Green roofs, stormwater and sustainability

Augustenborg as a research site

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Published in:
The Eco-City Augustenborg

2020

Document Version:
Publisher's PDF, also known as Version of record

Malmö, Sweden

The Eco-city Augustenborg

– experiences and lessons learned

Editors: Monika Månsson and Bengt Persson

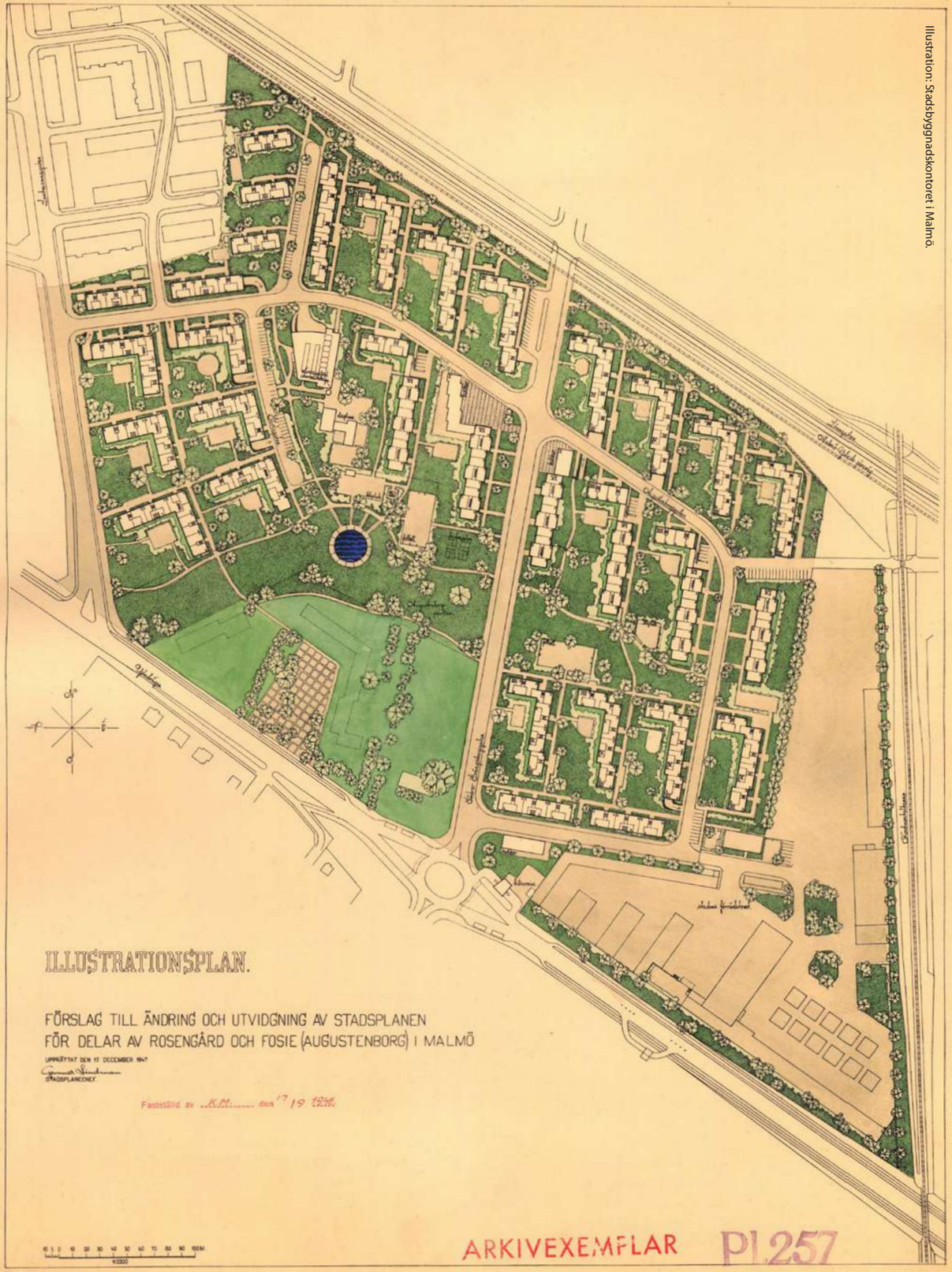

Illustration: Stadsbyggnadskontoret i Malmö.

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Malmö, March 2021

Arkus publication 79

Editors: Monika Månsson, City of Malmö and Bengt Persson, Swedish University of Agricultural Sciences (SLU Alnarp)

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Graphic design: Garbergs Malmö

Translation: Urbanisland

Images: Cover image and theme images by Sanna Dolck. Image on page 256: Gugge Zelander

Printing: Stibo Complete

ISBN: 978-91-519-7868-0

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Augustenborg and the good life

Since the 1940s the Augustenborg residential area has been a model and a success story, at the forefront of developing a high quality green residential and urban environment. When Augustenborg was planned and built in 1948-1952, it was the first major housing development project in post-war Malmö and the first in the hands of the city's newly formed housing company MKB. A long line of exceptional housing projects followed.

The story of Malmö's modern transformation that puts focus on sustainable urban development usually revolves around the Western Harbor, but in fact this journey began in Augustenborg. When the Eco-city project was implemented in the late 1990s, it was the first time an existing residential area had been transformed through a major sustainability initiative and environmental regeneration. It became a benchmark that many subsequent projects were measured against. Now that Malmö, Sweden and the world face major challenges in creating the good housing of the future, Augustenborg can again become a guiding light.

Malmö was the first municipality in Sweden to sign The Shift, a worldwide initiative which includes cities, regions and others working to make housing a right. It is binding and commits the city to create housing that low income residents in Malmö can afford. The focus has so far been on newly built homes and how they can provide sustainable, good and affordable housing. But in sustainable urban development it is even more important to consider the existing housing stock and how it can develop in a sustainable direction, while avoiding unreasonable rent increases. In this, Augustenborg can once again take the lead and set an example.

Malmö, October 2020

Katrin Stjernfeldt Jammeh
Chair of the City Executive Committee, Malmö

Lars-Erik Lövdén
Chair of the Board MKB

Research and practice

Arkus foundation was established to promote practical research and development in architecture and the built environment, and to make its information and results readily available. For us, it is important to help ensure that the experiences and lessons from a pioneering project such as the Eco-city Augustenborg are compiled and disseminated. It is also especially pleasing for Arkus foundation to contribute to a book in which scientific texts shedding light on important social issues sit next to evidence-based specialist writing. This gives us new opportunities to spread scientific knowledge to practitioners.

Augustenborg is an important testbed for the environmental adaptation of an existing neighbourhood and a unique example of how this can be done. At the same time, Augustenborg is a classic and well-built example of a neighbourhood unit that became a model for post-war urban development across Sweden. The neighbourhood units are and remain very well-functioning models that provide the fortunate residents with a high quality of life and housing. Carefully and sustainably developing Sweden's neighbourhood units is an important goal. Arkus sees this book on Augustenborg as an important tool to document how such development can be driven and to spread the message to a wide selection of planners, architects, politicians and others who influence planning and social development.

Stockholm, October 2020

Olof Philipson
Chairperson of Arkus Foundation

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A book about the Eco-city Augustenborg

Bengt Persson, Monika Månsson

Bengt Persson, from the Swedish University of Agricultural Sciences, and Monika Månsson, at the Environment Department in the City of Malmö, are the editors of the anthology.

Augustenborg is both unique and totally ordinary among Swedish residential areas. For those who moved here between 1949 and 1952, they came to apartments that for most were total luxury. But as social problems rose and the expectations on housing increased during the 1970s and 80s, conditions declined, and the district's many small apartments no longer felt very appealing. The area began to truly shine in the late 1990s and early 2000s with the then (and largely still) unique Eco-city which strove to improve the entire residential area both socially and environmentally and thus also economically.

The Eco-city and Augustenborg have been discussed locally, nationally and internationally. It has attracted thousands of students, professionals, politicians and others with an interest in environmental and social regeneration in an existing residential area. Alongside the Bo01 housing expo, Augustenborg has helped define the City of Malmö's brand as a pioneer of sustainable construction and sustainable development. The City of Malmö has published two anthologies about Bo01 and the Western Harbour intended to give an accurate picture of the projects, what they did, how they did it and, as far as possible, how it went. An equivalent anthology has been missing for Augustenborg. It may seem a little late to publish a book about the Eco-city 20 years later, but interest in Augustenborg remains high and Augustenborg, and the work that happened there, is (unfortunately) still rather unique.

Our hope with this book, as with those on Bo01 and the Western Harbour, has been to have the main texts written by people with knowledge of the projects who have not themselves been involved in implementing what they write about. Facts and descriptions must be controllable and reliable. But in some cases, inside perspectives and more personal reflections can be important contributions, alongside interviews with those who were involved, fact boxes and stories from the area. Such sections are presented on a green background, or with a green bar running down the side of the page.

Over the years, Augustenborg has been the subject of many types of scientific research. This anthology contains eight newly written scientific chapters, at least one for each theme. A separate scientific editorial board has invited potential researchers, selected contributors and then reviewed and handled the articles. Each chapter has then been checked by internationally renowned scientific reviewers, in accordance with established best practice (a list of reviewers can be found on the copyright page). The scientific texts have a narrower focus than the other chapters and perform deeper dives into the subject matter.

The book was initiated by the City of Malmö's Environment Department, which also assumed editorial responsibility. MKB Fastighets AB, the Swedish University of Agricultural Sciences in Alnarp and the Sustainable Business Hub later added their names to the list of publishers. The Arkus foundation provided a grant and has distributed the book. Grants have also been won from the sustainable research council Formas, the Sten K Johnson Foundation, Vinnova and Mistra Urban Futures Local Interaction Platform in Skåne.

Six themes

The content of this book has been split into six themes:

1. The Eco-city as a project and testbed
2. Living in Augustenborg
3. Gardens and green roofs
4. Stormwater
5. Recycling, energy and mobility
6. Augustenborg today and tomorrow

Each theme opens with a general overview and contains one or two scientific chapters, mixed with others that address different topics within the theme. After reading all the chapters, the puzzle should hopefully fall into place, and the picture become clearer. The editors hope you will come away with an in-depth understanding of a normal, yet extraordinary small residential area in Malmö.

The Eco-city as a project and testbed

A key takeaway from the Eco-city Augustenborg is how it was conceived and implemented. For the concepts behind the Eco-city to inspire other residential areas that need environmental and social regeneration, we must demonstrate how such a project can be established. It seems like a series of threats and required actions laid the foundations that spurred the key players into action. There were several driving individuals who were given room to maneuver, find the resources needed and initiate the project. External financing unlocked internal funds. These were the main driving forces although there were certainly good and creative ideas about what to do. Another interesting consideration is whether the Eco-city project (which ran between 1998 and 2005) created lasting conditions for innovation and testbeds in Augustenborg during the 15 years since it ended. Many of the initiatives in Augustenborg were not innovative individually, but taken as a whole, with so many ideas put into practice, the project becomes very interesting. Augustenborg has been a testbed for property owner MKB, which has trialled new ideas before expanding them across its portfolio. But the area has also been a testbed and source of inspiration for others.

Living in Augustenborg

It took half a century to develop the conditions that finally spawned the Eco-city project. It started with the creation of neighbourhood units in Augustenborg. These reflected the dominant thinking in Swedish urban planning in the late 1940s and 1950s. Augustenborg was Malmö's first neighbourhood unit project, and the first ever project for the new municipal housing company MKB. Augustenborg's residents were to live in "houses in the park" with contiguous green spaces and invisible borders between properties. This later proved to be vital for the stormwater system that was installed during the Eco-city project. Rainwater must be allowed to follow the topography irrespective of property borders. In recent times one interesting project has been MKB's Greenhouse, which was opened in 2016. It was a densification project with several purposes, one of which was to make Augustenborg a more attractive place to live.

Greenhouse also follows the tradition of using Augustenborg as a testbed for forward-looking solutions and new forms of housing. The book gives us an inside view on how Greenhouse residents see their home, but also explores the views of others in Augustenborg.

Gardens and green roofs

A lot of attention has been paid to Augustenborg's green spaces over the years. Those working on the projects were careful to respect the history and culture when changing the gardens in the Eco-city. The courtyards were once designed by Malmö's city gardener Birger Myllenberg and this section of the book takes us on a journey from his work to today. The Eco-city also aimed to foster biodiversity and the botanical green roof-garden on the roofs of the Service Department's warehouses and workshops, have reached national and international audiences. The green roof-garden was an important testbed for larger scale use of green roofs the sister project Bo01 housing expo. The thrilling blow-by-blow account to find funding for the project is one of many interesting stories about how the Eco-city project was started.

Stormwater

Augustenborg's sustainable stormwater system is what truly put the Eco-city on the map, alongside the roof-gardens, and a symbol for all of Augustenborg. The blue-green infrastructure is a visible and integrated element in the district's green spaces and sets Augustenborg apart. It stemmed from the need to find a solution to a combined sewage and stormwater system which would regularly flood basements during heavy rain, causing extensive damage. The alternative to a surface-level solution which contains the water, would have been to build overflow tanks underground for combined sewage management. The neighbourhood unit design, which integrated green areas, helped the project, although the conditions were otherwise difficult as the land had few natural inclines. The chapters in this section offer an account of how the sustainable urban drainage system is built, how it works but also what it is like to manage it today.

