloterham to a living-working area. Mid-2013, the first building activities were started on plots 5 and 3. Self building was introduced by the municipality as a result of the crisis and the lack of commercial real-estate development interest. It is also a new form of development which allows residents to create the house of their liking and the development process mostly managed by future residents themselves.



healthcare or elderly care facilities, clothing shops or pharmacies. Food facilities are scarce and are mostly snack-corners serving inexpensive fast food.

Gravity point for creative and sustainable (urban) developments

There is a significant number of companies that have a sustainability drive, most of which are located at the sustainability office park De Ceuvel and at the company collective New Energy Docks. Facilitated by the municipal tenders, several unique urban development projects have already arisen in Buiksloterham. The self-build homes, of which the first ones are being built as we speak, have generated national attention amongst others through a feature in the Dutch documentary series Tegenlicht (Backlight). De Ceuvel, a temporary creative zone with ateliers and offices on a polluted empty plot of land and also housing a popular café, has generated large national and international attention in the past year.

Map on the right:
Creative Developments

Map on the left:
Typology Service 2014

de Ceuvel and Schoonschip

As a result of the sustainability tenders by the municipality, two unique projects have come forth. De Ceuvel, consisting of retrofitted houseboats placed on land, and Schoonschip, a new-built floating housing community. Aiming at setting a new pattern for urban development, both sites have high sustainability targets: 100% renewable electricity, heating and hot water, 100% water self sufficiency, 100% waste water management, 50-70% nutrient recovery, 10-30% food production on site for de Ceuvel and for Schoonschip these goals are even set higher. By integrating different resource flows and developing smart financial scenarios, both developments yield a high return on investment for the applied clean technologies and have become financially feasible for the communities.

De Ceuvel opened its doors in June 2014 and has ever since attracted numerous visitors from all around the world. Schoonschip is in the final engineering phase and construction is expected to start mid-2015.

Mobility & accessibility

Buiksloterham originated as a water-based industry area and has therefore never been developed to be well connected over road. In the current outlay of Buiksloterham, there is a clearly visible and simple mobility network. Currently there are 17 different roads measuring approximately 6 km. In addition there are another 5 km of cycle -and footpaths.

Access of Buiksloterham is mainly through the Papaverweg, Distelweg and Klaprozenweg which are now better connected through the recently implemented Ridderspoorweg (2006). Until 2007 Buiksloterham was connected from the IJ corner of Distelweg with Amsterdam West through a ferry that was also accessible by cars. Buiksloterham is only connected to NDSM through the Klaprozenweg; both the Distelweg and Papaverweg dead-end in the direction of NDSM. Recently (2012), a bike bridge was opened to connect Buiksloterham to NDSM via the Papaverweg. The route from Overhoeks starts among a green shoreline, but the plots directly bordering the IJ in the South of Buiksloterham make it impossible to continue a green route.

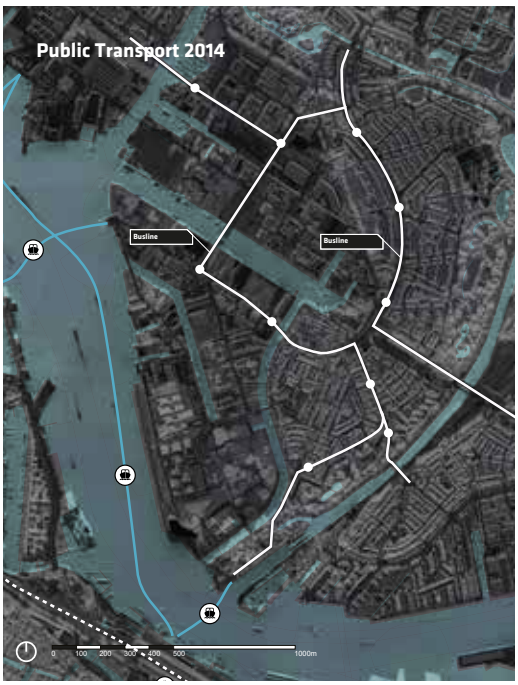
Transport of dangerous and toxic substances is diverted through Buiksloterham over the Ridderspoorweg. There is little use of freight transport over the widely available waterways and roads are heavily used for the current industrial transport.

In terms of sustainable transport, there are limited charging stations for electric vehicles (3 stations with a total of 6 charging points) and there are no car sharing opportunities yet

There is ample parking space available in Buiksloterham currently and free of charge. Prominently present in the area are the trucks of Omya minerals and the many cars in front of one of the 21 car garages in the area.

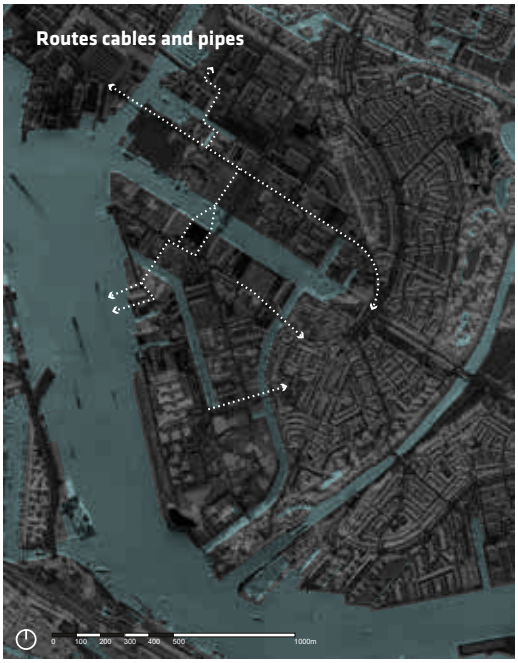
Relatively poor public transport connections

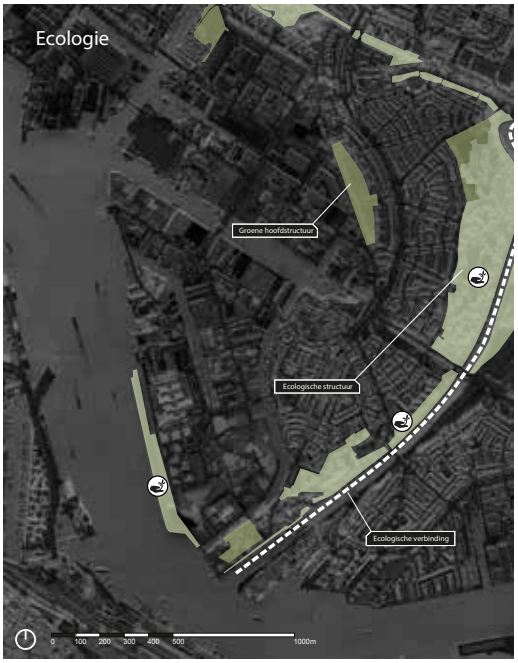
In terms of public transport connections Buiksloterham currently faces various shortcomings. There is only one bus connection from Central Station. The Southern part of Buiksloterham below the Tolhuiskanaal is poorly connected (>400 meter radius from a single busstop). For pedestrians and cyclists, Buiksloterham is accessible through the Buiksloterveer from Central Station (high frequency, short crossing time) and the Distelwegveer from Tasmankade in Amsterdam West (low frequency, short crossing time). There is no direct ferry connection between Buiksloterham and central station.



Map on the right:
Trafic cars 2014

Map on the left:
Public Transport 2014





Map on the left:
Routes, cables and pipes

Map on the right:
Ecology in Buiksloterham

Infrastructure

Building plans should take into account the major routes of the cables and pipes. This may mean diverting to alternative routes for the building plan. Given the nature and the extent of the routes rather large investments should be accounted for. The area also hosts a large number of 'dead' infrastructure pipes and gutters, which need to be removed by the responsible parties. Most of the to-be developed plots require plot specific infrastructure to be installed, representing a window of opportunity to innovate at an infrastructural level

Ecology & biodiversity

Research by the project bureau Noordwaarts itself indicates that there is little biodiversity currently in Buiksloterham; almost no amphibians and mammals are found in the area (Investeringsbesluit, 2005). The highest ecological value is present in the IJ water: various salt and oxygen degrees result in a rich fish population. Current green areas are disconnected and mostly inaccessible for humans. There are a large amount of fruit bushes (mainly berries) showcasing an interesting pocket of a biodiverse landscape that has emerged in empty plots over the past years of vacancy.

Pollution & water safety

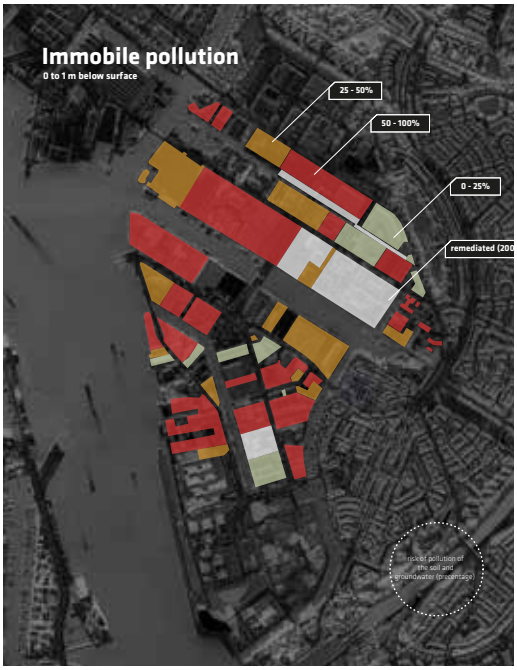
Approximately 80% of the soils in Buiksloterham are contaminated with immobile contaminants such as heavy metals and asbestos. In addition large areas are contaminated with mobile agents, primarily volatile chlorinated organic compounds (VOCs) and mineral oil.

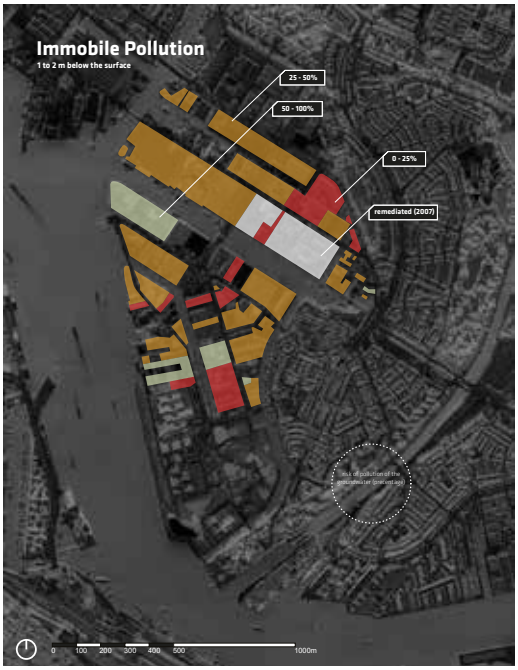
This is mainly a result of the sludge from various other locations in Amsterdam that was used to create the polder and to heighten the land, but also as a result of the industrial activity here (such as the former waste incineration plant).

Remediation of the soil will be based on the proposed plan for specific plots and the nature of the impurities that exist. Between 2005 and the present, a number of additional studies were done. Depending on the results of removal of the source, the plume will be treated until a stable end situation occurs. For half the area of Buiksloterham, the chance of the discovery of strong contaminants in the topsoil is above 50%.

Over half of the surface of Buiksloterham contains a substrate (1 to 2 meters below ground level) where the likelihood of encountering a strong contamination lays between 25 and 50%.

The total cost for soil remediation is projected





Map on the right:
Immobile polution,
(1 to 2 bellow the surface)

Map on the left:
Immobile polution,
(0 to 1 bellow the surface)

Map on the botom right:
Green Structure (current
situation)

Map on bottom left:
Mobile polution

at €16 million but will most likely be much more - depending on the actual chosen thoroughness of remediation. The municipality can only invest if they are able to make a return or have the financial means to invest. The municipality is careful about investments and could allow for plots to remain empty because the cost for remediation is too high. However the empty brownfields will lower the liveability and attractiveness of the area.

In terms of water safety, Buiksloterham does not currently reside a in safe zone. A breakthrough of the Lekdijk is, for Amsterdam, seen as the most realistic risk because the chance of breakthrough is greater than at other dikes. If the dike breaks, the water flows over the low dikes of the Amsterdam-Rhine Canal and enters Amsterdam. Regardless of a future climate scenario and the rate of sea level rise the Dutch Delta program assumes that the level of 140cm + NAP is realistic.

Economy & society

The current economical situation in Buiksloterham is largely determined by its businesses and characterized by the absence of a local economy. There are around 3.750 people working in Buiksloterham, of which most are commuters from outside the area. The lack of a local economy can be attributed to the amount of overlapping or unrelated businesses/industries active in the area between which there are low grades of economic interaction. As little of the facilities and companies in Buiksloterham are aimed at providing primary services like daily groceries or catering it is unlikely that much of the worker's income recirculates in Buiksloterham.

From observation and stakeholder interviews however there is some evidence of business-to-business services between local companies in Buiksloterham, for example print shops serving offices and locally produced mushrooms sold to Café de Ceuvel. One could also imagine the numerous interactions and collaborations within one of the many company co-location spaces but no detailed data is available.

The vacant fenced-off brownfields, the wide streets bordered by large parking lots and the substantial amount of empty buildings present a shabby appearance of the area.

There are no dedicated statistics for Buiksloterham alone about the perception of current users and residents the quality of life in the area, but the overall liveability of the IJ-oever district is rated 6.4 which is lower than both North and Amsterdam.

Health & quality of life

Aside from the soil pollution discussed earlier, noise and air pollution are two main areas of concern for Buiksloterham. Noise levels are regulated in Dutch planning practices through the Noise Abatement Act. In Buiksloterham, the cumulative noise level caused by industrial activities must not exceed 50 dbs while for traffic along roads it can not exceed 48 dbs. Currently nowhere in Buiksloterham is noise measured lower than 50 db.

FROM NOW TO 2034

Currently Buiksloterham is at the beginning of a transformation from an industrial area to a mixed living-working area. The first concrete housing developments have started in mid-2013. The municipality of Amsterdam envisioned the redevelopment process in three key documents. Although never formally adopted, a Redevelopment plan (2003) for the Northern IJ-oever bank including Overhoeks, NDSM, Buiksloterham and Hamerstraat region laid the foundations for the transition process of Buiksloterham. In 2006, the municipal council accepted the Investment plan (Investeringsbesluit Buiklsloterham. Transformatie naar stedelijk wonen en werken) for Buiksloterham's development. Total projected investments were €157 million, while the total projected income from ground lease was €141 million (NPV 2006), leaving a €16.3 million gap. The plan outlines the urban planning strategies, building program, environmental- and civil technical, and financial framework for the development of Buiksloterham. Based on the Investment Plan, the zoning plan for Buiksloterham was developed and set. In 2009 the planning process finally resulted in a revised zoning plan for Buiksloterham.

The development and transformation approach opted for by the municipality is quite unique. Where traditionally the municipality buys out remaining users and clears the land, this was financially impossible mostly as a result of the heavily polluted grounds. A gradual, organic transformation approach was opted.

The transformation of the area is set up in a step-by-step process, with 'rules of the game' and a general vision, but no urban design blueprint. This method allows for the gradual and organic transformation of a traditional industrial zone to a more mixed-function area while respecting the current established (mostly industrial) users. As a consequence of this approach, the zoning plan sometimes gets into conflicting situations between different functions with different environmental impacts. Some industrial land-use functions with an environmental impact category higher than 3.2 are normally not located nearby residential functions, but in Buiksloterham these two functions can be combined.

As soon as the zoning plan was complete the financial crisis emerged, damaging the viability of the real-estate sector. As a result of the crisis, the municipality had to pro-actively find ways to continue the development of housing and office space in Buiksloterham. To do so, it introduced the principle of bottom-up self build plots, which allows individual people or groups of people to develop and build their own estates. In addition, sustainability tenders were awarded to innovative developers for the right to develop on four separate plots owned by the municipality.

Sustainability policy and development approach

Sustainability tendering offers a unique opportunity to integrate sustainability initiatives into the development process. However it is important to specify what the targets and objectives are early on. This includes specifications for waste and emissions reductions, reducing energy and water use, increasing biodiversity, increasing social and community cohesion and health along with other related goals. If these goals are specified early then the municipality can establish sustainability targets and guide development towards their specific ambitions.

One of the ambitions for Buiksloterham was to set a standard for climate neutral buildings. The

city of Amsterdam has a goal for all new buildings to be climate neutral starting from the year 2015. The sustainability tender and right to build in Buiksloterham would be awarded based on innovations in sustainability outlined in the proposal. Approval was given after two selection rounds, the first qualifying round being based on an overall vision while the second round included a sketch design and an expanded description of the original proposal.

Final approval was based on:

- A sustainability score for the development based on the 'GPR Gebouw' tool;
- Climate neutral building score based on 'Rekentabel Klimaatneutraal Bouwen' and the 'EPL Quickscan';
- Translation of the original vision into a realistic design proposal.

In Buiksloterham the sustainability tendering process was used for four plots owned by the municipality which were awarded to different developers who envisioned the most innovative and sustainable uses for the areas. The process was successful because the price was set at an attractive level for independent developers. Large housing and commercial developers did not participate because their standard economical models were not adaptable to the municipality's tender process. Two of the awarded projects, De Ceuvel and Schoonschip, are discussed earlier in this report.

Buiksloterham has a strong long-term outlook and the sustainability tender process was able to implement creative and interesting ways to develop the land. However there was a lack of procedure in the tendering process which led much of the development to be guided by the market. This could limit the municipality's influence on monitoring and guiding sustainable development. There was no integrated sustainability vision and no procedure to monitor or report on the sustainability of the area. Instead sustainability was guided by the minimum standards for development specified in the building regulation (Bouwbesluit).

BUIKSLOTERHAM IN 2034

General description urban plan and zoning

Following the development plans for the area, Buiksloterham is projected to be a completely revitalized, new city district in Amsterdam. Based on the zoning plan and the insights gained from stakeholder interviews, we have attempted to sketch a picture of Buiksloterham in 2034, 20 years from the present. There will be a mix of working and residential spaces. A total program of 1.000.000 m2 bruto floor surface will be realized with an equal mix between living and working.

Plots in the (South-)East of the area are more fragmented and can result in a fine-grained mix of residences and companies. Most of the other plots that will have been developed however are large. In theory the diversity in plot size can attract a diversity of development plans and companies. At the head of the Johan van Hasseltcanal large developments of up to 80 meters high are allowed.

Increase in interconnected urban water and green

Water will play a more prominent rule in the urban landscape of Buiksloterham in the future, both as a recreational and mobility feature. There will be an increase of public space at the many waterfronts. Non-public shores will need to be accessible by boat through piers. Parts of the Johan van Hasselt canal will be used for marina- and nautical activities, but also partially for housing plots with houseboats. Shores of the canal are supposed to form the new center function of the area, where entertainment and hospitality is projected. The Northern banks of the IJ will be shaped as a new tourist attraction area and urban green spot for local residents. Although public space will increase, there will also be a significant increase in paved public space to serve the function of traffic.

Working living mix

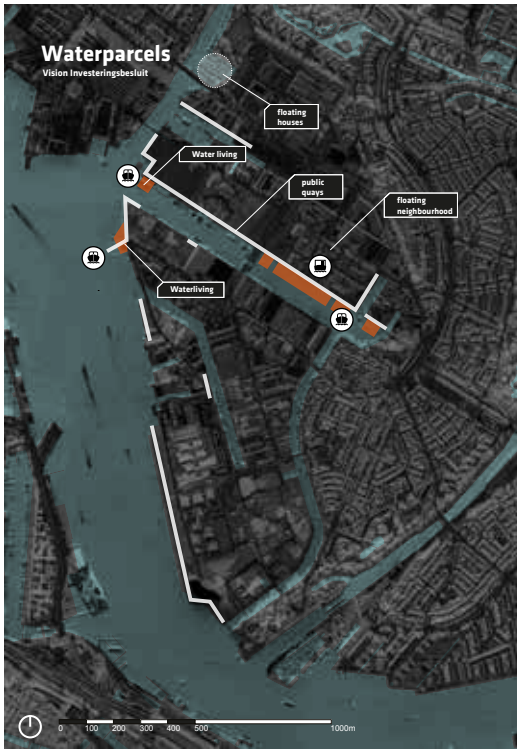
In the east facilities and working spaces primarily exist, with a 30-70 living to working. Existing areas are further densified and complemented. Further to the (North)West, higher value residential areas can be developed, and zoning here is largely 70-30 residential – working. Around 25% of the buildings will be ground bound houses, and 75% layered apartments.

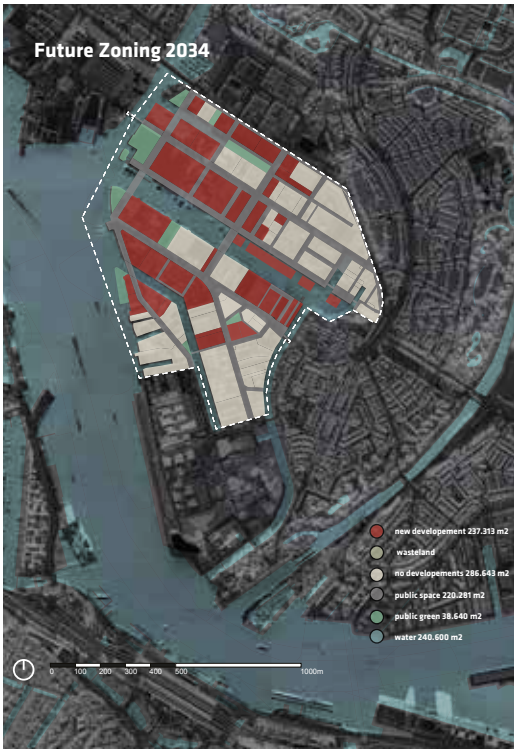
Demographics, users and facilities

Urban pioneers with a sustainability interest

On the basis of the zoning plan, the Investment Plan and interviews with stakeholders, it is projected that around 6.500 people will live in Buiksloterham and around 8.000 additional people will work here once the development is completed. It is assumed for now that the residential development will be finished before 2034, but given the uncertainty around some of the larger plots owned by the municipality with problematic pollution, this is still highly unsure.

