CONNECTING WALK-UP APARTMENTS TO LOCAL CLOSED FLOWS

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ABSTRACT

This paper aims to summarize the physical interventions needed in post-war walk-up apartments to improve their current performance and to connect them to local looped flows such as water, energy, waste and materials. The specific location of this research is a neighbourhood in Rotterdam south, called Carnisse. The walk-up apartments that'll be studied are a design by J.H. van de Broek from 1939. By using a method developed by Superuse Studios, based on the principles of urban ecology, the potentials of the flows in Carnisse and the possibilities to short-circuit these flows were found. The area contains almost only housing, some retail and quite a big area with allotment gardens. Lots of food is going into the system, lots of waste, organic waste and sewage sludge is going out. Opportunities here are generating energy and food locally. By adding different cyclifiers (objects that enable loop closing) such as a biogas plant, CHP unit, greenhouses, seasonal thermal storage, PV-panels and a helophyte filter, the different flows can be closed locally. This has consequences for the walk-up apartment, the installations and piping needs to be compatible with the properties of the new energy source. Next to that the water system needs to separate the different types of water (black, grey, rain) and greenhouses need to build to enable the food production. Interventions that need to be done to the walk-up apartments anyway are enlarging of the dwelling, refurbishment of kitchen and bathroom, lower the energy demand, solve cold bridges, solve moisture problems due to lack of ventilation, reduce noise pollution, replace outdated piping and installations and make sustainability visible. Combining the interventions needed anyway with the interventions for the flows lead to a roadmap which can be used by architects, urban planners and municipalities to (re)design neighbourhoods into self-sustaining and resilient areas ready for the future.

KEYWORDS: *Post-war walk-up apartment, Industrial Ecology, Energy Flows, Material Flows, Rotterdam, Carnisse, Refurbishment*

I. INTRODUCTION

Cities consume energy, water, food and materials, leaving a heavy ecological footprint. Our current way of consuming is too big of a burden for the planet and isn't something we can keep up for the coming decades. Today cities are for 95% dependent on external resources. Going on in this line of action our natural resources will run out eventually, probably even within this century. This means a major shift in acting and thinking is needed. Instead of a linear economy, where we take, make and dispose, we should transition to a circular economy where material, products and waste are reused, recycled or refurbished and where physical (e.g. water and food) and energy flows become closed circuits. In the most ideal situation this leads to a world without waste. Van Timmeren [1] states that this transition from unsustainable cities to more sustainable and resilient cities must gradually develop. Open and global systems for energy and materials need to be complemented by more local and regional short circuit economies. This means cities will be less dependent on resources from outside the city. Material and energy flows will become smaller loops within certain areas of the city. Superuse Studios (former 2012 Architecten) developed a strategy to analyse the flows in a city to find their potentials to be short-circuited and the spatial implications of the integration in a (re)design. This strategy is based on the idea of Industrial Ecology, which will be explained later. One third of the building stock in our cities has been built after the Second World War. This post-war building stock is not rising up to current sustainability standards anymore. When redeveloping cities into more sustainable and resilient places, areas with these outdated housing blocks will inevitably be part of the challenge. These neighbourhoods shouldn't be considered waste, but as a resource for urban resilience.

This research will focus on a location in Rotterdam, the pre-war neighbourhood Carnisse. This neighbourhood, and more specifically the post-war walk-up apartments in the Eilandenbuurt, designed by J.H. van den Broek in 1939, is part of Beyond the Current, a research group from the department Heritage & Architecture at the faculty of Architecture of the TU Delft. The following research question will be attempted to answer: *What interventions are needed in the post-war walk-up apartments to improve their current performance and connect them to different types of local streams (water, waste, energy, nutrients, materials) in the neighbourhood?*

This study aims to summarize the physical interventions needed in building blocks and dwellings to link them to the closed energy and material loops in the neighbourhood. This will be done by combining three research methodologies: a literature review, an analysis of the neighbourhood Carnisse according to the method of Superuse Studios, called recyclicity, and an observation of seven case studies of sustainable neighbourhoods.

The literature review is about the location Carnisse, the architecture and the current constructive status of the walk-up apartments. The aim of the analysis is to find the potential of the flows in Carnisse and the possibilities to short-circuit these flows. This has implications for the interventions needed for the building blocks and dwellings. The case studies all concern existing and some non-built sustainable neighbourhoods. Within these case studies the characteristics of the location will be described and an overview will be given of the system of streams; food, heat, electricity, water, waste, materials/built environment and social. Each case study will elaborate on the interventions/design aspects that were needed to connect the dwellings to these streams closed within the neighbourhood.

Combine data from the literature review with the information extracted from the case studies. Resulting in a roadmap for architects/developers/inhabitants to integrate post-war housing to sustainable neighbourhoods.

II. FINDINGS

2. Potentials

2.1 Industrial ecology

Industrial Ecology (IE) focusses on the sustainable combination of environment, economy and technology. One goal IE is to change the linear nature of our industrial systems to a cyclical system where waste is reused as energy or raw material for another product or process [2]. IE has some essential principles [3]. The first principle is the analogy between biological systems and industrial activity, where natural eco-systems are seen as models for our human made industries. It's about the idea that we should design our industrial activities by example of ecosystems. In an ecosystem nutrient recycling and energy cascading occur very efficiently. One organism's waste or excrete is another organism's food or a resource for any other form of energy. This could be called roundput. Eco-systems have more of these characteristics or conditions that make them resilient and adaptable to changes, like locality (adaption to local circumstances and respect for limiting factors), diversity (enormous variety of species which makes the system flexible) and gradual change (enables species to adapt to a changing environment). The second principle of IE is that it operates from a systems perspective, which means looking at the functioning of the whole system, not just some of the parts.

Superuse Studios developed a design strategy based on the above principles of IE. The goal of this strategy is to analyse districts or regions and find different potentials to create closed loops of different flows within that area. First a material flow analysis is done (MFA). It's the mapping of all the in- and outflow of different types of materials, as well as their conversion and accumulation inside the system. In order to do this all the different actors, materials and flows that need to be studied are defined. Next to that the systems boundaries need to be determined, whereas changing the boundaries changes the scope of the assignment. After analysing the system where information about the physical layer of the system is gathered (e.g. streams of food, water, energy and other materials as well as traffic and the state of the built environment) [4], cyclifiers need to be found that connect streams at the local or regional level. Cyclifiers are catalyst entities that enable the closing of loops, for example a heat storage unit that stores waste heat. The final step is to make an integrated design including all the cyclifiers and a timeline of how the system changes over time. These different steps will be applied to the chosen design location, the pre-war neighbourhood Carnisse in Rotterdam.

2.2 System analysis Carnisse, Rotterdam

2.2.1 Background information

Carnisse is one of the pre-war neighbourhoods in Charlois, the south of Rotterdam (see appendix 1 for map). The development of Carnisse was part of the urban plan designed by W.G. Witteveen between 1920-1930, called the 'Uitbreidingsplan'. The main concept for the pre-war neighbourhoods was the 'wijkgedachte' (neighbourhood idea), where the social and cultural life was the starting point [5]. Almost all the dwellings are built right before the second World War (49%) or just after (43%) (see appendix 2 for chart). The neighbourhood is a high dense area and counts a high percentage, 70% (see appendix 3 for chart) , of 'portieketagewoningen', walk-up apartments with no elevators. These apartments are especially liked by starters on the housing market. However, this housing stock is not rising up to the current sustainability standards anymore. They are badly insulated, are small, have moisture problems and outdated installations. In 2016 Carnisse was counting just over 11.000 inhabitants, living in 5992 dwellings. This means there are foremost one or two person households (of the total of 5875 households) [6]. Only 17% of these households have children, and 60% of the inhabitants is moving away again within four years [7]. The inhabitants are from all over the world, only 37 % is native [8]. The largest part of the inhabitants is between 15 and 65 years old (75%) [9]. The average value of the dwellings in Carnisse is €86.000, which is low compared to the rest of Rotterdam (see appendix 4 for chart), 13% is social housing, private rental and private owned both take up 43% [10]. These facts and figures show that there's a low differentiation in housing but also in inhabitants, mostly couples and singles with a relative low income. Their relations with the neighbourhood don't seem to be tight, whereas the moving rate is quite high. This is confirmed by the safety index (see appendix 5) of the neighbourhood. This index also shows that the neighbourhood experiences vandalism and nuisance. This could contribute to the fact that people move away from the neighbourhood. Appendix 6 shows a strength and weakness analysis of the neighbourhood performed by the municipality and some social housing companies. This shows the before mentioned problems and stresses the lack of unity and diversity.

The municipality of Rotterdam writes in their 'Woonvisie 2030' [11] that a variety of dwellings should be realised, fitting to the diversity of the inhabitants and the different neighbourhoods in Rotterdam. The dwellings need to be of high quality and energy efficient. They need to be flexible to the changing needs of the Rotterdam inhabitants. The quantity of the middle and high segment housing has to be increased, making it possible to move within the city instead of moving away to find a bigger home. Living in Rotterdam needs to be good, also for the elderly and the less fortunate people. Appendix 7 shows the future strategy for Carnisse. The main points are improving the living environment, strengthen the identity and differentiation of the different area's in Carnisse and improve the existing stock. Next to that creating more space for companies and small businesses improve the diversity and job opportunities. The public space and green needs an upgrade and the strength of the existing canals and the connection with Zuiderpark could be exploited.

Carnisse's location is very central in the city, with lots of facilities at a walking distance (see appendix 8); shopping mall Zuidplein, swimming pool Charlois and Ahoy. The metro and bus station (at Zuidplein) provide transport in all directions. The Zuiderpark, south of the neighbourhood, facilitates all kinds of sports and recreation. For daily groceries there are shops at the Dorpsweg, Katendrechtse Lagedijk en Pleinweg. Between the south border of the neighbourhood and Zuiderpark there are different primary and secondary schools. Most of the neighbourhood is only housing, except in the north, in Carnissepunt, there it's a combination of retail with above housing.

2.2.2 System analysis

For this area the boundaries of the neighbourhood itself are determining, but are extended a bit to the south in order to include the different schools, the allotment gardens and the other green structures in the Zuiderpark, containing a total area of 125 hectares (Figure 1). This extends the diversity and thus the possibilities for this system, whereas the neighbourhood itself mostly contains housing. This determination of the boundaries doesn't mean the scope can't be broadened a bit (involved actors, materials, flows). Including some surrounding actors, in this case for instance a swimming pool or Ahoy, an event hall, could open up new possibilities for sinks and sources or streams. The systems boundaries include 11.000 inhabitants, about 3500 students, 21 hectares of allotment gardens, green and water structures. A schematic drawing of this system can be seen in Figure 2. Appendix 9 shows a map of the area pinpointing the characteristics and opportunities.

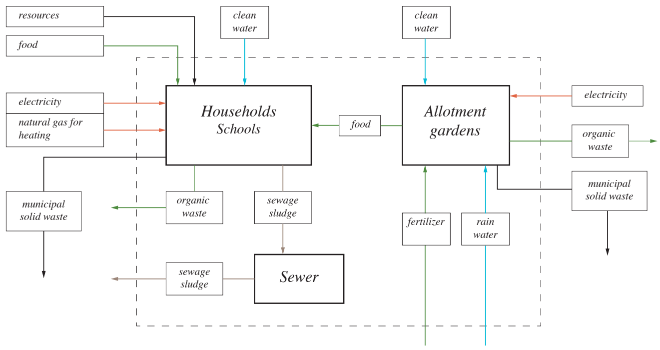


Figure 1. Google maps image with systems boundaries.

Figure 2. Schematic drawing of the current system in Carnisse. The green lines are organic flows of food and organic waste, the red lines indicate energy flows, the blue water flows, the brown line is the sewage sludge, the black one other resources and products, the dotted line represents the systems boundaries (see appendix 10 for larger image).

After analyzing the local and regional circumstances it's possible to identify the opportunities for connecting different streams. The main elements and actors with potential to become cyclifiers are listed in Table 1. Because of the high percentage of housing in the area the main streams going in and out are food and (organic) waste. The other important element that's present is the area with allotment gardens. Here people who live in the city have their own private garden, which they don't have at home, where they spent time during weekends and holidays. These gardens are often also used by the owners to grow some vegetables and fruits. These allotment gardens produce organic waste as well (crop residue and garden waste) and a really small percentage of the consumed food is produced here. Local food production would be a big opportunity in this area. The allotment gardens can be transformed into an efficient food production area. Next to that, additional greenhouses could be realized in between the housing blocks that currently have a large backyard. These now private gardens will become public space dedicated to food production. The existing water structures can be used as irrigation canals, buffering, or for water purification.

Table 1. The actors and elements with potential as cyclifier in and around Carnisse.

Actor or element inside the system of Carnisse	**Potential**
Allotment gardens	Local food production
Existing canals and surface water	Irrigation canals, water purification, water buffer
Housing (courtyards)	Local food production, source of organic waste
Schools	Education about urban farming/ training to become farmer
Actor or element outside the system of Carnisse	**Potential**
Van leeuwen Recycle group (waste and metal)	Provide organic waste (food and/or energy cycle), or needed metals for renovation housing
Charlois Swimming Pool	Provides waste heat/energy
Ahoy Event hall	Provides waste heat/energy

2.2.3 Cyclifiers and loop-closing

Currently none of the streams in Carnisse are looped. There's no local food production, no local energy production and no local wastewater and organic waste treatment. The following text will elaborate on the possible cyclifiers and possibilities to close different streams within in the system. Appendix 11a and b provide a map with the different possibilities and a scheme of the future looped system.

Food: Local food production is one of the main elements in the Carnisse system. The allotment gardens will be transformed into efficient food production areas which will provide food for the inhabitants of Carnisse. This will mainly be vegetables and fruit. Egg production could also be a possibility, whereas the allotment gardens are relatively far away from the housing. The Dutch law 'Wet geurhinder en veehouderij' [12] prescribes a minimum distance from a livestock farm to housing in the inner city of 100 meters. The distance from the allotment gardens to the nearest housing block is 150 meters. As mentioned before to complement the food production at the allotment gardens, greenhouses could be realized in between the housing blocks. Currently there's a large space in between the housing block with private gardens. The greenhouses would replace this and provide areas to produce food and public space. The greenhouse is also a good combination with the housing in terms of energy.

Energy: In order to close the energy loop within the Carnisse system, an energy source, an energy production method and energy storage needed to be found. The households in the area produce a huge amount of sewage sludge and organic waste and the newly introduced local food production produces crop residue, animal manure and organic waste as well. One energy source that fits these characteristics is a biogas plant. Besides biogas, a biogas plant produces at the same time fertilizer and grey water. This can be used to manure and water the farmlands and greenhouses. If needed the organic waste that is collected by the recycle company north of the Carnisse system could be used for the biogas plant as well. To be able to produce heat and electricity a Combined Heat & Power (CHP) unit will be added. A side product of this unit is CO_2 which can be fed to the greenhouses. In order to store heat underground seasonal storage can be added to the system. Heat produced with the CHP can be stored here, but also the waste heat from the households, schools and the greenhouses. It could also be considered to connect the swimming pool and Ahoy, just outside the systems boundaries, to this heat storage, whereas they produce a lot of waste heat as well. The greenhouses in between the houses provide an extra energy buffer during the winter, which lowers the energy use of the housing blocks. If needed photovoltaic panels could be added to the housing block's roofs.

Water: Helophyte filters will be installed in order to filter the grey water coming from the households and the bio-digester in the biogas plant. This can be reused in the households or to water the crops on the farmlands or in the greenhouses. To complement this rainwater could be captured and stored in the existing canals and surface water structures or within the building blocks to be able to use it for the households as well. This also means that a system is needed in the building blocks to separate the black water (sewage sludge) from the greywater and rainwater. Used water from the greenhouses can be filtered in the helophyte filtered and stored until it's needed.

2.3 Summary

Table 2 sums up the different cyclifiers that are needed to close different streams within the system of Carnisse. This is only possible when the outdated existing housing stock is addressed and people are educated on sustainable living and urban farming. The present schools in the area could play a part in educating the residents. In primary and secondary school this could be integrated in the school program.

Table 2. Cyclifiers that need to be added to the system to close different streams within the system of Carnisse.

Cyclifier	**Purpose**
Allotment gardens	Local food production
Greenhouses	Local food production in between housing blocks
Biogas plant	Burning of local organic waste and sewage sludge, produces biogas, fertilizer and water for farms
CHP unit	Convert biogas to heat and electricity, generates CO_2 for the greenhouses
Seasonal thermal storage	Store waste heat
PV-panels	Generate local electricity
Helophyte filter	Filters local grey water
Existing canals and surface water	Distribute water, act as water/rain buffer

The different cyclifiers have consequences for the arrangement of the built environment. The outdated walk-up apartments in this area need a serious update to be able to integrate them into the new system of Carnisse. The current status and performance of these dwellings need to be researched and the different ways and techniques to redevelop them. For this research focus will be on the Eilandenbuurt, designed by J.H. van den Broek. The following text will elaborate on that.

3. Walk-up apartments

3.1 Architecture

As mentioned before the development of Carnisse was part of the urban plan designed by W.G. Witteveen, called the 'Uitbreidingsplan'. During the Second World War a lot of houses (25.000 in Rotterdam) were destroyed or heavily damaged. In addition, the population grew strongly after the war from 8.8 million in 1940 to 12.9 million in 1970, the so called 'babyboom' [13]. Knowing that there had been almost no construction of new buildings since 1942, there was a very high housing shortage after the war. This was the foundation for the reconstruction and expansion plans at that time. Right after the bombing in 1940 Witteveen was assigned to come up with plans for the reconstruction of the city centre of Rotterdam. After some turmoil about Witteveen's ideas regarding unity in his architecture and urban design his subordinate Cornelis van Traa was appointed the assignment. A new trend came up within the development of these reconstruction plans. More than before these plans were based on scientific knowledge about population forecasts, traffic developments, employment opportunities etcetera. There was a search for a balance between social, economic developments and the lack of space for living, working, traffic and other functions [14]. This integral planning lead to the drafting of a 'structuurplan' (structure plan) for the whole city. This structure plan contained the location and the size of (new) neighbourhoods, the need and location for industrial sites and the infrastructure and connections between the old and the new city parts [15]. The new concept arising from this was the before mentioned 'wijkgedachte', social and cultural live was the starting point.

The traditional way of designing an urban plan was with closed building blocks. At that time the modern principle of open building blocks became the starting point for many new areas that were developed. One of the parcel principles that arose was the 'strokenbouw' (building in strips) [16]. Within this parcel principle the dwelling strips are oriented as much as possible towards the sun. This is the parcel principle applied to Carnisse as well. The focus of this research is on the 'Eilandenbuurt', an area within Carnisse, designed by architect J.H. van den Broek. Van den Broek finished his education to become an engineer at the 'Technische Hogeschool' in Delft in 1924 [17]. In 1927 he founds his own architectural office in Rotterdam. He is designing foremost for housing associations and private clients. In 1937 he succeeds the passed away Leendert van der Vlugt as partner of J.A. Brinkman. Together they realise among others the departure hall of the 'Holland Amerika Lijn'. Van den Broek got involved with the reconstruction of Rotterdam right after the bombing in 1940. He was part of many committees that studied new ways of living. After the Second World War in 1948 Jaap Bakema joins the firm and after Brinkman passes away in 1951 the firm is known as Van den Broek en Bakema.