Recycling, energy and mobility

The waste management solution was another cutting-edge project in Augustenborg. Today it is taken for granted, but when garbage chutes were removed from stairwells in the 1990s and 13 recycling houses were built it was a major innovation. Added to this were the composters that were installed in each recycling house to provide Augustenborg with its own soil to use in gardens. We follow the work to build a functioning system and the changes that have come since as the structure of waste management shifted. Compost is generally no longer produced on site in apartment buildings, and the waste is instead transported to a large-scale biogas plant. Local energy production and energy efficiency drives have been present in Augustenborg, but they largely lacked the innovation that characterised much else in the Eco-city. On the other hand, the trackless train Gröna Linjen (Green Line) innovation linked Malmö's southern districts to the amenities that were available elsewhere. The Green Line was electric and ran for four years before funding ran out and it was discontinued.

Augustenborg today and tomorrow

What is Augustenborg a symbol for today, and how will we view it in the future? The final part of this anthology explains what Augustenborg's role is in the international context. It summarises the lessons that can be taken from the Eco-city project and the changes that have happened since. Another interesting question is how Augustenborg will develop. It is today a residential area with many forward-looking solutions. It could be used to show how a developed residential area can be regenerated without too much change and gentrification, and the unreasonable rent hikes that follow. Sustainable urban development is today keenly focused on new development, while largely ignoring the large stock of existing homes and residential areas. Good accommodation for a reasonable price cannot be found in new developments, but in existing areas. Augustenborg is a good example, and in many ways sets an example, of how existing buildings can be modernised in a social and environmental way. In the best case, there will be further development in Augustenborg which will make it even more interesting in 2025, or 2030. But if not, it is interesting enough today.

Image by Marc Malmqvist/City of Malmö

Editors Bengt Persson and Monika Månsson on site in Augustenborg

Augustenborg in numbers

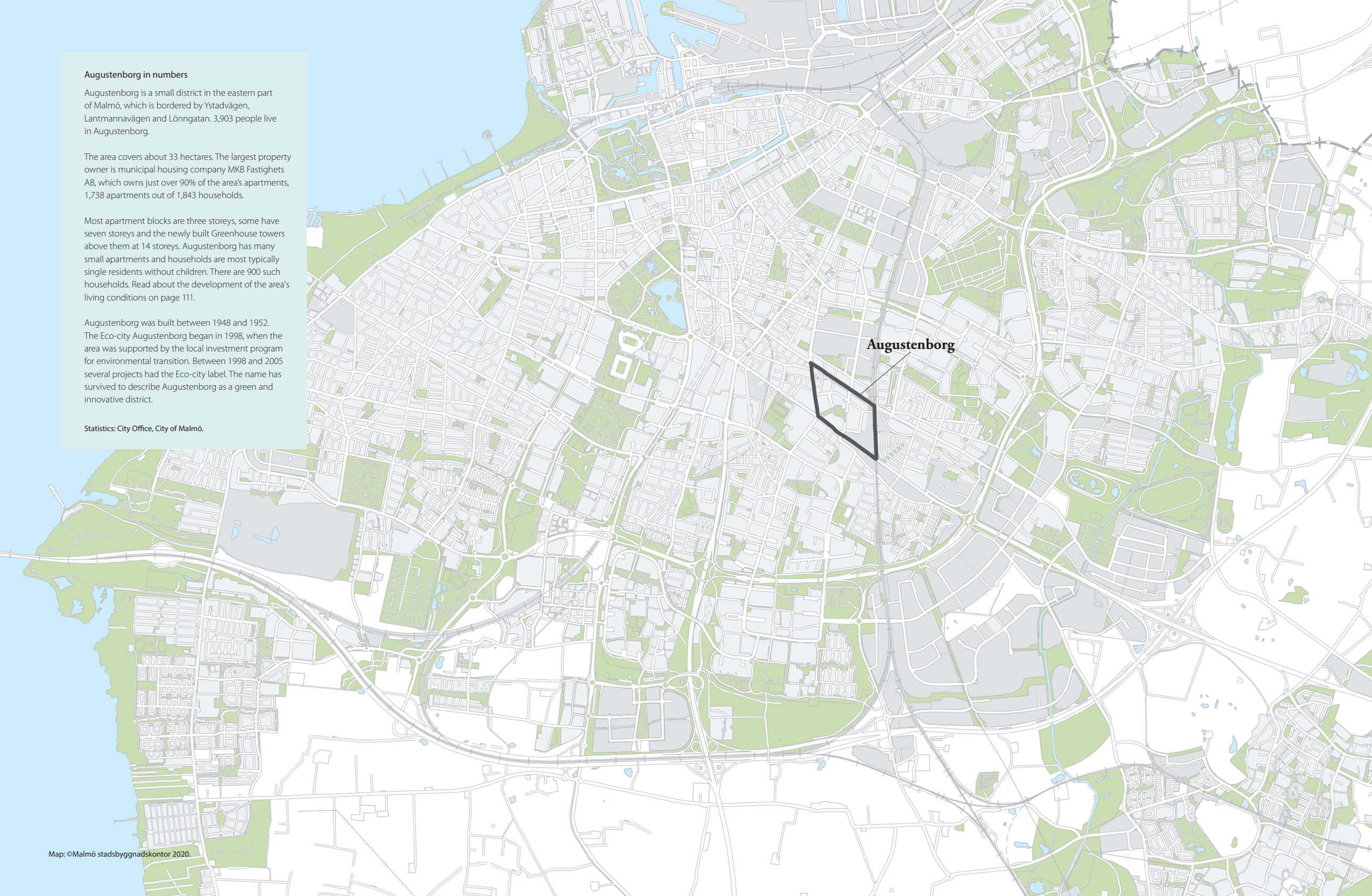
Augustenborg is a small district in the eastern part of Malmö, which is bordered by Ystadvägen, Lantmannavägen and Lönngatan. 3,903 people live in Augustenborg.

The area covers about 33 hectares. The largest property owner is municipal housing company MKB Fastighets AB, which owns just over 90% of the area's apartments, 1,738 apartments out of 1,843 households.

Most apartment blocks are three storeys, some have seven storeys and the newly built Greenhouse towers above them at 14 storeys. Augustenborg has many small apartments and households are most typically single residents without children. There are 900 such households. Read about the development of the area's living conditions on page 111.

Augustenborg was built between 1948 and 1952. The Eco-city Augustenborg began in 1998, when the area was supported by the local investment program for environmental transition. Between 1998 and 2005 several projects had the Eco-city label. The name has survived to describe Augustenborg as a green and innovative district.

Statistics: City Office, City of Malmö.



The beginnings and creation of the Eco-city Augustenborg

Bengt Persson

Bengt Persson, PhD, landscape architect and former senior lecturer specialised in dissemination and cooperation at the Swedish University of Agricultural Sciences. Has been employed as a consultant on the development of strategic environmental projects in the City of Malmö since the end of the 1990s.

When creating this book on the Eco-city Augustenborg, a key question we wanted to explore was how the project was initiated and implemented in such a comprehensive and cross-sectoral way? Those of us who worked on the anthology, and many others, believe that the special conditions surrounding a handful of initiators created unique opportunities and allowed the project to be initiated and implemented. One of the Eco-city's features was that many measures could not have been implemented by only one party, but are instead the products of a shared approach taken by departments within the City of Malmö and municipal housing company MKB. This chapter will outline the process which led to the project being funded and implemented. The implementation itself is described elsewhere in this book. The chapter is largely based on an interview with Peter Lindhqvist from February 2017. He is now retired but at the time worked as the development manager at the Internal Services Department in the City of Malmö. Peter Lindhqvist included four others in the inner circle which kicked off and planned the Eco-city project: Christer Sandgren, MKB; Peter Stahre, VA-verket; Gunnar Ericson, Streets and Parks Department; and Bertil Nilsson, seconded headmaster from the Augustenborgsskolan school.

Through the history of Augustenborg it is clear that ideas, driving forces and resources have been key to development. When Augustenborg was founded and developed in the late 1940s it was very much shaped by the neighbourhood unit concept which was the urban development ideal of the time. The driving forces were powerful individuals in the City of Malmö who, in the spirit of the times, formed the municipal, non-profit housing company MKB and entrusted it with the project. Financing came from favourable government loans, which were especially good for public housing companies.

The next major step in the district's development was taken during the Eco-city project in the mid-1990s. This utilised the new ideas of sustainable development and social environmental regeneration that came to be leading and widely accepted signs of development. A few key individuals were the driving forces of the project, among them property owners and business and infrastructure leaders in the district. The three most important were:

- MKB, which had to contend with increased social and structural problems in Augustenborg that had made the district an unattractive residential area.
- The Internal Services Department, which owned warehouses and workshops in the area, but which was threatened with having its activities moved to the outer parts of Malmö.
- VA-verket (later VA Syd), who was responsible for the sewage and drainage system which regularly flooded basements during heavy rains.

Funding was sourced from national and European Union environmental grants. In turn, by winning these (relatively limited) grants the organisations could justify dipping into their own pockets for the remaining money. An exception was the botanical roof garden, which was wholly funded through EU grants and national support. Financing is discussed further on page 56.

Only see challenges and opportunities, never problems and obstacles

With these conditions in place, the people who were active driving forces within the responsible organisations could set the course for the projects that over five years transformed Augustenborg into the Eco-city Augustenborg. They were all senior enough to act with force. None were chief executives or directors but were given the mandate to run the projects. Peter Lindhqvist, who started working in the City of Malmö in 1989, emerged as the decisive player, and helped initiate development processes and projects. Peter Lindhqvist rarely sees obstacles, and instead finds challenges and opportunities in everything. All he needs is a good helping of creativity, good will and a positive attitude. He says, for example, that those running the projects never spoke ill of Augustenborg and never highlighted problems and disadvantages. Instead they only spoke of potential and opportunity. It would prove a successful concept.

According to Peter Lindhqvist, the European housing expo Bo01 in Malmö explains why he and other key individuals could work with the Eco-city project in a way that was very integrated and holistic. During the latter half of the 1990s, urban planning in the City of Malmö was so focused on Bo01 that radical development in the Eco-city could slip slightly under the radar:

"Without Bo01, which became the sole focus of the obstacle-finders in the City Planning Department, the Environment Department and the Property Management Department, the Eco-city would never have become what it became."

Peter also says that usually developments were not coordinated but run out as individual projects. In the Eco-city, on the other hand, the efforts were coordinated, changing the whole project and giving it a combined force. Peter Lindhqvist was joined by MKB head of property Christer Sandgren, VA-verket's head of department Peter Stahre, Streets and Parks Department head of section and city gardener Gunnar Ericson, and Bertil Nilsson, the headmaster at the Augustenborgsskolan school who was seconded to become a project leader at the large social URBAN project in Malmö. The project therefore gathered everyone with an interest in, and control over, different parts of Augustenborg. The vital coordination and initiative was provided primarily by Peter Lindhqvist.

Another condition that proved important was the formation of a steering body, which included political leaders from the most important committees and municipal companies. Its role was mainly to help overcome internal hurdles and obstacles within their organisations. The body included Christer Brandt, chairman of the Fosie District Committee; Emmanuel Morfiadakis, chairman of the Technical Committee; Per-Olof Pettersson, chairman of the Services Committee; and Magne Larsson, chair of the board of housing company MKB. Other important contributions included MKB chief executive Allan Karlsson, who had major ambitions to change Augustenborg and gave head of property Christer Sandgren a clear mandate and free reins. Streets and Parks director Rolf Jonsson's strong and trusting relationship with Peter Lindhqvist was also key. The Streets

Image by Karin Oddner

Bertil Nilsson, Augustenborgsskolan headmaster and a project leader for URBAN, tells MKB head of property Christer Sandgren about the Augustenborg's botanical roof garden. Peter Lindhqvist, development manager at the Service Department, looks on happily.

and Parks Department was also responsible at that time for VA-verket, which oversaw stormwater management in Malmö, among other things.

Green roofs at the beginning

Let's go back to what Peter Lindhqvist believes was the real origin of the Eco-city project: an internal assessment into moving the Internal Services Department's workshops and storage in Augustenborg to the suburbs of Fosie. His investigation overwhelmingly showed that it was best to stay in Augustenborg. Peter was then tasked by his managers to figure out how to keep the workshops and storage in the district. His work spawned a plan to create an eco-industrial park as a way to modernise the facility and its operations. The new German trend of laying green roofs was mentioned at a seminar organised by Augustenborg's adult learning school. To Peter Lindhqvist it seemed an interesting addition to the eco-industrial park. He had seen an article in consultancy JoW's customer magazine by landscape architect Pär Söderblom, who created the first Swedish publication describing green roofs (Söderblom, 1992). Peter contacted Pär Söderblom, who was employed as an expert in the project that would become the botanical roof garden. There is more on that story on page 149.