The type of future residents of Buiksloterham currently attracted by the developments are not straightforward dwellers. As former industrial site, the area will remain 'rough around the edges' and with industrial character for the coming years. The main picture depicted is that of urban pioneers with an interest for sustainability. Eigen Haard, who already sold the first phase of houses in their development, sees a clear pat-





Map on the left: Waterparcels

Map on the right: Future zoning 2034

tern of future residents of small houses: young, highly-educated, couples from Amsterdam. 30% of Buiksloterham is projected to be dedicated to social housing.

No everyday retail projected

Retail and commercial facilities will only be located around the Klaprozenweg. Only peripheral retail is allowed, which means only boat, cars, caravans, furniture and do-it-yourself (DIY) stores. For daily groceries, Buiksloterham inhabitants have to go to the Van der Pek area, in particular Mosveld, where a 7.200 m2 commercial zone is projected to be developed. The area around the Asterweg and IJ shore will be maintained for industrial functions which do not allow for mix with residential functions. Buiksloterham by function is projected to be a recreational and entertainment zone which will attract both locals and residents from surrounding neighborhoods.

Company activities are mainly organized along the streets and residential functions along the water. The zoning plan and building development plans describe the mixed percentages specifically. The type of commercial activity that is attracted is focused on sustainable, creative and nautical companies which allow for combination with residential functions. Social facilities are supposed to be clustered around the Johan van Hasselt kanaal.

Mobility

Increased traffic absorbed by increased roads

An extensive grid of main and side streets will be built with idea of increasing accessibility and dispersing traffic. A key strategic development is the widening of the major access road Klaprozenweg from a 2x1 lane to 2x2 lane to absorb the increased traffic. At the same time, this also poses threats to the projected development of additional green space that connects the IJ with Waterland. By limiting the vehicles access of the public shores only to destination-traffic, the municipality aims to keep the quality of the space high.

Currently, there are 17 different roads measuring approximately 6.1 km total. With the increase in residences and office buildings, these numbers will probably increase by about 30%.

Increased access by bikes

By widening the public roads, more space is created for bicycles. At the same time, an increase focus on individual bike transportation will heighten the demand for bike storage spaces. It is planned to create at least one bike parking per 25m2 housing. The accessibility of Buiksloterham through Overhoeks is projected along the shore, partially guided by wooden deck construction right of the shore where plots like Shell will border the IJ directly. Part of this bike path has already been constructed along the shore of Shell but stops abruptly where the docking bays of the industries start again. There are no plans to connect this path to the NDSM cyclist bridge from the Klaprozenweg.

Parking quotes can lead to total construction of ground-level

As with all new residential and office building developments, parking norms determine the amount of parking spots needed to be realized per developed surface office, housing or facilities. Taken into account the maximum built program, the norm leads to 6.000 parking spots. Because of a decentralized parking policy and flexibility in parking solutions, the area runs the risk of large, paved surfaces maximized for parking.

Mobility over water made more accessible

The municipality has projected to make the area more accessible by water for both recreational purposes and mobility. It is planning moveable bridges at the beginning of the Johan van Hasselt kanaal to allow for accessibility of larger vessels. Nevertheless the projected bridges will be a barrier for freight traffic over water.

There are several ferry landings planned although there are no public plans for new dedicated ferry lines to Buiksloterham. The increasing number of passengers (+10% per year currently) and the relatively limited ferry capacity is recognized as one of the weakspots of the connection from central Amsterdam to North.

CityPlot development

One of the large developments that are currently planned is that of housing corporation De Alliantie. On the former Air Products site (26.000m2) – a large industrial facility – they aim to build a new development that is programmed for housing and businesses. The concept of CityPlot is that small city areas are created within a larger development and at the same time supported and made lively by means of 'urban activators'. Urban activators serve a purpose in the beginning of the development, by already attracting future residents to open social functions like café's and workshop spaces, but theses functions will remain active throughout the overall development. The Urban Activators as envisioned by De Alliantie are directed at innovation in the field of energy and building materials.

Public transport

On the level of public transport, the municipality aims to facilitate the switching of different modes of transport (from public transport to individual sustainable transport like bikes, e-bikes and electric vehicles) although it is unspecified which facilities would be required for that. The accessibility of North by public transport to the center will be strengthened by the new metroline (Noordzuidlijn) which will be opened in 2017 if no further delays occur. In the future a bypass from the Noord-Zuidlijn is also expected over the Klaprozenweg or Johan van Hasseltkanaal as a new connection to Zaanstad. Bus transport will be better linked to the ferry and accesspoint from all residential housing will be secured within 400 meters.

Infrastructure

In the projected scenario for 2034, Buiksloterham will see a generally straightforward mix of infrastructure for drinking water, wastewater, electricity and gas. As is currently projected, most of the area will be supplied for heating by the heat district net. Heat is supplied from the Western harbour district, mainly from the waste-to-energy plant. According to various sources, 15% of the connections (up to 1.500 households) can be exempted on the basis of the equivalency principle (providing heat equally sustainable to the heat from the district). Alliander is interested to make 'open infrastructure' to allow others to connect a diverse range of supply sources.

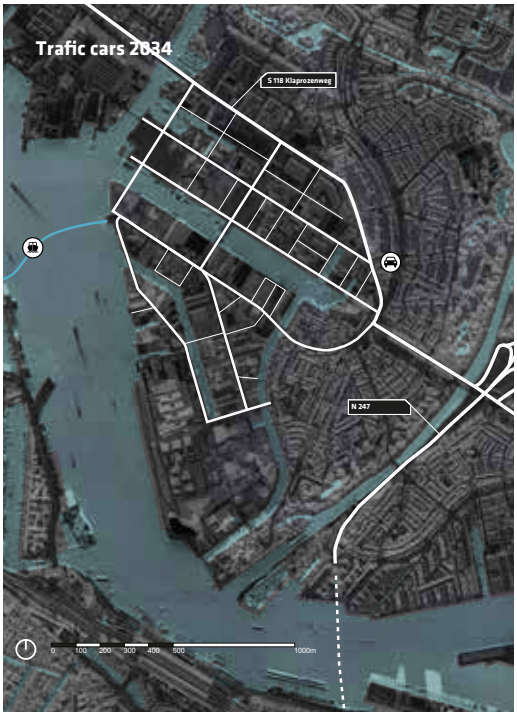
Waternet is the managing authority for waste water, drinkingwater and water system in the area. In general, the guidelines for stormwater management are that:

- reuse is preferential over discharge;
- polluted stormwater should be separated from clean stormwater, and stormwater needs to be collected separately from wastewater;
- and plot owners are responsible for their own stormwater management on site.

It is therefore foreseeable that a stormwater sewer will be installed but at the same time that plot-owners will take stormwatermangement measures reducing the capacity of the network. Waternet then has the responsibility to collect water from the plots and to dispose of it correctly. It is also the authority to deal with the rainwater from public surface, in collaboration with municipality who governs the public space. The stakeholder platform Amsterdam Rainproof tries to encourage real-estate own-

Map on the left:
Typology Housing 2034

Map on the right:
Typology Service 2034



ers to create additional buffer space (like blue roofs) and permeable surface.

Drinking water is sourced from three sources (amongst others the Rhine) and no decentral drinkingwater production is projected. A normal central drinkingwater grid is therefore to be expected. Officially Waternet is only considering decentral treatment of waste water in cases where it has proven benefits over centralized treatment and in principle only for new-build developments over 10.000 houses. Waternet is currently not planning decentralized treatment facilities or source-separated collection of urine, but it is important to note that Waternet is highly interested in using Buiksloterham as testbed for innovations in watercycle in the field of energy, water and nutrients.

Ecology & biodiversity

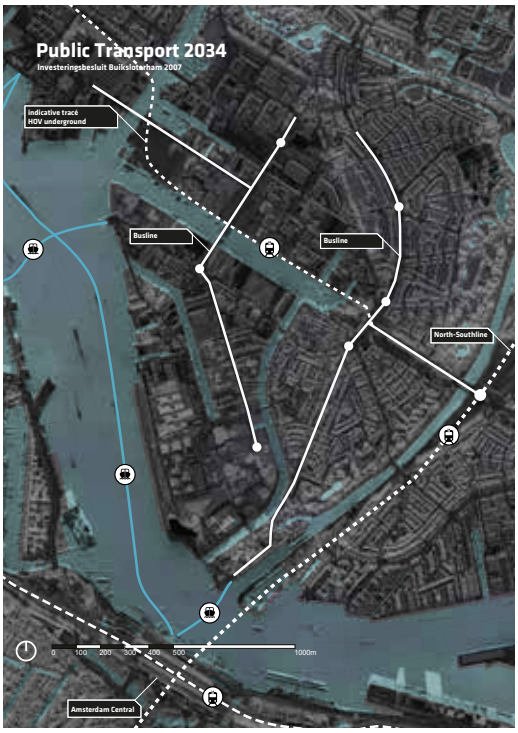
Buiksloterham holds an opportunity of creating a continuous green link between the Klaprozenscheg and the rest of Amsterdam North. The core of the framework of public spaces is formed by the network of main streets. Along this network are the main public spaces, parks and quays. A green IJ bank and green 'heads' are places that, due to their location on the open water, have a higher potential of usage. Not only would this strengthen the public function of the green space, but also be a corridor for migrating habitats. One of the projected developments is creating a green shore along the IJ at the head of the Grasweg. This development is not in the investmentplan of the municipality which is a risk for the realization of this plan. To make better use of the diverse water quality properties of the IJ water, the municipality intends to create shallow shores, which could function as breeding beds for fish and crayfish, and amphibians, waterbirds and dragonflies.

Pollution & water safety

The heavily polluted grounds pose one of the main barriers for the development of some of the plots of Buiksloterham. Even though the municipality has set out an original budget for

Map on the left: Trafic cars 2034

Map on the right: Bikepathes 2034



the area's development in the Investment plan of €157 million, of which €31 million is allocated to remediation of the soils (€7 million for urgent remediation and €24 million for projectbased remediation).

The municipality does not address water safety currently although some plots are projected to be slightly elevated. Not to the level that is required for a potential protection against 1.40m NAP. Most plots will be elevated with a meter of clean, porous topsoil to avoid problems with the high groundwater and at the same time to remediate the immobile soil pollution.

Economy & Society

The significant shift in number of residents and business in Buiksloterham will create a much different socio-economical picture in a plus twenty scenario. Based on the m2 prices and the type of residents that are currently attracted it is already visible that a higher segmented of real-estate is put in the market. With only a projected 30% social housing, the area will look much different from the neighboring Volewijck.

Depending on the type of business that will actually reside in Buiksloterham in 20 years, there could be a significant business to business economical activity and even between residents and business. But this will not come automatically, given also the current picture in which little businesses work complementary to each other. The absence of local retail for daily needs like groceries in the projected scenario will not lead to a local economy as much as could be possible.

Health and quality of life

The transition from an industrial area to a mixed-use area will imply that industrial and groundwater pollution will need to be remediated to some extent.

1 - Offices/companies 1PP per 125m2 bruto floor surface (GFA)

-Facilities 1PP per 100m2 GFA

-Social housing 0,5PP per property

-Free sector 1,5PP per property

-Visitor parking 0,25PP per property

ZOOMING IN ON THE AREAS AROUND BUIKSLOTERHAM

Volewijck

The neighboring area Volewijck is one of the most prominently connected areas to Buiksloterham, consisting of the areas Van der Pek, Mosveld, Floradorp and Bloemenbuurt, amongst others. This area is important to understand better because of the traditional and native Amsterdam-North demographics alongside which Buiksloterham will develop. It is also important because of its projected function of retail on which Buiksloterham will be mostly dependent.

Volewijck is one of the earliest housing developments in North and is characteristic for the overall urban habitation of North (Stadsdeel Noord, 2010). It is characterized by a great diversity of cultures and facilities. The area itself is positively developing on some fronts, but in general the area has problematic socio-economic characteristics, compromising the overall quality of life for its inhabitants. Many of the houses are small, inexpensive social houses and the area is one of the poorest areas of Amsterdam. The property value of houses is also lowest in North, and compared to the average value in Amsterdam (WOZ value €235.000) houses here value on average €162.000). Also the quality of life and safety is rated as one of the lowest in Amsterdam. Most poverty and unemployment is found in the Van der Pek area, where residents are also the least satisfied with their living environment. Unemployment in general is high in Volewijck, incomes are low and a high percentage of youth is an early school leaver.

Volewijck statistics (DRO, 2007)

- Surface: 131 ha;
- Number of houses: 4.870;
- Number of residents: 9.395;
- Number of workers: 1.791;
- Healthcare facilities: 22;
- Wellness facilities: 9;
- Leisure facilities: 11;
- Outdoor playing facilities: 17.

There are many different types of business in Volewijck, especially concentrated around the van der Pek straat, Mosveld and Hagendoornweg.

NDSM

Buiksloterham shares the northern IJ bank with in the west the NDSM area. It is useful to understand this area better because of its projected function of cultural hot-spot from which Buiksloterham can benefit, and of the comparable developments of this former industrial area into a combined living-working area.

NDSM, the historical remainder of the largest shipyard in Amsterdam, is now developing itself into a creative city and has grown into a cultural hot spot in recent years. The wharf is declared a National Monument in 2008 and has the promise to grow continuously as a gravity center of urban creative energy.

The zoning plan for the area aims 45.000 m2 added gross floor area to the original existing 65.000 m2. Although transformative development was restricted, the area is destined for living, hospitality, culture, shops, offices and tourism, adding new functions to the area (Gemeente Amsterdam). With 2.000 residences, living will be the main function of the area. The zoning plan includes new constructions at the plot of the former Docklandhal and art studios in the former boat ramp. The north of the NSDM currently remains the traditional business area. The south, apart from the Baanderij and headquarters of HEMA/VNU, is currently undeveloped but will be actively developed and leased.

Overhoeks

The former Shell grounds, Overhoeks, east from Buiksloterham on the northern IJ bank steadily develops into a proper living area with urban facilities. Characteristic for the Overhoeks is the low percentage of office units. The area is designed to be a living and working mix area with hospitality venues and cultural facilities, with the Eye Film Institute and Overhoeks tower A'DAM as cultural hotspots. The land was purchased and cleared by the municipality which then sold the development rights to one developer. The developer built several high-end luxury apartment buildings. In 2014 the construction of 520 residences will be finished and in 2018 1.200 residences will be added.

Amsterdam trends

Amsterdam's population is growing steadily with around 10.000 inhabitants per year. To accommodate this growing population, the city has a significant ambition to realize more new housing (5.000 houses per year) (recent Bestuursakkoord, 2014). Industrial areas will be converted into working-living areas and space will be used more intensively to create more space for people and business.

Quality of life becomes more important. The city turns to the use of public space, increasing focus on urban green and the use of water around the city. Additional to more emphasis on green areas, the center expansion and internationalization of the southern flank, the city of Amsterdam directs its spatial ambitions to the development of the IJ banks.

Ferry connections were made from the southern to the northern banks of the IJ, making transportation between the center of Amsterdam and the northern banks of the IJ easier. It has already stimulated development through the migration of creative individuals and businesses. In order to fulfill her role as a metropolis the city of Amsterdam plans, next to the Noord-Zuidlijn connection, more frequent and comfortable public transport on a regional scale.

National trends

It is depicted that the population for the Netherlands will continue growing from 16.8 mln to about 17.8 mln inhabitants in 2040 (CBS, January 2013). The population will decline in the peripherals and growth will mainly occur in the

Randstad this will affect the city of Amsterdam.

With an equal distribution of male and female, Dutch population consists mainly of inhabitants between the age of 40 and 66 (38% of the population). The amount of young people will keep reducing but not as fast as during the seventies and eighties. Almost one fourth of the population had the age between 0 and 19 years in 2012. This will gradually change to one fifth in 2025. In 2012 more than a fifth of the Dutch population was considered immigrants. This number will grow to just under a third in 2040 (CBS, 2013). Although aging of the Dutch population is inhibited by the strong growth of non-western immigrants the amount of 20 to 40 years olds will decrease from 60% in to 52% in 2040.

STAKE HOLDER ANALYSIS

This section describes the main results of the stakeholder analysis. There is a diverse pallet of stakeholders active in the area, ranging from individual current users to large stake-owners such as the municipality and infrastructural parties. By means of more than 20 in-depth interviews and informal conversations with a carefully selected group of stakeholders with decision-making power (such as large developers) or those who are subject to the decisions made (such as local users), many interesting insights were gathered about the many layers of interest that create the complex web of the redevelopment of Buiksloterham. The stakeholder analysis portion of the urban metabolism scan is critical to understanding the human element at play in the area: it is impossible to create any kind of meaningful or lasting change without broadly engaging the parties within a particular context who either: (1) have decision-making power or (2) are subject to the results of decisions made.

STAKEHOLDER PROCESS

Stakeholder analysis process

As part of the stakeholder analysis, we first identify the stakeholders, then classify them into groups, and finally involve them in a custom engagement process (which ranges from digital surveys to joint workshops, depending on the stakeholder and their role in the project). Stakeholders are those who have a direct stake in the development of Buiksloterham as a result of their power, those who are subjected to the power of decision-makers or those that have in some way a stake in the development of the area.

General interest groups include those who are engaged or interested in the area, but do not have a financial or personal stake. This includes groups like academic or advisory parties or non-local government agencies who have a broader interest in the development in the area.

Based on these categorizations, we have developed further sub-categories to help us determine which groups to interview in more detail during the stakeholder process: stakeholders with site-specific interests and stakeholders with a general interest.

Stakeholders with site-specific interests:

- Property owners (& future property owners);
- Renters (local businesses/organizations and residents) (& future renters);
- Infrastructure and utility companies with a financial stake in the area;
- Public and government agencies working in the area;
- Local associations (e.g., self-build association, entrepreneurs' association);
- Groups actively leading neighborhood-focused activities;
- Developers and groups active in surrounding neighborhoods (like Overhoeks, van der Pek and NDSM area).

Stakeholders with general interests:

- Public and government agencies not directly working in or around Buiksloterham;
- Academic and educational institutions, including student groups;
- Advisory groups/knowledge institutes;
- Visitors, tourists.

From the stakeholders with a site-specific interest, a representative selection for each of the different sub-categories was made of stakeholders with whom interviews were scheduled. To name a few of our selected stakeholders:

- Most of the developers active in the area were invited. This includes the large housing corporations Ymere, Eigen Haard and the Alliantie, as well as smaller ones such as Lemniskade and Bunder;
- Involved public agencies were invited, like from the municipality of Amsterdam Grond & Ontwikkeling, DRO and the Omgevingsdienst Noordzeekanaal which governs the environmental regulations;
- All infrastructure parties were interviewed; for some parties multiple departments within the organization (Waternet, Alliander, Liander, NUON) were interviewed to get a good understanding of interest and planning procedures. Exceptions are for a data/IT infrastructure stakeholder and the public transport (GVB) provider, as there was no available contact information;
- A representation of local businesses was interviewed, mainly those with large material flows;
- A representative of the local self-builders;
- Local enterprise association for Buiksloterham.

Out of the 74 stakeholders categorized in this group, we invited 41 stakeholders for interviews. From those invited, we finally interviewed 23 stakeholders. Not all selected stakeholders have responded to our request for interviews, even after reminders. Some will instead come to the stakeholder session and use this time to contribute ideas and thoughts. By handing out flyers to the smaller companies currently active in the area we aimed to inform most current users about this project and during this process informal conversations were held in which additional data was collected.

From the group of stakeholders with a general interest, no one was invited for a dedicated interview, but a selection of these has been invited for the stakeholder meeting.

For this section, a qualitative analysis was performed based on the results of the interviews. The interviews were performed by members of the project team.

KEY INSIGHTS FROM STAKEHOLDER INTERVIEWS

Large number of stakeholders involved in the area's redevelopment

A first insight from the stakeholder analysis is that, aside from the local users of the area, there is a significant number of stakeholders directly or indirectly involved with the development of Buiksloterham. Because of the divided ownership of the whole site, the municipality along with many different site-owners or developers have a stake in the area. The actual ownership data of the different plots in Buiksloterham is quite dispersed; the municipality had limited and incomplete information and only through the (paid)database of the Kadaster (land registry) it would be possible to request more accurate information.

Until the recent changes in the governing structure of the Amsterdam municipality, the management of the re-development of Buiksloterham fell in the hands of project bureau Noordwaarts. Noordwaarts was created to form the link between Stadsdeel Noord and the Municipality, Grond & Ontwikkeling. Grond & Ontwikkeling is the development agency of the Municipality of Amsterdam and is in charge of realizing Amsterdam's ambitions in the field of area- and real estate development for the city. Since 2014 the governing structure of the municipality is adjusted and most of the municipal tasks are back in the hands of the central city governing body instead of the local city district councils (stadsdelen) and project bureaus (like Noordwaarts).

Since early 2014, Noordwaarts is de-institutionalized and the tasks for governing development are back in the hands of Grond & Ontwikkeling and Stadsdeel Noord. It is Grond & Ontwikkeling's tasks to shape the area development in Buiksloterham, which in practice implies the issuing of ground/developing rights, the guidance of initiatives and developers and the development of the zoning plan. In short, ensuring the boundary conditions for the different developers to act within the area and allow the municipality to reach its real estate development goals to meet the ever-increasing demand for housing.

Current users have mixed perspectives on the redevelopment

In various talks and interviews with current users of the area, it became apparent that there are positive and negative attitudes towards the redevelopment of Buiksloterham into a mixed-use zoned area. Some of the light industries, in particular car garages, indicate to feel threatened in their core activities by the arrival of housing in the area. The freedom they experience now with free parking and open public space is something that in their perspective will change to their disadvantage. Other local business, like the small antique- and second hand stores, see

the redevelopment of Buiksloterham as positive because of the increased number of local inhabitants and liveliness of the area. Also the current land and building owners in Buiksloterham, as well as the housing corporation developers, are mostly positive about the redevelopment of Buiksloterham, it is clearly an area with potential for financial gains from this moment on.

Large industries currently remaining could form a barrier for the development of housing in Buiksloterham. For example, as a result of noise from industries the current zoning at the IJ-oever make it impossible to develop housing there. At the same time, these industrial parties are not interested to relocate and prefer to see the zoning keep housing developments distanced from their activities.