One of the projects that had a great influence on the transition from closed to open building blocks was a housing project at the Vroesenlaan (see appendix 12) built between 1929 and 1935 [18]. Van den Broek designed it as half open building blocks. The ground floor was just half above street level and it was built in a concrete structure which was rare at that time. Glass folding doors made it possible to change the layout of the dwelling from a day to a night variant. In 1939 Brinkman en van den Broek were assigned a housing project in the Eilandenbuurt in Carnisse. The project was an initiative by some interest groups including 'Algemeen Belang'. The most important motivation was the stagnation of the housing market. There was a growing shortage of cheap rental dwellings. The difference between this project and the housing block at the Vroesenlaan is that all the extra's like the ornamental garden, frame construction, flexible dwelling floor plans and the combination with high rise building were left out. Optimal use was less important than optimal flexibility in the urban situation. Important was the width of the dwellings of 6,5 meters and the standardization and flexibility of the floor plan so it would fit in almost every urban situation. This flexibility was achieved by the application of the 'wisselbeuk' (switched bay). On the opposite of the stairwell in the portico, in the same bay there's an extra bedroom (see appendix 13). This creates a differentiation in dwellings with two or three bedrooms, but also the opportunity to switch the stairwell in the portico with the bedroom without constructive problems. This made it possible to adjust the housing blocks to the urban situation. This type of dwellings was often situated in a north-south directed street pattern, whereas it was favourable to have the bedrooms on the eastside and the living rooms on the west. The architectural firm didn't just deliver a design for this specific situation, but a design as a product of a research about the standardisation of the dwelling floor plan. Together with the design they delivered a detailed scheme of the needed materials and a time-organisation schedule. The production process was no longer separated from the design but an integrated part of the whole project.

3.2 Current status/performance

This standard floor plan was the foundation for the urban plan and the design of the housing blocks in the Eilandenbuurt and just outside this area (see appendix 14). It's a repetitive pattern of two housing blocks with backyards in between. There's two types of floor plans, the first has its balcony and living room oriented towards the backyards and the second has the balcony and the living room oriented towards the street (see appendix 15). The housing blocks have three stories and a half lowered basement that's used for storage. The dwellings are all one level apartments which all have their front door in a central stairwell. One stairwell gives access to six dwellings and the storage space in the basement. For the different floor plans see appendix 16. The elevations have the same repetitive design as the floor plans, following the orientation of the dwelling (see appendix 17). Central is the entrance with the stairwell, with on both sides straightforward window frames with, or without balcony. The findings about the construction and installations are based on drawings in appendix 18-20.

Construction: The housing blocks are built on a foundation of wooden poles and concrete foundation beams based on 5 bays in the following order; two bays for left dwellings, 1 one bay for the stairwell, 2 bays for the right dwellings. The basements floors and walls are poured concrete as well. The ground floor, first and second floor are constructed with load bearing brick walls and wooden joist floors. The stairwell floors, the area around the fireplace, and the balconies are reinforced concrete slabs. The cantilevered balcony is supported originally by two steel beams, but during the construction only one was applied. The brick façades are self-supporting with some supportive steel beams at floor height above the windows. In the core of the building there's two more steel beams to help connect the inner load bearing walls. Originally the windows had wooden frames but most of them were replaced over the years for aluminium or plastic ones with double glazing.

Installations: Hot water is originally provided by a central heating system in the portico, in Dutch called 'blokverwarming'. A central gas fireplace in the living room was the only source of heating for the complete dwelling. Nowadays in many dwellings this is replaced by central heating or combination heating. Mostly the boiler needed for this system is installed in the kitchen. The energy source for cooking is gas and a ventilation shaft in the corner of the kitchen sucks the air out (see appendix 20). Water and electricity pipes are central situated in the portico and from there connected with the dwellings (see appendix 20). Ventilation of the other rooms in the dwelling is by means of opening a window.

Usage: From the central portico you enter a small corridor. From this corridor the resident can enter the bathroom, a bedroom and the living room. From the living room it's possible to enter the kitchen and the second bedroom. Depending on the orientation the living room and kitchen are at the garden side or the street side. The basement, accessible through the portico, is used for storage. Small windows at the top of walls provide some daylight. Originally the kitchen and the bedroom are separated by (sliding) doors from the living room, but today these doors are often removed to create more space. The second bedroom is often sacrificed to create a bigger living room with windows on both sides. The total size of a two-bedroom apartment is about 47 m^2, including the balcony. The apartments with three bedrooms are about 54 m^2. The kitchen and bathroom, being 3,1 m^2 and 2,3 m^2, are really small. Especially with all the new devices like an oven, microwave, boiler and other kitchen supplies the size is too small. The balcony with a depth of just 1 meter is also not a generous size (see appendix 21). Some ground floor apartments made a connection to the basement (storage) or an extension to the garden, making it possible to create an extra (bed)room.

Issues: In a meeting with Leo Oorschot (part of the research group Beyond the Current, TU Delft) some main issues about these type of walk-up apartments were mentioned; outdated floor plans, high energy demand, airtightness, moisture problems due to lack of ventilation, noise pollution from neighbours and poor fire safety because of wooden floors, outdated pipes (asbestos) and shallow balconies. In this meeting Leo Oorschot also mentioned a questionnaire they did among residents of post-war walk-up apartments. The most important changes they would like to have are refurbishment of the kitchen and bathroom, more space by means of adding a glass house, noise reduction and making sustainability visible. A sustainable character seems to create some sort of status. The residents don't mind the stairs as long as they're health allows them to take it. The basement is mostly used as storage and sometimes connected to the ground floor apartments to create an extra (bed)room. This basement could be used more efficiently and is an opportunity to create more space in the whole building block. The construction of these apartments is sound, so making adjustments or even extensions on the roof shouldn't be a problem. The connection between the façade and the balcony has no thermal bridge stop (see appendix 20). The concrete of the balcony floor is degrading. It's crumbling and powdering due to a chemical reaction triggered by water between the steel in the concrete and the concrete itself. Originally the floor levels weren't visible in the façade but degradation of the bricks in front the steel beam in the wall (because of chemical reaction between water, brick and steel) made them crumble over the years. This strip of bricks had to be replaced and this is now visible in the façade because of a slightly different colour of the bricks (see appendix 22). Most wooden window frames have been replaced for plastic or aluminium ones. The steel beam that supports the concrete balcony slab has been covered in some places to reduce the cold bridge (see appendix 22).

The main problems that need to be addressed when redeveloping the walk-up apartments in the Eilandenbuurt are enlargement of the available space (also enlarge balcony) and refurbishment of at least the kitchen and the bathroom. Lowering of the energy demand and solving the cold bridges is one of the biggest issues. Ventilation possibilities to reduce moisture problems could be improved and reduction of the noise pollution from neighbours is important. All the installations and piping are outdated and don't meet the current requirements anymore, they should be replaced.

4. Possible interventions for a sustainable neighbourhood

To research what possible interventions and design strategies could be done to upgrade the walk-up apartments in the Eilandenbuurt and to be able to connect them to the improved flow system of the whole neighbourhood Carnisse, case studies were done on seven sustainable neighbourhoods. These case studies also show that certain interventions actually work in practice, in real life. According Two of these neighbourhoods are still theoretical, but chosen because of their relevance. MSP Heerlen is an area in Limburg, The Netherlands, which was used by Superuse Studios as a case study to explain their strategy of redeveloping cities in to more balanced, metabolistic environments. The other theoretical case study is Schiebroek-Zuid in Rotterdam. This was chosen because it's in the same city, thus the circumstances are quite the same. The other five case studies are already realized and are located in the Netherlands, Sweden or Germany. EVA-Lanxmeer in The Netherlands is a good example because it's in the same country and thus the same laws and climate characteristics apply. The other four case studies are pioneer projects in the field of sustainable neighbourhood design. Only MSP Heerlen and Schiebroek-Zuid are redevelopment projects, all the others are new built projects.

When studying these projects there was a distinction made between interventions needed on neighbourhood level and on building level. There were nine recurring themes in all the case studies; heat, electricity, transport, water, waste, green structure, food, materials/built environment and social aspects. These themes are about more than just the flows, they contain all the layers needed for a sustainable neighbourhood like transport and user's behavior. These case studies will help to find possible interventions to enable the flows, but also all the other aspects that make a neighbourhood and the way people live sustainable. These can be used as inspiration when (re)designing a neighbourhood. to these themes the case studies were researched and summarized in a table, showing briefly the interventions needed on neighbourhood and dwelling level. The complete case studies and the summarizing table can be found in appendix 23 and 24. The following text will elaborate on this by discussing each theme.

Heat: In almost all the cases the heat is provided by a combined heat and power system (CHP) and thermal storage in the ground or water and distributed in terms of district heating. The source for CHP is in three cases biogas (burning of organic waste and sewage sludge) and in one case regular gas. Except for MSP Heerlen and Kronsberg, additional heating is provided by solar collectors on the roofs of the houses. MSP Heerlen, EVA-Lanxmeer and Kronsberg integrated greenhouses in the design of the dwellings, which act as thermal buffer needing less heat. In Kronsberg each building has a transfer station with a heat exchanger to provide heating and hot tap water at the same time.

Electricity: In most cases electricity is generated by the CHP with (bio)gas as source. In all the cases the needed electricity is supplemented with photovoltaic (PV) panels on the roofs of the dwellings. In BO01 the electricity is generated by PV panels in combination with a wind turbine. In Vauban an electricity plant operating on woodchips and natural gas provides the electricity. Hammarby Sjöstad has its own version of using biogas. Each dwelling has a biogas cooker that operates on the organic waste the residents produce themselves. In many cases the dwellings have efficient lighting and appliances to minimize the energy use. In Vauban there were even energy plus houses realized.

Transport: In MSP-Heerlen, EVA-Lanxmeer and Vauban cars are not allowed in the living environment, central parking facilities are realized at the borders of the neighbourhoods. In BO01 and Hammarby Sjöstad parking is realized underground or under the buildings. The parking ratio is in most cases 0,7 or 0,8, meaning less than one car for each household is allowed. In hammarby Sjöstad and Vauban car-sharing and carpooling is stimulated and residents are rewarded when joining this with a year of free use of public transport. In all the cases bus or tram stops are within 300 or 400 meters from each dwelling. Walking is prioritized, mainly by quick, interesting and high quality routes.

Water: In all the cases rainwater is captured and stored for reuse. Greywater is purified and reused as well. This means there's a separate stream for black water and grey water. In MSP Heerlen and EVA-Lanxmeer a helophyte filter is used to purify the grey water. In BO01 and

Kronsberg there's an open system to drain the rainwater. In BO01 the rain is drained in above ground gutters that are also part of the design of the housing and the public space. Particularly the projects in Sweden make use of green roofs as part of rainwater drainage. In Hammarby Sjöstad, Kronsberg and Vauban water saving appliances (water-air mixers, flow limiters, water meters, vacuum toilets) were integrated in the dwellings.

Waste: In the projects that use biogas as energy source, the sewage sludge from the toilets and the organic and garden waste from the buildings is collected to burn in the biogas plant. In Schiebroek-Zuid residents are stimulated to recycle their waste as much as possible with a reward system, and urine separating toilets are implemented to process the urine to high quality fertilizer. In BO01 and Hammarby Sjöstad household waste is collected with a vacuum system. In BO01 the vacuum chutes are underneath the sink, in Hammberby Sjöstad the chutes are at a central place in each building. In Vauban a vacuum system for the organic waste is implemented in the building in order to enable biogas cookers.

Green structure: In MSP Heerlen old dried op creeks are used again to transport water and the available greenland is used for urban farming. In EVA-Lanxmeer the concept for the green structure is based on permaculture. In this concept zoning of the public space is done a specific way. The private gardens are always connected to the shared gardens, and the latter are connected to the public gardens. In BO01 the architects of the different building blocks were given a green points system and a green space factor of 0,5. The latter meant that the balance between paved and green surface needed to be 0,5. The green points system was a list of measurements and design aspect of which for each projects at least 10 had to be implemented. In Hammberby Sjöstad the concept for the green structure was based on increasing the biodiversity by using the right biotopes. At Vauban green roofs and vertical greening were implemented in the design.

Food: Only in MSP Heerlen, Schiebroek-Zuid and EVA-Lanxmeer food production is considered part of the flow system. MSP Heerlen implemented greenhouses in between the existing apartment blocks to be able to produce food. The available greenland is used for this purpose as well. Empty buildings are used to grow mushrooms and existing water structures are optimized for fishponds. In Schiebroek-Zuid the concept for food production was an edible landscape and to use one hundred percent of the roof surface for this purpose. In EVA-Lanxmeer there's some food production in the shared gardens and there's a cities farm just outside the neighbourhood. This farms purpose is mainly social and educational.

Materials/built environment: In MSP Heerlen materials from demolished buildings are used locally to build new needed structures. The amount of roads and pavements is reduced as much as possible. In Schiebroek-Zuid diversity and flexibility in the program, density and dwelling type should make the environment more resilient over time. Designs are based on minimum direct use (insulation, ventilation, passive resources, installations, lighting and devices) and small, smart, high quality spaces are preferred above big houses. In EVA-Lanxmeer living, working, recreation and local food production are integrated. The housing offer is diverse with a minimum of 30% affordable rental dwellings and is built in a bio-ecological way. In BO01 the architect teams had to submit a materials plan that assessed the environmental impact of the chosen materials. The height of the ground floor in al buildings is slightly higher to enable potential shops and services, activating the plinth. The blocks have a close-knit and various network of pedestrian routes. It's a mixed use area with integrated public plazas and parks. In Hammberby Sjöstad there's water views from all the public areas and residences. There were design rules like building-depths, set-back penthouses and multilevel apartments, generous balconies and terraces, large windows, flat roofs and pale plaster facades. In Kronsberg a zoning structure is present where the density and building heights decrease as one approaches the countryside. All parking and sidewalk paving is permeable and social housing was included in the neighbourhood.

Social aspects: In MSP Heerlen the newly implemented agriculture provide new jobs. The fishponds allow recreation and a gathering place for residents. The greenhouses between the housing blocks not only function as food production areas but also provide public space. Schiebroek-Zuid implemented flexible public spaces and ateliers to create meeting opportunities for the residents. In EVA-Lanxmeer all residents are obliged to join the resident's association where the participatory elements of the area are discussed. The gardens are collective maintained. In Vauban the housing blocks were designed in so called 'Baugruppen'. These were formations of collectives of future home owners that would purchase a site and built their own housing. The healthy competition between these Baugruppen stimulated the sustainable character of the different housing blocks.

5. Summary

To research what different interventions are needed to improve the current performance of the post-war walk-up apartments and to connect them to the different local streams in the, different scales were addressed, the complete neighbourhood, the dwellings and the inhabitants. The following text is a quick recap of the research.

Main problems neighbourhood: The neighbourhood has a low differentiation in housing but also in inhabitants, mostly couples and singles with a relative low income. Their relations with the neighbourhood don't seem to be tight, whereas the moving rate is quite high. Creating more diverse dwellings, also for families and elderly could be an option.

Future vision municipality Rotterdam: A variety of dwellings should be realised, fitting to the diversity of the Rotterdam inhabitants. The housing is of high quality and energy efficient. More middle and high segment housing needs to be realised to prevent people from moving out of the city. The character and identity of Carnisse needs to be strengthened and more differentiation in function and public space is desirable.

Future sustainable and resilient Carnisse: By adding different cyclifiers like farmland, greenhouses, a biogas plant, a CHP unit, seasonal thermal storage and helophyte filters it's possible to produce food locally and provide local energy and water treatment. This makes it possible to close the different streams within the system of Carnisse. This is only possible when the outdated existing housing stock is addressed and people are educated on sustainable living and urban farming.

Main problems building level: The main problems that need to be addressed when redeveloping the walk-up apartments in the Eilandenbuurt are enlargement of the available space (also enlarge balcony) and refurbishment of at least the kitchen and the bathroom. Lowering of the energy demand and solving the cold bridges is one of the biggest issues. Ventilation possibilities could be improved and reduction of the noise pollution from neighbours is important. All the installations and piping are outdated and don't meet the current requirements anymore, they should be replaced.

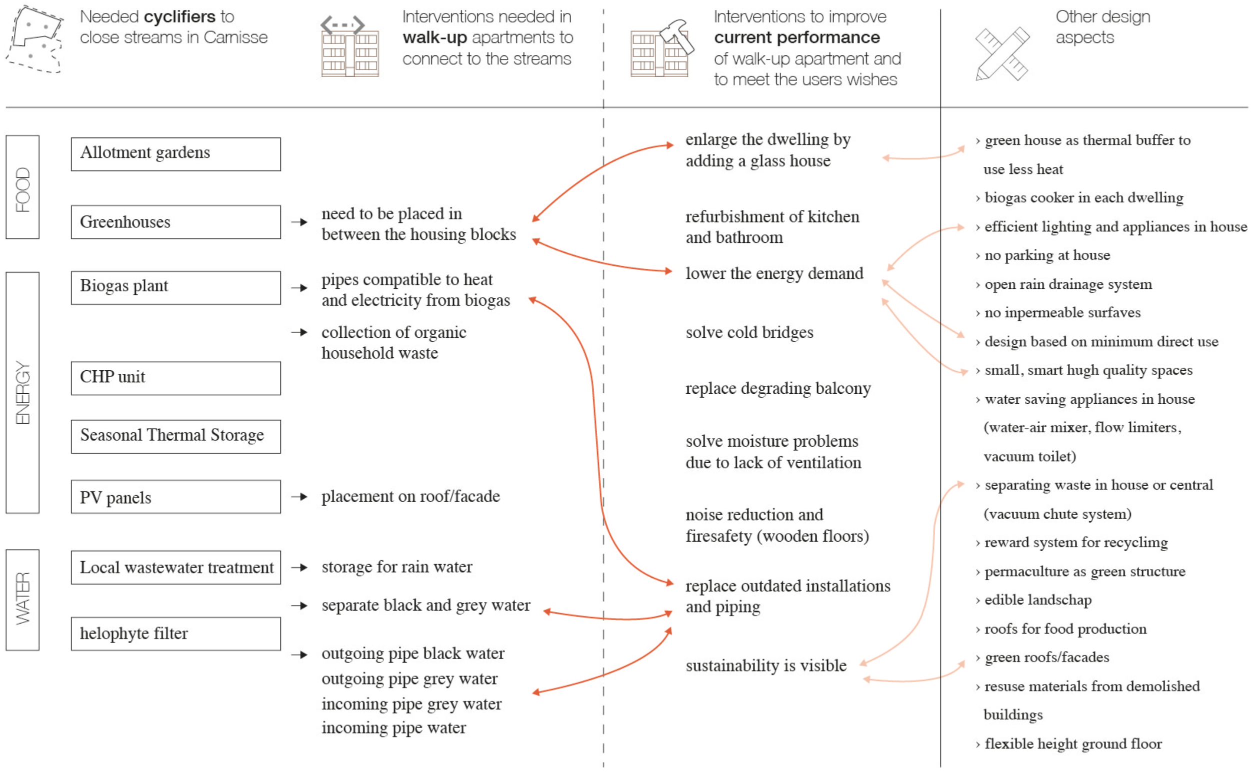
What residents want: The most important changes they would like have are refurbishment of the kitchen and bathroom, more space by means of adding a glass house, noise reduction and making sustainability visible. A sustainable character seems to create some sort of status.