The Internal Services Department's customer advisory council included, among others, VA-verket head of department Peter Stahre and city gardener Gunnar Ericson from the Streets and Parks Department. The idea to install a larger green roof on the Internal Services Department's Augustenborg site was suggested to the advisory council. Peter Stahre thought such a project should include local stormwater management. Peter Lindhqvist then contacted MKB, which owned the neighbouring property, and head of property Christer Sandgren, who had been commissioned by MKB's chairman Magne Larsson (Social Democrats) and CEO Allan Karlsson to improve things in Augustenborg. Next on the list was Augustenborgsskolan headmaster Bertil Nilsson, who was involved in the EU-backed URBAN project.

Another key person was the coordinator of Agenda 21 for the City of Malmö, Per-Arne Nilsson, who later became head of section at the Environment Department. He presented the funding opportunities within the local investment programs for environmental sustainability, LIP. The LIP funding became crucial for the Eco-city project. Peter Lindhqvist wrote most of the application and Christer Sandgren dealt with the sections on regenerating houses and facades. Together, they drew up plans for the Eco-city and its projects. To prepare, Christer Sandgren and MKB surveyed tenants in Augustenborg about what they wanted to see. Many requested better access to amenities such as banks, post offices, health centres and alcohol stores. It proved difficult to encourage such amenities to open in Augustenborg. The alternative became to establish an electric trackless train between Augustenborg and adjacent districts, see page 246. Peter Lindhqvist and Christer Sandgren thought it vital to meet the wishes of local residents, so improving access to services became an important part of the Eco-city.

LIP became the largest external financier of the Eco-city. The green roof garden was part of the LIP application, but it was rejected by the Swedish government and removed from the project, so had to find separate funding. On the other hand, the trackless train Gröna Linjen (the Green Line) won part of its funding from LIP, and could complement that elsewhere. See more on LIP grants on page 56.

Unique stormwater management

The way stormwater was handled in Augustenborg has become one of the Eco-city's best-known projects. When the district was built, the wastewater and stormwater disposal was combined in the same pipes. Therefore, during heavy rain, sewage mixed with rainwater could sometimes flow back into cellars across Augustenborg. Combined systems for waste and stormwater disposal are common in older buildings (as well as flooding problems) and the normal solution is to install a new pipe for stormwater and sometimes replace the wastewater system if it has become obsolete. In the Eco-city, developers chose a different option: during heavy rain the water is diverted into a system of gutters and ditches. The old pipes are only used for the wastewater.

This is the well-established story of how the famous stormwater system was created. But what is more shrouded in mystery is how this system was developed and implemented in Augustenborg. The main driver was Peter Stahre, who was head of department at VA-verket in Malmö. As he died in 2009 he is unfortunately unable to tell his own story about how such a radical solution was implemented in Augustenborg. We tried to find part of the story in Peter Stahre's own writings on Augustenborg or in other documents based on his stories[1]. Sadly, we have not found anything that explains how the system could be installed in Augustenborg, when it has proven practically impossible elsewhere.

A common obstacle to innovative thinking in stormwater and sewage management is the

[1] For example in the pamphlet/book *Blue-green fingerprints in the city of Malmö, Sweden – Malmö's way towards a sustainable urban drainage*, VA-Syd 2008, which was written by Peter Stahre himself and which describes the different environmental stormwater facilities in Malmö. In it he wrote that "In the Eco-city Augustenborg it was decided to manage the overburdened sewage network in a more sustainable way." He does not explore how this was able to happen in Augustenborg in any further depth.

Figure 1. Augustenborg is built as a neighbourhood unit which follows the "houses in the park" urban development tradition which dispenses with visible borders as far as possible between the land linked to apartment buildings and their surrounding parkland, streets and public land for school, etc. But plot boundaries, as shown in the map to the right, add a complexity that any stormwater system needs to tackle, as water does not respect property boundaries but moves according to the topography from higher to lower lying points. The stormwater system is connected to the public drain network in the west, marked with a blue dashed line. All excess stormwater will be led here.

perception that the public sewage network is responsible for managing all stormwater and sewage. The management of stormwater and taking care of land is beyond the responsibility of the water utility. The cost, for example, of rerouting and storing surface water therefore falls on the property's owner. But at the same time, the water utility is responsible for ensuring there is enough capacity in the sewer network, to avoid (basement) floods during normal rainfall. The water utility (then VA-verket, now VA Syd) normally has no influence over the property's design, and cannot pay for changes on individual properties. This approach can create sub-optimal conditions and mean that cheap stopgaps substitute more expensive solutions, such as installing new pipes. It is not possible to transfer funds from the water utility to individual properties or vice versa. That ends discussions about sustainable solutions, and everyone takes care of their own issues. This means that the usual solution for inadequate capacity (as in Augustenborg) is to build a new public stormwater drain, to which property owners can connect. We do not know how this obstacle could be overcome.

We want this book to include an evidence-based discussion of the Augustenborg backstory and not re-tell the normal story. But we can only speculate how the legal, economic, and practical problems were overcome to create a still rather unique stormwater system. One of the explanations that MKB's then property manager Christer Sandgren gives is that the municipal housing company already wanted to fix the yards. There were already funds to cover some of this work, which was topped up by LIP grants. MKB's staff and residents also thought that an open and visible stormwater system would have aesthetic qualities. When the question arose in discussions between Peter Stahre and VA-verket, it became a eureka-moment. "An sustainable urban drainage solution can be interesting for both of us," they realised. The implementation of the project was rosy and Christer Sandgren says there were no disputes or disagreements. Thanks to the LIP grant, and MKB's planned investment in the yards, financing never became a decisive issue. The discussion over whether VA-verket should invest in MKB's properties was avoided.

Augustenborg was built in accordance with the urban design concept of the neighbourhood unit and "houses in the park" (see figure 1). This meant that there was enough spare land in Augustenborg to re-route the stormwater before slowly disposing of it in a way that the public drainage could manage, without causing floods. But what may look like a cohesive green urban environment with no boundaries, in fact hides a pattern of bordered plots that a stormwater system must traverse where the water follows the land, not the man-made boundaries.

The property boundaries in Augustenborg are shown in Figure 1. In Malmö, the Internal Services Department is responsible for the municipality's properties. The Internal Services Department, which ran operations in the warehouses and workshops in the southern part of Augustenborg, was also responsible for managing the school grounds and buildings. Peter Lindhqvist coordinated the Service Department's areas of responsibility. Headmaster Bertil Nilsson drove the work inside the school. The park land was run by city gardener Gunnar Ericson. There was no advocate for the streets within the inner circle, so they did not become a radical part of the Eco-city[2]. MKB's property portfolio in Augustenborg means it owns a large part of the district. Its properties were run by Christer Sandgren.

By gathering people with enough influence over most of the area's property in an inner circle, the team was able to unlock the potential of implementing a radical and unique stormwater system. Some of the funding was won through LIP grants. The remaining costs were shouldered by MKB as part of refurbishing the yards and the outdoor environment; the Service Department paid for work on the industrial and the school; and the park administration stood for costs associated with the parks.

Ideas, driving forces and resources

The history of the Eco-city Augustenborg shows how one problem - the threat to move the Internal Services Department's workshops and warehouses - sparks positive change. The snowball effect, or if you like - a wingbeat of a butterfly that chaos theory proposes. Did Malmö have unique features that set this snowball in motion? It is hard to say in retrospect, but it is clear that Malmö was in crisis in the mid-1990s. High unemployment and a large population flight caused tax revenues to fall. But costs remained high, and the municipality would have spiralled towards bankruptcy, if that were an option for public bodies. The municipal leadership, led by chair of the City Executive Board, Mr Ilmar Reepalu, gathered in 1996 for a crisis meeting to create a strategy to lead Malmö out of crisis. It's two main threads were to create attractive housing by the sea (Bo01 and the Western Harbour) and to establish a university in Malmö. This plan did not encompass Augustenborg, but it is claimed, and the Eco-city example seems to bear this out, that because the municipal leadership was aware of and driven by the crisis, it gave resourceful officials a lot of space and created a culture of freedom under responsibility in the

[2] See page140 for the landscape architect Anders Folkesson's story of his inability with the Parks and Highways Department to push through a radical transformation of Augustenborgsgatan to make it into a flood plain for stormwater during extremely heavy rain.

organisation. Malmö has today left the crisis of the 1990s behind and the culture is different.

The initial challenge which spawned new opportunities was how to keep the Internal Services Department's operations in Augustenborg. In the spirit of the time, society's quest to increase sustainability laid the ground for the project to become an environmental industrial park. The snowball gathered pace and collected new snow from other challenges and solutions that were deemed environmental or green. External grants, which supplied the seed funding, were focused along the same lines, an excellent coincidence for the snowball. The openness and hunt for solutions which characterised the start of the Eco-city project is rare. Looking back, we cannot know exactly what it looked like and why these solutions were possible. But it seems that without Peter Lindhqvist, the Eco-city would never have been designed holistically. And without other key people who focused on finding solutions, it would have been impossible to create the solutions that are, unfortunately, unique in Augustenborg's regeneration.

So, for those of you who want to create your own Augustenborg: Don't see problems, only see opportunities. Be sure to collect everyone with influence over different parts of the organisation to remove the obstacles that surround you. You also need funding, so look for external opportunities that can provide the drops that start the flow internally.

Ekostaden Augustenborg as a permanent urban laboratory

Andrew Karvonen

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For over two decades, Ekostaden (Eco-city) Augustenborg has served as an exemplar of sustainable urban development in Sweden and around the world. The longevity of the initiative is astonishing when compared to similar programmes and projects that expend significant energy and enthusiasm for a limited period of time and then fade away as funding is exhausted and momentum fades. The long tenure of Ekostaden Augustenborg is punctuated with a multitude of successes and failures of real-world innovation. This chapter reflects on Ekostaden Augustenborg as a permanent urban laboratory with sustainable innovation as a fundamental guiding principle. The initiative has evolved through three stages of innovation including 1) the technical upgrades of the built environment, 2) institutional restructuring of municipal governance, and 3) social engagement to foster sustainable lifestyles. Together, this has resulted in an enduring ethos of experimentation, creativity, and change that serves as a unique example for other neighbourhoods to learn from while creating their own sustainability journeys.

Retrofitting the built environment

When compared to its sister project, Bo01 in the Western Harbour, Ekostaden Augustenborg started out at a distinct disadvantage. Bo01 was established on a former Brownfield site and thus, the designers had a tabula rasa to invent a completely new sustainable neighbourhood of the future. In contrast, Augustenborg was an existing neighbourhood with multiple physical and social problems that could not be addressed through comprehensive design measures. Reflecting on the beginnings of the project, an Ekostaden founder notes that "Augustenborg at the time was one of the poorest neighbourhoods in Sweden. And they had a lot of empty apartments in Augustenborg. And they were losing a lot of money." But as the old adage goes, with crisis comes opportunity. Much of Augustenborg's story centres on attempts to reform the built environment to simultaneously solve environmental, economic, and social issues (mirroring the classic formula of sustainable urban development). And the stakes at Augustenborg were much

lower when compared to the intense scrutiny and expectations of the Bo01 redevelopment project. This provided license for the Ekostaden founders to innovate under the radar and to take risks.

The retrofitting of Augustenborg is closely intertwined with the broader historical evolution of the city. The deteriorated conditions of the neighbourhood were symptomatic of the larger crisis in Malmö with the collapse of the shipbuilding industry in the mid-1980s (Anderberg and Clark, 2013; Anderson, 2014). So while Ekostaden Augustenborg is often associated with environmental and social innovations, its origins are strongly rooted in the financial crisis of the late 1980s and early 1990s as Malmö transitioned from an industrial economy to a knowledge economy (Holgersen, 2014). Creativity would serve as the underpinning philosophy for the city's new industry and it was understood that Malmö could reinvent itself through the reformation of its built environment. And in Augustenborg, the proponents of regeneration found multiple opportunities for intervention.

A principal advantage of Augustenborg is that it comprises a spatially distinct area, bounded by formidable transportation infrastructure networks on all sides. The large main roads and rail lines create a clear delineation between what is inside and what is outside of the experimental boundaries (Karvonen and van Heur 2014). There is no ambiguity about where Augustenborg stops and where the rest of Malmö begins. Moreover, the site is largely homogenous, dominated by public housing that is owned and managed by MKB. This makes it relatively straightforward for the municipality to rally local stakeholders around a shared redevelopment agenda.

Within the Augustenborg boundaries, activities to retrofit the built environment provided highly visible and tangible evidence of intentional change. The project continues to attract over a thousand visitors every year to see the open drainage systems, green roofs, photovoltaics (PVs), and other retrofit technologies in action. To be fair, none of the technologies were incredibly novel or untested; PVs were commonplace and proven, the green roofs were inspired by German examples, and the open drainage systems had been, at least partly, developed in other parts of Malmö (and around the world) since the late 1980s. However, co-locating these technologies in the same place created a diverse showcase where the efficacy of these technologies could be demonstrated. Ekostaden Augustenborg provided living proof that it was possible to reform the existing urban fabric.