Not everyone is taking the current plans and talks about redevelopments seriously – it has been a topic for almost a decade now and some local stakeholders have responded with suspicion about the pace and actual realization of the development: the time has come to show, not tell.

Self builders/developers and temporary projects have boosted the overall redevelopment

Self-build development refers to the development of houses that are (partially) designed and built by house owners. Self-building in the Netherlands has been a growing trend over the past decade, inspired by examples in amongst others Germany. In 2011, around 3% of the houses in Amsterdam could be classified as self-built and the Dutch national average is 7%.

The municipality of Amsterdam has had an ambition to realize more self-built housing developments for years, but had difficulty finding the right plots. In 2006 the municipal council accepted the proposal to build 10% of all newbuild in a self-build fashion, but this was not realized. When the crisis hit the real-estate sector

in 2009, there was an immediate gap in developer's interests. Giving out self-build plots was one of the strategies to re-start the development of Buiksloterham. As also described in the context section, the municipality not only gave out self-build plots, it also started for tenders for plot development which were mostly based on sustainable criteria.

Currently, the first developments that make Buiksloterham's development concrete are the self-built houses on BSH 3 and along the Ridderspoorweg. The self-builders and temporary developers like the Vereniging de Ceuvel are therefore currently responsible for the first results of the redevelopment of Buiksloterham. Out of their own passion and interest, these groups have generated a large amount of publicity (through blogs like deceuvel.tumblr.nl, bsh5.nl and the site portal www.buiksloterham.nl) and developed active marketing for the area (the selfbuilder collective from VinkBouw has taken the (co-)initiative to set up Beleef Buiksloterham www.beleefbuiksloterham.nl, the marketing portal for the site).

The self-builders, the collectives and temporary initiatives have invested significantly with their own resources and created more traction and attraction for the area.

Fragmented role municipality

One of the barriers faced by local developer stakeholders was described as fragmented guidance of the municipality. The integral link within the municipality was supposed to be Noordwaarts, but the right redirections or follow-up actions were frequently unclear for stakeholders. This has been especially true in the sustainability tender plots, where initiatives were still faced with lengthy 'normal' procedures after the awarding of the plots. De Ceuvel had to go

through a zoning change and a complex building permit procedure for a highly unusual plan. Vereniging de Ceuvel had won the sustainability tender with their plans to place upcycled houseboats on the polluted former shipyard - something that hadn't been attempted previously. The actual enforcements of building rules happened on the level of Stadsdeel Noord where standard procedures had to be followed which led to long, uncertain and time consuming procedures. In general it has been stated that developers (sometimes one-man developers) have spent a lot of time and hence money on process costs - much higher than in other projects. Often a costly affair – one smaller developer estimated to have spent 0,5fte over the past 5 years on processes with the authorities.

According to some stakeholders with current real-estate or real-estate developers, it has been a struggle to understand the exact 'rules of the game'. Contradictions or incomplete information was provided about actual zoning restrictions, for example whether horeca would be allowed in certain locations. It was difficult to make concrete arrangements with project bureau Noordwaarts or to get the right information in the right time.

Worrisome to many that area becomes monofunctional housing area

Buiksloterham in its current state has an unusual mix of facilities and as we've seen in the context analysis, based on the zoning plan and vision for Noord, all retail is to be concentrated at Mosveld where more than 7.000 m2 of retail will be developed. Many stakeholders believe the exclusion of retail from the area is one of the biggest threats to development, thinking this could lead Buiksloterham to become a monofunctional housing area.

Heavily polluted empty plots still no purpose

For some of the most heavily polluted lands owned by the municipality there are currently no plans developed. This is mainly the result of the significant costs required for remediating the soils, amounting to several tens of millions. The municipality can only invest if they make returns or have the financial means to invest.

Some developers that are currently developing or have development plans re-iterate the importance of slow, high-quality development to avoid Buiksloterham to become a characterless living space. It is a risk that once the current pioneering fase of development transforms into more standard development practice that attention to develop unique and authentic buildings reduced.

Another important thing to note is that the municipality is currently careful in allowing temporary activities. These can be costly in terms of capacity of civil servants and almost always require a basic investment in infrastructure and ground pollution remediation. Keeping vacant is sometimes a better choice, even though these empty plots currently reduce the overall attractiveness of the area.

Infrastructure planning not adjusted to self-build scale and timelines

Infrastructure planning in a transformation area with a large amount of developer groups - from individuals to large housing corporations - is obviously a challenge. Especially when historical concession made on infrastructure such as a heat district network impose limitations to the freedom of choice of developers on basic choices such as (renewable) heat supply. This causes a lock in which self-build groups have difficulty securing exemptions for - even though the policy allows for this option on the basis of equivalency principles where equally or more sus-

tainable alternative sources are proposed. The scale and differing time-frames at which standard infrastructure connections are required also pose challenges to (small) developers. Often mentioned examples are the lack of glass fiber connections and basic connections of electricity and water before the establishment of a house numbers or official address.

With regards to sustainable infrastructure and clean technologies many parties point towards the fragmented approach to sustainability and the lack of central coordination. This results in suboptimal solutions on a building level or a plot level, such as closed heat & cold storage systems on a plot level, whereas with better coordinated open systems could have delivered all parties more benefits.

General positive attitude towards testbed

Many of the larger stakeholders in the area in terms of ownership or investment – mostly the infrastructural parties and Grond & Ontwikkeling – are interested in the area as a testbed for innovation. Grond & Ontwikkeling is interested in sustainable area development but issues a caution regarding the pace of the development which should not be frustrated. Both Waternet and Alliander are highly interested and see many opportunities for innovative infrastructure and cleantech applications if Buiksloterham were to be developed into a Living Lab.

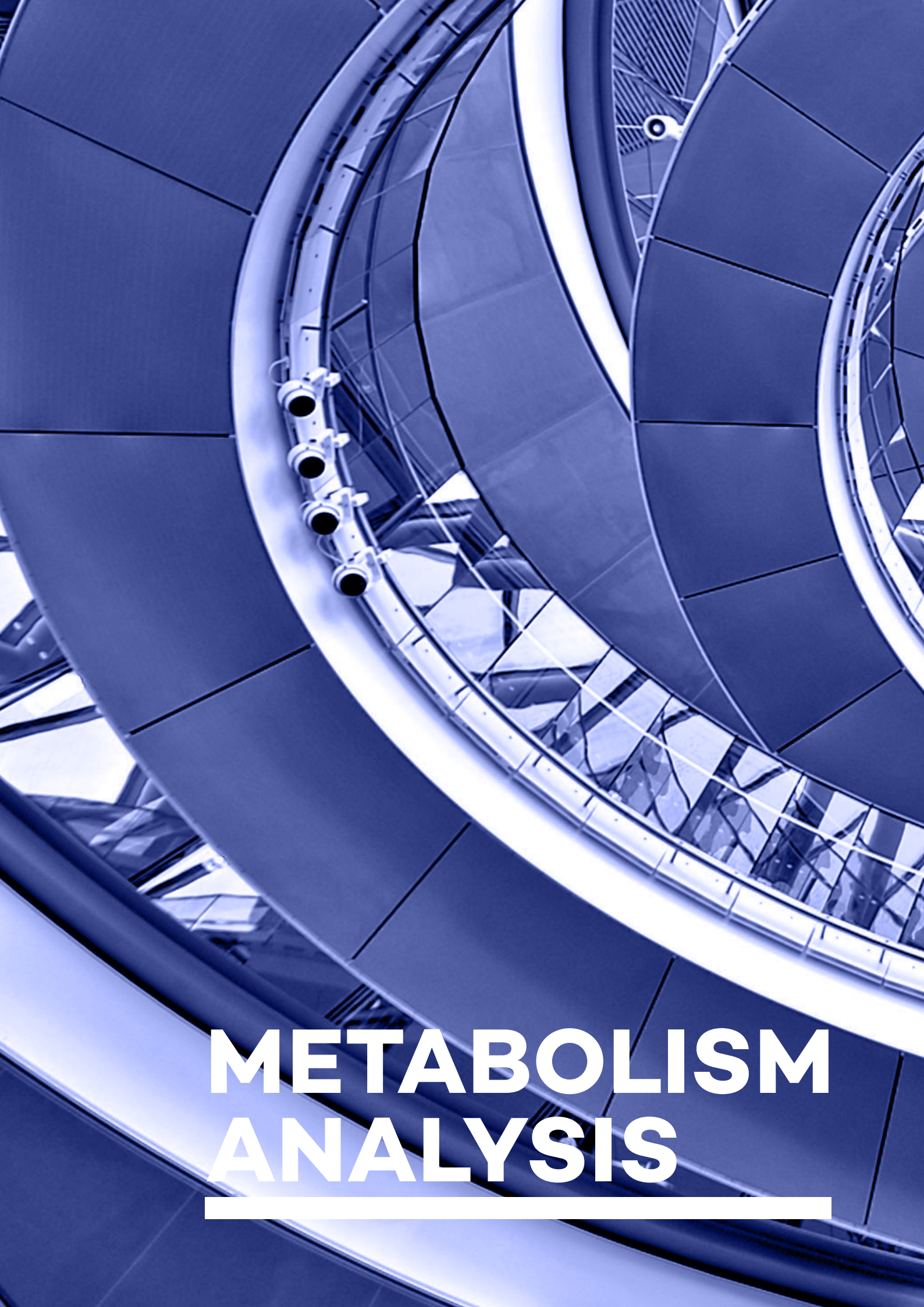
From the local users mixed signals were sent. Many of the developers and real-estate owners seem interested but clearly indicate the need for financial feasibility. The majority of them have not taken (significant) steps, such as implementing renewable energy but are considering taking these steps eventually.

From our interviews with current owners and developers, it has become clear the sustainability initiative is not new and that most are actively considering it in their development plans. Self-builders in general indicate to have a high interest and application of clean technologies for the provision of renewable heat and energy, as well as sustainable water management practices.

Decision making mandate for sustainability interventions

One of the apparent results from the interviews was that some of the larger industrial companies and organizations have little mandate to make operational decisions. The NH Hotel located right outside of Buiksloterham for example is part of a large international chain for which all procurement is centrally organized. OMYA is a worldwide operating business where decisions about energy procurement and facility plans are made on a centralized - European - level. What this means on the level of circular or sustainable interventions is these can not always easily be realized.

When we look at the office collectives in Buiksloterham - there are around 8 of them - we see a traditional split between users and owners. The users mostly pay a utility fee for services, which includes water, energy and such, whereas the building owner has the (financial) mandate to make investment decisions that would affect the energy supply or demand side of the building. Because of this split-incentive there are little interventions currently being taken for the reduction of energy demand or the production of renewable electricity.



METABOLISM ANALYSIS

The purpose of the Metabolism section of the analysis is to get insight into material stocks and flows within Buiksloterham and surrounding areas and to understand how these are projected to change over time. This analysis was used as the foundation for modeling the proposed goals and interventions for moving to a Circular Buiksloterham.

As with the context and stakeholder analyses, we have assessed the current state in Buiksloterham and also created a model for the projected state in 20 years time. This analysis looks primarily at the type and quantity of physical flows (energy, water, materials), though some non-physical flows, like money, have also been considered. The data are based on bottom-up modeling using known and projected numbers of vehicles, buildings, residents, and other drivers of supply demand. The +20 model is based on our understanding of development plans, policies, and the intentions of stakeholders. It extrapolates current resource flows to the future state based on the best available information, including new building codes and policies. Where site-specific data were not available, gaps were supplemented with statistical information.

The interventions that are proposed in the roadmaps for moving towards a Circular Buiksloterham have been evaluated using the +20 model. Where possible, we have used the model to quantitatively assess each intervention's projected impact on supply and demand of resources.

Metabolism analysis summary

Transitioning from industrial dominance

Buiksloterham's current material metabolism is still dominated by its industrial character. This is readily evident in the local distribution of energy and material demand. Around 42% of the energy used in Buiksloterham goes towards industrial functions, despite the fact that there are only a few heavy industrial parties remaining in the area. Likewise, industry by far dominates local material demand, consuming an estimated 130.000 tonnes of material per year, which accounts for approximately 90% of all incoming material. A large part of the remaining material inputs into the area, an estimated 10.700 tonnes annually, is large household waste that is collected from throughout Amsterdam North and processed at Buiksloterham's waste facility. The one material flow category for which the industrial character of the area is not currently apparent is water demand, because none of the industries in Buiksloterham are particularly water-intensive; industrial functions now account for only an estimated 14% of local water use.

Because there are currently only 252 registered residents in Buiksloterham, typical domestic material flows (food, household products, water, and wastes) are still relatively low. Office material demands are estimated at only 100 tonnes annually for all 135 offices. The development plan for Buiksloterham includes a scheduled increase of 700.000 square meters of usable space from the current 300.000, with primarily residential functions in the planned expansion. When all of the area's development plans are complete, the number of residents is projected to go up by approximately 25-fold and the number of offices is projected to go up by over four-fold. This will dramatically change the demand profile of the neighborhood and reduce the dominance of industry. Residential and commercial functions will account for a combined 57% of local energy use, with 21% of the remainder attributable to the increase in local motor vehicle transport.

Likewise, water and material demand as well as waste generation will increase for both commercial and residential functions, commensurate with an increase in these activities. A summary of the anticipated changes in overall resource flows in the area is shown in the table below.

Snapshot overview: Current vs. +20 projections for Buiksloterham

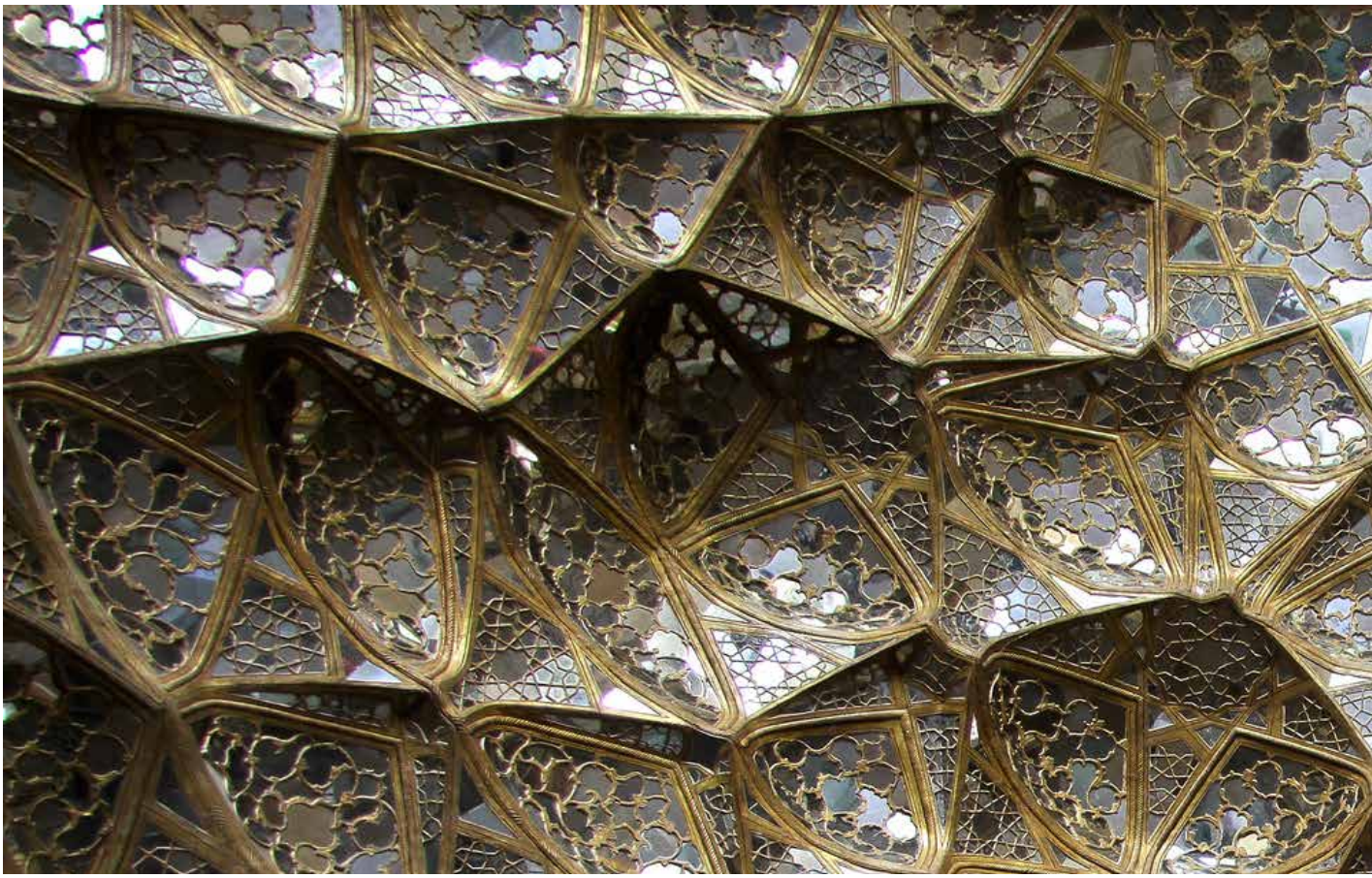
- Energy demand will increase almost 3-fold;
- Heating demand will increase 5-fold;
- Electricity demand will increase almost 2-fold;
- Vehicle fuel demand will increase almost 6-fold;
- Water demand will increase almost 4-fold;
- Food demand will increase 9-fold;
- Waste production will increase almost 3-fold;
- Household good demand will increase by 25-fold.

Local resource potential

Locally available renewable energy and water resources could theoretically supply all local demand within Buiksloterham.

Even using conservative estimates, the solar potential of the total area (100 million kWh) exceeds the current total demand (93 million kWh), though not by a significant margin. Aside from solar potential, there are of course other potential sources of renewable energy supply within Buiksloterham (wind, geothermal, biomass). Based on the total potential from all sources, and a strict energy efficiency program for new construction and mobility, we estimate that it should be possible to achieve full renewable energy self-sufficiency within Buiksloterham, though it is likely that this will partly depend on the emergence of more efficient renewable energy technologies.

There is an estimated 850 million m3 of rainfall in Buiksloterham per year in addition to a significant amount of surface and groundwater. Currently only around 90 thousand m3 of water are used per year, which is projected to increase to roughly 674 thousand m3 in the +20 scenario. Though there is clearly sufficient water to sup-



port all local activities, relying on this water for local functions is not necessarily recommendable from either a financial or sustainability perspective due to the high capital, material, and operating costs of installing appropriate decentralized water treatment. However, as much rainwater as possible should be diverted and used for low-quality functions to improve local water management and reduce storm water overflow.

Local socioeconomic flows

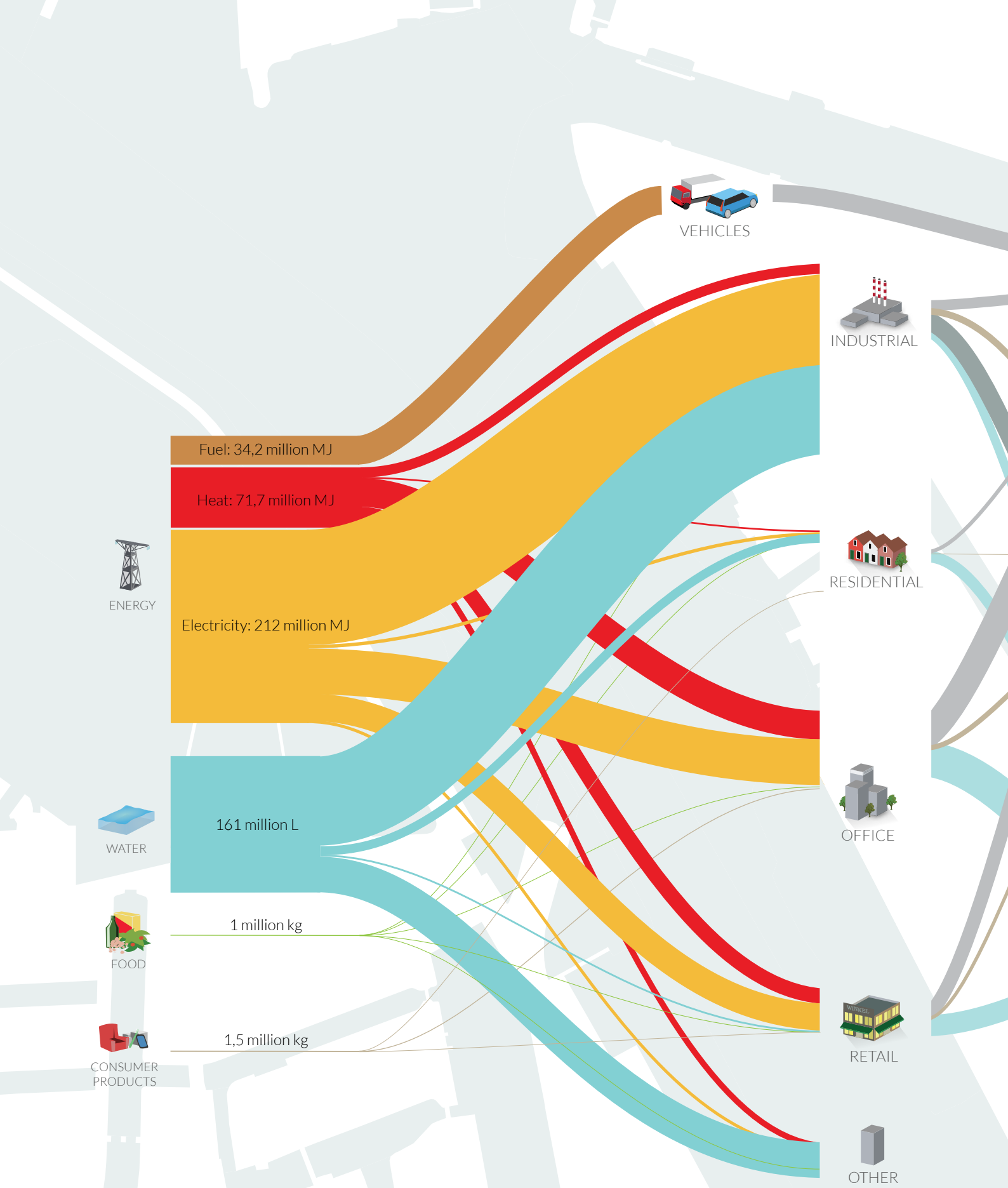
Due to the nature of the local activities, most of the income generated in the area leaves Buiksloterham. The dominant industries manufacture products and provide services that are generally delivered outside of Buiksloterham; only a relatively small percentage of income is spent in the local area. The strength of the local economy, in terms of local value exchanges and local investment in the area by local actors, is therefore still quite low. An estimated 3% of the total income generated within Buiksloterham stays in the neighborhood in the form of salaries paid out to local residents, taxes, and rent. Based on our projections of greater local employment in the +20 scenario, the amount of local income that stays within the area will increase to just over 7%, however this is still a low figure (does not include real estate investment costs). Increasing opportunities for local trade and investment among the emerging local population will be essential to fostering a more vibrant and tightly-knit community in Buiksloterham.