Interventions possible: Heat: solar collectors on roof, greenhouse as thermal buffer. *Electricity:* PV panels on roof/façade, biogas cookers, efficient lighting and appliances. *Transport*: no parking at the dwellings, parking under the ground or underneath the building. *Water*: use of rainwater for toilets, dishwasher and laundry, storage for rainwater and grey water, separate black from grey water, green roofs, water saving appliances. *Waste*: urine separating toilet, separating household waste in dwelling or in housing block by a vacuum system. *Green structure*: green roofs, façades. *Food*: use roofs for food production, green houses in between building blocks. *Materials/built environment*: reduce roads and pavement, reuse material from demolishment, minimization of direct energy use, small smart high quality housing, impact of used building materials on environment as low as possible, height of ground floor for flexible use. *Social*: greenhouses as public space, flexible public spaces, ateliers and offices within the building block, different target groups as residents, collective maintenance, include affordable rental and social housing.

III. CONCLUSIONS

There are different interventions needed on neighbourhood scale to make local closed streams possible in Carnisse. These interventions influence the walk-up apartments, which means adjustments need to be made to the housing to be able to connect them to the local streams. On the other hand, the current performance of the walk-up apartments is not meeting up to the current sustainability standards anymore. This research aimed to find these needed interventions. Figure 3 (for enlargement of the image see appendix 25) shows a roadmap with the interventions needed for the system and what needs to be done to the walk-up apartments to be able to do this. It also shows the interventions that are needed anyhow to improve the performance of the walk-up apartments. Some interventions overlap and can be combined. Next to that there's a list with other design aspects that sums all the different design strategies that could be useful when redesigning the walk-up apartment. This roadmap is of course specified to the location of Carnisse, especially the new flow system whereas that's always location specific. The analysis of the walk-up apartment is more general, whereas lots of the same type were built and they all have rather the same issues. In this paper a specific method was used where first the big scale is analysed, then the dwellings and then it's combined to see what interventions could be done. This approach could be used for other redevelopments as well. The roadmap could be the starting point for architects, urban planners and municipalities to (re)design neighbourhoods into self-sustaining and resilient areas ready for the future.

Figure 3. Roadmap with interventions needed to connect the walk-up apartments to the local flows, and interventions that are needed to improve the current performance of the apartments. For bigger size of the scheme see appendix 25.


Needed **cyclifiers** to close streams in Carnisse
Interventions needed in **walk-up** apartments to connect to the streams
Interventions to improve **current performance** of walk-up apartment and to meet the users wishes
Other design aspects
FOOD
Allotment gardens
Greenhouses
need to be placed in between the housing blocks
ENERGY
Biogas plant
pipes compatible to heat and electricity from biogas
collection of organic household waste
CHP unit
Seasonal Thermal Storage
PV panels
placement on roof/facade
WATER
Local wastewater treatment
storage for rain water
helophyte filter
separate black and grey water
outgoing pipe black water
outgoing pipe grey water
incoming pipe grey water
incoming pipe water
enlarge the dwelling by adding a glass house
refurbishment of kitchen and bathroom
lower the energy demand
solve cold bridges
replace degrading balcony
solve moisture problems due to lack of ventilation
noise reduction and firesafety (wooden floors)
replace outdated installations and piping
sustainability is visible
› green house as thermal buffer to use less heat
› biogas cooker in each dwelling
› efficient lighting and appliances in house
› no parking at house
› open rain drainage system
› no inpermeable surfaves
› design based on minimum direct use
› small, smart hugh quality spaces
› water saving appliances in house (water-air mixer, flow limiters, vacuum toilet)
› separating waste in house or central (vacuum chute system)
› reward system for recycliing
› permaculture as green structure
› edible landschap
› roofs for food production
› green roofs/facades
› resuse materials from demolished buildings
› flexible height ground floor

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[4] 2012 Architecten, & Goossens, F. (2009). *Recyclicity: Industrial Ecology applied in the urban environment.* [online] Available at: https://issuu.com/2012architecten/docs/recyclicity_research [Accessed 13 Dec. 17].

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[7] Gemeente Rotterdam (2014). *Buurtmonitor. Wonen in Carnisse.* [online] Available at: https://rotterdam.buurtmonitor.nl/jive/report/?id=wonen&openinputs=true [Accessed 21 Nov. 17].

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[9] Gemeente Rotterdam (2016). *Wijkprofiel Carnisse*. [online] Available at: http://wijkprofiel.rotterdam.nl/nl/2016/rotterdam/charlois/carnisse/ [Accessed 22 Nov. 17].

[10] Gemeente Rotterdam (2014). *Buurtmonitor. Wonen in Carnisse.* [online] Available at: https://rotterdam.buurtmonitor.nl/jive/report/?id=wonen&openinputs=true [Accessed 21 Nov. 17].

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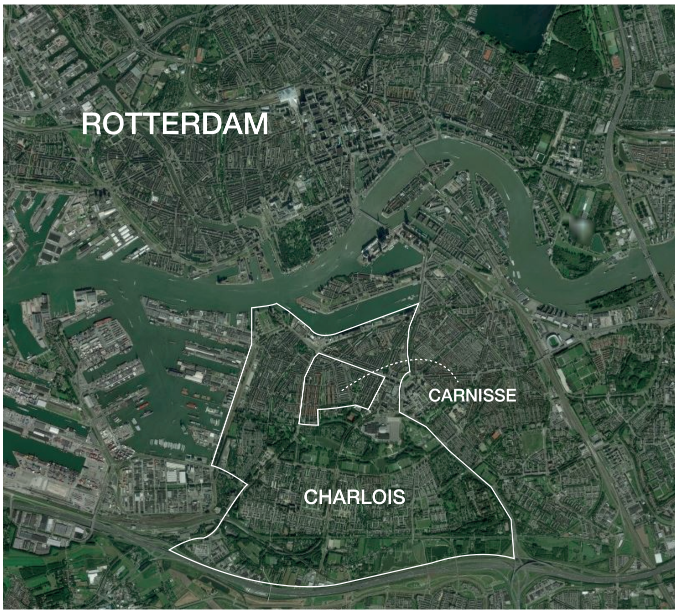
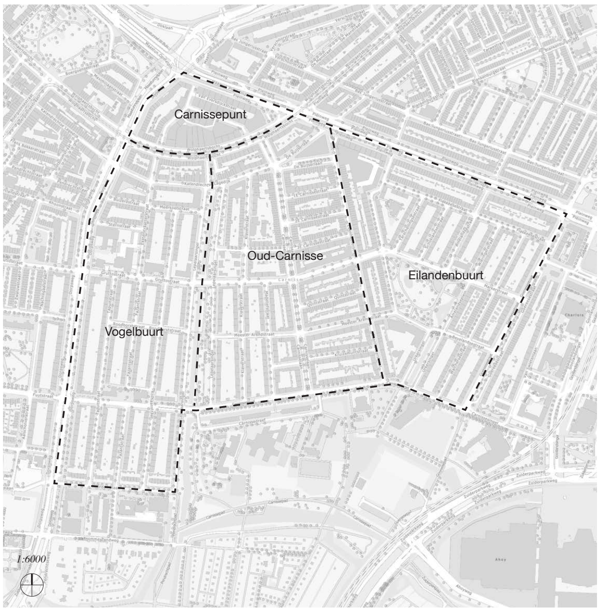
Appendices

Appendix 1

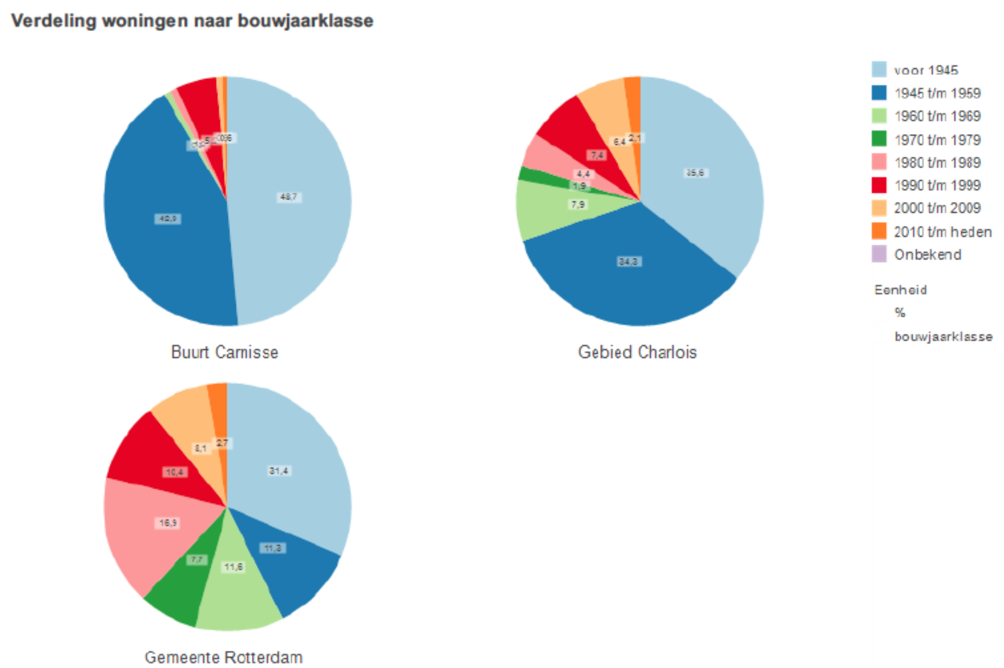


Location Carnisse in Charlois, Rotterdam (own image)



Different areas in Carnisse

Appendix 2



Construction period Carnisse[1]

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[1] Gemeente Rotterdam (2016). *Wijkprofiel Carnisse*. [online] Available at: http://wijkprofiel.rotterdam.nl/nl/2016/rotterdam/charlois/carnisse/ [Accessed 22 Nov. 17].

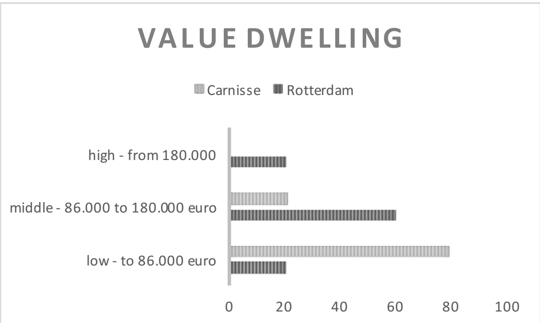
Appendix 3

Verdeling naar woningtype

	Buurt Carnisse	Gebied Charlois	Gemeente Rotterdam
Eengezinswoning	3,8	16,0	26,2
Benedenwoning	11,2	11,4	9,6
Beletage / souterrain	-	0,0	0,1
Vrije bovenwoning	10,7	7,6	6,1
Etagewoning	0,8	2,7	4,6
Onvrije etagewoning	0,4	1,3	1,4
Portiekwoning zonder lift	69,9	37,2	23,9
Galerijwoning zonder lift	1,3	5,7	4,1
Portiek- / galerijwoning met lift	1,7	17,9	23,7
Onbekend	0,1	0,1	0,2

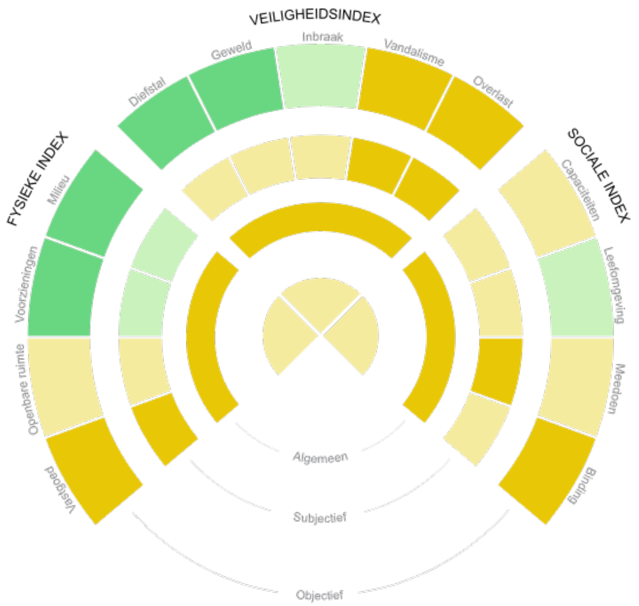
Differentiation of dwelling types in Carnisse[1]

Appendix 4



Value of dwellings in Carnisse in comparison to Rotterdam[2]

Appendix 5



Safety index neighbourhood Carnisse[2]
Green: strong aspects
Yellow: weak aspects

[1] Gemeente Rotterdam (2014). *Buurtmonitor. Wonen in Carnisse.* [online] Available at: https://rotterdam.buurtmonitor.nl/jive/report/?id=wonen&openinputs=true [Accessed 21 Nov. 17].
[2] Gemeente Rotterdam (2016). *Wijkprofiel Carnisse.* [online] Available at: http://wijkprofiel.rotterdam.nl/nl/2016/rotterdam/charlois/carnisse/ [Accessed 22 Nov. 17].

Appendix 6

bebouwing Pleinweg

Sterk
Centraal gelegen op Zuid.
Nabijheid Hart van Zuid met voorzieningen en OV.
Nabijheid Zuiderpark met groene uitlopers in de wijk.
Verzameling buurten met in aanleg eigen identiteit.
Milieu Klepelkat en vrijstaande villa's.
Voorzieningen (school, gezondheidscentrum, moskee, winkels in Carnissedriehoek).
Werkende mensen: laag tot gemiddeld inkomen.
Sociale huurvoorraad voor 15 jaar.
(Fysieke) aanpak omvangrijk afgelopen jaren, meer bewustzijn onder betrokkenen (actiever VVE's).

Ligging en voorzieningen

Kans
Ligging in het groen (Zuiderpark), groene kwaliteiten als Amelandseplein en singels.
Kansrijke plekken/ gewilde woonmilieus uitbreiden (Lepelaarsingel, Roerdomplaan, Kromme Zandweg, dorp Carnisse).
Verdwijnen lintbebouwing Humanitas (kan voor betere verbinding Zuiderpark zorgen).
Verbetering/ herstel Oud Carnisse.

Kans: ligging benutten, meeliften op kwaliteiten in omgeving

Zwak
Eenzijdige saaie bebouwing, te veel van hetzelfde (klein, gestapeld en goedkoop).
Onuitgesproken imago.
Hoge omloopsnelheid in grote delen van de wijk: Eilandenbuurt, Vogelbuurt, Klaverbuurt, Kop Carnisse.
Achter Pleinweg en Dorpsweg en daarmee onzichtbaar/ onbekend.
Probleemgebied in sociale index.
Matige verbindingen richting Hart van Zuid, park en haven.

Functioneel tekort, verwaarloosde uitstraling

Bedreiging
Kansrijke plekken zijn nu te klein, onvoldoende schaal/ massa.
Eenzijdige bebouwing te veel en te saai.
Hoge omloopsnelheid in de particuliere voorraad incl. wisselende bevolking (daardoor weinig binding).
Karakter buurt (weinig binding) leidt makkelijker tot illegaliteit, overlast e.d. en leidt niet tot investeringen in de wijk.

Dreiging: achteruitgang wanneer niet geïnvesteerd wordt in de wijk

"Carnisse is niet een wijk, maar een verzameling buurten met verschillende karakters."

portieketage woningen Vogelbuurt

woningen Roerdomplaan

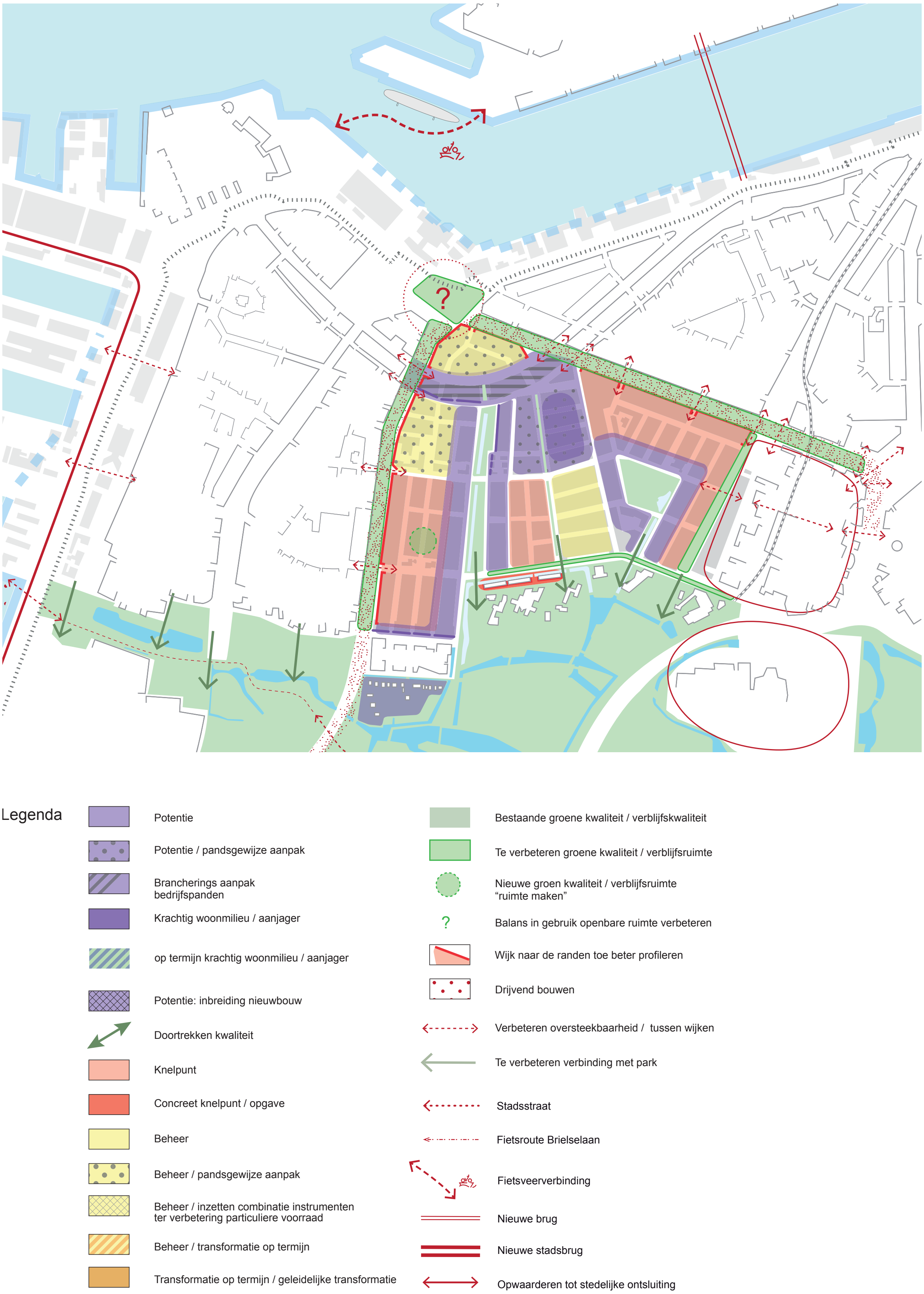
bebouwing Carnissedreef

portieketage woningen Eilandenbuurt

Characteristics existing situation Carnisse

[1] Programmabureau NPRZ (2013). *Nationaal Programma Rotterdam Zuid. Handelingsperspectief wijk Carnisse.* [online] Available at: https://www.rotterdam.nl/wonen-leven/opgave-nprz/handelingsperspectief-Carnisse.pdf [Accessed 14 Nov. 17].