The many green roofs are well integrated in the district, but development and testing still continues at the Augustenborg Botanical Roof Garden. Image by the Scandinavian Green Roof Institute

And these demonstrations were not only there to be witnessed by visitors, the sustainability principles were intended to be transferred and applied in other locales. For example, the green roofs that were initially trialled at the International Green Roof Institute served as proof of concept for the private developers at Bo01 in the Western Harbour. Reflecting on the importance of demonstration, a municipal staff member notes that the Bo01 developers "wanted to see it built." So Ekostaden Augustenborg emerged as a real-world testbed, a place where the future could be empirically verified and experienced.

Image by Sanna Dolck

In Augustenborg sustainable solutions were on display in the built environment, including solar energy, as living and daily evidence that the transition works.

Of course, not all interventions were successful. The project included multiple initiatives that were proposed and then abandoned for various reasons. An electric street tram provided residents with connections to local community services for a brief period but eventually proved to be financially untenable. Efforts to develop an employment programme for local residents to manage the green spaces and recycling services failed to materialise. And a withered green façade on one of the municipal buildings continues to serve as a reminder of the ever-present risk of failure when innovating.

Despite these failures, it is surprising to see how many of the interventions that were introduced in Augustenborg over the last two decades have actually worked. Moreover, it is fascinating to see how they have gradually blended into the neighbourhood to become "normal" features of the built environment. The area does not advertise itself as being a cutting-edge exemplar of sustainable urban development; instead, it simply exists as a liveable neighbourhood. Paradoxically, Augustenborg could easily be mistaken for any other Swedish neighbourhood from the 1940s. It is simultaneously a place that is familiar but unique. A former municipal staff member notes, "Is everything hunky dory here? No, far from it. But it is a damn sight better than it was. Physically, it's lovely. And from an urban planning perspective, it is a pretty good example of medium density residential." This points to an elusive goal for all sustainable urban development projects; namely, to transform the novel and special into the normal and everyday.

Reforming local governance

Beyond the physical interventions that have taken place in Augustenborg, the innovation journey has also involved the reinvention of the processes that underpin urban change. This suggests that sustainable urban development is not simply about the implementation of new technologies and strategies but about the means of governing cities (Bulkeley and Castán Broto, 2013). This shifts the emphasis towards processes through which various stakeholders can realise change on the ground and effectively steer cities towards improved futures.

Much has been made of influential political leadership, exemplified by former mayor Ilmar Reepalu (1995-2013), who sustained enthusiasm and momentum for the post- industrial narrative of Malmö during a key period in the city's urban development history. A handful of municipal

Image by Sanna Dolck

In recent years there have been experiments with green facades in Augustenborg.

employees (Peter Lindhqvist and Peter Stahre, among others) capitalised on this city-wide narrative to develop a new mode of local sustainable governance. They started with the ambition to create a new sustainable industrial area in Augustenborg, comprised of existing municipal buildings, but quickly expanded this vision to encompass the entire neighbourhood.

And from the start, they recognised that taking sustainable urban development seriously would require new modes of working in the city. They positioned themselves as intermediaries and created connections across existing departments to facilitate collaborative problem-solving activities (Lenhart *et al*, 2014; Fitzgerald and Lenhart, 2016). The various technical strategies to retrofit the built environment thus emerged from unique collaborations that brought together the required expertise to make them happen. For example, the open drainage systems not only involved the Environmental Department but also the Streets and Parks Department and the Internal Services Department, among others. This involved a significant departure from the "silo mentality" approach to governing that is commonplace in most municipal governments (including Malmö).

A key factor in mobilising the various stakeholders around a collaborative agenda involved the funding of the various initiatives. The financial crisis of the early 1990s meant that capital to realise the new post-industrial narrative for Malmö was not readily available. However, the various champions were successful in attracting local, national, and international funds to support a suite of projects under the shared theme of sustainable urban redevelopment. Augustenborg served as a posterchild for the crisis that was enveloping the city as a whole and emerged as an ideal place to trial potential solutions.

The funded projects ranged from the relatively standard to the very innovative and often involved technologies and strategies that were imported from elsewhere and adapted to the Augustenborg geography. The municipal government was desperate to fill the hole left by the loss of an estimated 30 000 jobs in a short period of time, and urban development became an important part of the new economic model for the city. Meanwhile, the size of Malmö provided a distinct advantage. A municipal employee noted that "Malmö is big enough to work a lot with branding but small enough to be able to do this experimenting." In other words, the municipal government was small enough so that they could test new governance strategies but big enough that they could then advertise these activities to the outside world (Listerborn, 2017).

The mode of governance that emerged in Ekostaden Augustenborg suggests a transdisciplinary mode of sustainable governance that transcends existing departmental silos and embraces synergistic thinking (Fitzgerald and Lenhart 2016). Unfortunately, this new mode of governance would not last. As the various funding sources were exhausted, the municipality gradually went back to its old ways of working while the key proponents of Augustenborg moved on, retired, or passed away. A former municipal staff member notes, "After Bo01 and Ekostaden had been a success, everything went back to normal again." Today, this spirit of transdisciplinarity and collaboration has taken root in a new initiative, the Malmö Innovation Arena, a project financed by Vinnova and the European Union (McCormick and Kiss, 2017). However, it is unclear how any of the lessons from Ekostaden Augustenborg have influenced this new project and if the newly-emerging transdisciplinary form of governance can be sustained in the long term.

Fostering sustainable lifestyles

The infrastructure retrofits and governance activities at Ekostaden Augustenborg exemplify two approaches to urban innovation. However, a third and arguably more long-lasting legacy of

Augustenborg involves the residents, many of whom have lived in the neighbourhood since before the Ekostaden concept was even conceived. It is increasingly fashionable today to develop and promote "living laboratories" where occupants are co-creators and collaborators in experiments (Marvin *et al*, 2018). However, two decades ago this was a fairly novel concept, not just in Sweden but around the world. From the start of Ekostaden, the proponents recognised that it was essential to involve the neighbourhood residents in decision-making processes to achieve long-term buy-in (Fitzgerald and Lenhart, 2016). This emphasis on community also predates the Swedish government"s shift towards "social sustainability" that began around 2010 (Anderson, 2014).

The community agenda has always been present in Ekostaden Augustenborg but it has taken on more prominence over time. MKB, the public housing company, was a participating partner from the start. After the project funding ended, they slowly replaced the municipality as the primary champion of the Ekostaden agenda. They shifted the emphasis to green lifestyles, signalling a new phase of innovation for the neighbourhood. They consciously transitioned from retrofitting the various neighbourhood-scale collective services to supporting a constellation of individuals and families in their daily activities.

The Greenhouse tower is the most visible example of this new agenda of sustainable living and community empowerment. The building has multiple features that facilitate environmental lifestyle choices for the residents and represents a more personalised approach to sustainable innovation when compared to the previous infrastructural retrofits. Examples of this include private balconies with ample growing space, a novel design for the collective laundry facilities, customised recycling bags for each apartment, and a high-tech solid waste monitoring system (MKB 2019). This provides a direct route to diffuse innovations first tested at Augustenborg to the broader MKB housing stock (comprising 33% of Malmö's rental market). An MKB staff member notes that Augustenborg today is a "testbed for environmental solutions" that can then be transferred to other neighbourhoods.

Beyond technological innovations, there is a particular emphasis on using green as a way to enhance social bonds among the residents. MKB attempts to be less of a landlord to its tenants and more of a facilitator and supporter of community decision-making. This aligns with the long-term goal of Ekostaden Augustenborg to empower residents to co-manage the built environment (VA Syd, 2008). This is particularly evident with the urban growing agenda that the Greenhouse residents have strongly embraced and carried forward, including active community gardens, frequent social events, free training sessions, and more. This represents a significant shift from the physical design of the neighbourhood to the social design of residential lifestyles. The residents have emerged as the primary carriers of sustainability through face-to-face and virtual meetings, group meals and activities, and participation in working groups to support the various sustainability aims.

Of course, the emphasis on sustainable living and community governance at the Greenhouse is not perfect. Some of the proposals have tested the patience of the residents and there is a need for periodic meetings to ensure that the innovations align with their daily activities. Some residents are not so interested in being actively involved with their neighbours. Moreover, the emphasis on sustainable lifestyles has inadvertently created a divide between the Greenhouse and non-Greenhouse residents. A former municipal employee admits that "there are elements within the community who see [Greenhouse tower] as being a little bit elite". This suggests the need to extend the community building activities into other parts of Augustenborg.

In addition, the emphasis on the residential parts of Augustenborg misses other potential opportunities for sustainable urban development in the neighbourhood. The local school was an early partner in Ekostaden Augustenborg and the infrastructure upgrades were integrated in their curriculum but today, the pupils are only marginally involved in the Ekostad agenda. Likewise, the local businesses in the neighbourhood could be mobilised more thoroughly. According to an MKB staff member, they are currently developing a sustainability week at school that will use the neighbourhood as a teaching opportunity and they have enticed green businesses to locate their offices on the neighbourhood square where storefronts have sat empty for many years. This points towards a more expansive sustainability agenda in the future that includes living as well as working and education.

The contemporary focus on sustainable lifestyles and communities provides a way to extend the innovation agenda into the long-term future. Where the original funding for Ekostaden Augustenborg was time-limited, the current MKB agenda on community development is integrated into its estate management activities, ensuring that the neighbourhood will continue to innovate. Reflecting on Ekostaden, an MKB staff member notes that "it doesn't have a finish date, it is ongoing." This represents an important evolution in Ekostaden Augustenborg from a "space" where sustainable technologies can be trialled for limited periods to a "place" where sustainable practices can be continuously enacted.

Innovation as a way of life

Today, Malmö is a city that "has become synonymous with innovation, creativity, resident participation and sustainability" (Anderson, 2014: 15). Ekostaden Augustenborg is one of several initiatives that has played a significant role in supporting this new urban reputation over the past two decades. The evolution from physical interventions to transdisciplinary governance to community building hints at a learning trajectory to redevelop existing neighbourhoods and make them more sustainable. What started as a series of funded projects morphed into a broader approach to urban governance and finally into an enduring ethos of sustainable living.

An example of local innovation from Augustenborg: the so-called onion gutter in the open stormwater system. Image by Sanna Dolck

Image by Sanna Dolck

In Augustenborg, you can find an enduring ethos of experimentation, creativity and change.

The longevity of the neighbourhood's innovation journey can be attributed to the creation of an adaptive space with a core ethos of sustainability but also having sufficient flexibility for different interpretations and agendas to emerge over time. Had the neighbourhood been more rigidly managed by the municipality or MKB, it is likely that it would not continue to exist as an urban laboratory today. It is this enduring commitment to change that is perhaps the most important achievement of Ekostaden Augustenborg. It will be intriguing to witness how this continuous pursuit of more sustainable futures will evolve and grow at Augustenborg over the coming decades.

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Augustenborg – innovation with a social angle

Trevor Graham was project manager for Ekostaden Augustenborg throughout the project, 1998 to 2007. He was mainly active in the social processes and in engaging residents. This chapter includes personal reflections on his work with the Eco-city project.

The Eco-city Augustenborg was an initiative for sustainable regeneration of a built-up area both in Sweden and Europe. The project ran parallel to the development of the first stage of the Western Harbour. The two projects came to complement each other, and demonstrated both a technical and social breadth to sustainable urban development. While the Western Harbour is perceived as a sustainable area which attracts new residents and high earners, Augustenborg brings sustainability to those who already lived there.

Partnership

The partnership and engagement between the municipal administrations (Internal Services Department, the Streets and Parks Department's water and park sections, and the District Administration), municipal housing company MKB and external actors showed how important it can be to find shared targets and develop a focus on finding solutions to problems that can not be solved in traditional silos. Working across borders was seen as unusual in the 1990s. The work was initiated and carried out across the silos. The participants had a shared commitment to overcoming challenges, without blindly sticking to their own areas of responsibility, and to find room in budgets and funding through joint efforts. The idea was to overcome challenges without the boundaries of property and responsibility getting in the way.

The Eco-city Augustenborg has coped fairly well while transitioning from a fixed-term project with earmarked resources to one of administration and continuous development. The engagement and dynamics between the participants have evolved at times, but are still largely intact, with MKB mainly in the driving seat today. The municipality may have stepped back, but this is a natural part of a transition from project to administration. MKB's commitment has shown itself, not least through the investment in Greenhouse, where the ideas behind the Eco-city have shaped decisions.

The project's strength has, however, also proved its weakness. Its beginnings were in a series of handshakes between influential people in the city's departments and in MKB. The development was driven by strong individuals, and without these men (yes, they were mostly men who had worked through the hierarchy) the project would likely never have happened, at least not in such a radical way. Their commitment, and that of others who joined during implementation, was crucial to make the Eco-city what it then became. The professional processes were driven by personal conviction, creating a form of value-driven business development that was ahead of its time. What appeared to be a creative culture was in fact a network of creative individuals granted freedom to act, who were well-anchored in their respective organisations and with politicians. When they disappeared - to a new job, retirement or long-term sick leave - the project's survival and its ideas were threatened. Creativity, a focus on finding solutions and sustainable thinking, did not permeate the entire organisation. Yet large parts of the ideas that underpinned the Eco-city project have nevertheless survived personnel changes.