Primary conclusions

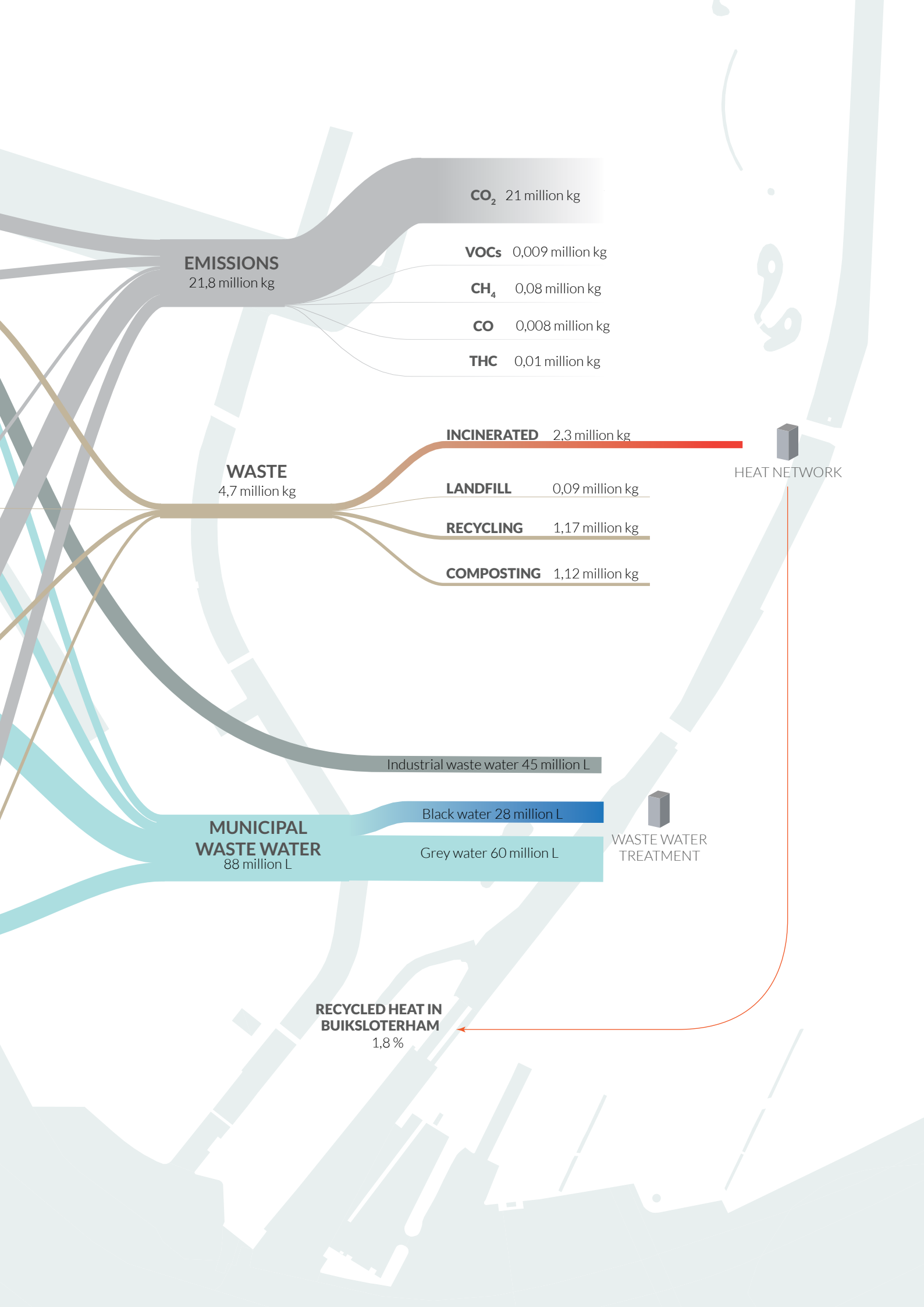
Understanding the sources of these demand increases at a more detailed level is a key to determining which areas are possible targets for re-design before decisions are made that will lock the development direction into certain patterns. It is clear that some of the projected increases in resource demand and waste generation result from suboptimal technologies and systemic inefficiencies (e.g., household heating and lighting systems), some stem from behavioral patterns (usage of lighting and personal

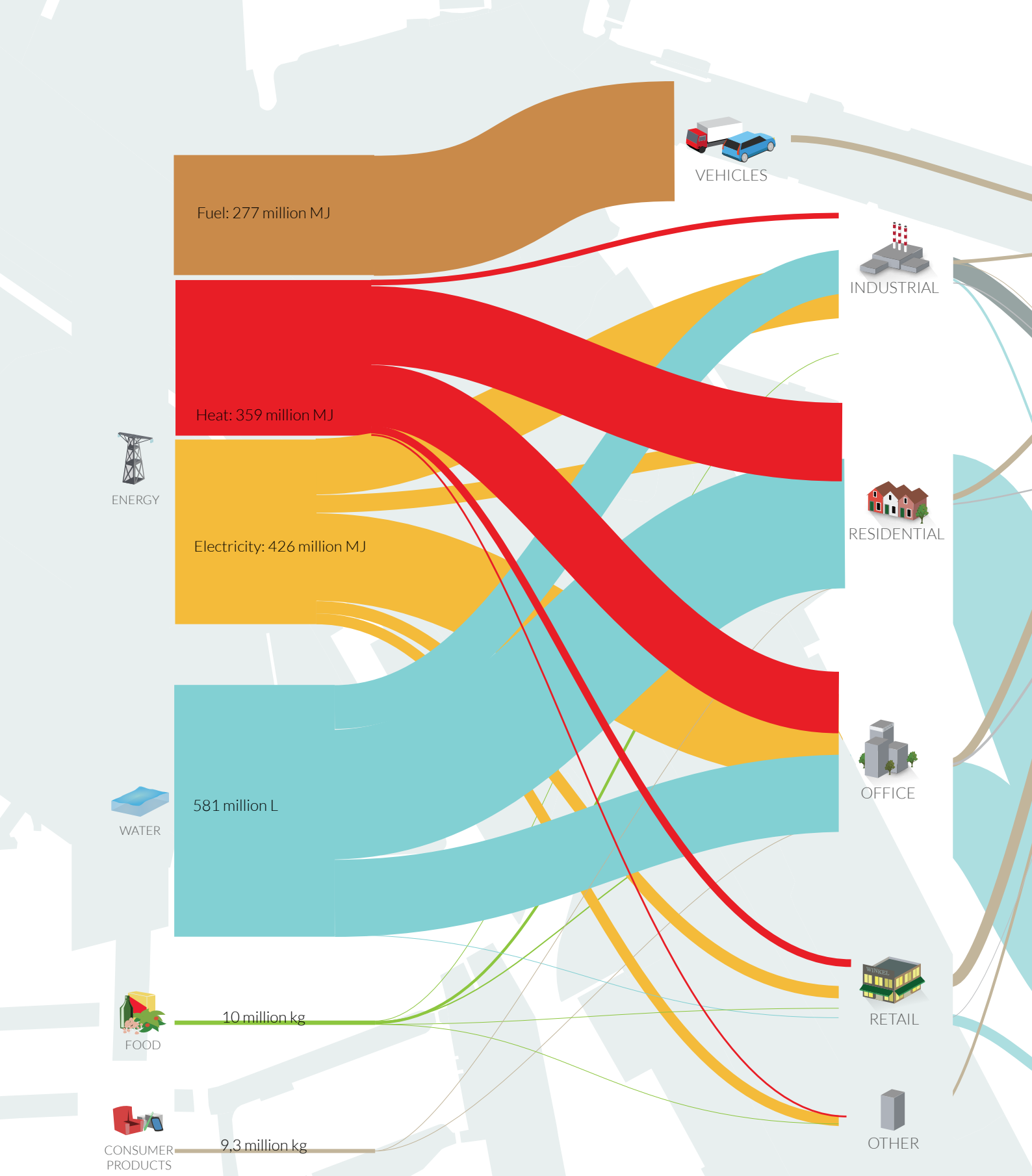
1 - Monitor Energiebesparing in de gebouwde omgeving 2012. Agenstchap NL. http://www.rvo.nl/sites/default/files/2014/05/

Monitor%20energiebesparing%202012%20%28okt%202013%29%203.pdf

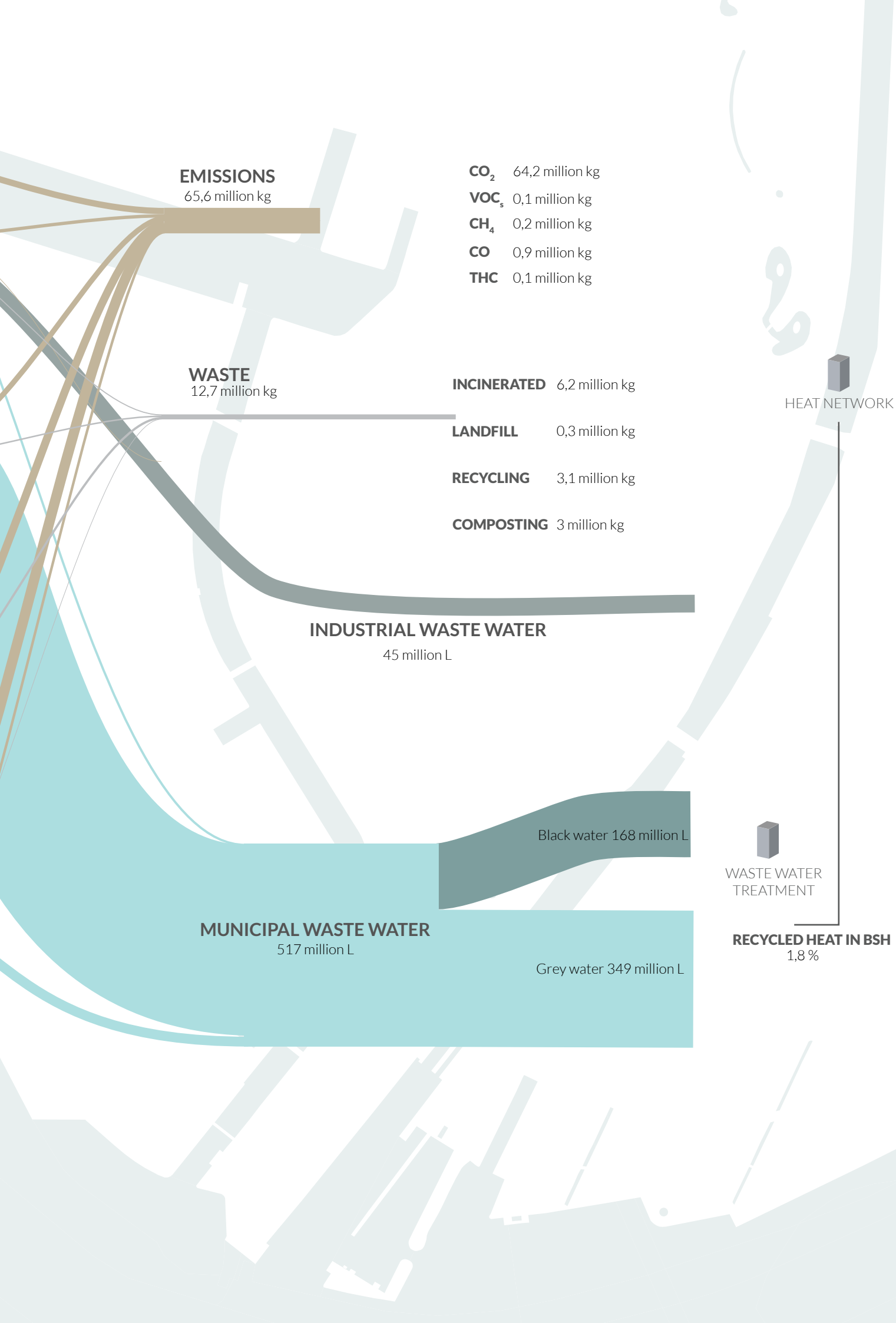


BUIKSLOTERHAM / CURRENT / OVERVIEW


EMISSIONS
21,8 million kg
CO_2 21 million kg
VOCs 0,009 million kg
CH_4 0,08 million kg
CO 0,008 million kg
THC 0,01 million kg
WASTE
4,7 million kg
INCINERATED 2,3 million kg
LANDFILL 0,09 million kg
RECYCLING 1,17 million kg
COMPOSTING 1,12 million kg
HEAT NETWORK
Industrial waste water 45 million L
MUNICIPAL WASTE WATER
88 million L
Black water 28 million L
Grey water 60 million L
WASTE WATER TREATMENT
RECYCLED HEAT IN BUIKSLOTERHAM
1,8 %



BUIKSLOTERHAM / + 20 YEARS / OVERVIEW


EMISSIONS
65,6 million kg
CO_2 64,2 million kg
VOC_s 0,1 million kg
CH_4 0,2 million kg
CO 0,9 million kg
THC 0,1 million kg
WASTE
12,7 million kg
INCINERATED 6,2 million kg
LANDFILL 0,3 million kg
RECYCLING 3,1 million kg
COMPOSTING 3 million kg
HEAT NETWORK
INDUSTRIAL WASTE WATER
45 million L
Black water 168 million L
WASTE WATER TREATMENT
MUNICIPAL WASTE WATER
517 million L
Grey water 349 million L
RECYCLED HEAT IN BSH
1,8 %

transportation), and others are rather inelastic (food demand). In the development of our interventions, we began by targeting those areas of demand that are most sub-optimized, either technologically or behaviorally.

Based on our modelling, we can conclude the following:

- **The single most significant driver in energy demand during the development of Buiksloterham is the need for space heating.** Much of the heating demand is currently projected to be supplied by the district heat network. The waste heat supply is primarily derived from the local waste incineration plant, and as such, this heat source cannot be considered entirely renewable. Eliminating a demand is almost always preferable to committing to a long-term supply of that demand, even if the supply is coming from renewable sources. Natural gas demand for space heating can be entirely eliminated in new constructions and mostly eliminated in retrofit constructions by adhering to Passive House standards or near Passive-House standards. This will be replaced by a relatively small increase in electricity demand for heat recovery ventilation systems, leading to an overall reduction in energy demand of approximately 90%.

- **The second largest increase in energy demand is projected to come from the increased number of motor vehicles.** A key strategy for achieving a local renewable energy supply will be to reduce the total demand for personal transportation, and to replace the remaining demand with electric and clean-fuel vehicles. This is also essential for reducing local emissions and improving local air quality.

- **Electricity demand can be reduced 50 - 70 % by optimizing: clothes washing, refrigeration, lighting, and the type and usage pattern of personal electronic devices.** Some of this demand remains inelastic due to the efficiency limits of certain technologies and the existing stock of devices owned by the incoming population. With community purchasing guidelines for new electricity-using-products, this electricity demand is projected to further decrease over time.

- **Public lighting infrastructure can be made much more efficient by switching to highly efficient and / or renewable sources of lighting.** Public lighting demand reduction can range from 50 - 100% of energy demand depending on the technologies selected.

- **The largest annual material flow into Buiksloterham is the 130.000 tonnes of material used for industrial purposes.** Because this is tied to the core activities of the companies in the area, it is not likely that the throughput of this material can be reduced. In order to fit into the picture of a "circular" neighborhood, however, the objective would be to ensure that the material that is leaving Buiksloterham in the form of products that can be recovered for multiple cycles of reuse without ending up as a downcycled product that has reached a terminal use phase. In addition, the mode of transport for this material should potentially be revisited to reduce the emissions and energetic impacts associated with it (for example, conducting a joint pilot with electric or hydrogen-powered freight).

- **The other annual material flows, aside from the industrial inputs, are very small by comparison.** In the current scenario, they amount to only around 3.400 tonnes of inputs per year.

- **In the +20 scenario, the non-industrial annual material inputs come to around 22.000 tonnes per year.** It is in this category that there is greatest potential for reduction of material throughput. Around 12.800 tonnes is contributed by food. The actual amount of food purchased is likely to be significantly greater than what is actually consumed, since there is 30 – 50% food spoilage throughout the production chain, much of which takes place at the hands of the consumer. Around 8.000

2 - "Full Size Electric Vehicles". Idaho National Laboratory. 30 May 2006.

tonnes comes from household goods and around 1.100 from packaging. An estimated 1.500 tonnes is used for office equipment. The household good category can potentially be reduced up to 50% through share and repair programs. Various strategies can be applied to reduce the demand for packaging (e.g., packaging-free store initiatives). Food and other organic wastes should be collected separately for nutrient recovery or energy production.

- **One of the largest material flow demands projected in the area over the coming development period will be in the form of building and infrastructural materials (steel, concrete, gravel).** For just steel and concrete, Buiksloterham will have an estimated demand of 376.000 tonnes. This material can be treated as a resource bank. Buildings should ideally be designed in such a way that the construction materials can be identified, recovered, and reused during refurbishment, renovation, and demolition cycles.

- **The total volume of wastewater produced in Buiksloterham is projected to increase by almost 8-fold between the current scenario and the +20 case.** If all buildings are designed to include standard toilet technology, we can expect approximately 168.000m3 of black water produced per year. The ability to recover nutrients and remove pollutants of concern from this waste stream can be greatly enhanced by moving to urine diverting toilets and creating a separate urine collection infrastructure. Urine contains a large portion of the nutrients and micropollutants and, if toilets are designed for urine separation, urine does not require flushing for collection. This approach could reduce around 80% of the volume of black water, and improve the nutrient concentration of the flows, simplifying material recovery.

In the following section there is a more detailed overview and breakdown of the flows per category and a description of how they will change from the current to the +20 scenario.

Detailed analysis

Buiksloterham has a gross surface area of 100 hectares, with a net development area of 52 hectares. The city owns 35 hectares of the total area, of which it has planned 4,6 hectares of green space and 3,3 hectares of public waterfront. Within Buiksloterham, there is currently 300.000 m2 of usable building space, which will go up to 1.000.000 m2.

There are currently 667 registered motor vehicles in Buiksloterham, a majority of which are used for commercial purposes. The number of vehicles is projected to go up to 5.156 in the +20 scenario.

The total number of residents is projected to increase from the current 252 up to 6.429. Local employment opportunities will increase from the current 4.660 to an estimated 17.700 jobs.

Energy

Current Energy Demand

Buiksloterham currently has an annual energy demand of around 335 Terajoules, or around 93 million kWh. This translates to an average demand density of 93 kWh per square meter.

The current breakdown of energy demand by sector in Buiksloterham is as follows:

- 42% industrial;
- 25% commercial;
- 14% retail;
- 10% vehicle fuel;
- 1% residential;
- 8% other.

The top energy demands by functional end use currently break down as follows:

- 36% operation of industrial equipment;
- 27% lighting (both indoor and outdoor);
- 21% space heating;
- 10% vehicle fuel;
- 6% ICT;
- 5% electricity grid losses.

Current greenhouse gas emissions from the total energy demand in Buiksloterham amount to 22.000 tonnes of CO2 equivalent per year.

Projected Energy Demand (+20 years)

Buiksloterham's projected annual energy demand amounts to 992 Terajoules, or around 276 million kWh. This translates to an average demand density of 276 kWh per square meter. The projected total energy demand is a 295% increase over the current scenario.

The projected +20 breakdown of energy demand by sector in Buiksloterham is as follows:

- 35% commercial
- 22% residential
- 21% vehicle fuel
- 14% industrial
- 5% retail
- 3% other

The top energy demands by functional end use currently break down as follows:

- 32% space heating
- 21% vehicle fuel
- 13% industrial equipment
- 10% lighting
- 7% ICT

Projected greenhouse gas emissions from the total energy demand in Buiksloterham will amount to roughly 60.000 tonnes of CO2 equivalent per year. This is a 272% increase over the current scenario.

Neighbourhood Supply Potential

The average solar "supply density" based on a conservative estimate of solar photovoltaic efficiency is 100 kWh per square meter. This translates to around 100 million kWh for the whole area.

An additional estimated 368.000 kWh of wind energy is potentially available based on locations that have been earmarked as possible sites for wind development.

The empty, polluted plots can be used for biomass production combined with a bioremediation approach.

There is an additional source of 932.000 kWh of waste heat available in the area.

To be able to supply the local demand with sufficient renewable energy supply, the only possible strategy is through a very thorough energy demand reduction approach. Without a steep reduction in demand, insufficient renewable energy is available in the area to provide an adequate supply.

Water

Current Water Demand

The current total water demand in Buiksloterham is an estimated 160.000 m3 per year.

- 61.000 m3 ends up as grey water (lightly polluted)
- 28.000 m3 ends up as black water (heavily polluted)
- 45.000 m3 is dedicated for industrial use

Projected Water Demand (+20 Years)

The projected water demand in Buiksloterham is an estimated 581.000 m3 per year.

- 350.000 m3 is projected to end up as grey water (lightly polluted)
- 168.000 m3 is projected to end up as black water (heavily polluted)

Neighbourhood Supply Potential

There is an estimated 850 million m3 of rainfall in Buiksloterham per year in addition to a significant amount of surface and groundwater.