Appendix 7



Future Strategy Carnisse[1]

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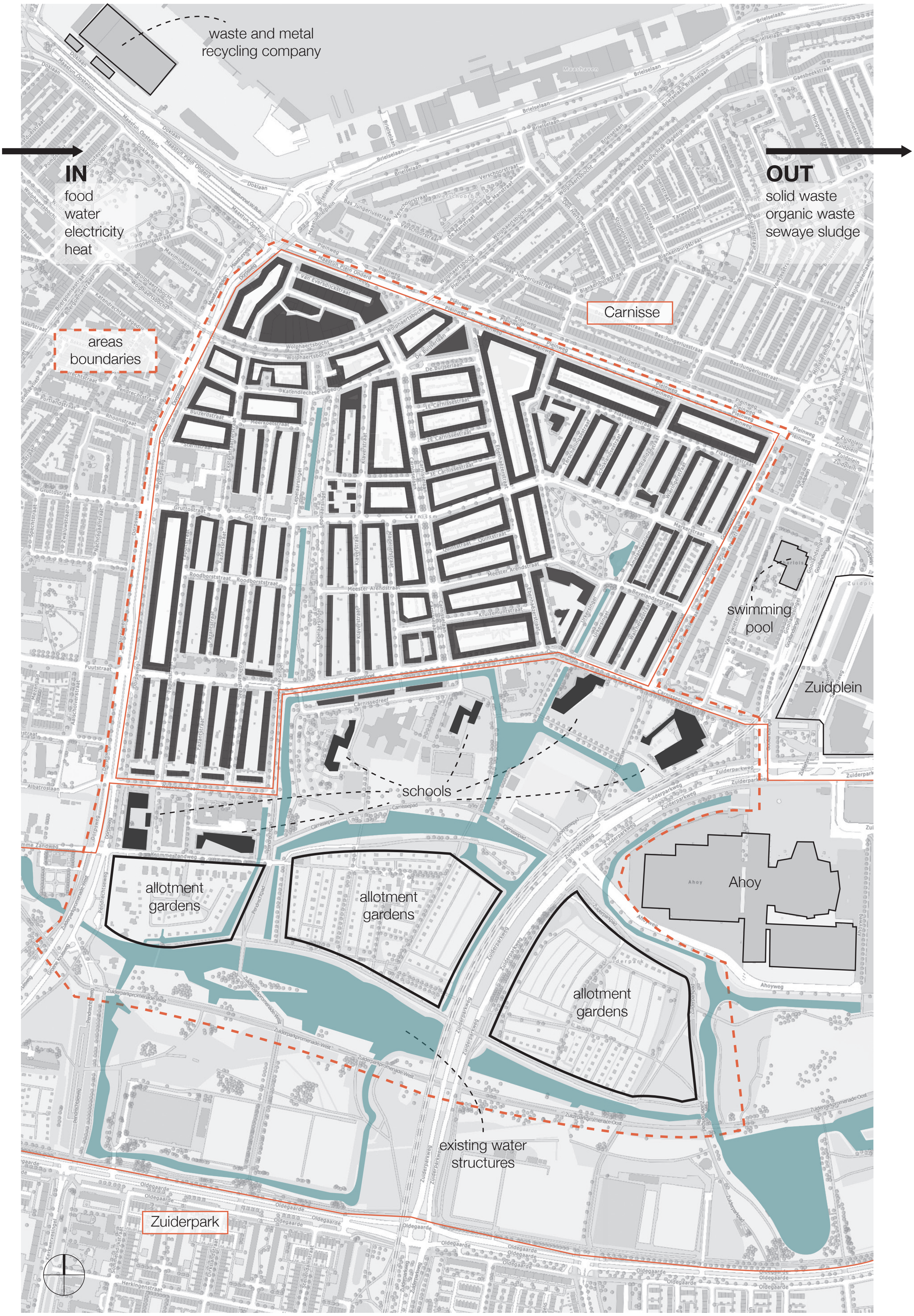
[1] Programmabureau NPRZ (2013). *Nationaal Programma Rotterdam Zuid. Handelingsperspectief wijk Carnisse.* [online] Available at: https://www.rotterdam.nl/wonen-leven/opgave-nprz/handelingsperspectief-Carnisse.pdf [Accessed 14 Nov. 17].

Appendix 8

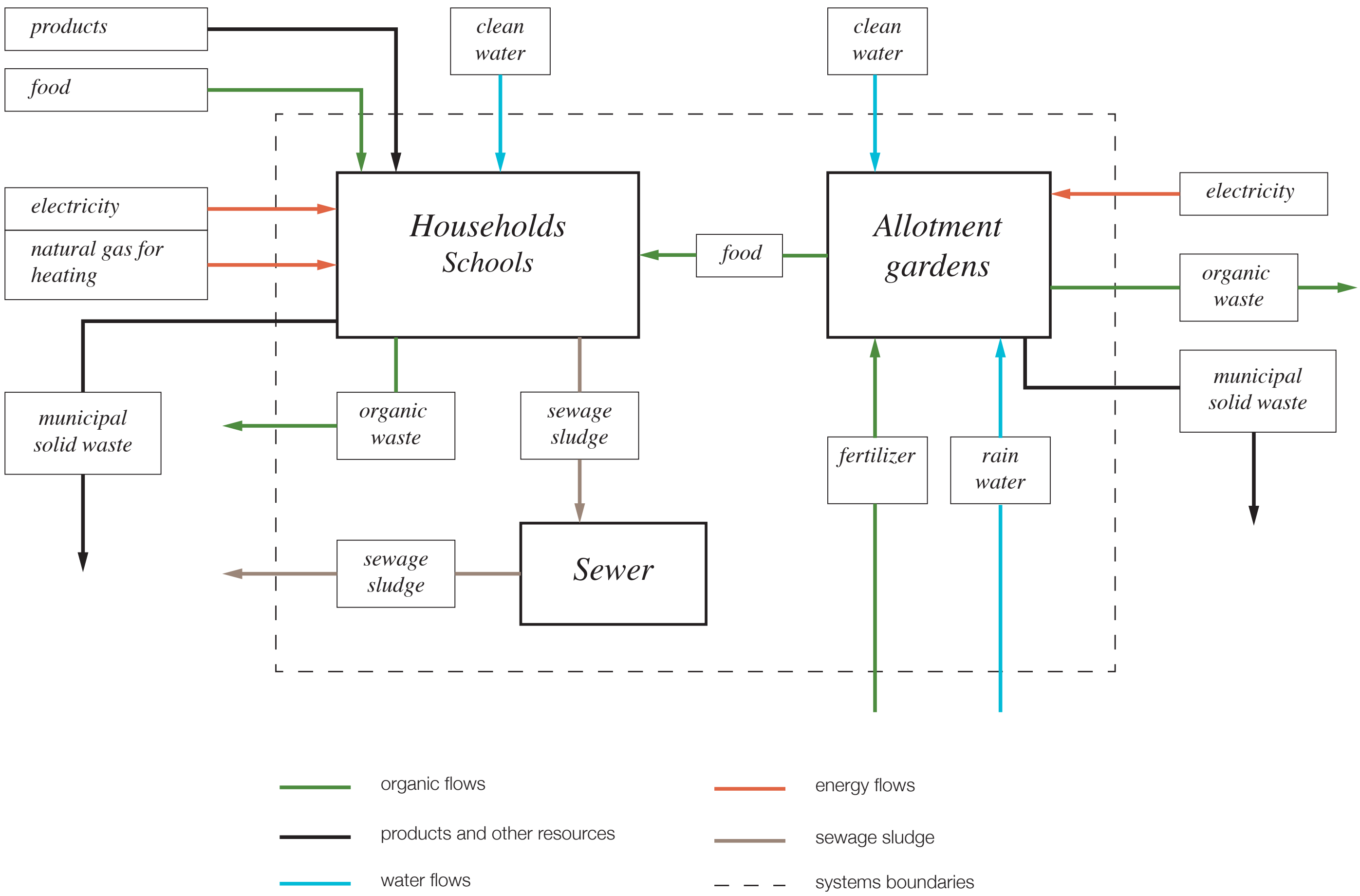
Functions in Carnisse (own image)

Appendix 9



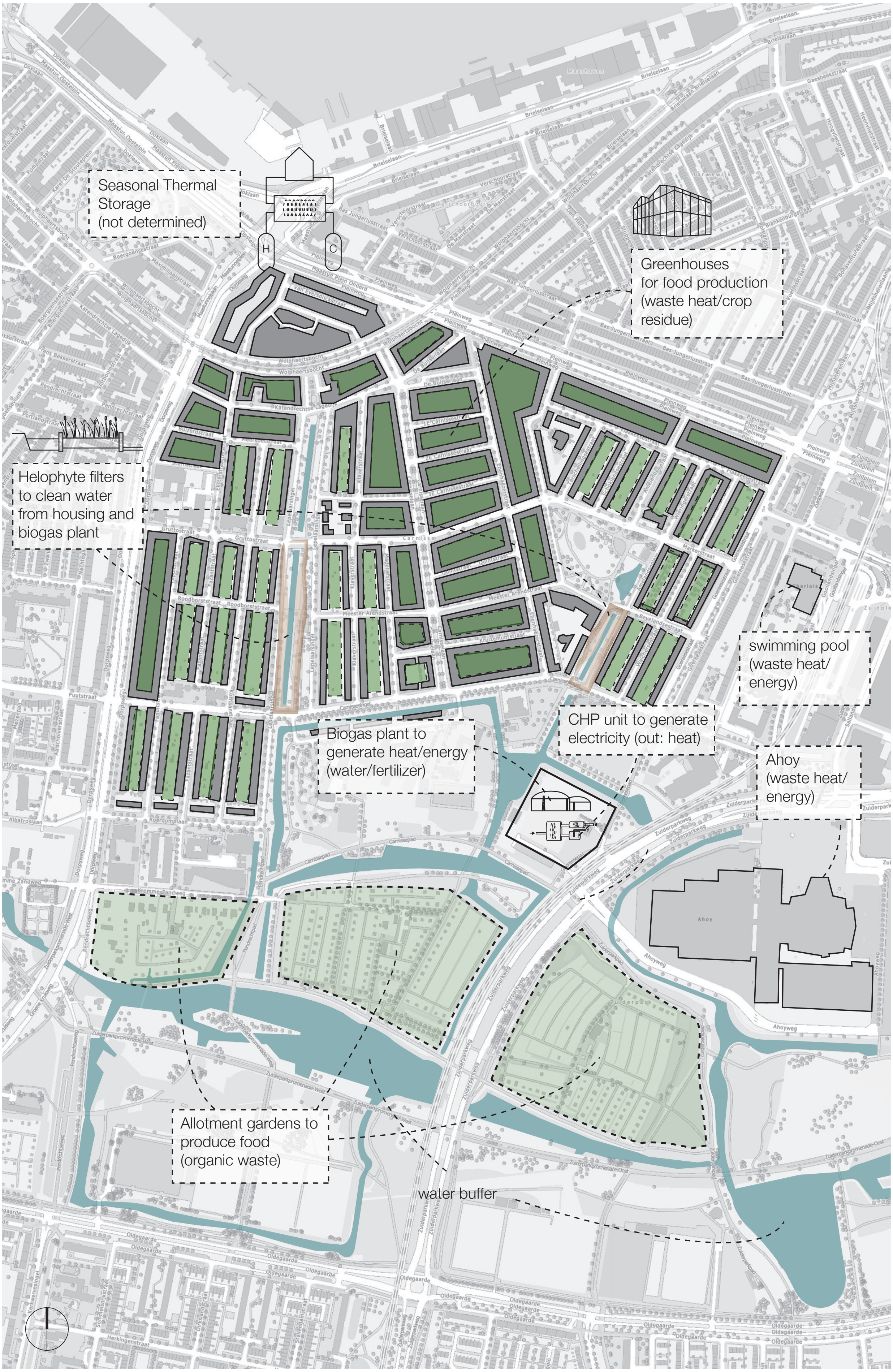
Characteristics and opportunities of the area (own image)

Appendix 10



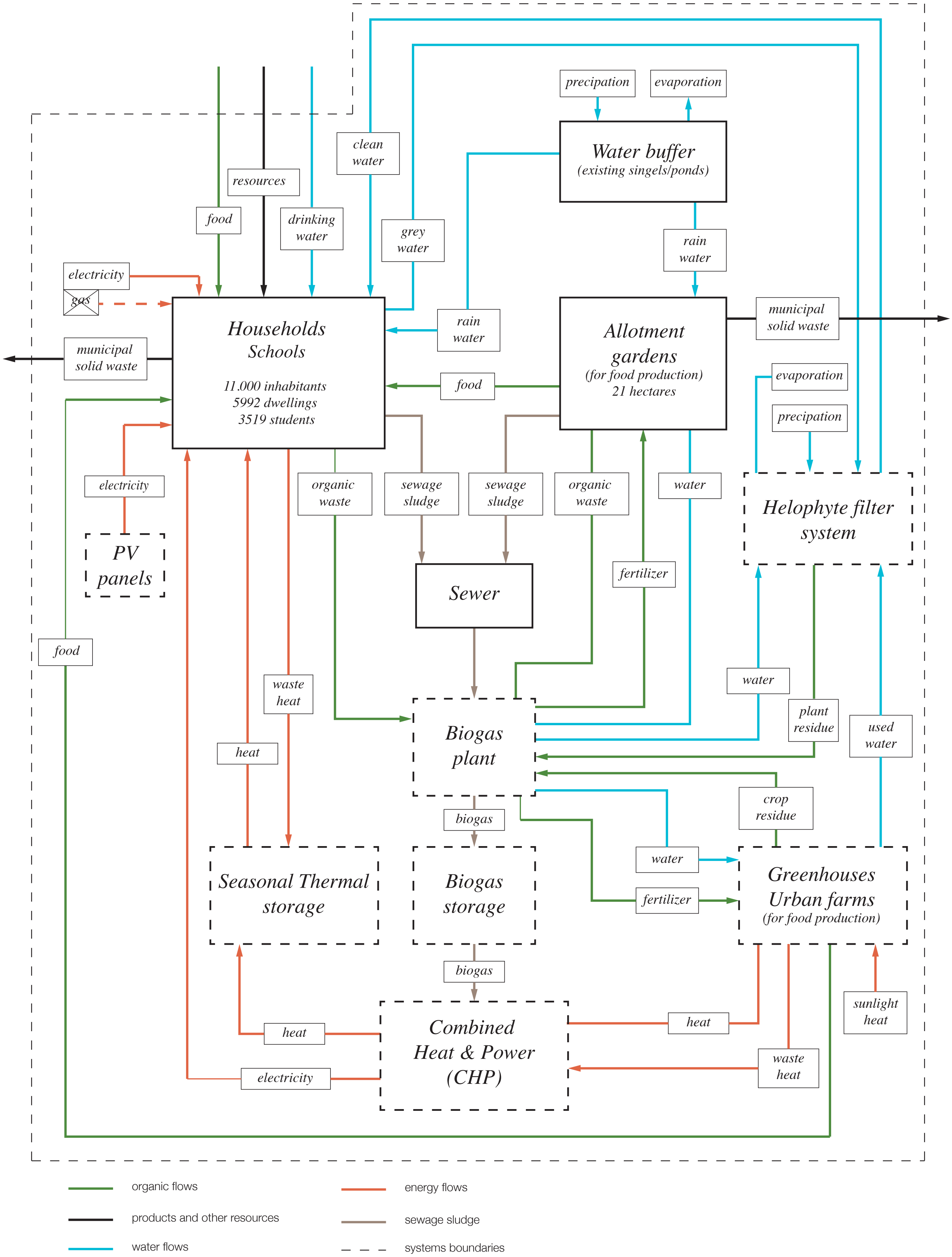
Schematic drawing of the current system in Carnisse. The green lines are organic flows of food and organic waste, the red lines indicate energy flows, the blue water flows, the brown line is the sewage sludge, the black one other resources and products, the dotted line represents the systems boundaries (own image).

Appendix 11a



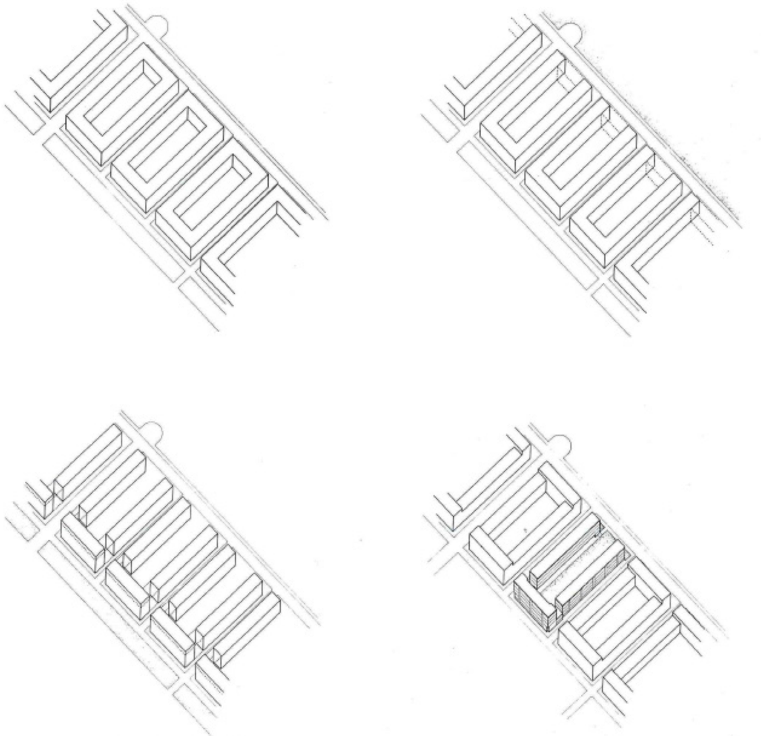
Cyclifiers to add to close loops in the area (own image).

Appendix 11b

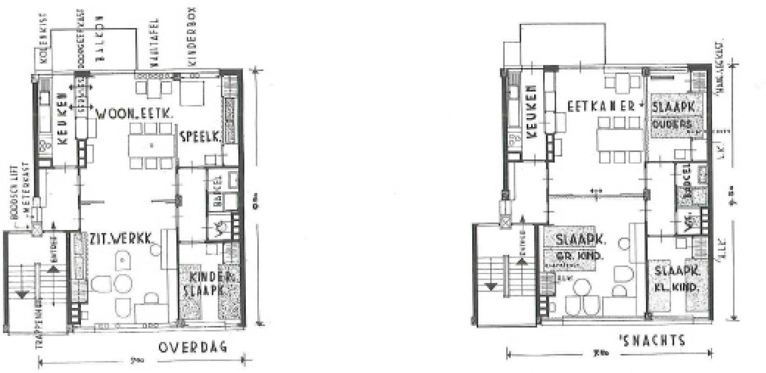


Future system of loops in Carnisse. The green lines are organic flows of food and organic waste, the red lines indicate energy flows, the brown line is the sewage sludge, the black one other resources (own image).