Image by Karin Oddner

Augustenborg residents Morten Ovesen and Curt Hallberg were involved in designing the stormwater systems.

Augustenborg as an innovation area

The first engagement with residents in the Eco-city was to ascertain how they felt about the design of the outdoor green spaces. It followed a tried and tested method used when upgrading yards, which was adapted to gather views on the physical design. Since the area's design was the part of the project where residents would have the largest opportunity to exert influence, the management team wanted to use this to actively mobilise more buy-in from locals. The initial work to design the green space was stopped and a different method to engage residents was chosen. The new method was broader, in order to encourage more engagement and share ownership of the regeneration process. There were games of football in the park, barbecues in gardens, and the project's leaders listened to hopes and challenges from the local community organisations. At the same time there were more open meetings in each garden so that tenants could have more influence in the design stage.

When the people said that traffic was one of Augustenborg's biggest challenges, it was natural to ask why the Eco-city barely included any major work with traffic. The Streets and Parks Department replied that "there are no traffic problems in Augustenborg - no one has died". Residents then performed their own traffic survey. In the space of two hours, they documented a large flow of heavy vehicles, cars reversing for hundreds of metres against the traffic on a one-way street, and a frontal collision between a car and a bicycle on a one-way street. But no one died. The Augustenborg residents made sketches of alternative solutions and despite everything managed to improve the situation, though not as much as they had wanted.

Sometimes local initiatives and the Eco-city's experts crossed paths. Those responsible for the stormwater system met a self-taught water innovator in his basement, and together designed the onion gutter, a much-discussed feature of the area's unique stormwater system. That spawned Watreco, an innovative company which planned to start exports, though never got as far as hoped.

In the late 1990s source separation of recycling was still controversial, but it became one of the basic ideas when planning the Eco-city project. Through a pilot project with the local Agenda 21 association, thoughts and ideas were gathered from around 70 households. This helped shape the physical design of the recycling houses. Information was distributed to tenants through interpreters and printed information in multiple languages - something else which was unusual at the time.

At one point a young single mother stormed down to the recycling house in a fury with a garbage bag full of babies' diapers and another full of soda bottles. She was angered by the source separation, but ended up having a conversation about the Eco-city and the other projects that were going on.

Anger turned into enthusiasm when she heard about the carpool that was about to be launched by some residents. She was an unemployed car mechanic without a car. She became chairperson of the carpool and later acknowledged that it perhaps wasn't all that bad to separate your own waste.

The carpool was not an original feature of the Eco-city plans, but came about after a visioning exercise with local associations, companies and engaged individuals in the first half of the project. Other projects that were added over time included Solstaden (Solar City) which produced solar energy. The Solstaden panels were installed on municipal property, but not on MKB's sites.

Among the most publicised parts of the project were the green roofs of the Internal Services Department's large warehouse and workshop site, on which work started in 1998. The project also created a demonstration area, which lets the public see and come into close contact with green roofs (see page 148). The roof garden proved very useful to the builders behind the housing expo Bo01 in the Western Harbour. They had to meet green surface requirements and needed to tick off items on a green scorecard and green roofs became an important part of reaching environmental goals. With the sedum carpet on Augustenborg's botanical roof garden beneath their feet, they were able to discuss construction, operational issues and costs, and the perceived risks with green roofs - moisture and leaks - became less of a concern.

Image by Marc Malmqvist/City of Malmö

Safija Imsirovic, who set up and still runs Gnistan, is one of many active Augustenborg residents with whom Trevor Graham collaborated during the Eco-city era.

Some initiatives, such as the electric trackless train Gröna Linjen (Green Line) electric train, were exciting pilot projects but did not last. Maybe the problem with Gröna Linjen was that it was unsustainable in the long run, or perhaps the project was 25 years ahead of its time. Another initiative that did not survive was the attempt to form a residents' council as a formal part of governing the Eco-city. It was perhaps idealistic and impossible even then, or just an experiment at the wrong time.

Lessons learned

The dissemination of lessons and experiences from both the techniques and processes used in Augustenborg has taken an interesting path. On the one hand, the Eco-city has become a key part of Malmö's sustainable identity and the city has shown it off to companies, government reviews, and development projects in the US, France, China and many other countries. On the other hand, the ideas developed in the Eco-city have not been widely spread. The connection that the project draws between physical investments and social issues has still not been formally adopted in local development projects in Malmö. Only now does it seem like a similar approach might be applied elsewhere. The stormwater solutions in Augustenborg have not been replicated to any great extent across the rest of Malmö.

Green roofs have become the norm in new construction in the city, in part thanks to the easily accessible demonstration roofs in Augustenborg. Carpools are no longer an innovation but a common solution that influences how many parking spaces a new development will need in Malmö and many other cities. Source separation is everywhere.

The huge international interest in the Eco-city Augustenborg is strongly linked to the relationship with the Western Harbour - the project's mirror and ally. The stylish new district and its attractive and sustainable gleam and sea views stands only a few kilometres away from the working-class neighbourhood with socio-economic challenges which offers a rawer and in many ways more normal picture of how to move towards a sustainable society. That these projects feel just as relevant today says a lot about how little has been achieved internationally since they were implemented, and how little has happened in Malmö.

Augustenborg and the Western Harbour had some conditions in common. Both had a clear vision, a strong foothold in politics and business, a partnership with shared targets, clear leadership and financial resources, in part from external funding from the state and the EU. In the wake of Bo01, which was the first stage of the Western Harbour development, the state of the art for new sustainable construction has progressed considerably. Bo01 showed what was possible with a little extra funding.

When developing a new area, there is a clear and established game plan. From the municipality to landowners, builders, construction companies and financiers, everyone knows their role and the rules of the game. There is a degree of tension at times in the game. Sometimes someone does not play by the rules. Sometimes the game takes too long. But in general, there is a clear and well-functioning process for new developments.

But when converting an existing residential area, there are no rules for the game. City planners are poorly equipped to deal with inconvenient existing areas. There are no high expectations. There is no strategic overview or long-term planning, but at best an ad hoc process run by individual property owners. In Augustenborg, investments were shared between different players. While the Western Harbour's lessons could be applied when developers moved on to their next project, the experiences from Augustenborg have no natural continuation. When regenerating an area there are no standardised processes, actors or roles so that experience can be gained and processes developed.

From district to city

When Augustenborg was developed in the 1940s and 50s, it was part of building a welfare state. The workers, the backbone of Swedish growth, were to be housed in good accommodation in areas that offered amenities, community and recreation.

When the Eco-city Augustenborg was developed 50 years later, it was a new stage of social development, now called the green welfare state. The government's investment in the local investment programme came after the 1992 UN Rio Conference, where Agenda 21 established the importance of local action, civic engagement and a holistic perspective in sustainable efforts. Augustenborg would now offer quality housing and a future to the workers who had lost their jobs and to their newly arrived neighbours from the war-torn Balkans.

The Eco-city has not had a transformative effect on the sustainable regeneration of European cities. Two decades on climate change is rising; large-scale migration has challenged systems; populism, protectionism and nationalism are on the rise. The gap between the Western Harbours and the Augustenborgs of the world is as large as ever.

The experiences from Augustenborg, together with the few other similar projects around the world, should form the basis for a long-term physical social investment programme that deals with the challenge of climate change, creates jobs and supplies better living conditions. In Malmö, in Sweden, in Europe, and in the world, we have a lot to learn, but also a lot to share.

Augustenborg's blue-green testbed – a place to develop and learn

Caroline Wigren, Håkan Rosqvist

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The Eco-city Augustenborg is a collective name for all ongoing efforts in the Augustenborg district of Malmö with the goal to transform a troubled district to become economically, socially and environmentally sustainable. The transformation has taken place over the past two decades and has included many initiatives. This text will focus on environmental sustainability and especially the development of services provided by the urban ecosystem. Part of this is an attempt to develop services and products for increased urban ecosystem services that can be commercialised. This was tested in a Vinnova-funded project.

Urban ecosystem services is an umbrella term for the value and functions that green and blue surfaces provide and which are necessary for us to live and thrive in cities. Practical examples include stormwater management, noise reduction, temperature control, air purification and the benefits to public health and wellbeing that green areas provide. Practices are required that can identify what needs cities have, develop solutions and identify and utilise the potential for innovation in these solutions. This can help cities become better at delivering vital ecosystem services. These processes have been the focus of work on the blue-green testbed in Augustenborg. The future technical green solutions in sustainable urban supply systems, tested and developed in Augustenborg, are a combination of technical solutions and urban ecosystem services.

The first testbed was established in Augustenborg as early as 2001 (read more about testbeds on page 40). The botanical green roof garden was built and green roofs were laid on buildings in Augustenborg, and sections of the residential area were regenerated. One of the goals was to reduce flooding. Most of Augustenborg has a combined wastewater and stormwater system, which frequently led to flooded basements. The testbed for green roofs primarily includes Augustenborg's botanical roof garden. In addition, many other green roofs in Augustenborg are showcases to demonstrate different types of vegetation, drainage and surface formation. There is research linked to the roofs.

The Eco-city Augustenborg has a long tradition as a testbed for blue-green solutions, and the Scandinavian Green Roof Institute has played an important role in both testing and demonstration. Image by Sanna Dolck

In addition to green roofs, the district has worked with infiltration surfaces, permeable paving and ponds in the residential area combined with canals and dry swales to move stormwater (Stahre 2008). Developers have also worked to create areas that have different characters. With concrete canals and ponds, an urban designed environment has been created on residential gardens; while natural parts of the landscape, such as meandering streams and lush wetlands, have been created elsewhere in the district.

Today, Augustenborg has finances to develop as a testbed, but the district has run other projects in the past aimed at testing new solutions in practice. One such project was BiodiverCity, funded by Vinnova. It is described in more detail below.

The change in Augustenborg should not be taken for granted. It took almost ten years before a sustainable urban drainage system was accepted by decision makers in the municipality (Stahre, 2006), albeit the regeneration project was run between 1998 and 2001. Augustenborg has therefore been developed gradually, in part by the municipality, in part by municipal water company VA Syd, and in part by municipal housing company MKB. It has involved many parties who normally live and work in their own silos. Creating somewhere like Augustenborg with the ability to be a testbed and to-scale model for continued development and innovation is difficult, cumbersome, time-consuming and improbable. It is a unique place for companies, innovators and other cities that want to develop and apply blue-green solutions to increase the range of urban ecosystem solutions.

Municipalities are not commercial players that sell solutions, nor are municipal companies. A challenge in the development of the testbed has been to find ways and organisations that can commercialise and sell new solutions, services and products. Some of the challenges associated with commercialising projects developed in a municipal testbed can be highlighted through the BiodiverCity project.

BiodiverCity

The Vinnova-funded BiodiverCity project was customer-focused from an early stage, based on the municipality (City of Malmö) as a customer, initiator and user of blue-green solutions to expand urban ecosystem services. One reason for this was the Swedish Public Procurement Act (LOU). To avoid potential conflicts of interest when finding contractors to implement the solutions, only a few companies, primary consultants, were involved. Expert knowledge was used to identify various requirements.

This phase involved both private and municipal developers, as well as consultants, researchers and municipal experts. Together they created the conditions the new products must meet. The new products were often created by combining existing products from the market, such as plants and soil substrates.

The idea was that products would eventually be procured commercially based on the specifications. Already at this stage, products were developed to be implemented in Augustenborg. The products were not off the rack, but tailor-made, which made it difficult to sell them on the market as finished products. They were also developed as part of the project, making it unclear who owned and who could sell them.

Financer Vinnova wanted companies to be involved towards the end of the three stages in the project. One objective was to work with a number of value chains and develop products that could be commercialised.

The companies were brought in at stage three to develop commercial solutions based on experiences from the two previous stages. The companies were divided into two groups to capture as much of the value chain as possible in each.

One group was expressly interested in stormwater and developed a small-scale residential stormwater solution, Urban Layers. The second group developed a bicycle shed adapted to blue-green solutions.

The work to develop products for the private market was led by the Sustainable Business Hub. The goal was to create at least two value chains, which included different partners.

BiodiverCity shows a couple of interesting angles of how to create commercial solutions from testbeds. One angle is the importance of a shared understanding of what work is to be done, and a shared language. Basic terms like products or markets carry different meanings depending on our professions, the organisations or companies we work for, and our past experiences.

Developing two value chains was not easy, and was never carried to fruition. One party believes there was no clear vision or business plan. It was also unclear who was responsible for what.

The project manager, who is a biologist, says:

"I come from the other direction. I am an ecologist so for me, the market has quite clearly shown that developers, private and municipal construction companies, are the target group and potential customers. That may be too vague (…) But, for an ecologist, it is perfectly sufficient."

Another important angle is to know what tools can be used when public and private bodies collaborate. Finally, a testbed has access to certain resources, but it is how they are used that is at the centre. It therefore a question of how to organise resources and create structure and routines for how the testbed is utilised.