Materials

Current Material Flow

There are currently several categories of material inputs in Buiksloterham:

- The largest annual material flow into Buiksloterham is the 130.000 tonnes of material used for industrial purposes.
- The second-largest annual material flow is the roughly 10.700 tonnes of "large household waste" that is imported from around Amsterdam North to be processed in Buiksloterham's waste facility. There are 88.196 total residents in Amsterdam North, who together produce an average of 11.000 tonnes of large waste that gets imported into Buiksloterham annually. There is still uncertainty about whether this waste point will stay in Buiksloterham or be moved to another location within North. However, it represents an opportunity for implementing new materials recovery practices, also by more broadly engaging the citizens of North. If there is already a waste processing facility, there are potentially other specialized treatment procedures that can be applied there than are currently practiced.

The other annual inputs together amount to only around 3.400 tonnes of inputs per year, of which:

- 1.400 tonnes of food;
- Currently the 252 residents of Buiksloterham consume on average of 96.569 kilos of food and 169.915 liters of beverages per year. This amount includes 8.221 kilos of fruits and 16.356 kilos of vegetables;
- 1.500 tonnes of household furnishings and equipment;
- 410 tonnes of packaging;
- 100 tonnes of office supplies;
- Total waste generated per resident in Amsterdam North is 398 kg per resident per year;
- Of this 47 kg are separated waste in the form of paper, glass, plastic packaging, textiles, and household chemical waste, and 122 kg of "large household waste" generated per resident.

Material Flow + 20 Scenario

Because we have no further information on changes to the industrial parties in the area, we are assuming for the purposes of the model that the 130.000 tonnes of material used for industrial purposes will stay the same in the +20 scenario.

If the waste point remains in Buiksloterham, which we have assumed it will, the "large household waste" flow is projected to increase commensurate with the increase in local population.

In the +20 scenario, the non-industrial annual material inputs come to around 22.000 tonnes per year.

- Around 12.800 tonnes is contributed by food. The actual amount of food purchased is likely to be significantly greater than what is actually consumed, since there is 30 – 50% food spoilage throughout the production chain, much of which takes place at the hands of the consumer;
- Around 8.000 tonnes comes from household goods;
- Around 1.100 from packaging;
- An estimated 1.500 tonnes is used for office equipment.

One of the largest material flow demands projected in the area over the coming development period will be in the form of building and infrastructural materials (steel, concrete, gravel). For just steel and concrete, Buiksloterham will have an estimated demand of 376.000 tonnes.

Modelling assumptions

Beyond specific data collected from interviews with local parties in Buiksloterham, we used standard statistical data for constructing some of our models. Below are basic resource demand summaries for Dutch households, offices, public lighting infrastructure, personal transportation, and food consumption.

Dutch households

In Dutch households energy demand in 2010 broke down as follows:

- 1.617 m3 of gas, used primarily for space heating (80 - 85%), followed by hot water (10 - 15%), and finally around 2 - 5% for cooking;
- 3.480 kWh of electricity, primarily used for cleaning i.e., laundry and clothes drying (~20%), refrigeration (~15%), lighting (~15%), followed by heating (electric heating systems), ICT, cooking, ventilation, kitchen appliances, other appliances, recreation, and personal care;
- Dutch domestic water use is around 127,5 liters per person per day. The majority of this water, around 50 liters, is used for showering, followed by 37 liters for toilet flushing, 23 liters for clothes washing, and the remainder used in sinks, dish washing, and food preparation. An estimated 60 liters of this water is consumed hot;
- Typical per capita waste production in the Netherlands amounts to an estimated total of 549 kg per year. This is slightly lower in Buiksloterham, where it is an estimated 398 kg per year.

Dutch offices

In Dutch offices energy demand in 2008 broke down as follows:

- 15 m3 of gas per m2 of office space, used primarily for space heating;
- 205 kWh of energy per m2, primarily used for lighting (21%), equipment like computers and printers (12%), followed by 7% for servers and decentralized ICT, and the remainder for transport, ventilation, and other functions.

Public lighting infrastructure

In the Netherlands there are around 3.000.000 lighting masts and around 3.500.000 lighting points for public lighting. These have an average power consumption of 50 W and 4.100 operating hours per year, leading to around 800.000.000 kWh of electricity consumption per year, or around 1,2% of national electricity use. Most of these lights are sodium light points. We modeled a projected assumption of 5 light points per kilometer of roadway.

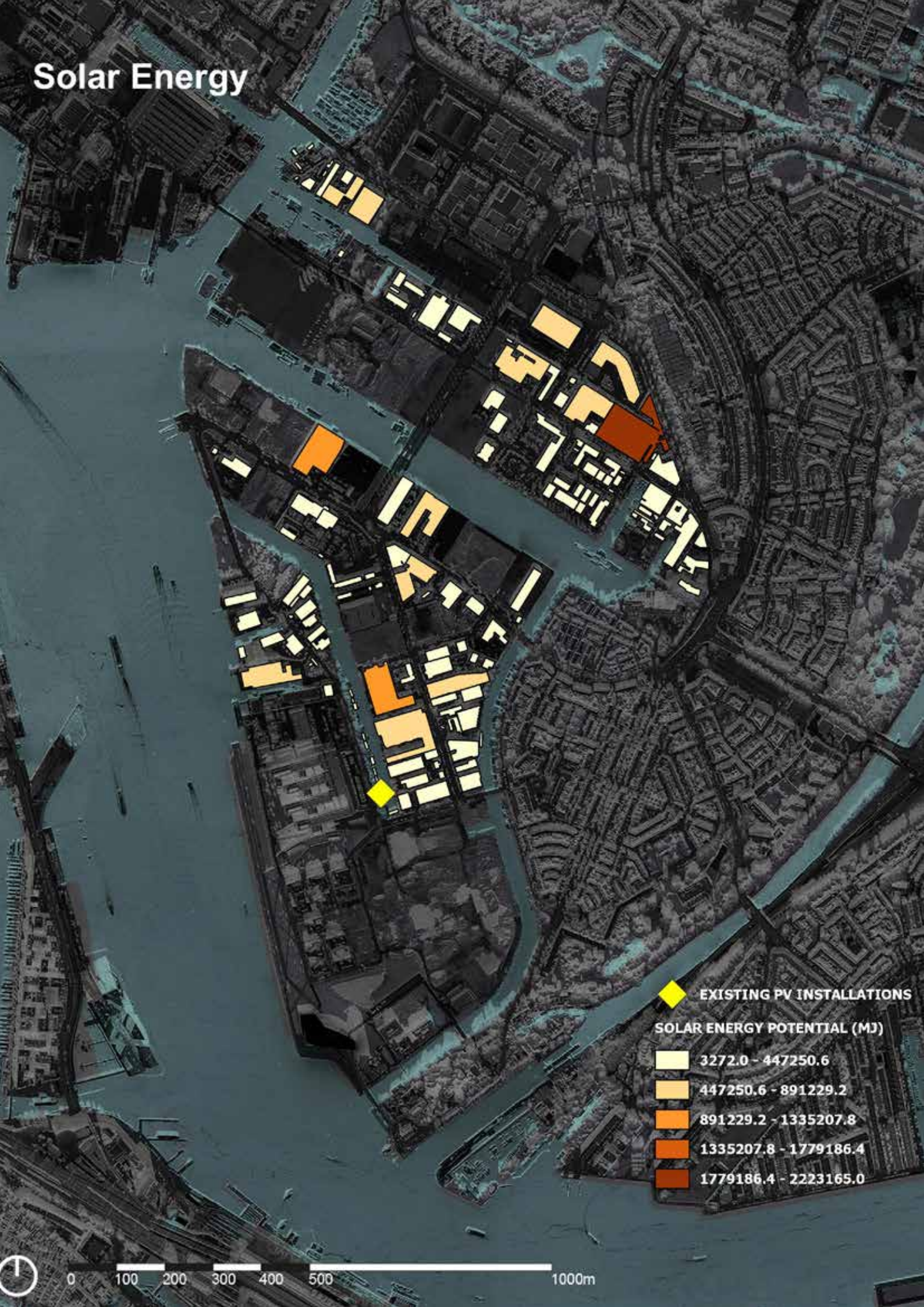
Personal transportation

Car ownership in the Netherlands is at around 400 cars per 1.000 people. The average travel distance by car is 40 km per day.

Food consumption

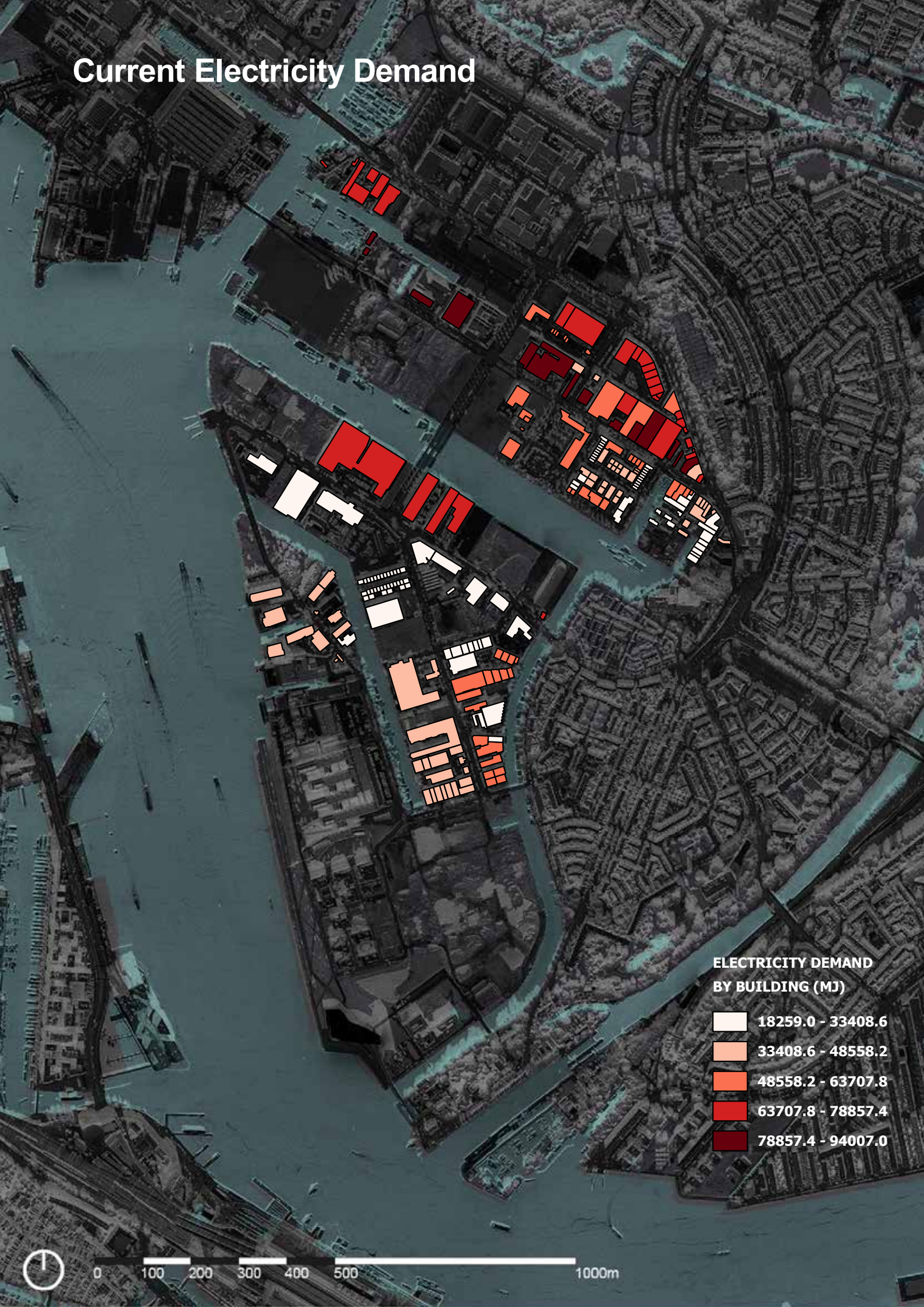
Food consumption data was based on a detailed study on typical Dutch food consumption conducted by research institute RIVM in 2011.