Appendix 12



transformatie van het gesloten- naar het halfopenbouwblok als reeks getekend



de flexibele woningplattegrond

Above: transformation of the closed to the half-open building block
Down: the flexible floor plan[1]

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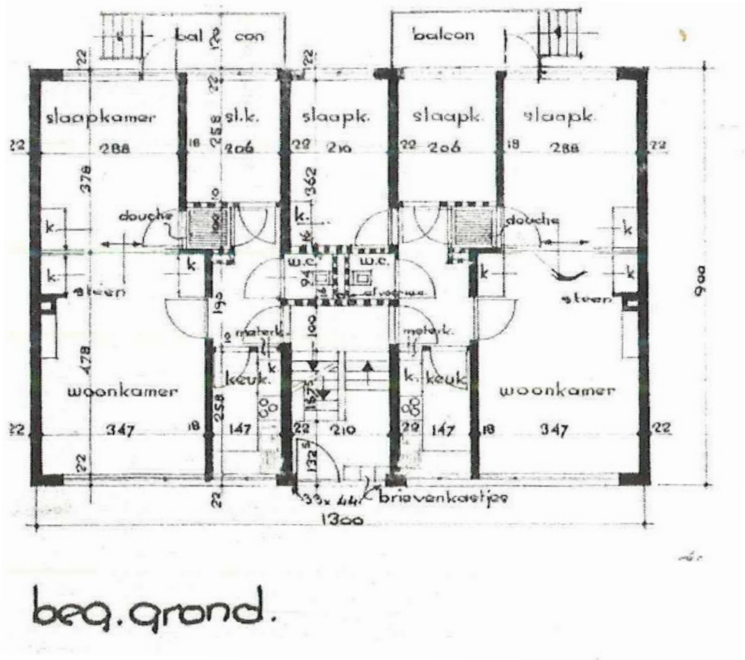
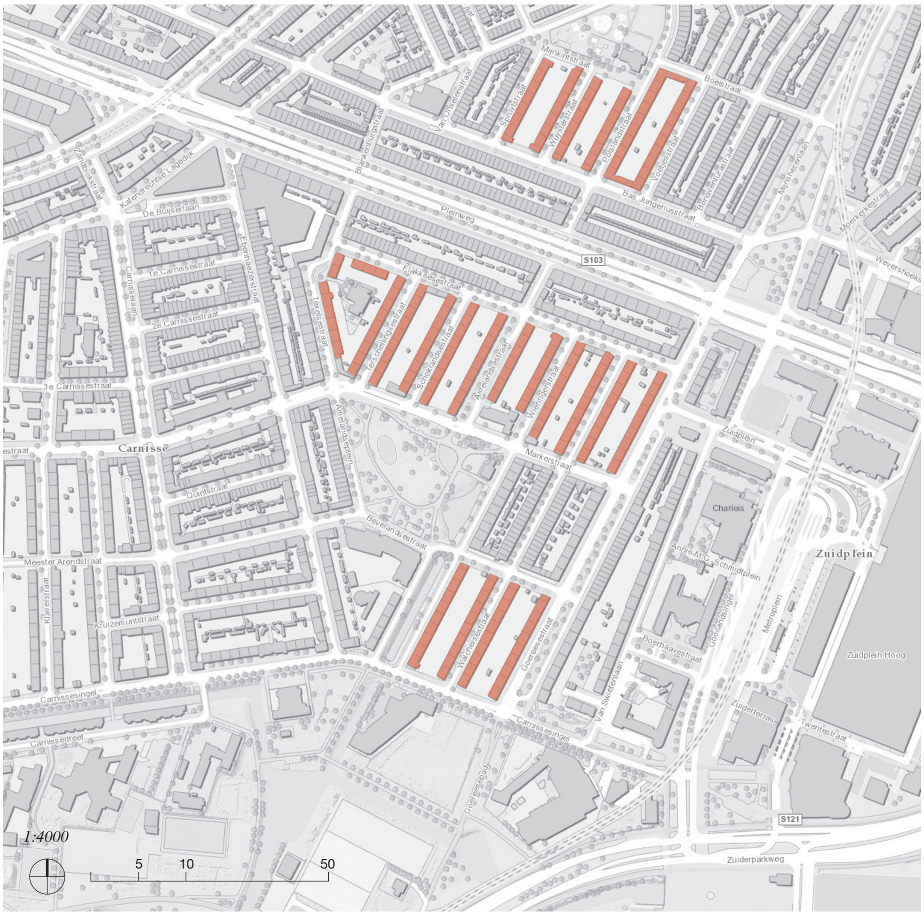
[1] Stroink, R., Fosso, M., & Meeuwissen, J. (1981). *Ir. J.H. Van den Broek : projecten uit de periode 1928-1948*. Delft: Delfste Universitaire pers

Appendix 13



standard floor plan with the 'wisselbeuk'[1]

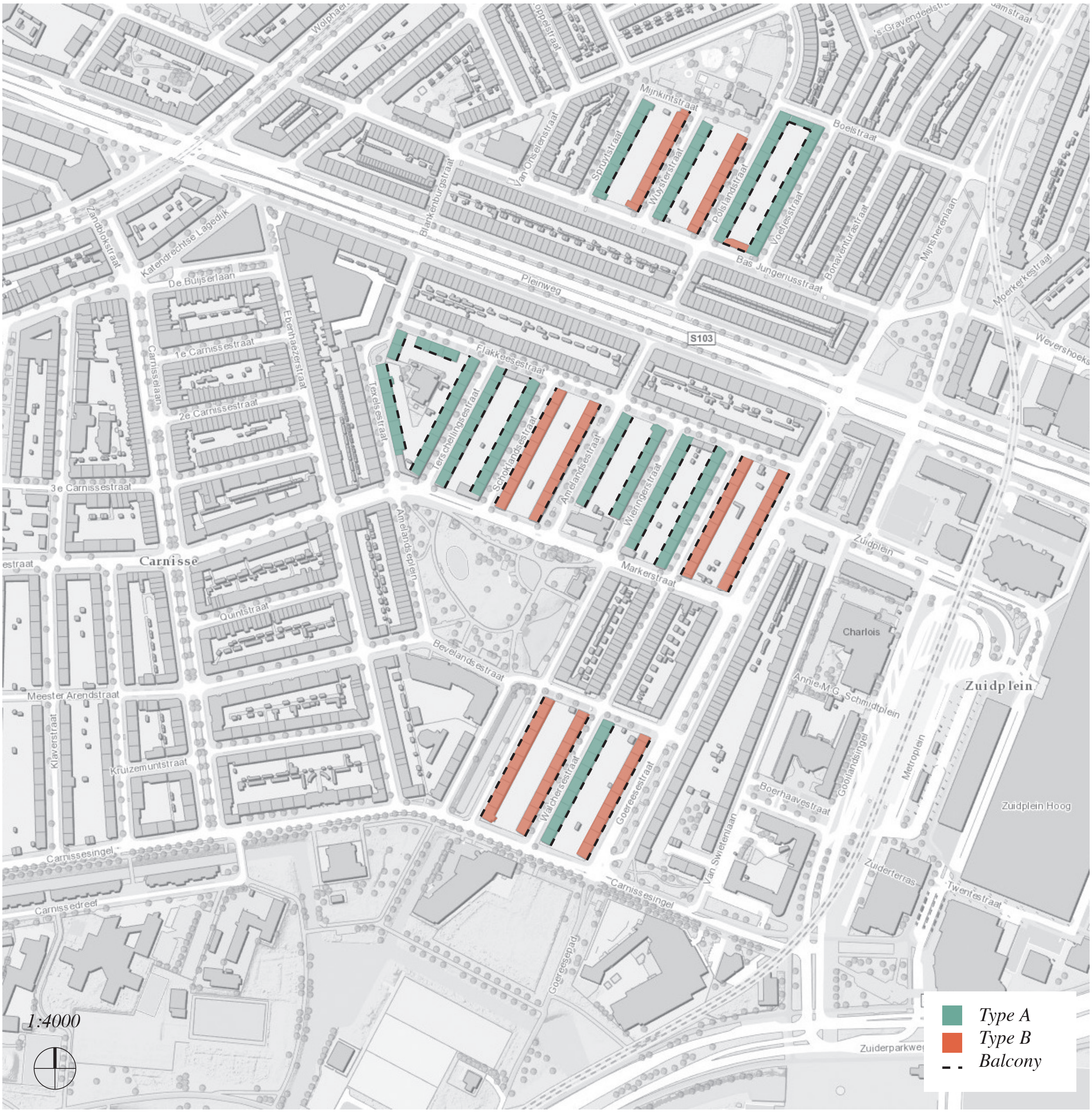
Appendix 14



repetitive design 'Algemeen Belang' (own image).

[1] Stroink, R., Fosso, M., & Meeuwissen, J. (1981). *Ir. J.H. Van den Broek : projecten uit de periode 1928-1948*. Delft: Delftse Universitaire pers

Appendix 15



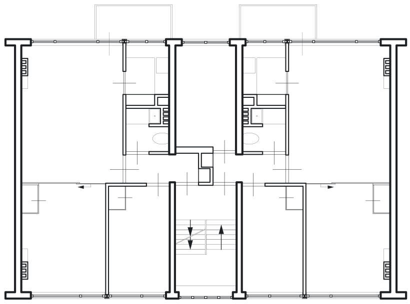
Type A - living area and balcony are facing the garden
Type B - living area and balcony are facing the street

orientation of the dwellings (own image)

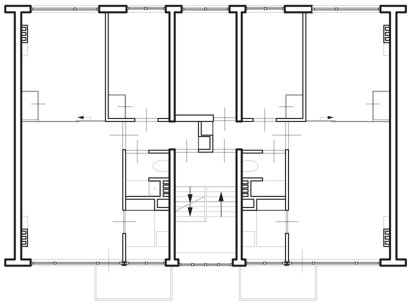
Appendix 16

Type A

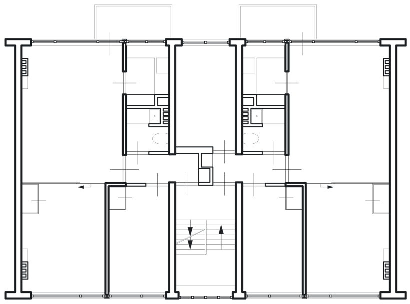
Type B



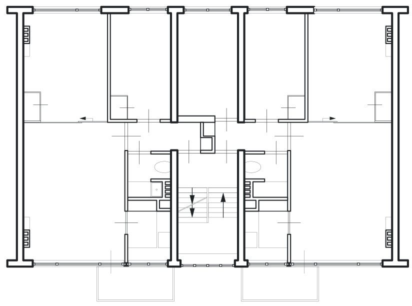
second floor



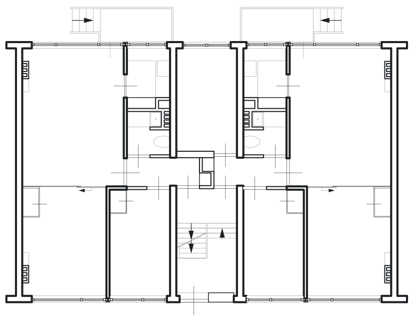
second floor



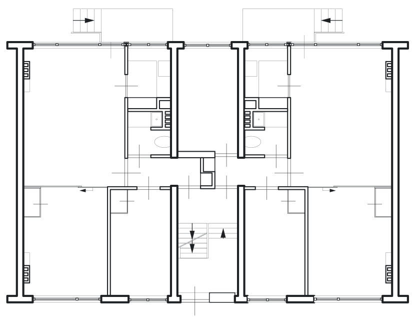
first floor



first floor



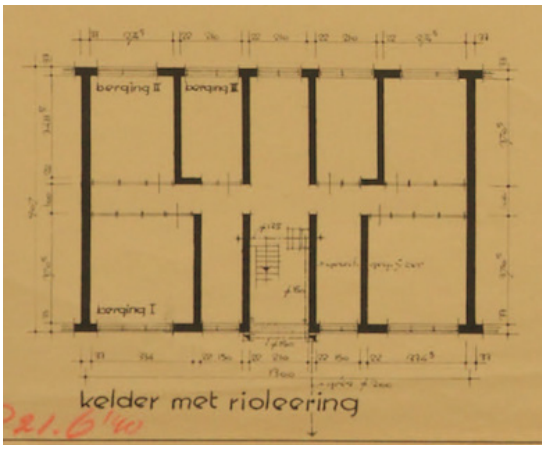
beletage



beletage

Above: Floor plans[1]
Type A: balcony and living room oriented towards the garden
Type B: balcony and living room oriented towards the street

Right: floor plan of basement[2]



[1] Own image based on the drawings from the archive of Het Nieuwe Insituut
[2] Archive Het Nieuwe Instituut

Appendix 17

Elevations Type-A
1939

front facade (street)

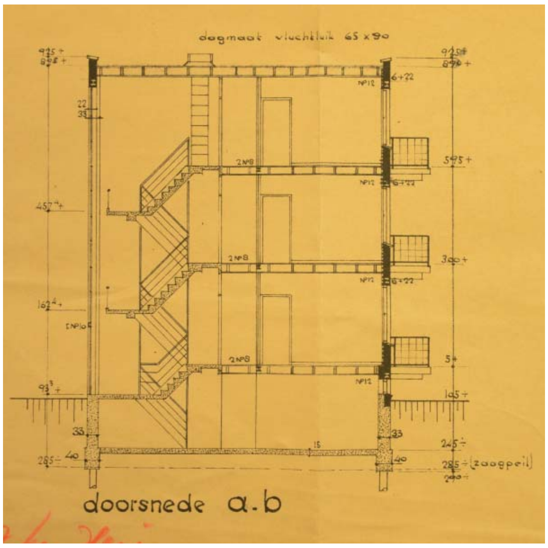
back facade (garden)

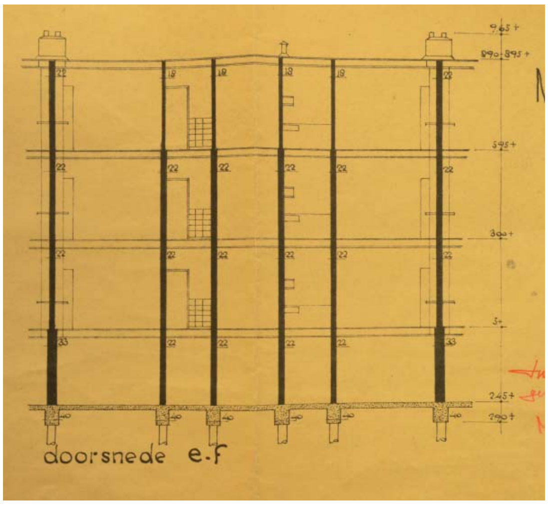
Elevations Type-B
1939

front facade (street)

back facade (garden)

elevations type A and type B[1]

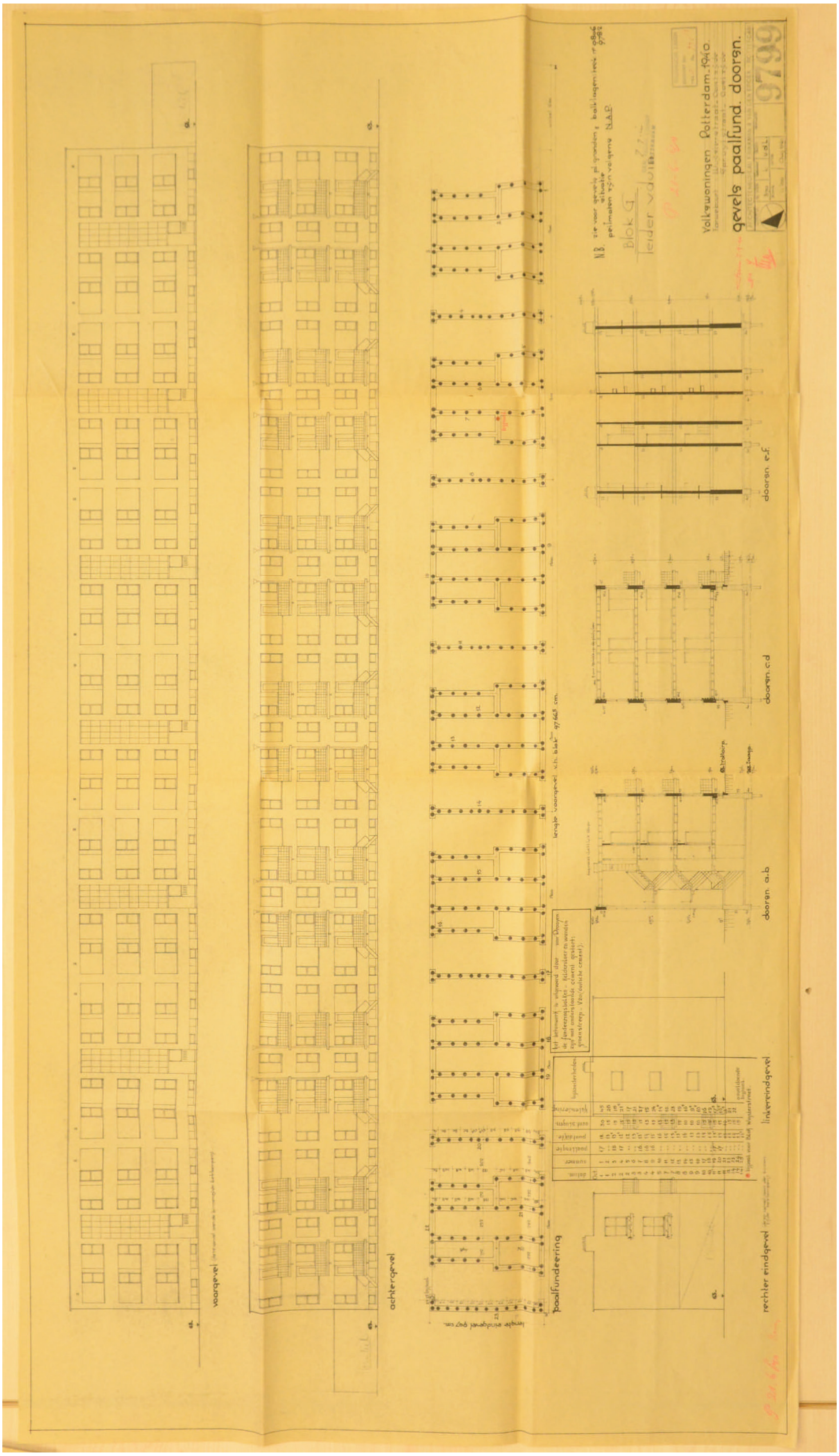




sections type A[2]