A testbed for blue-green urban solutions

Augustenborg took the next step in its knowledge journey during the last quarter of 2016. Vinnova approved a five-year funding plan to make Malmö districts Augustenborg and Sofielund testbeds for blue-green urban solutions. Blue-green solutions are considered to have enormous potential to grow, but opportunities for testing have been limited. The project has therefore given producers of different types of blue-green technologies a space to test and evaluate their solutions, which will stimulate development and business in the sector.

The project is led by the City of Malmö, and is run together with the Scandinavian Green Roof Institute, Malmö's municipal housing company (MKB Fastighets AB), Sustainable Business Hub, the Swedish University of Agricultural Sciences (SLU) and the IVL Swedish Environmental Research Institute. Scientists have been included in the project, primarily researchers from the Swedish University of Agricultural Sciences and IVL Swedish Environmental Research Institute. The Sustainable Business Hub adds market expertise and both it and the IVL Swedish Environmental Research Institute are used to running testbeds for environmental technology.

During the project's initial years, it focused on how to develop and utilise the testbed. This included the design and use of the physical site, but also the testbed's organisation and business model. For instance, solutions were needed for who owned the testbed, how to finance it, and if it should be run commercially.

In 2019, the testbed was formalised as the Blue-Green City Lab (BGCL). The lab's purpose is to test and verify products and components for blue-green solutions. The hope is that BGCL will encourage people and organisations to buy and install these new and, at times, unconventional solutions. Examples of blue-green solutions that can be tested in the future include green roofs, green facades, stormwater systems, biotopes, urban gardening and environments designed for outdoor learning.

An important point in the development of the project was the decision that the testbed should encompass the whole of Malmö. This means that different parts of Malmö can help develop the testbed and make it visible and accessible to citizens around the city. This allows cooperation between the city's organisations and exposes the people of Malmö to the project.

There were already testing surfaces on walls and roofs in the districts of Augustenborg and neighbouring Sofielund. In the summer and autumn of 2019 a collaboration with municipal parking company Parkering Malmö installed green walls on two of the city's car parks.

Insights and future challenges

The development of Augustenborg and Blue Green City Lab demonstrates the lengthy process needed to create a testbed for things as situationally specific as blue-green solutions. The work in Malmö has erased geographic borders. No longer is a small enclosed area considered the testbed, instead the whole city is involved. This creates opportunities to test solutions, but at the same time dilutes the draws for external field trips and other similar visits.

What exactly is a testbed?

The testbed concept is used in several contexts today, and many parties define it in different ways. A frequently quoted definition is Vinnova's:

> *"A testbed is a physical or virtual environment where companies, academics and other organisations can collaborate to develop, test and implement new products, services, processes or organisational solutions in selected areas."*

RISE, the Research Institute of Sweden, is tasked with making testbeds more accessible and maximising the use of testbeds that already exist, while meeting future demand for new ones. Through the Testbed Sweden project, RISE has created a channel and a network to increase awareness of testbeds, the benefits they can bring in bringing an idea to fruition, and to share strong market examples. According to Testbed Sweden, a testbed:

- is or is made available, and is kept open, for users outside the testbed's own organisation
- lasts beyond a single project
- is not confined in its use to one product, service, process or user
- is intended to test and develop new products, services and processes, with other words, not a display or a showcase.

Testbed Sweden also highlights that it is possible to describe testbeds through their "hardware", defined as their physical infrastructure (equipment, facilities, ways of measuring, location and so on), and their "software", which is competence, organisation, service offering or business concept. Testbed Sweden also says that a well-designed testbed effectively integrates both hardware and software so that it adapts over time alongside its users.

The City of Malmö was an early adopter of blue-green solutions. What is taken for granted today was unique when the journey started. A major challenge has been, and remains, how to conduct business between public and private bodies. Municipalities and municipal companies are major procurers and drive demand for new blue-green solutions. Municipal housing company MKB has been an important and valuable partner in bringing solutions to market.

Text: Caroline Wigren Kristoferson, Håkan Rosqvist

Image by Monika Månsson/City of Malmö

The lessons from the Eco-city Augustenborg's blue-green solutions are spreading in Malmö. In 2019, a collaboration with municipal parking company Parkering Malmö saw green walls being installed at the Anna car park, among other places.

When making the testbed financially sustainable the Scandinavian Green Roof Institute considered procuring ready-made or nearly ready-made solutions. The thought was that the producer would sell at cost, while the buyer would pay full price, with the difference going to BGCL which does tests. In addition, BGCL can offer procurement or maintenance help, which are other services they could sell to fund their operations. This business model has not yet been implemented within the project. One major question is of course whether companies are willing to sell at cost, and if they can make ends meet doing so.

Another tool would be a PPI. PPIs are public-private innovation partnerships and have been regularly used by the Danish public sector. In a PPI, the contracting authority works with companies to explore innovative solutions to specific challenges it faces. At its conclusion, the contracting body buys a product or a service. The PPI process is an exploratory phase.

The PPI agreement is co-operative and the contracting authority may have more than one collaboration. The agreement has four stages:

1. The contracting authority chooses which company or companies it wants to collaborate with during the project.
2. Terms are negotiated.
3. A PPI agreement is written, that is to say a collaboration around joint development. The agreement delegates ownership, usage rights and the right to market the fruits of the collaboration.
4. A public report is produced to showcase the collaboration's results.

It is important that the companies that are part of a PPI are not given preferential treatment in future procurement.

A PPI allows the parties to work together in confidence to jointly develop new knowledge during a limited period of time. The solution is tested on a small scale, allowing user experience to be taken into account.

A successful collaboration requires the parties to agree on common goals, and to assign costs. Transparency is also important, to allow the public body to run an open procurement in which the private party can bid.

As PPIs explore new fields they can result in new intellectual property rights. It should therefore be clear from any agreement who the rights will rest with. The authority must not be given the sole rights to the result, as that would mean the collaboration becomes a service procurement and public procurement laws would need to be applied.

Like in many agreements, the parties' goals may change over time. A PPI agreement can be terminated at any time. It is worth planning how to communicate this to users, politicians and officials. The process must conclude with a report which shares lessons, so other companies are not disadvantaged during potential future procurement.

Only few PPI agreements have been implemented in Sweden, but under the right conditions it can be a way to innovate through a collaboration between public and private actors. A PPI was used by waste management firm Nordvästra Skånes Renhållnings AB, to examine the conditions for on-demand waste collection.

To make BGCL a successful testbed, it is vital to identify ways to include private businesses. It is also important that different parties that influence the city's development are open to blue and green solutions. In Malmö, only Parking Malmö has so far implemented a new commercial solution.

Summary

Augustenborg is undoubtedly unique in how it applies blue-green solutions to increase the range of urban ecosystem services. There are few similar examples and above all none that environmentally regenerated a nearly 70-year-old residential area. But the dissemination of the innovation and solutions that were developed in Augustenborg has in many cases been limited, even as other solutions have spread. The work to establish a testbed for blue-green solutions in Augustenborg and utilise innovations and success stories shows that it is still difficult to commercialise the products and services. These ideas need extensive collaboration between many different types of actors in order to spread.

Stakeholder participation in the regeneration of Ekostaden Augustenborg

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Edwin Klint Bywater (translation)

Over the past decades, the United Nations has advocated for a people-centered approach to the development of sustainable cities and neighborhoods and urged urban authorities to promote and enable meaningful stakeholder participation in decision-making (United Nations, 1992; 2012; 2015; 2016). Participation can be defined in many different ways. Common to all definitions is the active role of those that are affected by a decision, to influence the decisions and the decision-making process (Smith, 1983; Rowe *et al.*,2004; Reed, 2008; Martinez-Avila, 2018). It has been argued that the inclusion of local knowledge can contribute to the development of an urban space that is adapted to the context and encourage the development of a safe urban space which is lively, inclusive and sustainable (Jacobs, 1993; Innes and Booher, 2004; Friedmann, 2010; Calderon and Chelleri, 2013; Wilkinson and Sayce, 2015).

Ekostaden Augustenborg in Malmö, Sweden is an example of how stakeholders have been involved in the regeneration of a neighborhood. The purpose of the project Ekostaden was to transform Augustenborg (built 1948-1952) to a socially, economically and environmentally sustainable neighborhood. The regeneration project was initiated in 1997, and since then the City of Malmö, the municipal housing company MKB (who owns and manage all the houses in the area) and local citizens have made efforts to engage in participatory activities to address the complex challenges in Augustenborg (Kazmierczak and Carter, 2010). At the earlier stages of the regeneration project, Swedish municipalities were working with the Local Agenda 21, which was an action plan that strongly promoted stakeholder participation at the local level, to foster sustainable development (United Nations, 1992). At that time, participatory processes were strongly supported by politicians. In Rolfsdotter (2009), Ilmar Reepalu, the mayor of the city of Malmö expressed a firm belief that participation by the local community was a key factor for a more sustainable city. Ekostaden Augustenborg was initiated using money from Naturvårdsverket, the Swedish Environmental Protection Agency, and specifically its Local Investment Program för ecological transition (LIP), a program focusing on engaging local residents

in planning and implementation of projects for education, employment and the outdoors environs. In 2010, Ekostaden Augustenborg received the UN Habitat World Habitat Award for the efforts made to engage the local community and for integrating social, ecological and economic sustainability aspects in the regeneration of Augustenborg (UN Habitat, 2010).

The aim of this chapter is to describe some aspects of the stakeholder participation initiatives that have been implemented throughout the regeneration of Augustenborg. The findings are based on a document analysis covering reports and other internet sources from different Augustenborg related projects, and interviews with three key stakeholders. The document analysis aimed to trace different participatory efforts, while the interviews focused on gaining information from actors that have direct experiences in working with local community participation in Augustenborg. The interviewees were: Trevor Graham, former project leader of Ekostaden Augustenborg and responsible for the stakeholder participation process; Ann-Sofi Högborg, Svenska Landskap, landscape architect involved in the collaborative green redesign of the courtyards in Augustenborg and Frida Persson, sustainability project manager at MKB and responsible for engaging residents in the Greenhouse project. The interviews were semi-structured.

The municipality of Malmö and MKB have each played a major part in the initiation of the participation initiatives in Augustenborg. However, there have also been cases of participatory initiatives initiated by individual residents and community groups. These different participation efforts can be categorized as either top-down participation (driven by the municipality and the municipal housing company MKB), or bottom-up participation (driven by the residents of Augustenborg). The focus of this chapter is primarily on the top-down participatory activities Ekostaden Augustenborg and the Greenhouse-project.

Ann-Sofi Högborg led consultation on how the gardens would be developed. Image by Marc Malmqvist/City of Malmö

Overview – participatory processes in Augustenborg

Below are descriptions of participatory processes initiated by the municipality and MKB (top-down) followed by those initiated by residents and community groups (bottom-up).

Participatory efforts initiated by the municipality or MKB - Top-down participation

Many of the participatory activities have been initiated by either the Municipality or MKB. At the outset of Ekostaden Augustenborg, an ideation meeting was organized by MKB and the municipality, which brought together stakeholders from the public and private sector as well as civil society to develop ideas and solutions for a sustainable neighbourhood – around 400 people participated in the event (Rolfsdotter, 2009). One issue, known since earlier, emerged as a priority during the meeting – the flooding problems in the area. According to Stefansdottir (2013), two residents with specialized knowledge in stormwater management offered to contribute to finding a solution to the problem. In the next phase of the project, a communication channel was established between the project and the residents, which entailed, among other things, a door-to-door campaign informing about the idea of the Eco-city (Ekostaden) and to engage residents towards active participation (Stefansdottir, 2013). Early on, participatory activities were also developed in relation to the redesign of the courtyards in Augustenborg (Ann-Sofi Högborg). Since 1998, a yearly event known as Ekostaden Day has been organized by MKB along with local organizations and businesses, as a way to create a forum and showcase for local sustainable development.

In later stages of the Ekostaden development, residents have also been involved in various projects. In 2010, MKB initiated a project concerning urban agriculture and provided residents with raised gardening boxes to grow food in community allotments in the neighborhood (Manola, 2013). Later on, support from the Green Roof Institute and MKB was given to develop raised garden beds at Augustenborgstorget (Trevor Graham). In 2014 MKB started the construction of the so-called Greenhouse, which is a multi-storey residential building with 46 housing units. The building is profiled as sustainable and is equipped with unique features that support sustainable living such as; gardening facilities in both private balconies and in the communal roof terrace; a household waste management facility and a communal laundry, designed to increase social interactions among the residents. The residents who first moved into the Greenhouse were involved in the design and implementation of raised garden beds in the rooftop garden (Frida Persson). Another project mentioned in conducted interviews aimed at changing the design of Augustenborgstorget, the central meeting place in the area. The project was led by MKB and included a participatory process involving several residents and an architect. The project resulted in new benches and other seating arrangements on the square.