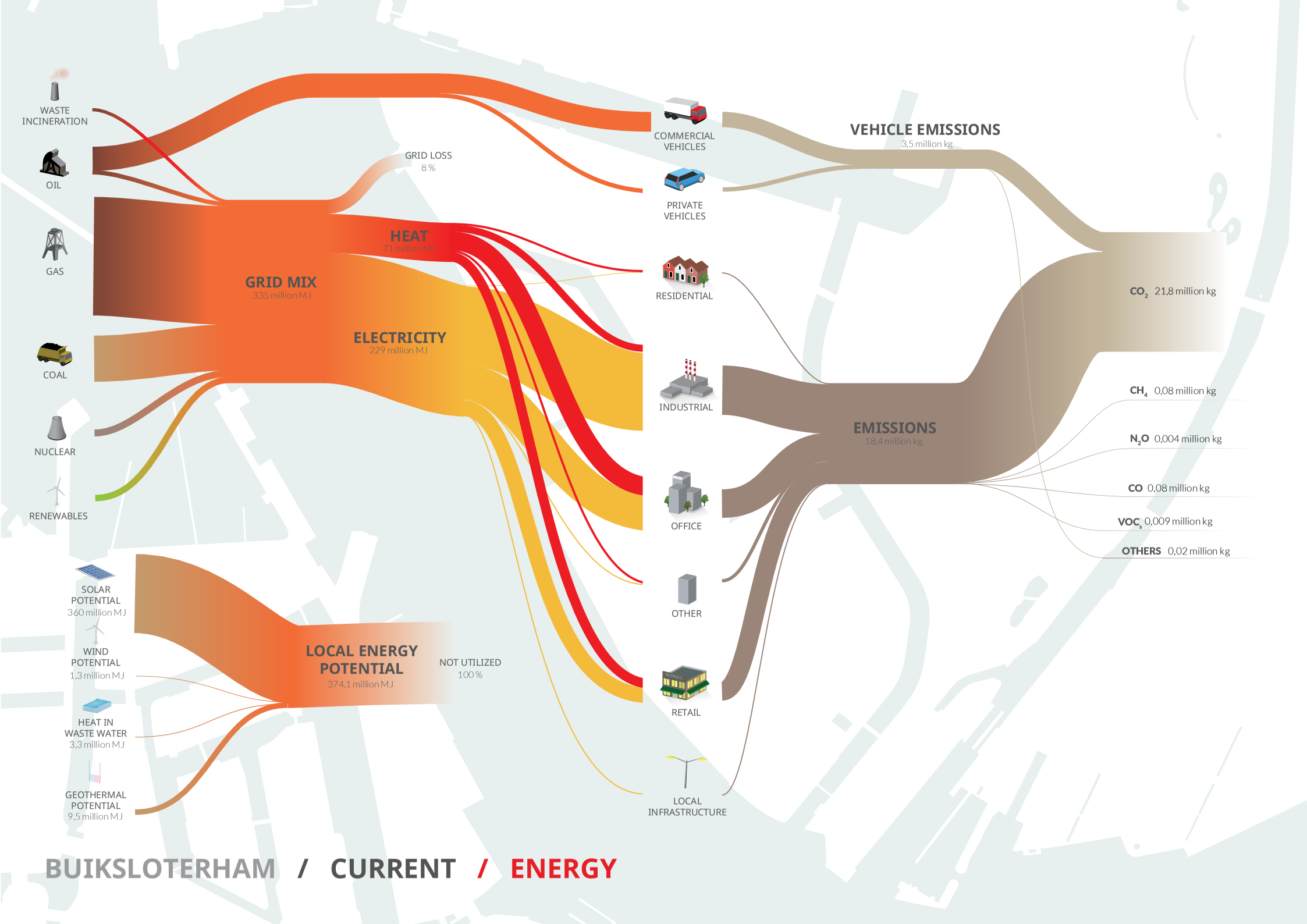
Solar Energy



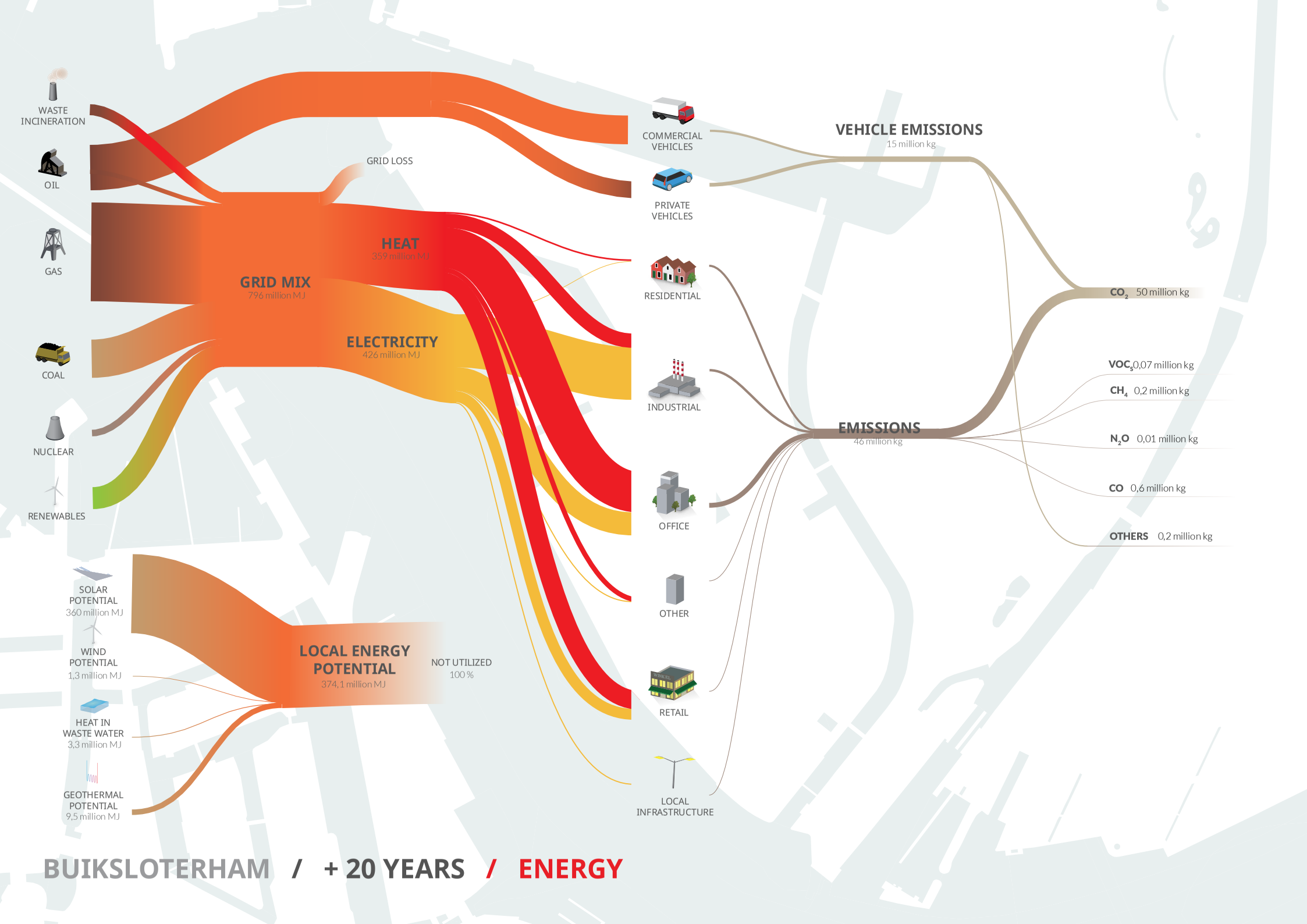
Current Gas Demand

Current Electricity Demand

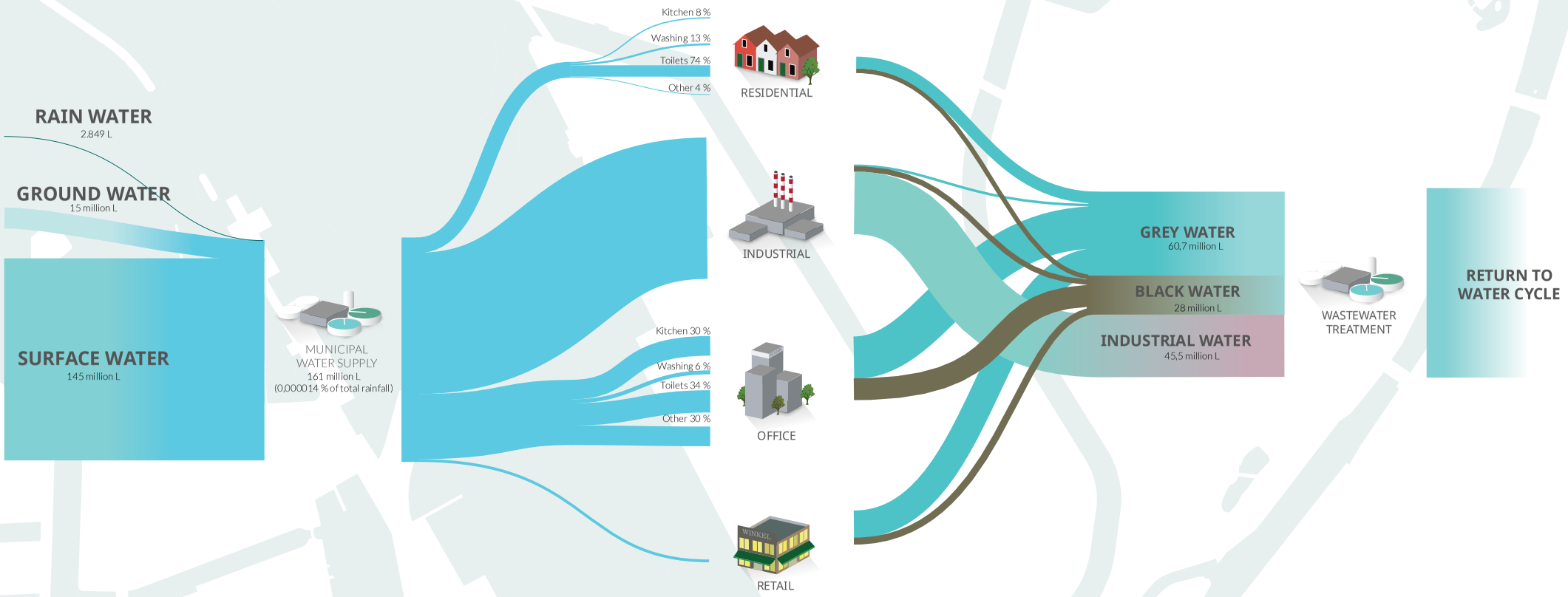




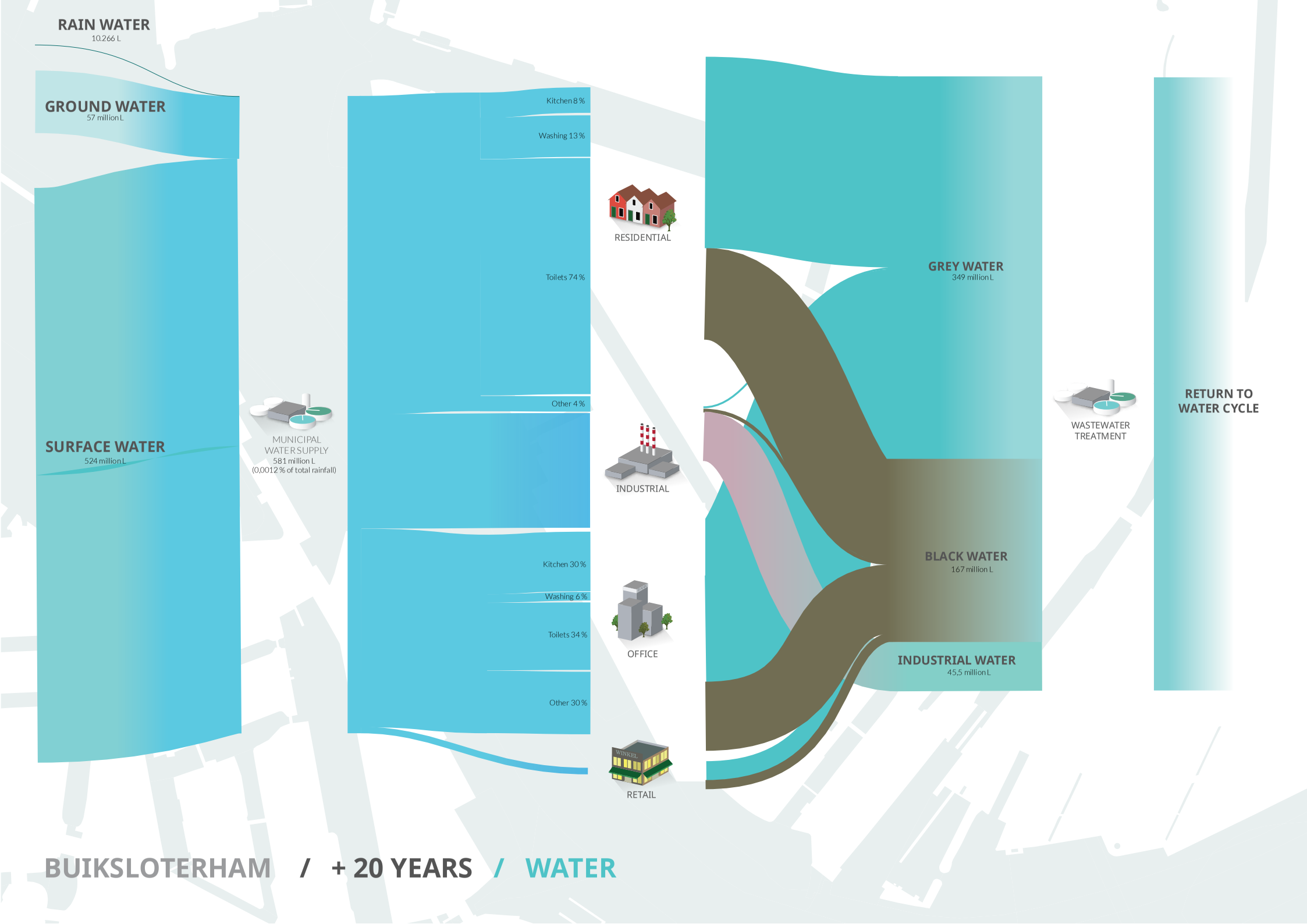
BUIKSLOTERHAM / CURRENT / ENERGY



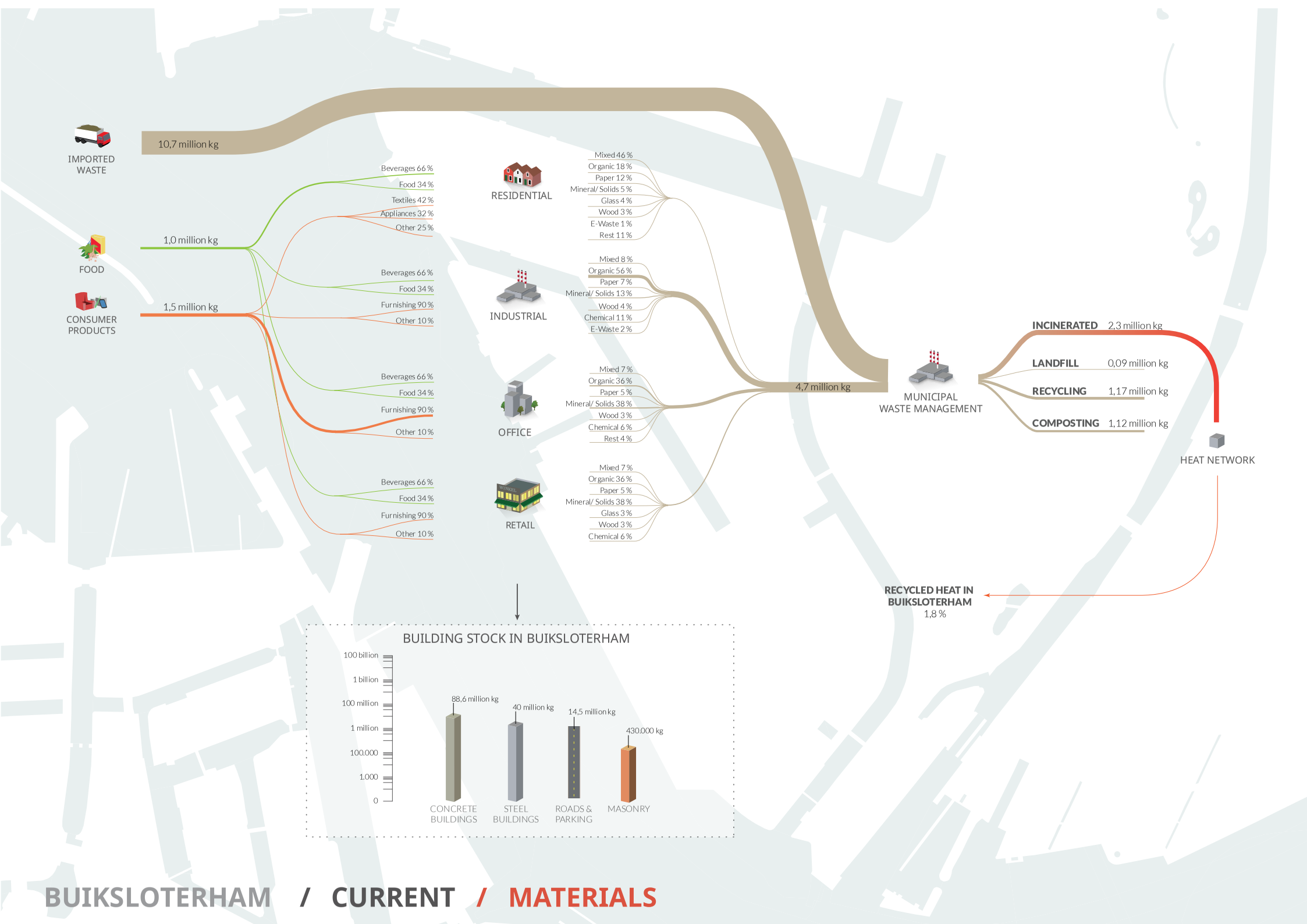
BUIKSLOTERHAM / + 20 YEARS / ENERGY



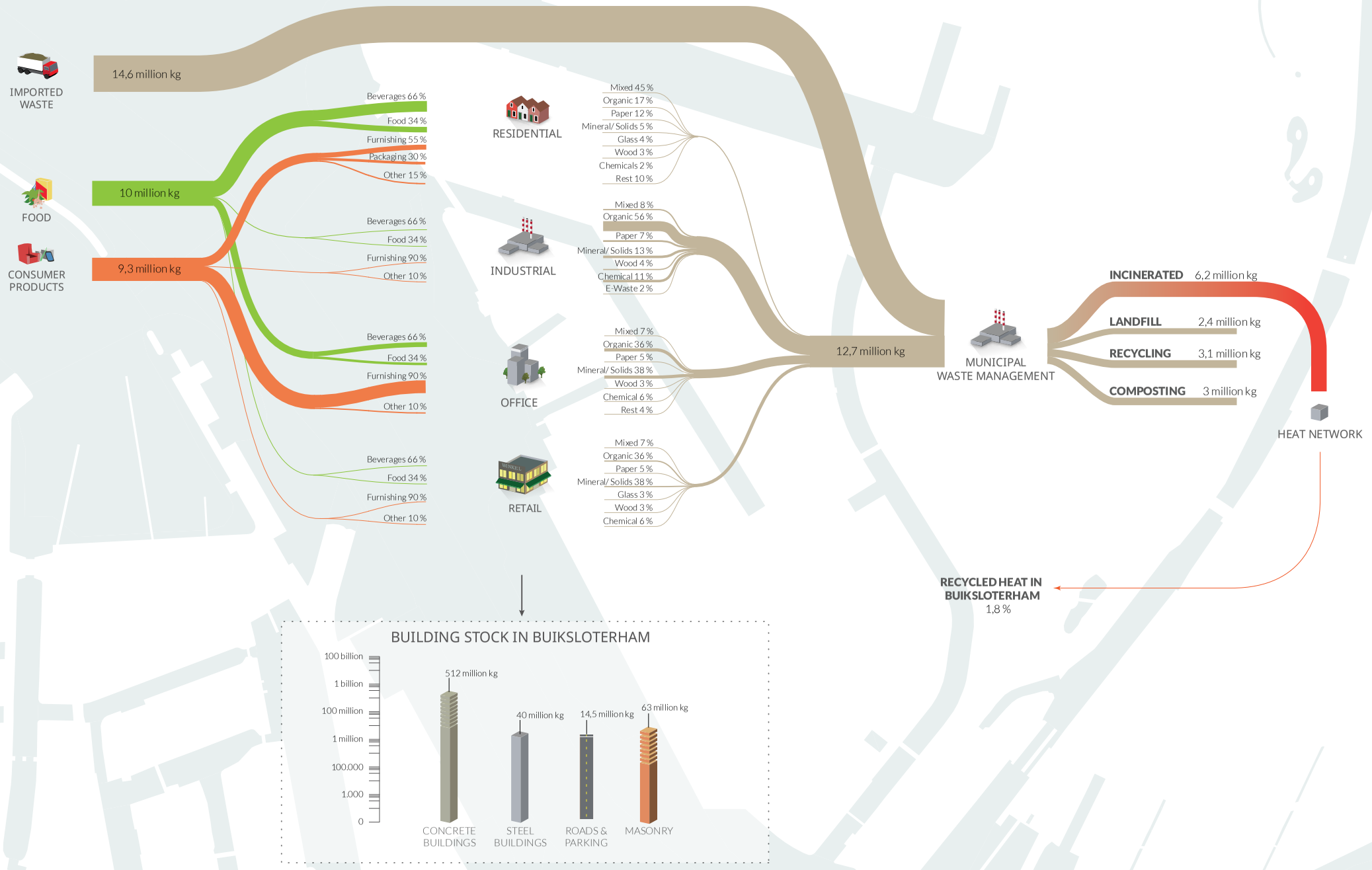
BUIKSLOTERHAM / CURRENT / WATER



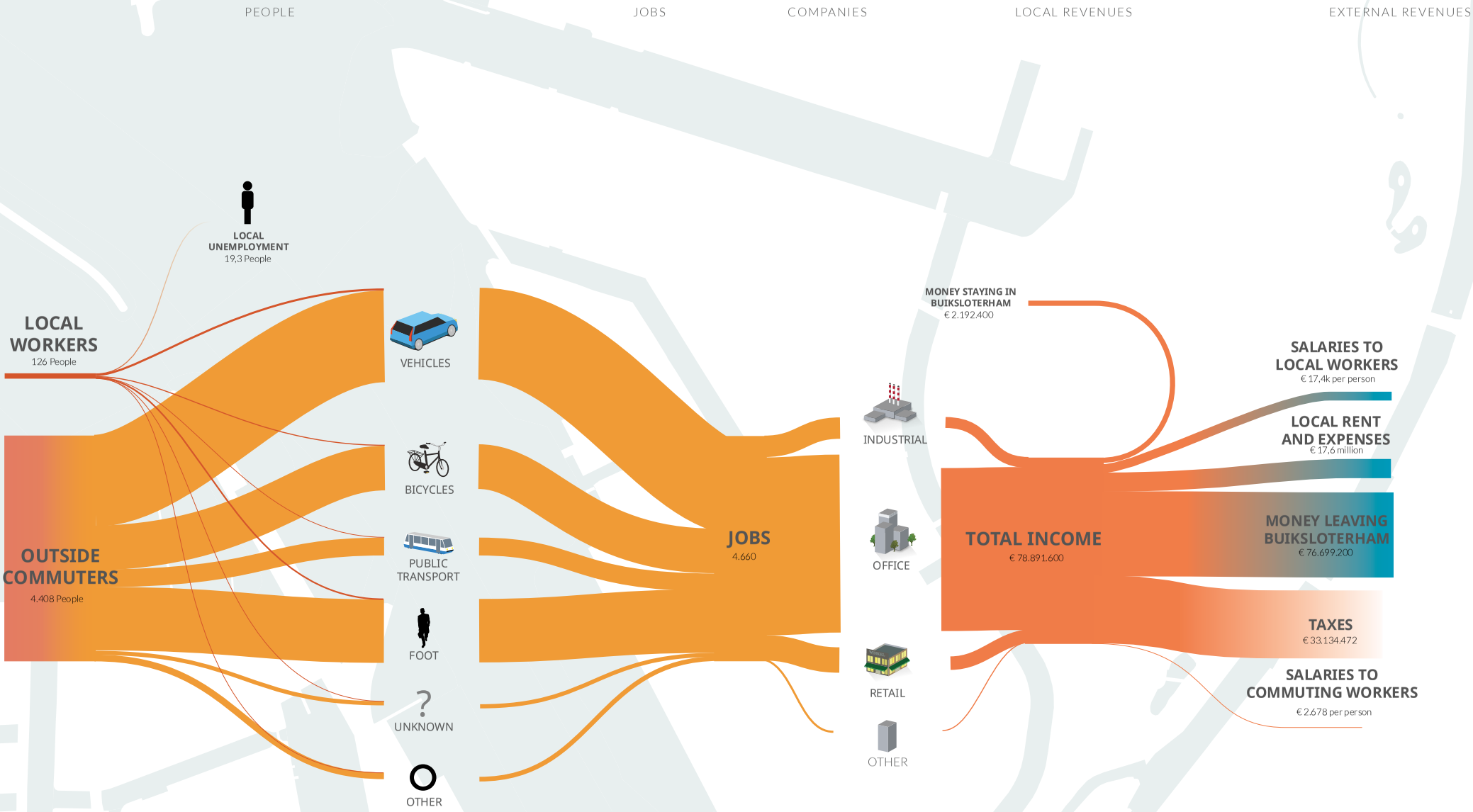
BUIKSLOTERHAM / + 20 YEARS / WATER



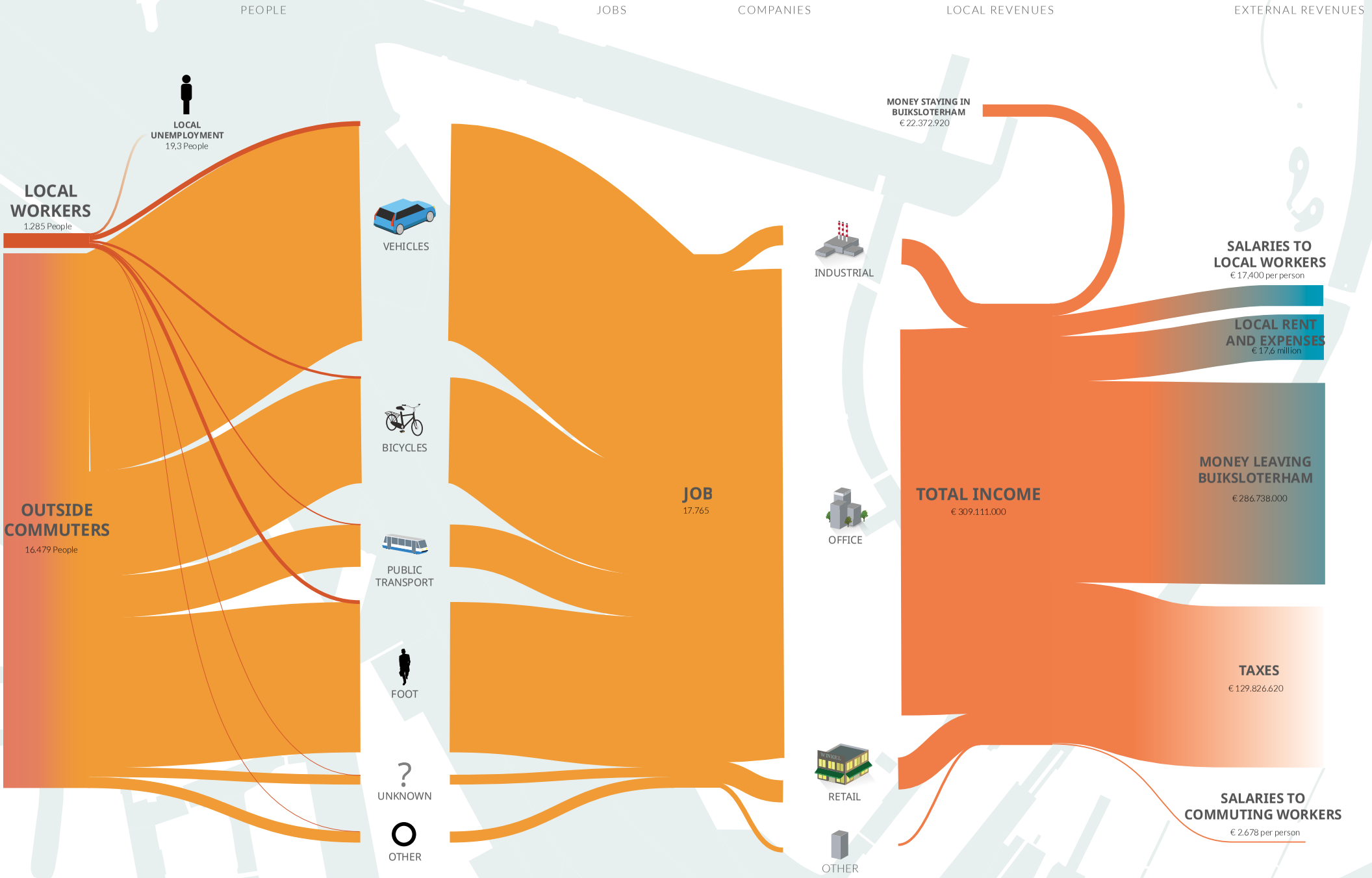
BUIKSLOTERHAM / CURRENT / MATERIALS



BUIKSLOTERHAM / + 20 YEARS / MATERIALS



BUIKSLOTERHAM / CURRENT / SOCIO-ECONOMIC



BUIKSLOTERHAM / + 20 YEARS / SOCIO-ECONOMIC

INTER-VENTION OPTIONS

This section contains a detailed overview of the interventions most of which are proposed in the exemplary Action Plan. Interventions are specific activities or technological applications designed to help achieve the goals set for a Circular Buiksloterham. We have separated interventions into systemic interventions, which enable or catalyze larger impact to take place, and technical interventions, which include specific initiatives, infrastructure, programs, and policies. The focus in this section is on detailing the technical interventions only.

Each intervention will need to be further worked out with the relevant partners and through additional research, design, and planning. This section is meant to provide additional background information and cases to supplement the proposed interventions in the Action Plan.

TECHNICAL

Technical interventions include specific initiatives, infrastructure, programs, and policies that are a means of achieving the higher level goals set for the project. Each goal is attached to a set of interventions, each of which acts as an integral piece in a larger system

ELECTRIC EFFICIENCY PLAN

energy

Interior lighting in offices, residential buildings and industrial makes up 12% of the total energy demand in the projected +20 scenario. Most of the electricity is consumed in offices (accounting for 47% of total electricity demand).

Several interventions can be combined to realize a 20% reduction in electricity:

- Maximizing solar daylight, using solar light tubes / skylights
- Installing heat recovery from warm waste water (if the water is electrically heated)
- Parallel DC and AC power system to reduce losses of conversion and transport
- Phantom power detection sockets that can turn on/off phantom devices
- Automatic light sensors
- Appliance guideline
- LED lighting to reduce energy demand
- Hot-fill washing machines (coupled with solar heat production)
- Monitoring and consumer feedback

RETROFIT EXISTING STOCK

Retrofitting refers to any type of upgrade to an old building that could improve energy efficiency, environmental performance, reduce water use and improve the quality of the space. These upgrades are meant to be structurally and technologically robust as well as economically beneficial on a long temporal scale. Retrofitting the existing building stock with energy reduction measures (for both electricity and heating) can save up to 30% of the total energy use, which 17% of the total project energy use of Buiksloterham.

energy

Benefits:

- Reduction in energy and water use, and hence a reduction in operational costs
- Better indoor air quality
- Higher levels of comfort
- Improved occupant satisfaction and worker productivity

Examples:

- Apartment building 'Tevesstraße' Frankfurt am Main[6]
- Post-war building renovation
- 94% reduction of annual heat energy demand
- Ventilation with heat recovery (efficiency >85%) in each apartment
- 100 sensors monitored buildings after refurbishment
- Passive House standard almost achieved with renovations and refurbishment
- PV panels (six at 7.5m² each) on roofs of attics]

Application:

- The plan for BSH is to develop retrofitting packages for at least 75% of the existing building stock through innovative financing schemes for example mortgage-based energy efficiency financing or on-balance equity financing[7]. In addition Dutch tax deductions will cover up to 41.5% of investment costs through the Energy Investment Allowance (EIA)[8]
- If an average of 30% in heating and electricity savings can be achieved in the existing building stock, this will lead to an additional 165 million MJ of savings in terms of energy, or a 17% reduction of the total energy demand.