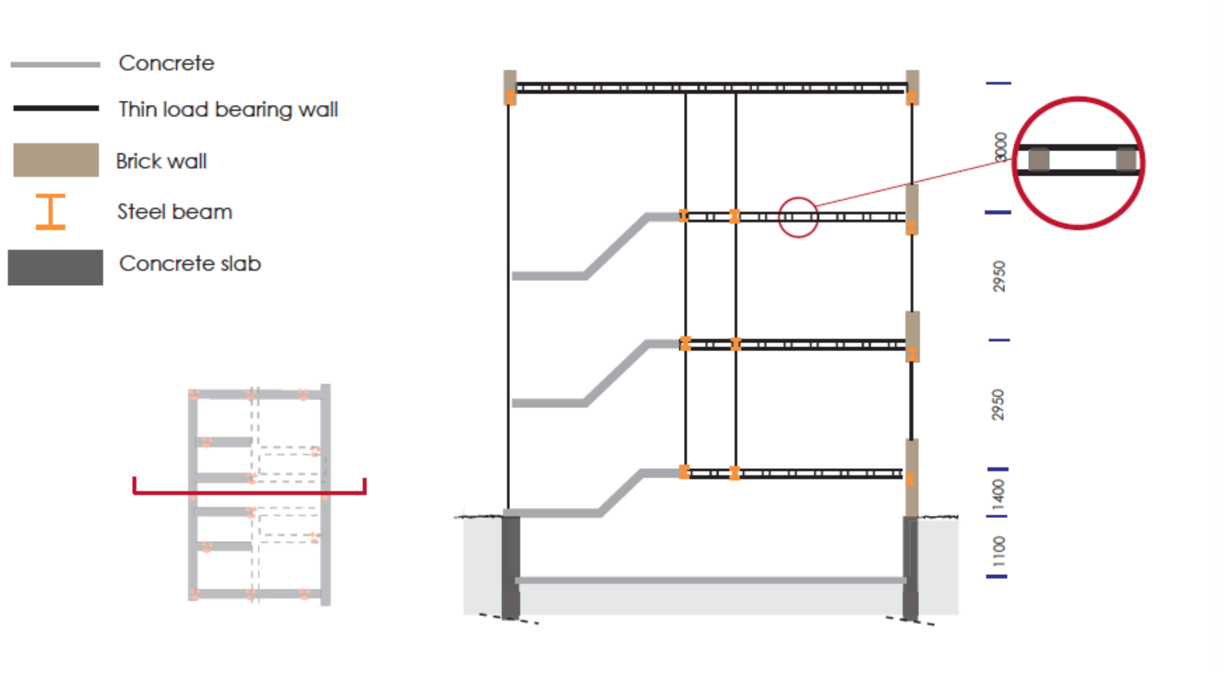
[1] Own image based on the drawings from the archive of Het Nieuwe Insituut
[2] Archive Het Nieuwe Instituut

Appendix 18



[1] Archive Het Nieuwe Instituut

Appendix 19

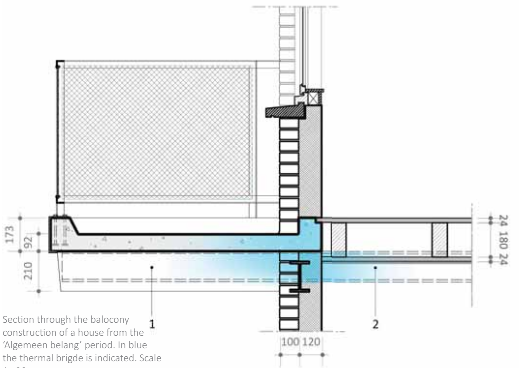


section trough the central stairwell[1]

construction floor plan[1]

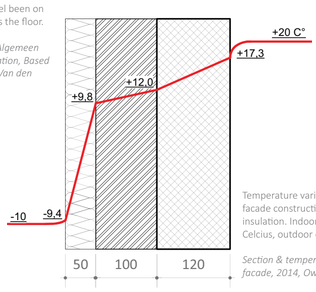
[1] Van Zelst, M. (2014). *Modernisme vs. Traditionalism: Comparing unpopular Van den Broek portiek-housing with populair 30s portiek-housing* (master's thesis).

Appendix 20



Section through the balocony construction of a house from the 'Algemeen belang' period. In blue the thermal brigde is indicated. Scale 1 : 20.
1. Extruded I-shaped steel beam encased in concrete balcony element.
2. Continuation of the steel been on the inside here is supports the floor.

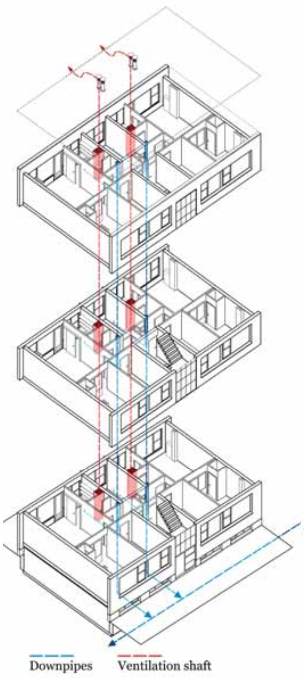
Drawing section balcony Algemeen Beland, 2014, Own illustration, Based on drawings Brinkman & Van den Broek 1938-1939.



Temperature variation in the adapted facade construction. Aditional exterior insulation. Indoor climate +20 degrees Celcius, outdoor climate -10.

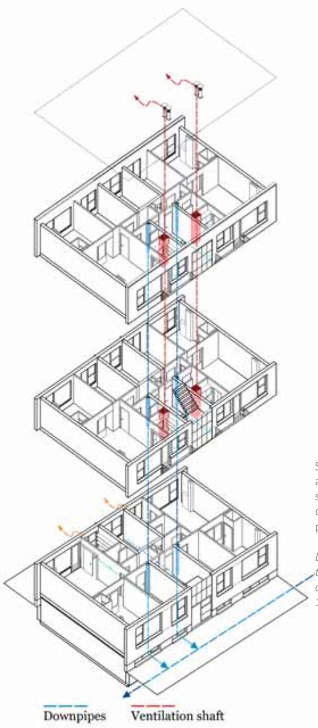
Section & temperature curve insulated facade, 2014, Own illustration.

detail of balcony[1]



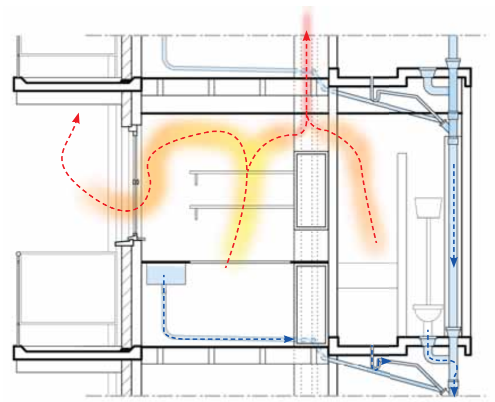
Piping and shafts Algemeen Belang block. Scale 1 : 300.

Drawing piping & shafts type-A, 2014, Own illustration, Based on drawings Brinkman & Van den Broek 1938-1939.



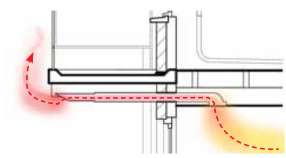
Piping and shafts Algemeen Belang block. Scale 1 : 300.

Drawing piping & shafts type-B, 2014, Own illustration, Based on drawings Brinkman & Van den Broek 1938-1939.



Section drawing indicating drainage and ventilation of the kitchen and sanitary room. Based on hand drawn designs for Algemeen Belang (see page 53). Scale 1 : 50.

Drawing section drainage & ventilation, 2014, Own illustration, Based on drawings Brinkman & Van den Broek 1938-1939.



Section drawing indicating adapted ventilation of the kitchen. Based on observation of backside of a small block on the Texelsestraat (see first photograph on page 56). Scale 1 : 50.

Drawing section adapted ventilation, 2014, Own illustration, Based on observations.

piping and ventilation shafts[1]

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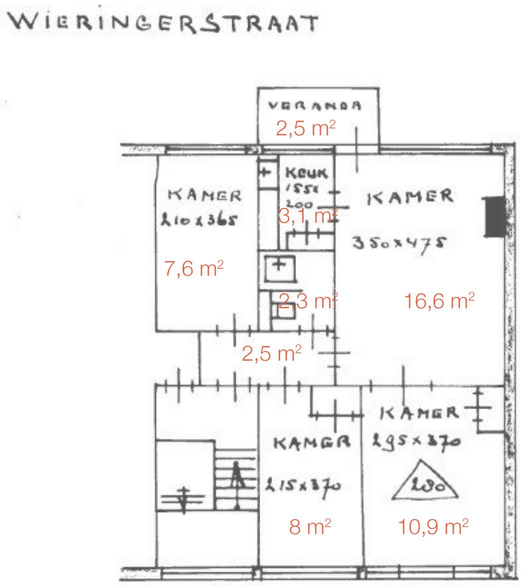
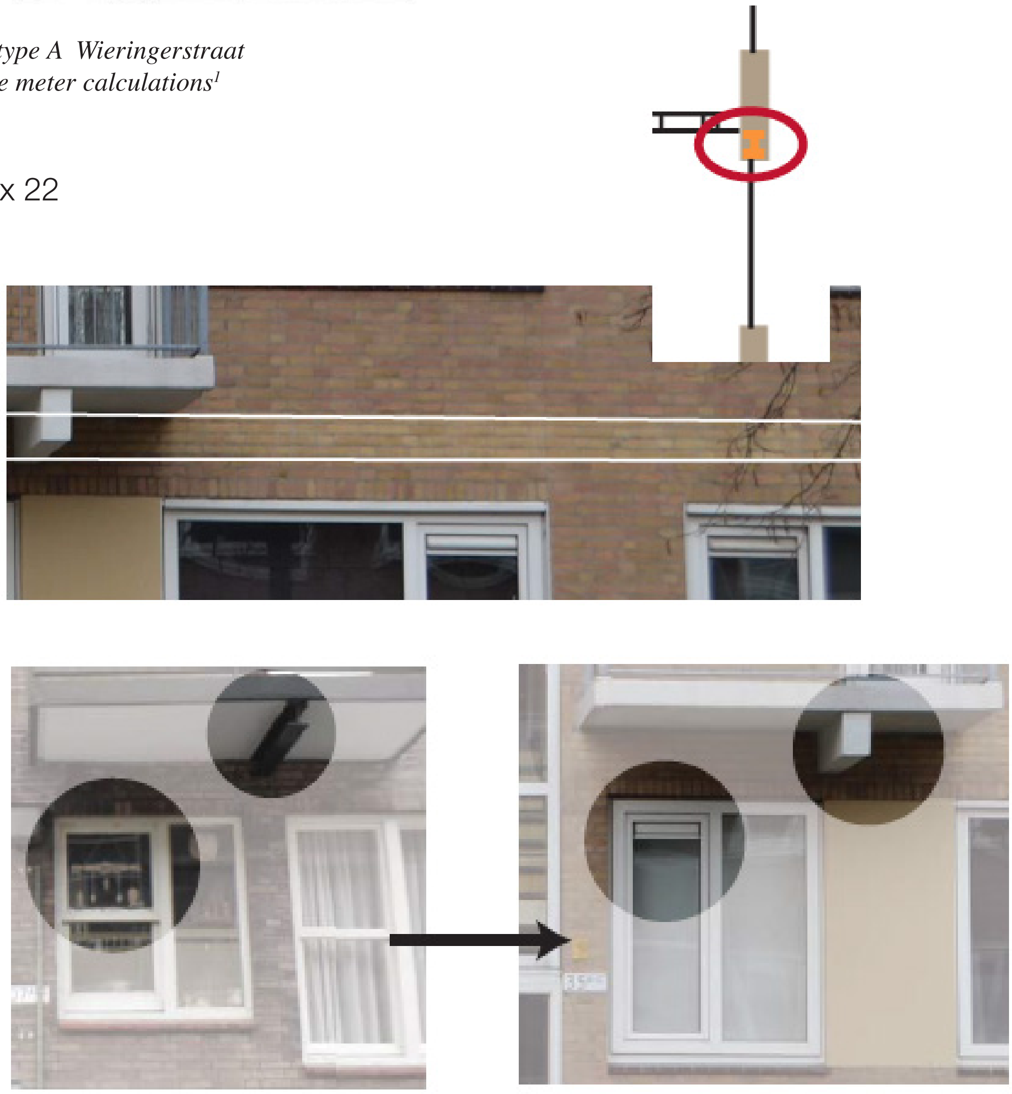
[1] Lagerberg, D. (2014). *Adapting the Eilandenbuurt, 75 years of evolution* (master's thesis).

Appendix 21



floor plan type A Wieringerstraat
with square meter calculations[1]

Appendix 22



replaced brick strip on the location of the steal beam in the facade
replaced window frames and covered steel beam to protect[1]

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[1] Adaption of archive drawing from the municipality of Rotterdam
[2] Van Zelst, M. (2014). *Modernisme vs. Traditionalism: Comparing unpopular Van den Broek portiek-housing with populair 30s portiek-housing* (master's thesis).

Appendix 23 (next page)
summarizing table case studies

SUMMARY CASE STUDIES

CASE STUDIES	scale	Heat	Electricity	Transport	Water	Waste	Green structure	Food	Materials / built environment	Social
MSP Heerlen (NL)		seasonal thermal storage, CHP biogas	CHP biogas solar cells	central parking	helophyte filter for grey water, buffer rainwater	sludge, organic waste, crop residue are used for biogas	dried up creeks are used again, local agriculture	(urban)farms, greenhouses, mushroom apartments	use of reclaimed materials in the area, reuse buildings	new jobs because of agriculture, fishpond recreation
theory		greenhouse as buffer between houses	connection to CHP solar cells on roof	-	separate grey/black water system, use of rainwater	separate organic waste	-	greenhouses between housing blocks	build with reclaimed materials	greenhouse between houses is public space
Schiebroek-Zuid Rotterdam (NL)		district heating, CHP biogas, solar collectors	Biogas, PV panels	Electric cars and buses	use of rainwater, local sewage treatment, recycling grey water	bio waste plant, reuse/recycling, living machine, thrift shop		edible landscape, productive gardens & 100% use of roofs	minimise direct use, diversity and flexibility	participation, smart grid, flexible public spaces, ateliers
theory		floor heating, closed terraces thermal buffer, green roofs, greenhouse	smart grid feedback system, PV panels	-	(re)use of rainwater and grey water	credit system, urine separating system, separate waste		green roofs for food production	glass, wood, ETFE, concrets vs. cob and reet	-
EVA-Lanxmeer Utrecht (NL)		solar collectors, district heating with ground water	max 40 GJ per dwelling, PV panels, Trias Energetica	car-free, parking only on borders of area	local treatment of all water, helophyte grey water, black biogas	organic household waste for biogas	permaculture, 'mandelige' gardens	urban farming with social and educational functions	integration of functions (living, working, recreate, food production)	residents association, no private gardens and collective maintenance
theory		solar collector on roof, add-on greenhouse	PV panels on rood	no parking at house	separate black and grey water	organic household waste for biogas	permaculture, 'mandelige' gardens	-	bio-ecological building	-
BO01 Malmö (SE)		CHP ground and sea water, solar collectors	wind turbine, PV panels	busstops within 300m, parking ratio 0.7, no cars in public spaces	rain water in above ground gutters, storm-water system	wastewater is treated by city (biogas), vacuum collection system	green space factor (0.5) with green points system	-	materials plan for architects, labyrinth of surprises, gutters	mixed-use and integration of public parks and plazas
built		solar collectors on roofs	PV panels on roofs	parking under buildings	green roofs, gutters part of the design	food disposal at kitchen sink	green space factor (0.5) with green points system	-	high ground floor height (active plinth)	residents have access to water and energy consumption data
Hammarby Sjöstad Stockholm (SE)		district heating biogas (purified waste water, bio-fuel, housh. waste)	PV panels	parking (0.7) under buildings, tram stop 300m, carpooling	storm-water retention, rainwater is drained directly or with canals	vacuum chutes, block-based recycling, area based collection	storm-water bioswale, use of biotopes that increase biodiversity	-	architectural agenda: set-back penthouses, multilevel apartments	Mix jobs and housing, monitoring drinking water consumption
built		solar collectors	biogas cookers, PV panels	parking under buildings	Green roofs, water-saving appliances	recycling rooms in buildings	-	-	building depths, flat roofs, large windows, pale plaster	-
Kronsberg Hannover (DE)		CHP gas powered, heat is carried by waterpipes	CHP gas powered, wind power and solar power	parking 0.8, walking is prioritized, tram stops 400m	saving drinking water, natural drainage, rain open drainage system	preventive waste management (also construction waste)	city as garden	-	compact, multi-use, high dense and diverse spatial experience	include social housing
built		transfer station with heat exchanger for heating and hot water	microclimate environmental filter, passive house, efficiency appl.	-	saving appliances (water-air mixers, flow limiters, water meters)	-	-	-	-	-
Vauban Freiburg (DE)		passive building, solar collectors	plant operating on wood chips and natural gas, PV panels	car-free living, parking in community facilities, car sharing	rainwater capture for reuse, storm-water treatment	no specific goals, recycling construction waste,	greenbelt, little pavement	-	green spine as hart of the district	diversity in living styles and residents
built		solar collectors	PV panels on roofs	-	vacuum toilets	vacuum system for biogas cooking	vertical greening, green roofs	-	-	'Baugruppen'

system neighbourhood   implications dwellings   CHP = combined heat and power

Appendix 24 (next pages)
complete case studies

MSP HEERLEN

Location	NL, Heerlen
Realised	**no**
Year	2009
Initiator	Superuse studios
Architect	Superuse studios
Built period	1940-1960
Population	6900
Area	356 hectares

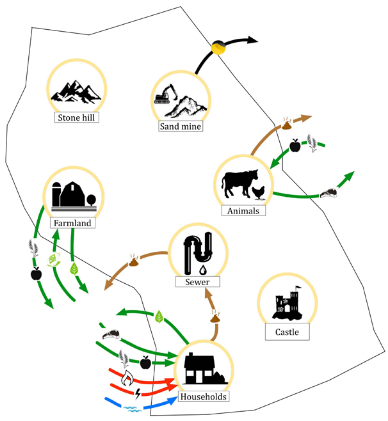
overview of the location: P = Palemig, M = Meezenbroek, S = Schaesbergveld


impression of architecture

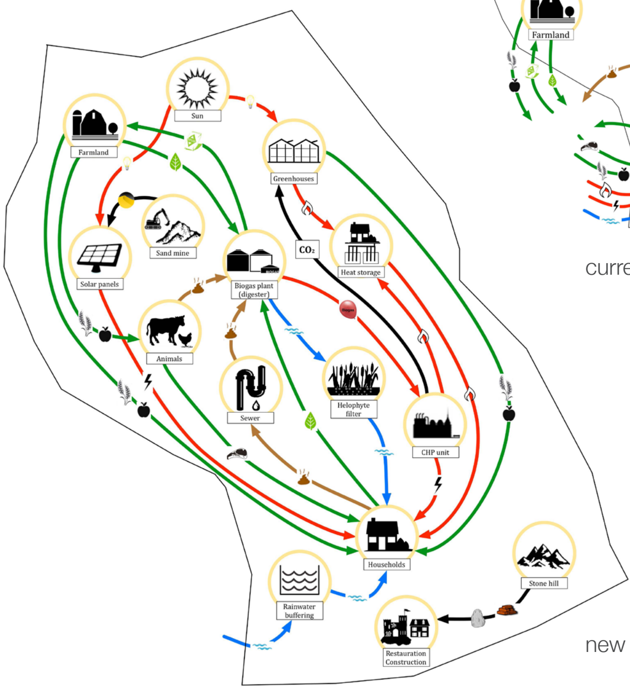
Characteristics area
MSP is an urban district in Heerlen and consist of two neighbourhoods and a small village; Meezenbroek, Schaesbergveld and Palemig. The neighbourhoods consist of old mining colonies and since they were closed in the 1970s the area is in decline. Palemig is a historical village that already existed before 1800. Meezenbroek and Schaesbergveld were mostly built between 1940 and 1960 as accommodation for the mine workers.