Participatory efforts initiated by the local residents – Bottom-up

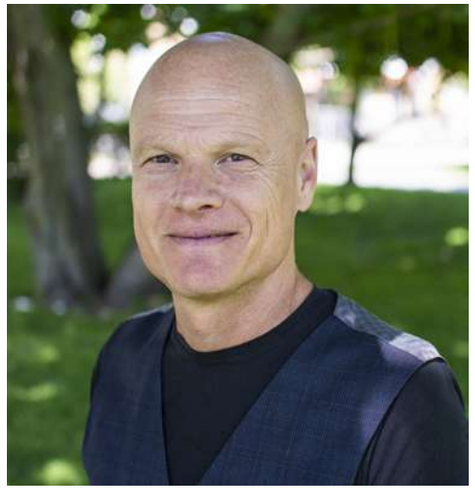
One example of projects initiated by local residents is the creation of a multi-sports arena aimed at encouraging young people to engage in sports and activities and create a meeting point. Another example is a survey carried out by the residents indicating a problematic traffic situation in the neighborhood. Planners considered the input, and the main thoroughfare Augustenborgsgatan was restructured and traffic was reduced significantly, also reducing traffic safety around the local school. Another example of a participatory initiative started by a local resident is Gnistan, an after-school club where parents can leave their children when they go to work or to adult school (see page 120 and 125). Gnistan runs a range of activities, both indoors and outdoors, and offers homework assistance as well. In 2017, the Gnistan Association took over the activities from the municipality, and they are now being run with support from the municipality and MKB.

Several growers-networks have also been established by residents. One which is active to this day is “Växtvärket”, an organisation involved with growing crops and centering learning for children around this (Frida Persson). Previously, a branch of the organisation Hemmaodlat was also present which specialised in hydroponic cultivation.

Participatory efforts between MKB and the local school

Since the start of the Ekostaden project, MKB has collaborated with Augstenborgsskolan in several ways. The schoolchildren have been involved in an annual cleaning-up the neighborhood event and received money, which has gone to charity projects. The school has also been engaged in household waste management activities such as; making art out of waste, to show how to sort the waste; co-design of a recycling station in the schoolyard as well as a music themed playground and garden in the Augustenborgsparken park (Rolfsdotter, 2009).

Image by Marc Malmqvist/City of Malmö



Trevor Graham, project manager for the Eco-city, focused early on active discussion to foster trust.

In what way did participatory processes manifest in Ekostaden Augustenborg and Greenhouse?

The participatory processes described in this chapter can be viewed from three perspectives: (1) trust-building (2) timing, level of ambition and aims of participation, and (3) participatory culture. These three perspectives have been identified through an iterative process involving interviews, documents analysed and scientific literature about participatory processes. Each following segment consists of two parts: what has been done to promote each perspective and what hurdles have been encountered.

Trust building

Trevor Graham was appointed as a project manager early on in the process to plan and implement a strategy for local engagement in Ekostaden Augustenborg. In the beginning of his engagement in the project, his main concern was to find a role for the local community. His focus was to develop close dialogue with the residents in order to breed trust. "We started working on an informal basis to engage the local community having different types of informal and unstructured interactions with people in the neighborhood". As a part of the trust building process, a local office was established in Augustenborg. Trevor asserts that the office facilitated easy reach-out both to the residents and the community organizations working in the neighborhood and describes the interaction as: "It was a two-way thing, we were helping them and they were helping us. For us, it was important getting to know the people and identify where the creative forces were in the area", and: "We spent a lot of time on building close relationships, so that people felt that they were taken seriously".

Ann-Sofi Högborg, who worked on the design of the courtyards, had a long experience, from the UK among other places, with participatory processes. When engaged in the Augustenborg project she used this experience to create trust in the process and where the keywords for a successful participation are; "listen and respect". She argues that it is through listening that the problems emerge and she gives one example where a bench was placed near a balcony which led to unwanted noises for the people in the apartment. This problem surfaced by talking to residents. Another important aspect of participation was opening up for the possibility to give each yard its own hallmark design. That the dialogue leader is knowledgeable within his or her field (in this case landscape architect) is of great importance in building trust.

Ann-Sofi also brought up an example where trust might corrode: starting a dialogue process with the residents without following through with action. MKB switched property manager, also rendering a smaller budget for gardening. The change led to more of a technical and less of a knowledge-based garden management, in turn leading to less engagement from residents. A result of this lack of knowledge was exemplified by Ann-Sofi: an unfortunate event in which all bushes were cut into ball-shapes, not recognising the fact that some bushes thus die or stop flowering, which was the main purpose with planting them in the first place. She added that what the inhabitants wanted is actually quite low cost to maintain, but the right knowledge is needed.

One of the purposes of the multi-apartment house, the Greenhouse, was to provide the inhabitants with spaces for growing and cultivating and to ensure some kind of self-governance of the communal growing areas. According to Frida Persson from MKB who was responsible for this process, many initial meetings were required, especially as nobody in the house knew each other and no previous structure for collaboration existed. To this end, early on in the project, a joint Facebook group was established for the new tenants of the Greenhouse to communicate with each other. Through the Facebook group, MKB and the facility management group could better meet and identify the needs and concerns of the tenants and the residents created relations among themselves and could easily get in touch with MKB. The Facebook group also became a platform for sharing and exchanging resources and services such as tools and babysitting. According to Frida Persson, the Facebook group was a successful means for communication in the Greenhouse project and the inspiration for the development of an app, aimed at improving the communication between MKB and its tenants in a wider context.

Frida Persson also gave an example of how trust is something that has to be maintained continuously if engaging with stakeholders. MKB had promised to provide soil to the tenants so they could start growing in their balconies when they moved into their new homes. Before the new tenants arrived, Frida realized that there was no soil in the building, so she acted immediately to fix the soil, as to give the tenants a flying start with their cultivation.

Challenges that are mentioned in relation to trust building concerns the lack of continuity of the participatory activities (Trevor Graham and Ann-Sofi Högborg) the difficulty of keeping the participatory spirit up over time and that participation also require the development of collaborative structures between the inhabitants (Frida Persson).

Image by Marc Malmqvist/City of Malmö

Frida Persson Boonkaew, strategic project manager for sustainability at MKB, is responsible for consultation with tenants in Greenhouse.

Timing, level of ambition and aims of participation

According to all three respondents the level, timing and objective of the stakeholder participation has varied across time. All three respondents agree that the chief aim has been solving concrete sustainability issues by identification of solutions. To reach these different targets, various methods have been used such as door-to-door communication, advisory functions and workshops in co-design. Door-to-door methods have been used for instance by Trevor Graham in the startup of the Ekostaden-project, as to inform about it. Workshops in co-design have been used by Frida Persson and Ann-Sofi Högborg.

In several cases, the participatory currents have taken shape once projects were already in motion. This, according to Trevor Graham, is due to Ekostaden having been developed from a top-down perspective (the municipality and MKB). One of the first instances of participation in the Ekostaden-

project was the meeting which gathered 400 participants, taking place in the onset of the project (Rolfsdotter, 2009). None of the respondents supplied detailed information about this meeting, making its exact aims and ambitions hard to determine.

Two of the respondents mentioned a series of workshops arranged in order to improve the design of Augustenborgstorget (the local square), resulting in new benches and other seating arrangements (Trevor Graham and Frida Persson). This process involved residents from beginning to end, indicating a high level of ambition.

In the Greenhouse project, the residents were involved only once the building was finished and the first tenants were moving in. Thus, no participation was present in architecture or design regarding the building. They were however involve in the design of the green areas in the rooftop terrace of the building as well as in smaller sustainability projects such as and in the development and implementation of a small-scale aqua phonic farming facility in the basement (no longer present), projects concerning energy consumption, sustainable mobility and aspects of sharing-economy (Frida Persson). Although residents weren't involved from the onset, the level of participation should be regarded as high on basis of the depth and multiplicity of factors involved.

The challenges which are discernable in relation to timing, level of ambition and aims are: Participatory processes are often instigated late in the projects when ideas have, to a large extent, been set in stone, i.e. the ambition pertaining to participatory intimacy is lower. The aim of participation has, many a time, been designing solutions to relatively narrow-scope problems rendering a loss of long-term engagement in participation. Trevor Graham, who was involved early on, claim that resident's engagements have decreased with time, and that one of the reasons for this could be lack of consideration of longer timeframes pertaining to participation. Ann-Sofi Högborg mentions that too much time passed between meetings with the residents and actual actions, as well as a smaller budget.

Participatory culture

Participatory culture consists of two parts, one entailing in what fashion participation is included into the organization and one pertains to knowledge about, and structures for, who participates and how processes are formed.

An important challenge in Augustenborg, according to both Trevor Graham and Ann-Sofi Högborg, was the lack of long-term commitment, which was negatively influenced by changes in personnel, values and priorities in the driving organizations (MKB and Malmö municipality). All three interviewees argued that even though there were high ambitions in the early outset of the project, these ambitions decreased over time due to a general lack of participatory culture. According to Trevor Graham, a systematic approach to the participatory efforts would have been beneficial for the long-term sustainability of the participatory processes in the area. However, as this did not exist, the initial interactions were therefore based on an informal and gut feeling approach to the engagement of the local community. Frida Persson brings forward a similar line of reasoning as she had no defined strategy to rely on but focused on her own development and a good communication structure with the residents. On a more personal level Frida Persson, argues that it may be difficult to involve and commit other colleagues to a participatory process, especially if participation is the task of one specific person. Trevor Graham, who has experiences from participatory processes both in England and Sweden, argues that the engagement of civil society regeneration projects is low in Sweden which makes the participatory efforts harder and more time consuming.

The difficulty to identify and reach out to a wide range of stakeholders was also mentioned by Ann-Sofi Högborg and Frida Persson. Högborg mentioned that many different types of persons were engaged in the design of the courtyards even if the age span 40-50 were more present. Frida Persson also surfaces the issues of only reaching certain groups: "we are just listening to those that are very

The annual Eco-city Day has been an occasion to come together in the area. In 2016 even more people than usual took part as Greenhouse was inaugurated that year. Image by Frida Persson Boonkaew/MKB

enthusiastic about the project. It is important to reach out to everyone, not just those that are proponents of the project, so we try to reach out to more people". Another issue mentioned by Frida Persson in relation to the lack of a participatory culture in the Greenhouse project was the hard job to keep the engagement going: "There were many participants in the beginning of the project but that number has been decreasing throughout the time. It is hard to keep the momentum. It is hard work to have people join our meetings''.

When Trevor Graham reflects upon participatory processes, he also mentions that deeper, committed, co-operation are unusual and that "there is a lot of work poured into ideas but not in changing the organizational structure. This undermines the whole point about participation".

In conclusion, the challenges, which can be noted in relation to participatory culture as understood here, are: long-term commitment and struggles with reach-out.

Concluding discussion in relation to scientific literature on participation

This chapter provided a glimpse to the efforts made by MKB and the municipality of Malmö to engage the local community in the regeneration processes of Augustenborg. These efforts have been championed by a few persons employed for a specific time period or for a specific project as a part of the larger process of regenerating Augustenborg. The process has led to many changes in the area and good partnerships between the local community, MKB and the municipality. Over time it has also enabled residents to start their own initiatives in the regeneration project. The outcome has led to an award winning neighbourhood which is word famous for its rainwater collection systems.

During the initial phases of the regeneration process, the municipality and MKB have made strong efforts to engage the local community in proactive ways as it was a prerequisite from the funding agency inspired by the ideas of Local Agenda 21. Research has shown that it is important that participation take place in different stages of a development process, especially as early as possible as participation in late stages provides minimal opportunities to influence decision-making (Reed, 2008; Martinez-Avila, 2018).

In the late 60s, Arnstein (1969) developed a typology of participation, in the form of a ladder with eight rungs, each representing a level of participation. The two lower rungs (manipulation and therapy) were according to Arnstein a strategy for

power holders to educate or cure the participants. The consecutive three levels (information, consultation and placation) may allow the citizens to be heard but decision makers still possess the power to decide based on their own interests. The upper three levels (partnership, delegated power and citizen control) allow citizens to obtain nearly full access to decision making or complete managerial control. Even if the level of participation has been quite high in terms of Arnsteins ladder, participatory efforts have, according to the three respondents, not led to the development of long-lasting structures for participation in the neighbourhood neither from the side of the inhabitants nor the municipality and MKB. Researchers have shown that if stakeholder participation initiatives and competences remain at an individual level (rather than mainstreamed at an organizational level), the engagement disappears or is disrupted if the personnel disappear (Martinez-Avila, 2018).

In the case of Augustenborg this seems to be due to the financing structure of the development project as well as a lack of municipal participation infrastructure. A long-term participation infrastructure is able to coordinate information flows between different stakeholders, host information about ongoing projects and integrate the input from the residents and other stakeholders in decision-making. The community facebook group developed at the Greenhouse and the local office created at the start of the first project are examples of participatory infrastructure between MKB and the tenants of the Greenhouse, which also inspired the prototype of digital application to be used in the whole of MKB. The placement of a project office in the neighborhood allowed the municipality to engage in close dialogue with the local community, which helped to increase the legitimacy of the project. Creating value for stakeholders, building trust and a basis for clear communication. Structures that need to be in place are, among others, processes for promoting information spread about ongoing projects, as well as processes for the integration of input from residents into decision making. The Facebookgroup created at an early stage of the Greenhouse project is an example of this kind of information-enhancing structure. This supporting function was then further institutionalized in the MKB-organization in the shape of a digital application with wider use inside of MKB. An early establishment of a local office helped the Ekostaden-project achieve dialogue between municipality and residents, and may have led to increased trust and legitimacy.