6 - http://www.sintef.no/project/eksbo/IEA-SHC_Task_37/task37-540-Frankfurt.pdf

7 - http://www.dgbc.nl/images/Financing_Tools_for_A_Green_Building_Stock_-_5_juni_2013.pdf

8 - http://www.aceee.org/files/proceedings/2012/data/papers/0193-000422.pdf

energy

PASSIVE HOUSE STANDARDS

In the projected business as usual scenario, space heating makes up almost 32% of the total energy demand for Buiksloterham (or 321 million MJ/year). Passive house standard for buildings results in up to 90% reduction in energy demand for heating. Gas or other forms (like city heat district) of heating are replaced by heat recovery ventilation systems which present a slight increase in demand for electricity. Heat from devices operating in the building (electronics) as well as body heat from residents is sufficient for most heating demand. Point-source secondary heating systems (e.g., infrared panels or low-temperature wall heating) may be supplied for the coldest days, but are generally unnecessary. This is the largest potential for energy saving in Buiksloterham, representing an approximate 290 million MJ of avoided energy demand, or a total of 29% of Buiksloterham's total projected energy demand for 2034.

The requirements of a passive house are as follows:

- space heating demand can not exceed 15kWh/m²/year or 10 W/m² peak demand
- space cooling energy demand matches heat demand requirements
- primary energy demand for all domestic appliances does not exceed 120kWh/m² of treated floor area per year
- Airtightness - maximum of 0.6 air changes per hour at 50 Pascals pressure (ACH50)
- thermal comfort must be met (qualitative and relative)
- thermal insulation - U-Value of 0.15W/m²K
- passive house windows - frames must be well insulated and fitted with low-e glazings filled with argon or krypton to prevent heat transfer. Cool-temperate climates U-Value of 0.80W9m²K or less; g-values around 50%
- ventilation heat recovery - 75% of heat from exhaust air is transferred to fresh air
- absence of thermal bridges - all edges, corners, connections and penetrations must be planned and executed to avoid thermal bridges (non-continuous junctions resulting in heat loss)

Passive House standard faces difficulties in large apartment buildings due to costs and because insulation under the slab and footings is difficult due to the weight of the building. There are, however, good examples of apartment buildings that meet passive house standards.

PASSIVE HOUSE STANDARDS (CONTINUED)

Examples:

- Kiln Apartments North Williams Avenue - Portland, OR[9]
- 19 units
- Nearly 5500 m²
- triple-pane windows, space heating through wall-mounted, hot water radiant heaters served from solar thermal roof panels
- continuous ventilation through centralized heat recovery ventilation system
- south-facing windows protected from solar heat gain by sunshades
- costs: 5-10% more than traditional buildings/energy savings 60-70%

Application:

Implementation of passive house standards requires upfront investments. The estimated costs of building passive-house is around 5-10% increase of the total construction costs. Given the increase of floor surface in Buiksloterham from around 375.000 m2 of residential and over 200.000 m2 of office space, with an estimate average basis of 2.000 euro per square meter in construction costs, this results in over 100 million euro of additional investment which could come out of the circular investment fund.

9 - http://www.schock-blog.com/passive-house-multi-family-project-kiln-apartments/

10 - http://www.bizjournals.com/portland/blog/sbo/2014/03/oregon-affordable-housing-projects.html

SMART USE OF HOT WATER

energy

Appliances like dishwashers and washing machines require hot water. Existing appliances normally heat the water with internal heating elements which are often quite inefficient, with washing machines using about 80-90% of their energy consumption for heating[11]. A hotfill system can reduce energy demand by prefilling appliances with hot water that is heated more efficiently and from renewable sources (thermal solar collector). Another important element for smart use of hot water is capturing heat from shower water with drain water heat recovery (DWHR) systems can contribute to minimizing energy waste in households.

Examples:

- ISE Appliances' W288eco washing machine has both a cold and a hot feed. [13]
- A DWHR system can reduce water heating costs by 40%. [14]

Benefits:

- Reduced energy demand
- Improved energy efficiency
- Further shift towards renewable energy sources

Application:

Measures to allow smart use of hot water like the hotfill and WDHR system have a relatively low payback period and should be included in the circular building manual.

12 - http://www.reading.ac.uk/web/FILES/tsbe/tsbe-Saker_June_2014.pdf

13 - http://www.iseappliances.co.uk/index.php/prod

14 - http://contractormag.com/residential-plumbing/double-walled-heat-exchanger-reduces-household-water-heating-costs-40

RENEWABLE ELECTRICITY PRODUCTION PLAN

energy

Buiksloterham has the potential to become energy self-sufficient. Assuming that the energy reduction target of 75% off the business as usual scenario will be met, a total energy demand of 245 million MJ remains. This demand is build up partially from electrical demand and partially from heat demand. Some of the proposed interventions are:

- two 2.5 MW wind turbines, which in total could 43 million MJ/year
- covering all the parking spaces (45.000 m2) with PV panels yields 16 million MJ/yr
- a 4 km long bike path through Buiksloterham covered with PV panels yields 2 million MJ/yr
- thermal PV (producing hot water and electricity) installed on 75% of all roofsurfaces in BSH: 95 million MJ/yr
- 156 million MJ/yr of additional production, for example through hydrogen production, decentralized digestion of wastewater, hydrogen fuel cell technology using urine, energy production from biomass (on polluted grounds) and other technologies. Some upcoming technologies are:

  - Hydrogen Fuel Cell[16]: Stationary hydrogen fuel cells for households exceed all other fuel cell market segments in terms of annual megawatts shipped. These technologies replace or augment both batteries and diesel generators and can be deliver both DC and AC power. An important component of the stationary prime power market is micro combined heat and power (m-CHP). These systems let small business and homeowners generate their own power and use thermal energy from the fuel cell for heating and other purposes. Some example projects:
    - Roger's Gardens - Orange County, CA - 15 kW : Fuel cells will provide electricity for operations and computer systems and byproduct heat will be used to for the nursery's orchid area.
    - Lafayette Hotel - San Diego, CA - 40 kW:Generates 45% of the building's electricity and enough heat to help keep the pool's temperature between 76 and 79 degrees all year round.
    - Güssing Renewable - Energy GmbH - Austria 5 kW: Fuel cell operates using biomethane generated from regional residual biomass. Part of a multi-phase, 50 MW, $500 million agreement.
  - Small-scale wind: The small-scale wind industry (<100kW turbines) has demonstrated significant growth in the past decade, as consumer interested increased and many new companies entered the sector (there have been more than 120 new manufacturers between 2000 and 2010). In the USA, the installed cost estimates of top ten small wind turbine models in 2011 ranged between $2'300/kW and $10'000/kW, and the average installed cost of all SWTs was $6'040/kW, an 11 percent increase from 2010.

16 - http://energy.gov/sites/prod/files/2014/03/f11/2012_market_report.pdf

ENERGY PRODUCTION FROM BIOMASS

energy

Capturing energy from vegetation grown on polluted wastelands and on the streets and other public spaces. Gasification of woody biomass provides an alternative heating fuel, and can ultimately be transformed to either thermal energy or electricity.

Benefits:

- 6 kWh/m^2 energy capacity from elephant grass, a crop widely used for soil remediation[18]
- 18.5 kWh/m^2 energy capacity from woody biomass[19]
- CO2-neutral energy generation
- Locally available resources

Application:

The gasification plant would be part of a central biorefinery that would collect biomass from all over Buiksloterham to produce power in various forms. It would not only provide an alternative source of electricity production, but would also be a functional way to remediate the soils. Alternatively, the biomass can be used for materials.

Examples:

- Naava Energy, located in Tampere, Finland, has a 30-year experience in combustion processes. Their goal is to produce the most environmentally friendly solutions for local energy production.[20]
- The Eco-Park is Szászbereki, Hungary, that produces ecopellets for burning purposes from green forage. They also have a factory that generates electricity from burning them. The pellets are also sold throughout Europe, the Middle-East and other parts of Asia.[21]
- The Dockside Green neighbourhood in Victoria, Canada is host to a gasification plant, along with on-building windmills and solar plants, all of which combined not only make it a carbon-neutral area, but also being the highest rated LEED Platinum certified project in the world.[22]

18 - Plant Research International, Wageningen UR

19 - http://www.sciencedirect.com/science/article/pii/S0961953402001034/pdf?md5=5d6afbb2b23f4a4938fc0c47dd18f8c7&pid=1-s2.0-S0961953402001034-main.pdf

20 - http://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/biobusiness_study_of_best_practices.pdf

21 - http://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/biobusiness_study_of_best_practices.pdf

22 - http://www.theatlantic.com/international/archive/2011/08/is-this-the-worlds-greenest-neighborhood/244121/

SOURCE SEPARATION

Aside from reducing the overall material throughput and wasteflow, focus should be put on source seperation. As 90-99% of the total residential waste stream consists of recyclable waste[23][24], recycling can be significantly increased and incinerated waste minimized. Source separation implies separating recyclables at the source and including them in a collected waste stream.

Waste seperation can be both source separation and post-separation at Amsterdam's waste facility (AEB), or a combination of both methods. High source separation rates are generally difficult to achieve in highly urbanized areas such as Buiksloterham difficult to achieve due to lack of space both indoors and in public space for infrastructure. A combination of source - and facility separation can be achieved for example by introducing different colors waste bags for recyclable wastes, which is collected in one container and then separated at the facility. By taxing grey waste more heavily Diftar (differentiated wastetarrifs) recycling is encouraged.

Benefits:

From a circular perspective source separation is preferred over end of pipe separation because it results in a higher quality waste flow. Treatment for cleaning, remanufacturing and reuse for recyclables is more cost efficient.

- The amount of incinerated residual waste can be reduced to 4% or less[25]; this results in the reduction of fine dust emissions and retention of material and financial value
- Recyclables are 100% separated and recycle streams are of good quality
- Necessity of recovering recyclables downstream of the waste flow minimized

Examples:

- Soerendonk (without Diftar)[26] pilot with 50 different households managed to reduce residual waste with 96%. Households were provided with the bags and crates with which they biweekly offered the separated recyclables and a small bag for residual waste, on front of their houses ready to be picked up by the garbage truck.

Application:

Collection and logistics is financed by residents' waste fees. With Diftar, the residual waste charge finances the system. Residents are provided with specific color-coded bags, bins, and crates. Collection can be facilitated by source separation chutes in high rise apartment buildings which collect source separated waste in containers on the ground floor of a building[27]. The application of vacuum systems which easily transports waste underground to a central facility should be further investigated.

products & materials

23 - SRE Milieudienst, Verkenning inzamelsystemen en inzamelpilots, mei 2013

24 - CBS, PBL, Wageningen UR (2013). Samenstelling van huishoudelijk restafval, 1940-2011 (indicator 0141, versie 13, 3 juli 2013)

25 - SRE Milieudienst, Verkenning inzamelsystemen en inzamelpilots, mei 2013

26 - SRE Milieudienst, Soerendonk Afvalloos - gemak zonder grijze bak, januari 2011

27 - http://www.mswmanagement.com/MSW/Articles/Collection_of_Organic_Wastes_From_HighRise_Buildin_20570.aspx

SINK MACERATORS

products & materials

Sink macerators grind up food waste and other organic material flows created in kitchens. Organic waste will be transported through the regular sewer system to a decentralized biorefinery, enabling circular use of wastewater and organic material at the same time.

Benefits:

- Efficiency improvement on waste collection and processing - compared to a situation in which no GF waste is collected
- Increased amount of biomass for circular applications (digestion, biorefining etc) if not heavily diluted (preferably not combined with grey or rainwater)
- Integrated use for collected rainwater
- Comfortable way for inhabitants to deal with their organic food waste

Examples:

- A pilot in Worcestershire[29] showed a reduction of 50kg/person/year waste flow through conventional collection methods of waste;

Application:

Sink macerators use approximately 10 liters of water and 0.022kw/h per kg of processed organic food waste. The costs of a sink macerator start at 100€ per kitchen implementation. A barrier is legislation on kitchen waste disposal in the sewage system, which is currently illegal in the Netherlands. There is also recent debate about the Dutch sewer to handle kitchen waste maceration - a nuanced perspective of infrastructure, length of infrastructure before treatment and the flow with which the macerated waste is combined (grey water, black water) will determine success and the need of the application.

29 - http://www.worcestershire.gov.uk/cms/pdf/-waste-disposal-and-recycling-2.pdf

ZERO FOOD WASTE & REDUCED PACKAGING PROGRAM

products & materials

Consumers waste between 10-15% of the food that they purchase. A zero food waste program would aim to reduce the amount of wasted food and by extension the packaging that the food often comes in. National campaigns are already in affect and tools are available to assist in the reduction of food waste.

For Buiksloterham, the total waste projected from packaging materials waste is expected to be over a 1000 tons per year, which is 11% of the total material throughput (not counting construction materials). Awareness of food waste in Buiksloterham is raised through education programs and marketing campaigns.

Reducing the amount of packaging used can create a 6% reduction in total material throughput.

Benefits:

- Less (organic) waste
- Increased awareness
- Smaller product flow
- Reduction of packaging waste

Examples:

- Weggooitest [30]- provides data on perishable date.
- Eetmaatje[31] - provides an exact measurement on the amount of projected food needed
- Digitale bewaarwijzer[32] - information on how to store food for it to stay preserved
- Slim Koken[33] - all in one app including recipes for dishes.
- These applications can be combined with smart-devices; such as an application in a smart-fridge that shows what ingredients should be used that day in order to prevent waste.
- Unverpackt[34] - Berlin, Germany - Crowdfunded store that runs well. a lot of visitors that buy relatively little compared to other supermarkets.
- In.gredients[35] - Austin, USA - Small, running well, attracts visitors all across the city

30 - http://www.weggooitest.nl/

31 - http://www.voedingscentrum.nl/nl/thema-s/1-miljoen-maatbekers-eetmaatje.aspx

32 - http://www.voedingscentrum.nl/nl/mijn-boodschappen/minder-verspillen/digitale-bewaarwijzer.aspx

33 - http://www.voedingscentrum.nl/nl/thema-s/hoe-voorkom-je-verspilling-Zo/Tools/app-slim-koken.aspx

34 - http://original-unverpackt.de

35 - http://in.gredients.com

LOCAL REPAIR PROGRAMS AND FACILITIES

products & materials

Increasing the longevity of products reduces the outgoing waste flows. Instead of acquiring fully new products, residents can access facilities and stores that offer components of a product or its repair. For certain products, particularly those with personal significance like furnishing, clothing, electronics, and accessories, repair is a preferred option as long as it is affordable and convenient. If 50% of all those type of materials would be (locally) repaired or upgraded, this could yield a significant reduction in material throughput (11%).

Benefits:

- Decrease of overall material throughput and outgoing waste flow
- Increased longevity of products (financial advantage for consumers)

Application:

- Within Buiksloterham inhabitants work together to increase the efficiency of existing products and reduce the waste flow. While an investment of time is needed to create productive results, the investment pays off financially and socially[38]

Examples:

- Community bike repair shop - Knowledge is provided by volunteers, materials are salvaged from bike-wrecks
- Phoneblocks - an example of modular product design. where specific parts of the product can be repaired.
- Makerspaces[36] and Fablabs[37] - Public workspaces where communities create a variety of products with the help of high level tools that would normally be unobtainable for a single individual.
- 3D printing - Allows for individuals to repair products and provide a lifecycle increase.

37 - http://maker-works.com/

37 - https://www.fablabs.io/waagsociety

38 - Moilanen, J. (2012) Emerging Hackerspaces – Peer-Production Generation. IFIP Advances in Information and Communication Technology

DESIGN FOR DISASSEMBLY OF BUILDINGS & CIRCULAR MATERIAL USE

products & materials

The total required construction materials for the planned developments in Buiksloterham, assuming average construction materials and methods, is estimated at 490 million kg or 492.000 tons of construction material. Concrete is the largest contributor to this stream with 72% by mass of concrete and 4% of steel mainly in form of reinforcement bars. Another 18% of the total is bricks for masonry walls and decoration while the rest 4% is plaster board and paint and the rest is asphalt mainly for the new parking spaces. Other building components like insulation, interior finishing, windows and infrastructural piping vary highly per type of building and are small compared to the structural mass.

The common practice for the end - of - functional - life scenario for buildings and especially for those with non-residential use is to stay empty till they are demolished. After demolition the recovered concrete is downcycled to rock granulate and used in low-grade application such as filler for road underlay, foundations for new buildings or for new concrete mixtures with a maximum recycled content of 20%. Although concrete recycling is currently achieved in a total 95% of the waste stream, the process is energy intensive and the cost of reusing the recycled material is higher than virgin material. High value reuse, such as concrete cut outs or using alternative materials in the first place.

Regarding steel, after the demolition process steel is reclaimed and recycled with a 91% rate. Steel has the unique property of being 100% recyclable without losing any of its initial properties. The constant raise of demand for new steel though cannot be met only from the recycled material resulting to high rates of new steel fabrication. Far from that recycling processes are energy intensive stating the steel industry in total responsible for 4-5% of the global CO2 emissions.[39]

Interventions to reduce the overall material flow and to make this long term stock flow circular include:

- designing with reuse in mind to ease component recovery
- use of other materials that substitute for concrete that can be reused after the buildings' lifetime
- use of recovered concrete components, steel and furnishing from other deconstruction projects
- use of recycled building and ecological materials
- Introduction of material passports to record material properties and -origin
- Introduction of construction information management systems (BIM) to optimize design processes

39 - WordSteel Association (http://www.worldsteel.org/dms/internetDocumentList/downloads/publications/Climate-change-position-paper-A4/document/Climate%20change%20position%20paper%20A4.pdf)

CIRCULAR CONSTRUCTION MATERIALS

products & materials

Furnishing of buildings is a less significant proportion by mass, but it is a relevant flow in the non-construction material flow (55%), or 19.000 tons. Aiming for 100% recovery of circular material flows means the avoidance of dispersed materials, like paints, glues and kits. Some furnishing materials, such as bamboo flooring, can potentially be grown locally on polluted ground, making Buiksloterham a testbed for circular building principles. Additional research is needed to explore the potential and safety risks.

ADAPTABLE AND UPGRADABLE BUILDINGS

Building in a modular way that uses prefabricated elements makes a building easily disassemblable. Buildings should be made adaptable in terms of function and easily upgradable to meet changing needs of renters and the market. In this way empty spaces can be avoided (e.g. if there is no demand for office space because of the large overcapacity in the Netherlands, the space can be used for different functions).

Some of the interventions include:

- Design for prefabrication and modular construction
- Simplify and separate building systems
- Minimize building components and materials
- Reduce building complexity
- Flexible zoning to make real estate assets economically adaptive, depending on needs of and changes in the market

products & materials

Examples:

Intelligent Workplace at Carnegie Mellon University[40]

- 100% pre-fabricated steel open-web trusses
- pre-fabricated and modular skin
- open trusses allow spaces for mechanical ducts and utilities

Bluewater Energy Services BV Headquarters - Hoofdorp[41]

- The Project combined BIM with materials passport that identifies and quantifies volume and value of building materials
- The building is seen in terms of residual value instead of building costs
- Materials are Cradle to Cradle Certified-CM, meeting design for disassembly requirements]

40 - http://www.lifecyclebuilding.org/docs/DfDseattle.pdf

41 - http://www.lifecyclebuilding.org/docs/DfDseattle.pdf

RAINWATER HARVESTING

water & nutrients

There is enough rainfall in the Netherlands to theoretically cover every household's need for low-grade water. Effectively harvesting rainwater would reduce the strain on stormwater systems and lessen the demand for drinking water, reducing costs across the system.

There are thousands of examples of small scale systems for rainwater reuse in households: for toilet flushing, irrigation and even water for appliances like washing machines. Large scale pilots in the Netherlands were set up between 1996 and 2006 which had quite some problems, for various reasons. Problems with in-house infrastructure, smell, water colour and most importantly wrong connections leading to health risks.

The experimental zones create an opportunity to pursue experimenting with a promising technical intervention but at a small scale with much lower costs. Gravity systems can avoid the need for pumps. Knowledge gained from past pilots can improve the safety and efficiency of the systems.

Benefits:

- Reduction of drinkingwater use
- Buffering of stormwater

INFRASTRUCTURE FOR URINE SEPARATION AND COLLECTION

water & nutrients

Urine is roughly 1% of the overall wastewater stream but contains 85% of the nitrogen and 50% of the phosphate in municipal wastewater. Urine separated at the source can be processed for nutrient recovery to recapture 90% of the nutrients and remove all micropollutants. On a larger scale, separating urine can significantly reduce the energy costs of waste water treatment and the size of aeration tanks. Efficient collection of urine requires (low-flush) urine-diverting toilets and (waterless) urinals in buildings.

Yet urine separation, collection and treatment is still in early stages of development. Pilots in the Netherlands, such as in a student complex in Zwolle have yielded mixed results mainly because of the limits of urine separating toilet technology. Urine separation toilets are widely applied in Scandinavia, but integration with resource recovery is not well developed.

The topic of urine separation definitely merits further research and development on the level of toilet technology, infrastructure and treatment technology. Additionally, infrastructure for rainwater harvesting and urine separating is an added investment cost. Therefore, it is advisable to research the feasibility further on short term and set up pilots in one of the developments.

42 - http://www.saniwijzer.nl/content/content.asp?menu=1000_47

DECENTRALIZED BIOREFINERY

water & nutrients

There should be one location in Buiksloterham that builds up to become a decentralized biorefinery. The biorefinery will be a producer of clean water, nutrients, energy and high value products (biomonomers for chemicals, coatings, adhesives, foams etc). The biorefinery takes in all the wastewater from Buiksloterham (new developments in Overhoeks and NDSM can also potentially be connected) as well as the organic waste from households kitchen waste macerators. The largely separately collected urine in Buiksloterham can be piped or transported to this central neighbourhood location where the urine is treated to recover nutrients and to biologically remove micropollutants. All green waste from the public space is brought here to compost or further refine to high value products. It should be modular and flexible to allow for additional modules to be added: for example to add a hydrogen fuel cell power by urine, or newly developed biological treatment steps to remove micropollutants.