Problems
Average income low compared to rest of the Netherlands, amount of people without a job and living from state support is much higher than average, level of education is low, quality of public space is low and cultural, recreational, educational facilities are not optimal, declining population. There are plans to demolish 759 dwellings, to construct 414 new ones and renovate 470.

Present factors
The boundaries that were chosen contain a total area of 356 hectares. This includes a silversand mine, 6900 inhabitants, 105 ha farmland and pastures, elementary and secondary schools, a biological school and a number of small companies. It also includes nature (forest), much extensive green, dried up creeks, a stone rubble hill and the ruins of a castle.



current system of streams



new looped system

Opportunities
Main possibilities are in the area of food production, because of the presence of a large amount of farmland. The old dried up creeks can be used as irrigation canals for water purification. The sand from the silversand mine could be used for local production of solar cells. Old mining shafts can be used for underground seasonal thermal storage. Also a few sources construction material are available; hill with mining rubble and material from demolished buildings.

Closed loops on neighbourhood level

Heat
Underground seasonal thermal storage

spatial implications - greenhouse/waterbuffer

spatial implications - farmlands

in mines.
CHP (combined heat and power) - heat from burning biogas.

Electricity
CHP - electricity from burning biogas (from sewage sludge and organic waste from the households, and crop residue). Solar cells electricity.

Transport
Central parking in empty buildings, to save land for food production.

Water
Grey waste water from the biodigester and from households is filtered with helophyte filter and can be used for irrigation of the farmlands and in the households. This is supplemented with reused rainwater buffering (buffered in the Silversand Lake). The old dried up creeks are used as irrigation canals and water purification.

Waste
Organic waste from households and regional crops residue from the farmlands and animal manure are used as a source for the biogas plant. This plant also produces grey water and fertilizer.

Green structure
Natural creeks are used again. Local agriculture for food production.

Food
(Urban) farms and greenhouses, mushroom apartments.

Materials/built environment
Temporarily or permanent use of empty buildings for food production, mushroom apartments.
Reuse building materials of the demolished buildings (bricks, window frames etc.).
Reduce amount of roads and pavement.

Social
New jobs will become available in the area (especially in the food production). The local culture could be strengthened by the fishponds; social and recreational activity.

Source: 2012Architecten (2009). Recyclicity. Industrial Ecology applied in the urban environment

SCHIEBROEK-ZUID

Location	Rotterdam
Realised	**no**
Year	2010
Initiator	Vestia
Consultant	Except
Built period	1920-1960
Population	16.277
Area	100 hectares

overview of the location

impression of architecture

Characteristics area

Schiebroek used to be peat swamp (veenmoeras) which was mined and drained. Between 1700 and 1850 wetlands were formed, which again were reclaimed and drained. This resulted in the formation of separate polders, including the Schiebroekse polder. Schiebroek was mainly built between 1920 and 1960. Schiebroek-Zuid has wide ponds and canals and there are three shopping strips.

Problems

Schiebroek-Zuid is a good example of the post-war neighbourhoods that were constructed after the bombing in 1940; repetitive housing and spacious streets. Today this resulted in problems like anonymity, lack of diversity and maintenance and lack of functions and social programs.

Closed loops on neighbourhood level

Heat

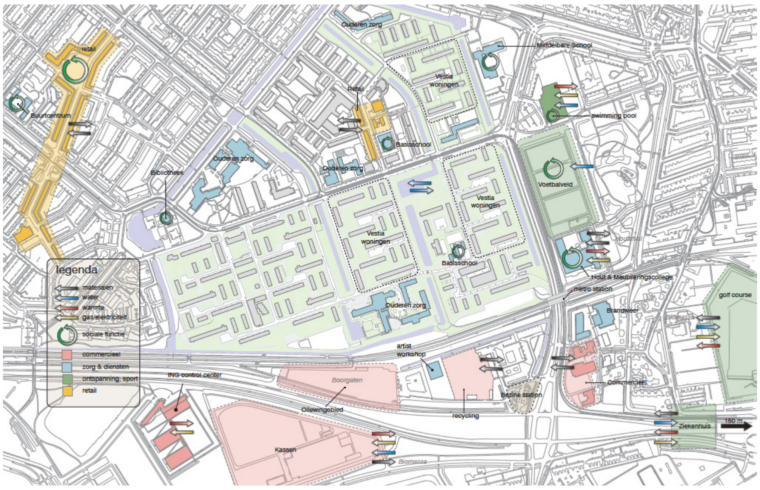
District heating, Biogas WKK installations and WKO, floor heating, closed terraces that act as a thermal buffer, green roofs, heat delivering green houses

Electricity

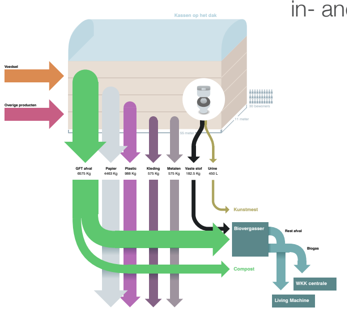
Biogas, Photo Voltaic panels and collectors.

Transport

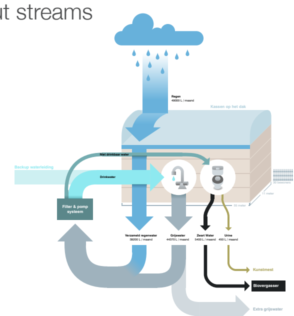
Electric cars and buses.



in- and output streams



local bio waste management



local water management

Water

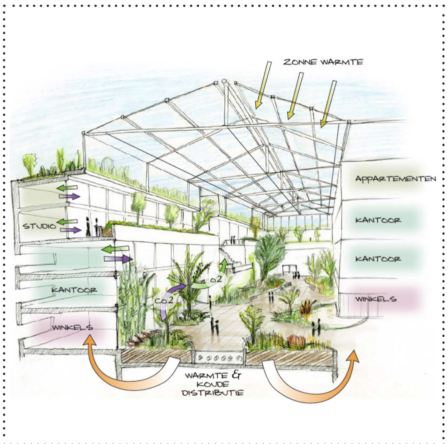
Local water independency

Rainwater is used for the households, rest is used for irrigation or groundwater. Only 10% of the surface is paved, 100 % local sewage water treatment, recycling of grey water

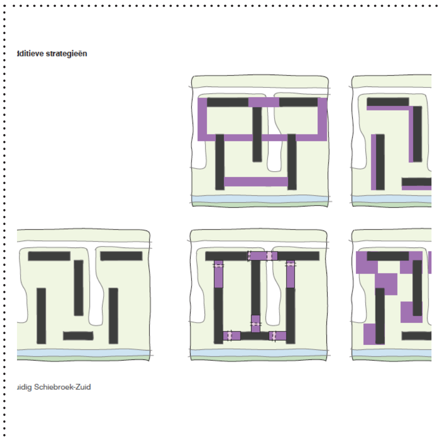
Waste

Local bio waste treatment

Waste management with ‘Schiebroek-Credit’ system. Waste is reused, reycled or used for biogas. Residue waste from biogas incinerator and WKK is processed within the neighbourhood with a living machine, urine separating toilet, trade centre like thrift shop, separating waste in each building



design sketch redevelopment walk-up appartments



Food

Edible landscapes and productive gardens, roofs are 100% used for natural services like food production and recreation.

Materials/built environment

Diversity and flexibility in program, density, dwelling type, scale and landscape. Buildings function as part of the ecological en energetic system, they provide permeability and diverse living, work and relax activities.
Use of glass, wood, ETFE, concrete vs cob and reet
Minimize direct use: isolation, ventilation, passive resources, installations, lighting and devices, feedback and economical stimulation

Sketch design of redevelopment of portiekflat:
three new living towers are added on the sides, one three story flat is topped up with one story, a big glass roof is placed between the buildings creating a big atrium, the new towers contain elevators which also provide the existing flats, galleries connect the flats tot the elevators

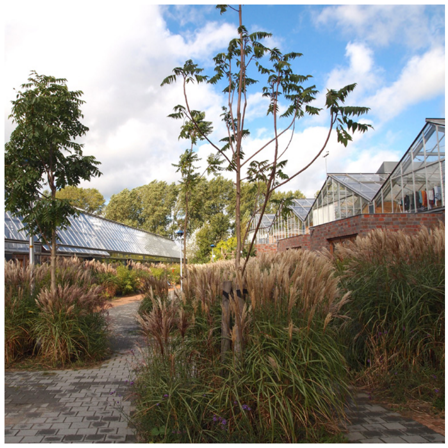
Architecture:
use of diverse typologies, flexibility over time energetic qualities and orientation, flexible inside spaces, small smart high quality spaces are preferred above big houses, greenhouse types (on roof or side)

Social

Smart grid > behaviour feedback to inhabitants about their energy use
Residents participation, ownership. The program in the neighbourhood should provide a solid social structure, self-reliance, flexible and reprogrammable, attractive living climate for different lifestyles.
Local food production as foundation for all of this
Strong local economy, and strong social neighbourhood: places to meet, neighbourhood 'cockpit', flexible public spaces, ateliers.

Source: http://wijkprofiel.rotterdam.nl/nl/2016/rotterdam/hillegersberg-schiebroek/schiebroek/
Mooi & Duurzaam Schiebroek-Zuid, Except

Location	NL, Culemborg
Realised	yes
Year	1999-now
Initiator	Municipality
Architect	Joachim Eble, opMAAT
Units	250 dwellings
Area	24 hectares



overview of the location

Characteristics area

EVA-Lanxmeer is a new built neighbourhood, located south west of the city centre of Culemborg. The location of EVA-Lanxmeer has been know for it's archaeological sites. It was mainly used for agricultural purposes. The idea was to create a neighbourhood based on interdisciplinary cooperation, resulting in a ecological living and working neighbourhood that should be seen as living lab for other initiatives.

Concept

EVA-lanxmeer was designed with three main principles. The first is Genius Loci, design with the characteristics and qualities of the location, the second is to design the allotments in such a way that it encourages social contacts. The last one is zoning of the public space by the principles of permaculture. Permaculture is the science of design of the human living environment in a way that it's ecological sustainable and economically stable. There are no hard boundaries between the different levels of living environment. Private gardens always in contact with the 'mandelige'(collective maintained) gardens and these are again in contact with the public gardens. Ecosystems in nature serve as example. Permaculture has multiple goals; food supply, improve water management, production of fuel or construction material, recover landscapes damaged by humans or creating a resilient environment that's able to withstand external stress like natural disasters.

Closed loops on neighbourhood level

Heat

Solar collectors and boilers and district heating connected to the ground water.

Electricity

Low energy and $CO2$ neigbourhood, Trias Energetica: limiting demand, sustainable generation and responsible energy use, dwellings and other buildings have progressive energy prestations, max 40 GJ. Each dwelling has PV panels.

Transport

Car-free living environment, parking is on the sides of the neighbourhood.



Water

Prevent desiccation, flooding (water level management, infiltration, retention and delayed drainage) and pollution (separate different water qualities, purifying, retaining/using rainwater The concept is the use of a water collection area. Clean water stream (rainwater from roofs) is collected in water storage ponds and is supplemented with rinse water. Grey water is purified by a helophyte filter and then transported to the watercourse. Black water is transported to a separate sewage system connected to a biogas installation. Rainwater from the streets is collected in a system of shallow wide wadies, where the water is maximum infiltrated in the soil.

Waste

Ambition was to process all the waste within the neighbourhood (compost, biogas installation), this was too expensive so is never realised, all the household waste is exported elsewhere.

Green structure

Permaculture

Food

Implement local and biological food production; Urban farming with social and educative functions, city farm where biological food is produced and provides day care for care recipients (social work place). Edible landscape.

Materials/built environment

Integration of functions; living, working, recreate, local food production Differentiated offer of dwellings with a minimum of 30% affordable rental and private dwellings, connect to existing city. Integration of urban, natural and agricultural elements and functions Closing of material cycles, responsible and sustainable material use, bio-ecological building and management.

Social

Residents participation in early stage (design, type of dwellings, management). All inhabitants are part of the residents association. There are only small private gardens ('mandelig'), everything is shared collective maintained.

Source: *http://www.eva-lanxmeer.nl/over/ontstaan/programma-van-eisen*
http://www.groenblauwenetwerken.com/projects/eva-lanxmeer-results/

Location Malmö, Sweden
Realised yes
Year 2001
Initiator
Architect Klas Tham

Population 2352
Units 1567
Area 22 hectares

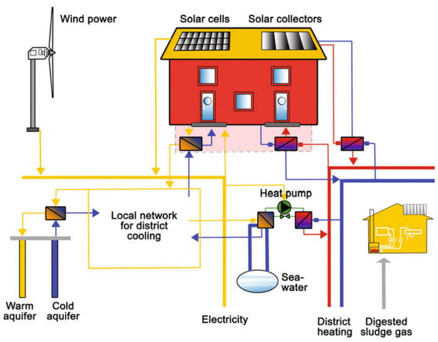
overview of the location

Characteristics area

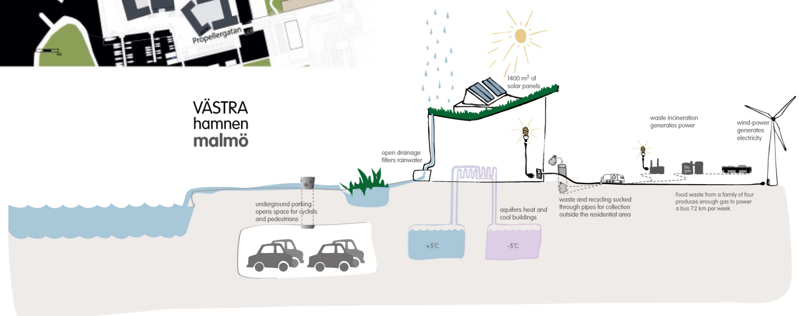
BO01 is planned and built on a site overlooking the Baltic Sea. This site became available because of the closing of the SAAB factory in 1990. It was built for the European Millennium Housing Exposition, opening a year late in 2001. It's part of a larger revitalization project called Västra Hamnen (Western Harbour). When the whole area is fully developed there will be about 8000 dwellings, commercial and service space for 20.0000 workers and students, ten schools and parks and recreation facilities.

Concept

The project received 27 million Euros from Sweden's Local Investment Program (LIP) based eight initiative areas. *Urban Planning*: concept plan was based on the traditional European perimeter block housing. *Soil decontamination:* clean the former initial site with 'cap and cover' strategy of existing infill soils. *Energy:* 100% of the energy is provided by efficiency improvements of the building and use of local renewables including wind, geothermal and solar power. *Eco-cycle*: minimize material use, reuse materials, recover energy form waste and residual products. *Traffic:* reduce need for transport and favor environmental friendly modes (make public transport frequent and nearby, green vehicles and carpool). *Green structure and water:* create a habitat-rich district, including an ecologically appropriate storm-



The City distribution system



water system, green roofs/facades, planting beds, permeable paving. *Building and living*: development plan and other specific rules concerning green and colour scheme. *Information and knowledge dissemination:* focus should be on information, knowledge and debate about sustainable urban development.

Closed loops on neighbourhood level

Heat

'Aktern' heat pump installation. Largest part of heat and cold is extracted from a natural underground reservoir. Cold is partly from the seawater. Cooling is mostly used for offices. Heat is supplemented with solar collectors (1400

view inside the first block, looking south

storm-water downspout

m^2) on apartment buildings. 200 m^2 of these are vacuum collectors. They are directly connected to the district heating system.

Electricity

Electricity for the dwelling is produced by a 2 MW wind turbine and 120 m^2 photovoltaic solar panels on the buildings. The system is connected to the net because the energy consumption is not parallel with the production of the installed renewable energy. It does produce the amount it needs.

Transport

Busstops are within 300 m, and come every 6-7 minutes. Parking is mostly underground, ratio is 0,7 later changed to 1,5. Most public spaces are closed to cars, reduce dependance on cars, stimulate bikes and walking by good networks and high quality (materials).

Water

Rain water is diverted trough above-ground gutters. The drainage system is designed to be aesthetically pleasing (waterfalls, ponds and various elements for buffering and purifying). Green roofs act as a buffer. Storm-water system that demonstrates water retention and acts as urban amenity. Wastewater is treated by the city (biogas plant).

Waste

Two systems to test both; a vacuum collection system at collection points, a food waste disposal system at each kitchen sink. The vacuum collection system locates connection points near the housing units with two collection tanks, a green one for food waste and a grey one for the remaining combustible fraction. Residents sort their waste in tear and moisture resistant bags. The tanks are emptied by a vacuum combustible vehicle and delivered to the cities combustible co-generation plant, the food waste is delivered the sludge digestion plant.
The food waste disposal system is installed in fifty units. The waste disposers drain into a separate tank, and the food waste is separated by sedimentation. Water is drained in the sewage system, the remaining food waste is collected by a vacuum collection vehicle.

Green structure

Habitat-rich city district, green space factor of 0,5 > green points criteria system. Network of parks and passages of different scales and uses that form an alternative for the streets.

Food

No specific measures for local food production were taken.

Materials/built environment

The architect teams had to submit a materials plan, assess the environmental impact of chosen materials and avoid ecologically harmful banned substances.

Permeable pavement. All buildings have high floor height in ground floor to allow shops and services, activating the plinth. Shortcuts through blocks allow a variety of routes.

Diversity in architecture with only a few restrictions (height, density, green points: e.g. all building material used in the courtyard has bee used before, all green roofs). Mixed use and integration of public parks and plazas. Gutters are part of the design of the public space.

All plots are designed by different architect-developer teams. Blocks have a medieval feel with random angled paths, small squares and different architectural expressions with contrast in scale, materials and form. Interior labyrinth full of surprises. Progression of space within space within space. Low-rise, high-density mixed-use blocks.

Green structure

Habitat-rich city district, green space factor of 0,5 > green points criteria system. Network of parks and passages of different scales and uses that form an alternative for the streets.