Examples:

The Waterschoon project (Sneek, started medio 2011):

Wetterskip Fryslân, Woningstichting de Wieren, STOWA, the municipality of Súdwest-Fryslân and DeSaH bv have jointly installed an innovative wastewater treatment system in the Noorderhoek district in Sneek. The "Waterschoon" project is the first in the world on this scale. The wastewater of 232 newly built houses will be collected separately at source, and cleaned in a small sewage treatment plant located in the district after a successful pilot with 32 houses. The waste water is source separated into blackwater and greywater streams. Blackwater from vacuum toilets and includes kitchen waste from sink macerators. Treatment of the two streams is done locally in a small treatment plant in the neighbourhood. The local plant produces biogas from blackwater and struvite (fertilizer) from greywater, recovers heat from greywater to heat houses, and removes micropollutants such as hormone-disturbing substances. Results in high water conservation by households (25-50%) and the removal of more than 90% harmful substances, such as nitrogen, phosphate and drug waste. [43] Treated water is discharged into the rainwater drainage system or surface water.

43 - http://www.waterschoon.nl/

GREEN ROOFS

Greenroofs involve installing vegetation on the top of buildings in Buiksloterham. Greenroofs come in different types. Extensive (sedum) roofs consist of the sedum genum of plants, or fat plants. Their underlay is thin, so weight is not a significant issue. Intensive roofs consist of moss, grass, herbs and fixed plants. They have a thick underlay, making the whole structure heavier, and also require consistent maintenance.

Benefits:

- Water collection
- Reducing 'heat island' effect
- Improving air quality through CO2 absorption
- Extensive roofs: low maintenance, no weight issue
- Intensive roofs: can even be used to grow trees, and is a good option for catering purposes and gardening purposes, given its capability to carry herbs, fruits and vegetables.

Application

- The optimal composition of the green roofs' vegetation will need to be further specified, but would naturally differ from building to building. The municipality of Amsterdam has subsidies for the installation of green roofs. Investment in green roofs, as well as in other water buffering methods, can be financed by Waternet's reduction of costs from avoiding underground infrastructure.

Examples:

- The CH2 building and the Condor Tower in Melbourne, the former being first 6-star Green Star Design commercial office building, and the latter incorporating a 750 m2 semi-intensive green roof.[44] [45]
- Germany has the longest tradition of installing green roofs. Munich uses several measures to promote them, e.g. grants for voluntary installation and a reduction in stormwater fees.[46]
- Portland, Oregon is dealing with an overloaded sewage system, so they also support green roof installations, mainly to create a sustainable rainwater management system.[47]
- Singapore has set a goal of 50 hectares of green roofs by 2030. [48]

44 - http://inhabitat.com/ch2-australias-greenest-building/

45 - http://www.fytogreen.com.au/green_roofs/projects/condor1.htm

46 - http://www.igra-world.com/images/news_and_events/IGRA-Green-Roof-Policies.pdf

47 - http://www.igra-world.com/images/news_and_events/IGRA-Green-Roof-Policies.pdf

48 - http://www.igra-world.com/images/news_and_events/IGRA-Green-Roof-Policies.pdf

BIOREMEDIATION & STRATEGIC TREE PLANTING

ecosystem & biodiversity

Bioremediation

Soil is a natural resource, which is of ecological, economical and social importance. Polluted soils form a threat to human health, livability, and natural and economical capital of the area. With selected plant species, some areas can be remediated biologically at a low up-front and running cost. A combination of bio-remediation, biomass production and social amenity create a true working landscape that is relatively straightforward.

Application

Stabilizing phytoremediation tree lines in Buiksloterham will form the foundation for treetop routes for the dispersion of the squirrels and bird species. It forms a green corridor network all over the neighbourhood to connect green spaces within Buiksloterham and in the future scenario (t+20) with the surrounding natural areas (Buiksloterbeek, Sneeuwbalweg, Noord Hollandsch kanaal, Florapark, Vliegenbos, Zijkanaal I Kadoelen). It will enhance human-nature interaction along paths and at squares. Costs for maintenance, operation and investment do not differ with other locations in the city. The financial structure should include monitoring pollution levels of the trees and the hydraulic buffer capacity. Planning depends on Buiksloterham infrastructure, location of soil pollution and underground water stream. In the far future (t>20) Buiksloterham can to be considered to be included into Amsterdam's green planning and ecological network.

Examples:

- Innovative in-situ bioremediation of soil are found within the CityChlor approach. The approach provides steps and a diversity of techniques including ATES (cold and heat storage) bio-washing machine (currently applied in Utrecht) to remediate volatile chlorinated hydrocarbons (VOCs) and utilize the remediation process as an additional source for sustainable energy in heating and cooling buildings.
- The existing nearby precedent of 'de Ceuvel' proves that it is possible to combine the development of social value with biological soil remediation - although effects still have to be examined.

Strategic Tree Planting

- Strategic tree planting doubles local biodiversity and adds aesthetic value and livability. Tree lanes function as hydraulic buffers to prevent mobile pollution from spreading. Introducing ecological corridors with tree species that take up large amounts of groundwater will prevent pollution from spreading out as well as lower the high groundwater levels in Buiksloterham. These corridors can additionally function as ecological corridors by creating a working framework for the area.

ECOSYSTEM ELEMENTS TO PROMOTE BIODIVERSITY IN THE AREA

Adding structural ecological niches for insects, managing vegetation, designing migration corridors and creating habitats for fauna can make significant steps towards building biodiversity in an area. Actions should be designed to protect local and regional species. Up until the 1970s, Amsterdam hosted the biggest natural population in the Netherlands of nesting Common Swifts (apus apus, Dutch: Gierzwaluw), which migrate every spring from Africa. Due to degradations to their environment, including consistent rooftop renovations, their population has faced a consistent decline. Habitat creation for birds like nesting sites help maintain bird biodiversity. Birds eat insects and add livability value to the area.

A wider scope of biodiversity interventions in Buiksloterham should support the conservation of the threatened European honey bee, butterflies, dragon flies and other endemic species in Europe.

ecosystem & biodiversity

Benefits:

- Promotes regional plant diversity
- Contributes to an increase of at least 100% in local biodiversity
- Adds ecological and aesthetic value to the area
- Increases livability

ELECTRIC VEHICLE SHARING PROGRAM

infra & mobility

Car-sharing programs are a form of vehicle renting where vehicles are rented per hour or on a subscription basis, allowing customers the benefits of personal vehicle mobility without the cost of owning an automobile. In an EV (electric vehicle) sharing program, all the vehicles offered are zero-emission electric vehicles. Such a program is by now well tested by the market and would lower car ownership while decreasing emissions, promoting a sharing economy and opening up space and disposable income for other uses.

Application

With projected population numbers and strategic interventions to lower automobile ownership, the amount of cars in Buiksloterham in 20 years will be 3.500. To facilitate remaining mobility demand an EV car sharing system can serve the area. The EV charging stations would be located in strategic locations nearby public transportation hubs and densely populated residential areas. These stations would contain parking lots covered in solar panels to generate the electricity needed to charge the EVs. One PV covered parking space could generate 2kW/h. These EV hubs will be connected with other car sharing programs in Amsterdam so that the influx of daily commuters will have complimentary transportation options.

The EV sharing program should be part of the broaded mobility plan where also 25% of the projected vehicle kilometers are replaced by non-energy kilometers and the remaining vehicle kilometers should be achieved by 50% efficiency increase in fuel use per kilometer.

Examples:

- Car2go - EV Smart sharing program in Amsterdam.
- In Grenoble in France a public/private partnership between the city and Toyota provides personal mobility to connect public transport and meet personal mobility demands. The average cost for user per month are around € 70.
- WeGo - private car sharing in Amsterdam (other example is SnappCar). App-based car sharing program where residents without automobiles are able to rent an automobile from their neighbours in a peer-to-peer model. An owner subscribed to the service has their car installed with the software, users locate the car and use the App to unlock it for use. Owners set the rate per hour + per kilometer.

SOLAR BIKE PATH - (DE ZONNEWEG)

The solar bikepath integrates solar energy generation with zero-emissions mobility infrastructure. An angled covering would be placed over a normal bike path. This covering would be installed with solar panels for renewable energy generation on one side. The opposite side would be a green roof.

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Application

As integrated measure to stimulate more alternative mobility and to generate renewable energy, an (elevated) bike path of around 4 meters wide and 4 km long could be considered. The path is covered on the southern side with solar panels and on the northern side with vegetation. The idea is to make a connection between the Buiksloterweg ferry and the EYE in Overhoeks to Grasweg, with a connection over the water to NDSM. This would directly connect two cultural hotspots while providing mobility to residents of Buiksloterham. This would be an initial construction of 1.8 km. An additional construction could be made on Distelweg covering 780 m and another addition on Ridderspoorweg covering 600 m for a total of 3.10 km. Additions could be made afterwards, including an elevated path from De Ceuvel over the Johan van Hasseltkanaal to Ridderspoorweg (451m) or to Distelweg (250m). If entire 4km bike path is constructed, there is a potential to produce 800,000 kWh from solar energy.

Benefits:

Integrates multiple uses (renewable energy generation, mobility, water buffering, biodiversity corridors) into one unique space. The PV panels will help Buiksloterham meet its renewable energy demand. The green roof will increase biodiversity and act as a water buffer reducing the needs for stormwater drains. The bike path would increase cycle use. The overall uniqueness and creativity behind the project could gain national and international attention, bringing light to the innovative and unique approach Buiksloterham is taking to its future development.

49 - http://www.copenhagenize.com/2011/12/innovative-elevated-cycle-track-in.html

MICRO-PORT

infra & mobility

The Micro-port is a land-water port providing trade and transportation centered around hydrogen power and electricity. Ships, buses, and other vehicles visiting the port can dock and refuel with hydrogen or renewable electricity. The aim of the micro-port is to connect several different parts of the Alternative Mobility Plan in one transportation hub using completely renewable energy and fuel.

Benefits:

- Eliminates emissions
- Strengthens local economy

Examples:

- Bristol hydrogen-powered ferry 'Hydrogenesis'. Initial funding:£225.000 (€287.430). Length: 11 meters, carries 12 passengers. Powered by four air-cooled PEM fuel cells providing 12kW of steady-state continuous power at 48v. Refuelled at on-shore hydrogen refuelling station with tank holding up to 350 bar[50]

Application

In Buiksloterham the Micro-port will be a model example of a trade and transportation hub that links the land and water. The port will house a hydrogen refuelling station for the fleet of hydrogen powered ferries bringing passengers and ships providing goods to the area. The ferries will be powered with the same type of technology used by the hybrid fuel-cell buses already used in Amsterdam. The port will also be a major public transportation hub, with a small bus port for the hydrogen powered buses that run on Line 38. A connection will also be made with De Zonneweg, which passes by the area on it's way to NDSM. Next to the port would be an EV-share hub with electric vehicles being charged by solar panels overtop the parking spaces. Locally produced biological food and other goods will come into the port to be provided at the bi-weekly BSH biological food market.

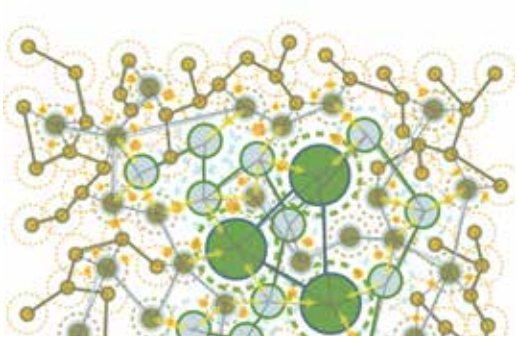
50 - Fuel Cells Bulletin Volume 2013 Issue 7. July 2013

DC SMART GRID

A Direct Current (DC) grid is an energy distribution system based on direct transmission of produced energy to where it is used. This is important for increasing renewable energy potential especially at the household level. DC electric smart grids offer benefits over Alternating Current (AC) grids. The conversion from DC > AC creates a loss in energy, without the need for conversion PV system performance improves by as much as 25%[52]. It is estimated that nearly 5% of total electricity used in the home is used for AC to DC conversion. An AC grid works well for transmitting large amounts of energy from one central location to the locations where it is needed, but this long-distance transmission results in a loss of energy. The "Smart" part of the grid means that data on energy is monitored and recorded in a database that can be accessed remotely online. The data monitoring allows for more efficient and transparent use of energy.

Application

Only a limited number of energy appliances indoors operates on DC. Ventilation and lighting are likely appliances to run on a DC net. In the future it is expected to have a wide range of household appliances available for DC. Homes will be monitored with sensors to track energy use and optimize performance. DC connections on new buildings will be ready to take power generated from renewable sources and use it directly on-site or sold back to the grid. Energy companies will be able to better control This DC Smart Grid is made 'smart' by the new locally based fiberglass internet hub.



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Examples:

- Worldwide, there are quite a few examples of projects where smart electricity networks are applied. DC systems are rarely tested or implemented yet despite the proven benefits. This offers a potential for Buiksloterhams innovation agenda.

Benefits:

- Transport and electricity grid losses account for a small but significant proportion of energy loss (a projected 3% of total energy demand in Buiksloterham can be attributed to grid losses through transportation). Likewise, the potential production of renewable energy can be increased by 25% if the conversion step from DC to AC is removed.

51 - www2.inescporto.pt/cpes-en/news-events/the-press-us/edp-investe-10-milhoes-no-inovcity-de-evora/

52 - http://smartgrid.ieee.org/questions-and-answers/902-ieee-smart-grid-experts-roundup-ac-vs-dc-power

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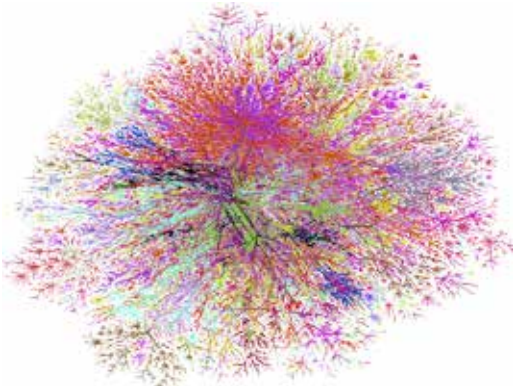
FIBER HUB

A glass fiber internet hub provides high-speed internet access that can facilitate all sorts of economic, educational and event healthcare services.



Benefits:

- Extremely fast internet speeds
- Boost to local economy

Application

- An internet connection hub would be centrally located in Buiksloterham using complete glass fiber infrastructure. This would be installed by the municipality and owned by the community. This local hub could generate internet speeds of up to one gigabit/second, giving Buiksloterham one of the fastest internet connections in the world. This would attract companies to Buiksloterham as an area on the forefront of cutting-edge and innovative business.

Examples:

- Chattanooga, Tennessee installed publicly owned municipal fiber internet grid that has a peak speed of 1 gigabit/second, 57x faster than the global internet speed (17,9 Mps) and nearly 25x the peak NL speed (36,6 Mps). Total costs were $320 million. Roughly 65k out of 170k homes and business connected to the grid are using the EPB FIber Optics. The grid covers 965 km2 and was built in 2,5 years. The network is a breeding ground for innovations for new IT and software services in areas such as healthcare and education.

ALTERNATIVE CURRENCY / SERVICE EXCHANGE PLATFORM

An alternative currency/service exchange platform allows residents to request or offer services such as household repairs, babysitting, gardening, bike or auto repairs through a platform and not based off of financial value exchanges (only). Instead, time-based "points" or a local currency can be used to exchange these services.

socio-cultural

economy

Examples:

- Timebank[53] - One Timebank Hour equals exactly one hour of work.
- Canhav[54] - Exchanging services and products (interchangeable)
- BarterSugar[55] - Trading services specifically for businesses
- Dropis[56] - translating services or time into currency called dropis. There is a wide variety of local currency projects around the Netherlands.

Benefits:

- Reduces the financial burden of residents and strengthens social cohesion.

53 - http://timebank.cc

54 - https://www.canhav.com/nl

55 - http://business.bartersugar.com/

56 - https://www.dropis.com/

57 - Tönnies, Ferdinand (1887). Gemeinschaft und Gesellschaft, Leipzig: Fues's Verlag

METHODS AND TOOLS FOR STIMULATING IMPACT

socio-cultural

economy

New subsidy schemes and tax incentives

Subsidies can be channelled towards preventative decentralized infrastructure investments and used to stimulate demand of impactful but initially costly interventions. Making subsidies available in Buiksloterham for green roofs and clean energy encourage small environmental investments, such as stormwater retention, energy efficiency, and increased biodiversity.

Example: Brownfield Tax Investments

Brownfield tax expensing led to the cleanup of an 8.5 acre former landfill and pharmaceutical factory in Pennsylvania and the redevelopment into a business center and public services complex. The tax relief provided the means to make the option with external benefits for society the most attractive one for the developer.

Incentives for social participation

Offering incentives to participate in environmental management and social services could support residents, decrease costs per unit of service provided, and create more community cohesion. In exchange for work that helps improve the area, those in need could receive free housing or other goods or services. This measure could be useful in Amsterdam North, where unemployment is more of an issue than in other parts of Amsterdam, to support other goals of employment and retraining.

Examples: Vooruit project

Students receive free housing in exchange for 40 hours a month civil service work with at-risk youth. This project resulted in better integration of immigrants, better school results for children and a higher livability in areas where this project is implemented. (http://www.vooruitproject.nl/VoorUit/VoorUit_Project.html)]

58 - http://www.energysavingtrust.org.uk/Generating-energy/Getting-money-back/Cashback-Calculator

59 - http://greenvalues.cnt.org/

METHODS AND TOOLS FOR STIMULATING IMPACT

Circular Economy Business Incubator development

An incubator is a physical location where start-ups find themselves in a stimulating and supportive environment in which they can develop new innovative services and products in the field of circular economy. Buiksloterham could accommodate a start-up incubator that is specifically aimed at the development of companies who target the main challenges of Buiksloterham's development for new innovations: closing the water-, nutrient- and material cycles, or working on innovative soilremediation techniques. Such a demand-driven approach not only provides specific services and products for the area, but also contributes to economic innovation potential of the metropolitan area in the field of circular activity.

Aside from a physical location, it could also entail a supportive acceleration program of mentorship and (pre-seed) funding. This program can be a successor to the recently completed Green Metropole support program for start-ups in the Amsterdam Metropole.

Examples:

Y Combinator (http://ycuniverse.com/) is a very successful seed accelerator whose past participants include AirBnB, Reddit & Dropbox. Bethnal Green Ventures is a seed accellerator program (http://bethnalgreenventures.com/about) with a business category specifically for sustainability and has funded Fairphone in the past under this program category.

socio-cultural

economy

EMPOWERING APP FOR BOTTOM-UP SOLUTIONS FOR PUBLIC SPACE

health & wellbeing

Simple applications can encourage Buiksloterham's community to fix small public space problems. The idea builds on existing public space hotline apps that focuses on citizen solutions instead of reporting a problem. Citizens connected to Buiksloterham can, if they currently do not have time to fix it themselves, upload a picture and location of the problem on to the app (weeds, loose tiles, broken lamp, dog poo). Others can rate them, find a solution for the problem and report the problem solved, subsequently consequently earning service points.

Benefits:

- Complimenting real time monitoring, the digital application empowers citizens and promotes bottom-up solutions to livability, safety and attractiveness.

Examples:

- Existing apps - Opgeruimd[60] (Amsterdam), MeldStad[61] (Groningen), Meldingen[62] (Den Haag), Beter Buiten[63], Verbeter de buurt[64]

60 - http://www.amsterdam.nl/wonen-leefomgeving/mor/

61 - https://play.google.com/store/apps/details?id=gemeente.meldStad

62 - https://play.google.com/store/apps/details?id=com.kodision.tripleforms.denhaag&feature=search_result#?t=W251bGwsMSwyLDEsImNvbS5rb2Rpc2lvbi50cmlwbGVmb3Jtcy5kZW5oYWFnIl0.

63 - http://www.buiten-beter.nl/

64 - http://www.verbeterde-buurt.nl/

COLOPHON

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Project team

Metabolic, DELVA Landscape Architects, Studioninedots, Frank Alsema, Peter Dortwegt, Saskia Müller (Amsterdam Smart City).

Overall project management

Sanderine van Odijk (Metabolic)

Authors

Eva Gladek (Metabolic)
Sanderine van Odijk (Metabolic)
Pieter Theuws (DELVA Landscape Architects) *uitgever*
Albert Herder (Studioninedots)

Graphic Design

Rui Lira (Metabolic)

Research team and text contributors

Sanderine van Odijk, Eva Gladek, Anastasios Kokkos, Barend Donkers, Chris Monaghan, Luuk de Klijn, Frances Rompas, Dániel Jaczkó, Rachael Hamann, Erin Kennedy, Kevin Gooley, Albert Herder, Steffan Dannel, Monika Pieroth, Steven Delva, Pieter Theuws, Jens Jorritsma, Peter Dortwegt.
Interviews were performed by Saskia Müller, Frank Alsema, Peter Dortwegt and Sanderine van Odijk

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Page Nr.	Author
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80 De Ceuvel
89 DELVA
94 Stadsdeel Noord
105 Michel Zappa
107 Nick Garrod
139 Ian Sane
142 Jude Hill
144 Rene Gademann
145 WinterOfDiscontent
146 Jeremy Levine
147 Matt Zaske
149 Casey Bisson
150 Petrr
151 Tobias Schaefer
152 Erik Söderström
153 Sandwich
154 ThePutFather
155 Seier Seier
156 Elif Ayiter
157 Tanveer Chandok
158 Susana Secretariat
159 Biopolus Copyright
160 Arlington Country
161 NRCS
162 Anonymous
163 Maurits Burgers
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165 Joseph Brent
166 Zachary Veach
167 Steve Jurvetson
168 Ängsbacka
171 Arne Hendriks
172 Nicola
173 The Bitten Word

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