Social

All residents have access to water and energy consumption data to change behaviour

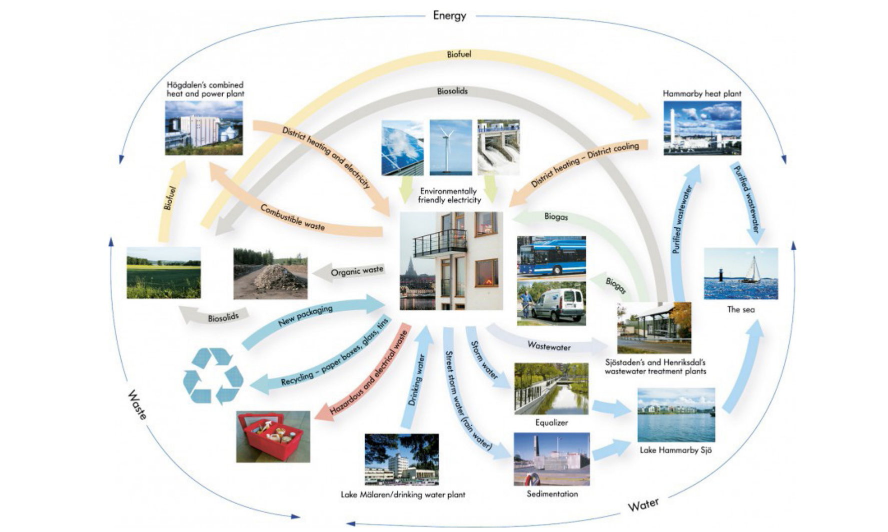
Source: *Fraker, H. (2013). The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities. Washington: Island Press*
http://www.urbangreenbluegrids.com/projects/bo01-city-of-tomorrow-malmo-sweden/

Location	Stockholm, Sweden
Realised	yes
Year	1997
Initiator	City of Stockholm
Architect	
Population	25000
Units	11000
Area	200 hectares

overview of the location

Characteristics area
The site is reclaimed industrial land, located in a valley with little wind power potential and has only a modest amount of winter solar radiation. Opportunities were taken in the cities waste flows and an integrated approach for the infrastructure design.

Concept
The concept of the model for this district is based on the integration of separate systems. The utility companies would recover energy from one another, energy that previously was wasted. 50% of the energy demand has to be supplied from on-site sources. The different architect teams designed individual blocks following a specific Design Code. This Design Code set out principles: mixed-use (functions, density, built form, public spaces and relationship to water), layout form & structure, architectural style, Stockholm inner-city block form as model, building form respond to related open space, scale order & variation, building types, building design principles, apartment standards, standard for additional services, building color and material, design of courtyards, design of public spaces, parks & streets.



Closed loops on neighbourhood level

Heat
Use of district heating. 34% of the heat comes from purified waste water, 47% from combustible household waste and 16% from bio-fuel. The remaining cold from the purified waste water is used for district cooling (e.g. cold storage in grocery stores, office buildings). Solar collectors.

Electricity
Solar cells on public buildings supply the energy for the public area's. Solar panels on residential building provide 50% of the hot tap water. 900 flats have biogas cookers. They produce the biogas themselves. It is formed when sludge from the waste water treatment is digested. The amount they produce is close to what they need for cooking. This lowers the electricity consumption with 20% in the buildings in question.


view of vacuum waste system stations


view of storm-water retention


storm-water bioswale

Transport
80% of residents' and workers' journey needs to be by foot, bicycle or public transit. Goals for households (15%) and workplaces (5%) to be signed up for carpooling by 2010. A light-rail tram has stops within a 300 meters radius of the homes. Parking (ratio of 0.7) is underneath the building blocks.

Water
A proper participation and education model for the districts residents and use of water-saving appliances which will save 50% of the consumed drinking water, next to reducing the amount of pollutants in wastewater by 50%. Rainwater infiltrates in the ground or green roofs directly or is drained of through canals that are part of the design. Runoff from roads is drained to treatment pools (settling tanks) before it's infiltrated in the ground.

Waste
Wastewater is treated locally, the sludge produced is recycled and used for fertilising farmland and forestry land. The biogas that's produced in this process is used as fuel for vehicles like buses, taxi's and waste collection trucks and to heat 1000 homes in the area. Heat from the treatment is used in the district heating.
Household waste: system with vacuum chutes, block-based recycling rooms, area-based collection points for residents to sort newspaper, glass, plastic and metals. Compost organic waste and use as fertilizer, collect hazardous waste for off-site disposal.

Green structure
A storm water bioswale runs through the whole length of the seven blocks, unifying the ensemble. The water and green are part of the cycles needed to treat water and waste and are at the same time contributing to a rich experience of the different water structures and recreation. New developed green space is designed with biotopes that increase the area's biodiversity.

Food
No specific measures for local food production were taken.

Materials/built environment
Typically inner-city street dimensions, block lengths and building heights. Water views from public space and residences. Parks and sunlight. A modern architectural agenda with restricted building depths, set-back penthouses and multilevel apartments Generous balconies and terraces, large windows, flat roofs and pale plaster facades.

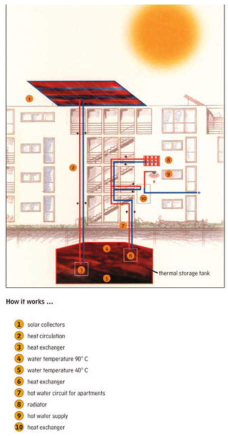
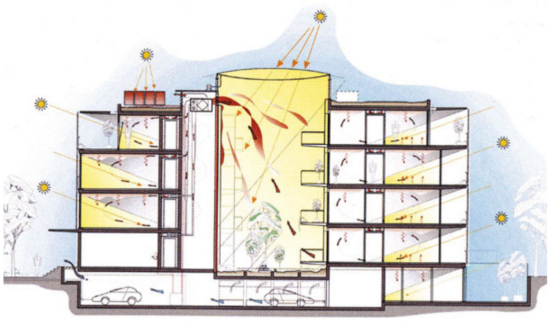
Social
Education and awareness for drinking water consumption Trough the internet residents can monitor their water use. Provide comfortable living with good lake views and promote healthy living in a natural setting. Mix jobs and housing.

Source: *Fraker, H. (2013). The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities. Washington: Island Press*
http://www.urbangreenbluegrids.com/projects/bo01-city-of-tomorrow-malmo-sweden/

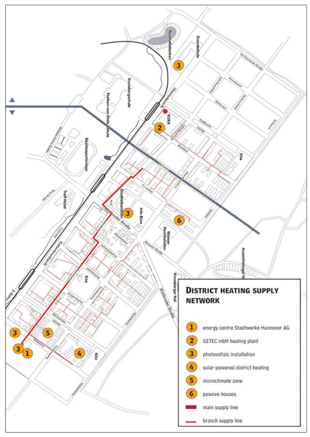
KRONSBERG

Location	Hannover, Germany
Realised	yes
Year	1991-
Initiator	City of Hannover
Architect	
Population	6600
Units	3000
Area	70 hectares


overview of the location

microclimate zone



Characteristics area

The city of Hannover planned for this project to become an exhibit at the World Exhibition in 2000. They wanted to apply all available knowledge of ecological optimization in construction and habitation.

Concept

The goal was to create a district that maximized the resident's quality of life while minimizing their use of resources. The principles involve environmentally compatible energy systems combined with environmentally sound construction and conservation of natural systems; energy efficiency optimization, water management, waste management, soil management and environmental communication and education. Property developers were bound to a Quality Assurance Program including provision of proof of the heating index, meeting of airtightness requirements, submission of defined planning documentation, inspection and checking of work.

Closed loops on neighbourhood level

Heat

CHP (combined heat and power) system. It generates both electricity and hot water. The CHP plants are gas-powered generators with both a thermal and a electric capacity. The heat is carried in a loop of waterpipes going to the buildings. Each building has a transfer station where hot water goes trough a heat exchanger, delivering heating and domestic hot water.

Electricity

Most of the electricity (72%) is provided by wind power and supplemented with solar power. Other systems like seasonal solar storage, a microclimate environmental filter (atrium between two rows of houses) and the passive house. High efficiency lighting and appliances, low energy building construction.

Transport

Goal is to minimize the use of the private cars. A new tramline provides a 20 minute link with the Hannover city centre. Stops are not further away than 400 meters from residents houses. The

interior microclimatic zone

relatively small city blocks ($75m^2$) give a pleasant walking experience. Parking is above and underground at a ratio of 0.8 per housing unit. Efficient bicycle routes need to stimulate use of bikes.

Water

The goals for the water system have three categories; a seminatural decentralized rainwater management system to preserve as far as possible the original natural drainage situation, drinking water economies as much as possible through water saving devices, raising of residents awareness of water issues trough education and information (water-air mixers, flow limiters constant flow devices and water meters).
Rainwater from the streets is collected in an open drainage system, Mulden-Rigolen system. In case of overflow the water is transported to large retention ponds, also landscape features. No rainwater capture and reuse or local grey water treatment systems were implemented.

Waste

Overal concept was preventive waste management. It focussed on construction waste and domestic and commercial waste. For the latter a reduction of 50% was the goal. A system for waste separation was deployed at convenient locations throughout the district.
100% of the excavated soil was used for landscape and environmental enhancements in the local area. 80% of construction waste was reduced by avoidance and recycling provisions.

Green structure

Concept is the city as garden. The different principles are a shift to ecologically responsible agriculture, enhancement of species diversity, biotope protection by creating habitats for flora and fauna and improvements to local recreation amenity value by enhancing the natural qualities of the landscape. Design strategies (parks, alley, corridors, hilltop woodland, street trees) are used to define, shape and enrich the urban form.

Food

No specific measures for local food production were taken.

Materials/built environment

Compact multi-use, high density and a diverse spatial experience in the district. Over 40 architect and landscape offices were involved. There's a zoning structure where the density and building heights decrease as one approaches the countryside.
All parking and sidewalk paving is permeable.

Social

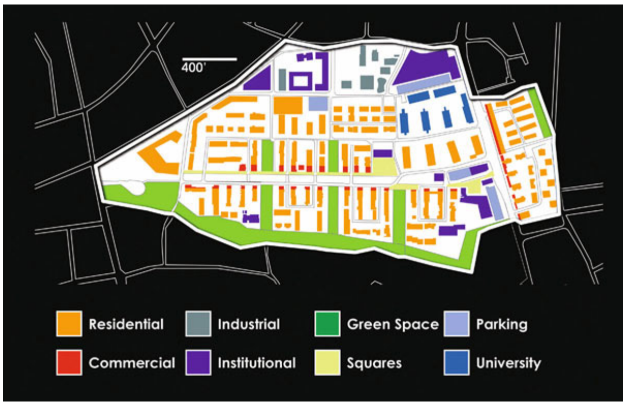
Avoid social segregation by mixing various forms of housing finance and ownership together with the development of flexible accommodations to cope with changing housing needs. This was done by providing a mixture of large and small apartments and apartments suitable for families and new lifestyles. This was supported by a mixed-use program including a full range of social and commercial services, easy access to local jobs, kindergartens and primary school.
50% of the houses are subsidized, making them affordable and the population diverse, 10% of the units are social housing. There are also accommodations for elderly and disabled.

Source: Fraker, H. (2013). The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities. Washington: Island Press

Location Freiburg, Germany
Realised yes
Year 1993-
Initiator City of Freiburg
Architect

Population 5000-6000
Units 714-1802
Area 34 hectares

overview of location



Characteristics area
The neighbourhoud is situated at the west edge of the Black forest. It has one the highest annual solar radiation in Germany. The site is a former French military area and the main goal was to build a mixed-income neighbourhood for approximately 5000 residents and 600 jobs. The site is located at the cities edge, surrounded by nature. Direct community participation in the urban design was a must.

Concept
The participation process was the driver for the concept of the neighbourhood. Community based building projects, called 'Baugruppen', were implemented where groups of future building owners directed their own cooperative building projects. An other principle was car-free living.

Closed loops on neighbourhood level

Heat
All buildings needed to be built to improved energy standards, 65 kWh/m^2/y instead 100 for heating.
Solar collectors are installed on the Baugruppen to assist in heating and for domestic hot water.

Electricity
Energy supply was to be provided by a high efficiency plant operating on wood chips and natural gas with a short-distance heating network.
Photovoltaics for electric generation on top of the roofs. A competition between Baugruppen even resulted in energy plus houses.

Transport
The concept of car-free living with the intention of reducing car use throughout the whole district. Pedestrians, cyclists and public transportation is prioritized.

All important functions for the residents are within walking and cycling distance. No parking, only drop-off and pickup, at residential doorsteps. Parking for residents is available in community facilities located nearby. Parking spaces on private property is prohibited. Residents can join the car-sharing program, of they do they get one year

Source: Fraker, H. (2013). The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities. Washington: Island Press


plus-energy houses


vertical green

free public transport passes. A tram is the backbone of the public transport, it connects the residents with ten minutes to the town of Freiburg and stops are at 300 meters from the housing.

Water
Goals for water conservation, reuse and rainwater capture were not specified but left to the ambitions of the Baugruppen. Many of the Baugruppen have employed innovative systems for conservation, reuse and rainwater capture (landscape irrigation, flush toilets in primary school, vacuum toilets). Storm-water treatment is designed to promote infiltration of rainwater in the ground, it has primary goal of groundwater recharge.

Waste
No specific goals were set, but were again left to the Baugruppen. Some have a vacuum system that delivers solids to an anaerobic digester, which ferments the solids along with food waste, generation biogas for cooking. The remaining wastewater is cleaned in biofilm plants and returned to the water cycle. During construction recycling stations for the disposal of scrap metal and construction waste were provided.

Green structure
Tramway tracks are not paved but in grass. Existing mature trees were maintained. Three green spaces cross the spine linked to a greenbelt and nature preserve along the entire length of the south edge. Many of the Baugruppen have vertical greening, living facades that provide cooling in summer. 50% of the buildings have green roofs to provide insulation and rainwater retention.

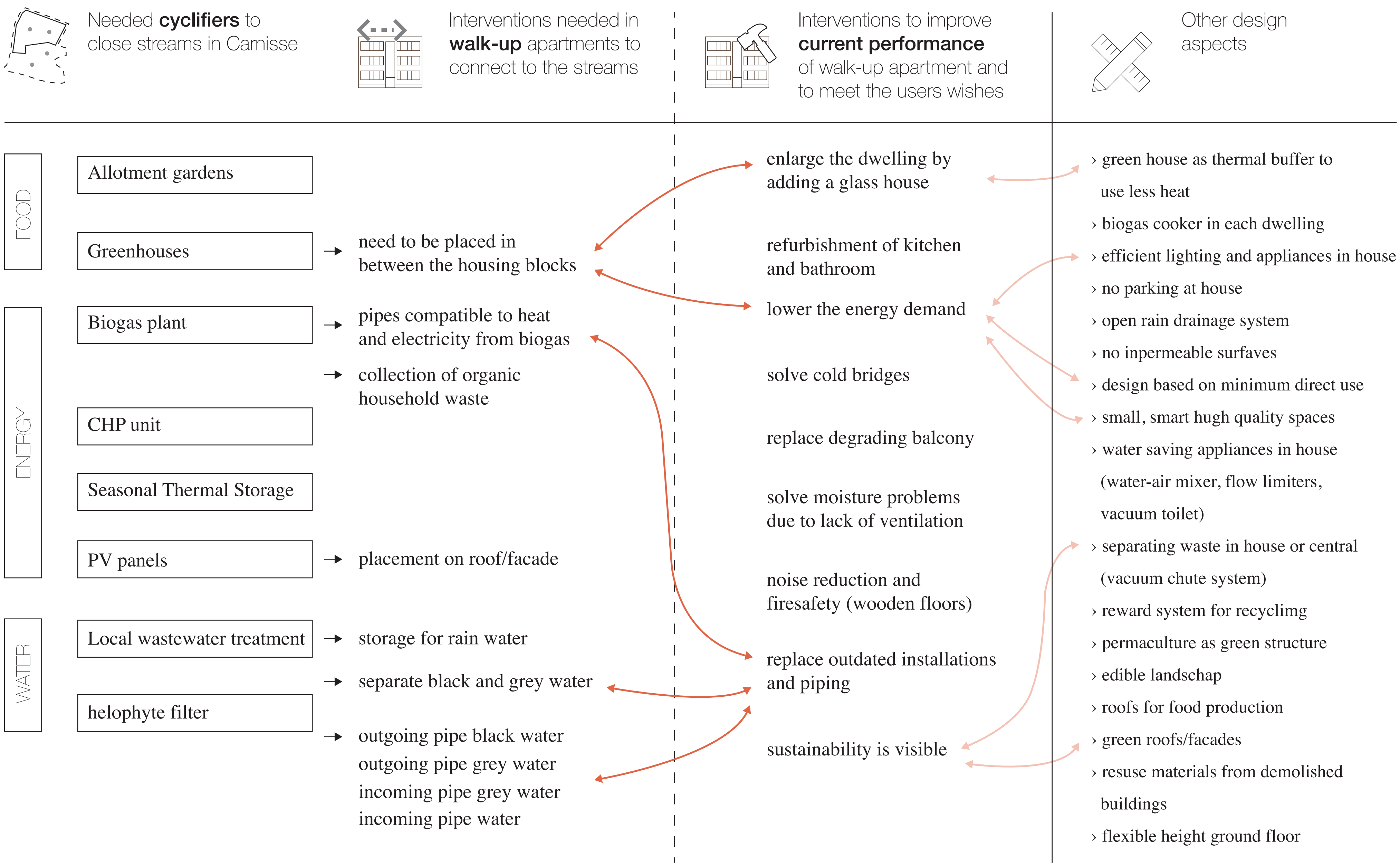
Food
No specific measures for local food production were taken.

Materials/built environment
The urban form can be described by a T shape, a one-sided commercial street at the head of the east entry, connected to a long green spine running east-west through the hart of the district. The spine contains two-way traffic, a tram and a storm-water swale. All the buildings at the space are facing it with their ends, allowing views into the residential enclaves.

Social
The most important aims are to achieve diversity in living styles of residents and to enable people from many levels of society to purchase their own homes; a balance of living and working areas, a balance of social groups, a mixed-use district centre with shops for daily needs, a primary school and kindergarten, family- and child friendliness in the design of public space, a neighbourhood centre for meetings, events and quests, a farmer's market. The Baugruppen formation of collective future homeowners to purchase a designated site and design and direct the building of their own housing, was the most important factor to achieve al the goals.

Source: Fraker, H. (2013). The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities. Washington: Island Press

Appendix 15



Needed **cyclifiers** to close streams in Carnisse
Interventions needed in **walk-up** apartments to connect to the streams
Interventions to improve **current performance** of walk-up apartment and to meet the users wishes
Other design aspects
FOOD
ENERGY
WATER
Allotment gardens
Greenhouses
Biogas plant
CHP unit
Seasonal Thermal Storage
PV panels
Local wastewater treatment
helophyte filter
need to be placed in between the housing blocks
pipes compatible to heat and electricity from biogas
collection of organic household waste
placement on roof/facade
storage for rain water
separate black and grey water
outgoing pipe black water
outgoing pipe grey water
incoming pipe grey water
incoming pipe water
enlarge the dwelling by adding a glass house
refurbishment of kitchen and bathroom
lower the energy demand
solve cold bridges
replace degrading balcony
solve moisture problems due to lack of ventilation
noise reduction and firesafety (wooden floors)
replace outdated installations and piping
sustainability is visible
› green house as thermal buffer to use less heat
› biogas cooker in each dwelling
› efficient lighting and appliances in house
› no parking at house
› open rain drainage system
› no inpermeable surfaves
› design based on minimum direct use
› small, smart hugh quality spaces
› water saving appliances in house (water-air mixer, flow limiters, vacuum toilet)
› separating waste in house or central (vacuum chute system)
› reward system for recyclimg
› permaculture as green structure
› edible landschap
› roofs for food production
› green roofs/facades
› resuse materials from demolished buildings
› flexible height ground floor