From the three interviews, it is discernible that the various Augustenborg-projects have mostly been concerned with solving concrete problems, rather than establishing more participation as such local level urban development. Research on participation has categorized three aims for participation: normative, substantive and instrumental (Fiorino, 1990; Bickerstaff and Walker, 2000; Stirling, 2006; Glucker *et al.*, 2013). The normative approach focuses on the democratic rationale and considering participation as an end in itself. The focus is on equality rather than on the quality of the process. The substantive approach focuses on participation as a means to an end and emphasizes the improvement of the quality decisions made. The instrumental approach, considers public participation as a means to re-establish credibility and trust, and legitimize decisions already made.

Thus, in Augustenborg the focus has been on substantive and instrumental arguments to participation rather than normative. This is in many ways logical as the regeneration project had concrete and practical goals. Research on participation confirms this picture and it has been argued that many project proponents often claim that the main objective for participation should be to generate legitimacy; therefore, motivations for the involvement of local communities have been instrumental rather than substantive and normative (Bickerstaff and Walker, 2000).

Participation has been criticized for not living up to its philosophies and for being merely a window-dressing-strategy to legitimize decisions already made (Checker, 2011; Rowe and Frewer, 2000). This has in many cases led to skepticism and distrust from the public who feel that their inputs have not been considered (Rowe and Frewer, 2000). In the case of Augustenborg, a mixed picture can be discerned. On the whole, the three respondents all seem to be of the impression that they have been able to generate trust among residents, whilst at the same time having had trouble with the lack of a more overarching participatory strategy.

Researchers have argued that in order for trust to take shape in a local community, project managers should engage participants in a meaningful and transparent way to foster long-term commitments (Teo and Loosemore, 2014). Long-term build up of trust also reduces the risk of conflict (Connick and Innes, 2003). With this study and previous research in mind, it is evident that long-term participation necessitates clear organizational structures, enough resources and intellectual capital and that processes are institutionalized into organizations. In a similar fashion to rain water management needing infrastructure, so is purposeful infrastructure needed for participation. In order to develop the full potential of participation, the focus ought to be managing with, not for, residents. In addition, adaptation to the local characteristics and context (social, economic, cultural, political) of the project is needed (Luyet *et al.*, 2012). With the teaching of Augustenborg in mind, it is important to, in future projects, define the big-picture purpose of participation. Furthermore, the municipality should construct structures lending support to participatory projects, whether the initiatives are top-down or bottom-up.

This short chapter is not able to provide the full picture of the participatory efforts in Augustenborg the last decades. However, remarkably small efforts have been made to evaluate these efforts and projects. The studies that have been performed have been in the shape of B.Sc and M.Sc theses, which have mainly focused on social sustainability in the context of participation (Elkhazzar and Nilsson, 2016; Xu, 2011) in the early stages of the regeneration project. These studies showed that earlier efforts of resident involvement in the regeneration project contributed to a stronger sense of community and social integration in the neighborhood. Since Augustenborg is often highlighted in sustainability contexts, more thorough and wide-spanning research is needed, looking into the participatory efforts in the area, covering all three sustainability dimensions. Such a study is currently being conducted by the authors of this chapter and will be published in a scientific journal.

Augustenborg from the perspective of sustainability history

Per-Arne Nilsson

Per-Arne Nilsson, senior environmental strategist and former head of section at the City of Malmö's Environment Department. He has worked with sustainable development at both local and global levels for many years.

Today, Augustenborg is one of our most important reference points when reaching for a more sustainable society and community development. But it has been a long road. The development in Augustenborg, and the knowledge, solutions and experiences that have developed there since the area was designed and constructed in the 1940s through until today, are unique and important from a local, national and international perspective.

This chapter places Augustenborg's sustainable development in a historical perspective. Because although our knowledge and vocabularies around what is sustainable societal development have changed, it is important to learn from past experiences and knowledge to allow us to solve the huge challenges we face today and in the future. Tage Danielsson put it well: "He who cannot look backwards, and refuses to look ahead, must look out!" (Samlade Dikter 1967-1967)

1940s-1950s

Augustenborg was built on the concept of the neighbourhood unit. In accordance with this concept, several large, uniform residential areas were built on the outskirts of the city with their own centre and identity. The homes were to be modern and have, for instance, hot and cold running water, gas stoves and indoor toilets. Augustenborg had its own coal-fired local heating plant that supplied homes with heating and hot water and housed a laundrette. There were schools, childcare facilities, green outdoor space and common facilities for theatre, cinema and other activities. The main idea was to provide good affordable housing. Augustenborg also kickstarted Malmö's municipal housing company, MKB. The neighbourhood unit concept was based on ideas of the welfare state but also the hope that good environments, health and hygiene could be a counterweight to the poor housing conditions that prevailed in the cities. In a radio series, and later book, author and journalist Ludvig "Lubbe" Nordström coined the phrase Lort-Sverige (Filth-Sweden). His reporting on the poor housing conditions across Sweden had a major impact in the public debate. In Skåne, where the radio series started, conditions were the worst and the series sparked the most heated debate. Augustenborg became an important reference point and testbed in building the welfare state and stepping away from Lort-Sverige.

1960s-1980s

In 1962, American biologist Rachel Carson published the book Silent Spring, which is usually described as the start of the modern environmental debate. Silent Spring described how increased use of agricultural chemicals not only threatened many of the birds that lit up spring with their songs, but also posed a risk to humanity and nature. The book had a huge impact across the world, in large part thanks to debates and programmes on the television, at the time a new technology. Silent Spring largely described the reality of Malmö and western Skåne as well. Even in the fields around Augustenborg, the environment had been damaged and birds had quietened. Over time, environmental questions morphed into worries about humanity's future existence on the planet. The UN organized the first global environmental conference in Stockholm in 1972. The concept of sustainable development was defined by the Brundtland Commission in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The idea was to combine environmentally, socially and economically sustainable development.

Housing construction in Sweden and Malmö developed during the 1960s into a large-scale industrial process. The neighbourhood unit ideal that characterised Augustenborg was abandoned for mass production, with scaled technology which had more in common with the high-rise buildings and housing cells inspired by Le Corbusier's functionalist ideas. Another trend was increased large-scale production of estates of detached houses, often on surrounding agricultural or natural land outside the cities. This was the core of the Swedish Million Homes Programme, an effort to stimulate the construction of one million new homes.

An important part of this development also supported car traffic. As a consequence many people relocated from the inner city in Malmö and other cities. Many higher earners were able to move to detached houses in neighbouring municipalities and commuted to work in the city. Many initially moved into new high-rises, but often only in passing before moving to single-family housing or more attractive residential areas. Increased relocation left more flats empty in Malmö and the city's population and tax revenue dropped sharply. This episode is usually called the "green wave" in Sweden. People fled the dirty and noisy city, to their own detached house in green surroundings and bought a car. In addition to this, increased immigration to Sweden brought new residents to the Million Homes Programme's vacant flats, further cementing problems of exclusion, poor integration, unemployment and poverty.

Community involvement in environmental and sustainable development issues both locally and globally grew strongly in Malmö and the rest of Sweden. The concept of eco-building developed, and several so-called eco-villages popped up for people who tried to live sustainable and environmentally friendly lives as far as possible.

In Augustenborg poverty and segregation increased.

The 1990-2020s

In 1992, United Nations representatives of countries and organisations around the world gathered in Rio de Janeiro for the Conference on Environment and Development. It was the largest UN conference to date and reached an important milestone when the delegates unanimously adopted the Rio Declaration and Agenda 21 – a comprehensive programme of action for the environment and sustainable development. The conference also recognised that humanity's impact on the atmosphere, climate, oceans and forests must be addressed. The guiding principle was that sustainable development must permeate both global and local social development. Sustainable housing and construction must be developed. Learning, spreading knowledge and supporting local efforts and examples were at the centre. Many young people and youth movements attended the Rio conference. In Sweden,

Image by Andre de Loisted

Malmö can learn a lot by pausing occasionally to look back at the environmental historical development, says Per-Arne Nilsson. Augustenborg is an especially interesting example.

and in many other countries, they came to exert strong pressure on the municipalities to work locally with Agenda 21. Environment and sustainable development began to increasingly characterise Swedish politics and discourse and Agenda 21 developed into a broad popular movement. Political debates included visions of "the eco-cycle society", "eco-cities," "the green welfare state" and "rebuilding a sustainable Sweden," among other things. This eventually also sparked major government investment. Among other things, the major new local investment programme for environmental conversion (LIP), the government's billion-SEK eco-cycle investment Kretsloppsmiljarden, the climate investment programme (Klimp) and various government schemes to support innovation and development (see page 56 on how the schemes were used in Augustenborg).

In 2015, the UN General Assembly in New York unanimously adopted the new 2030 Agenda for Sustainable Development with 17 sustainable development goals. The City of Malmö was the first municipality in Sweden to decide the global goals should become its own development targets. Later that year, a global climate agreement was adopted in Paris establishing an important framework for local and global efforts. Lately, "Testbed Sweden" which aims in part to "make Sweden a permanent global showcase of how to build a climate-adapted welfare society while also boosting exports" has become one vision for how Sweden can meet the targets of the 2030 Agenda.

Sweden's entry into the European Union in 1995 opened new funding channels for environment and sustainable development projects. This became an important part of how Augustenborg was developed. It also allowed officials to share and exchange their knowledge and experiences with other cities across Europe.

In the early and mid-1990s, the City of Malmö was in a difficult financial situation. It had been one of Sweden's richest municipalities in the mid-1960s, with significantly lower council tax rates than the national average. But by 1993 the city had built the largest municipal budget deficit in Swedish history. This was in large part a consequence of the Million Homes Programme, the green wave, the industrial crisis and problems of poverty and integration. Malmö managed to balance its books through a new government policy which transferred wealth from rich municipalities to poorer ones and by selling assets, including Malmö Energi, the energy utility, and shares in Sydkraft. The development of MKB was another key economic contributor.

In the Augustenborg of the early 1990s problems and challenges were on the rise and the district was singled out as one of Malmö's most vulnerable areas. As a result, Augustenborg became part of one of the first major EU projects in Malmö. The Urban project combined social development efforts with data and analysis on how the situation could be improved. In addition to growing social problems as people moved, communities became more segregated and unemployment rose, the question arose whether it was wise to keep an industrial area that housed the municipality's public works activities so close to people's homes. Furthermore, the drainage system in Augustenborg was faulty and basements often flooded when it rained.

In 1997, leading representatives from MKB, the Internal Services Department, water utility VA-verket and the Fosie District Administration met to discuss how to work together to develop Augustenborg and overcome their challenges. The parties agreed to develop the Eco-city Augustenborg together. At the same time, the Environment Department was commissioned to coordinate a joint grant application to the local investment program (LIP) for environmental regeneration in Malmö. Augustenborg became one of the main focuses of the LIP application. When Anna Lindh, the environment minister, gave a press conference in Malmö to announce the city would be one of the first to receive a LIP grant, Augustenborg was the natural backdrop. It was also natural that a few years later the whole government, led by Prime Minister Göran Persson and Anna Lindh, embarked on a field trip to Augustenborg to learn about the progress that had been made.

The collaborators hired a joint project manager from the United Kingdom to run the Eco-city project. From 1998 to 2003, he provided important knowledge and experience of local regeneration and cross-departmental collaboration (read more about his experience on page 31). With major efforts from, among others, MKB, the Internal Services Department, the Streets and Parks Department, the water utility VA-verket/VA Syd, the Fosie District Administration and the Environment Department - and with additional support from the government and the EU - the Eco-city Augustenborg became one of the most important examples of, and testbeds for, sustainable development. Social innovation projects such as Gnistan and the rabbit hotel (see page 120), and the establishment of the Green Roof Institute (see page 149), became important parts of the development and innovation.

In 2001, a landmark year, Malmö hosted the Bo01 housing expo. The Western Harbour and the Eco-city Augustenborg became international leaders and highly regarded examples of sustainable development. They were also important testbeds and development areas for sustainable development in Malmö. A lot of what was developed in Augustenborg and the Western Harbour has spread further afield, and even projects that were discontinued provided valuable experience.

The development of Augustenborg has become part of the wider story of sustainable development and the transformation of Malmö, together with the Öresund Bridge, City Tunnel, the transport system, development of new and city districts and regeneration of existing areas and nurturing of culture and business. Augustenborg is perhaps most important as an example to areas where there are still major obstacles to sustainable development, not least those linked to social challenges. But the transformation of Augustenborg can never be considered complete. It is an ongoing effort. By 2020, the social situation in Augustenborg has once again deteriorated somewhat, as major changes are happening in its immediate surroundings. This may make it necessary to one again embark on a more coordinated sustainable development drive in Augustenborg.

LIP and the grants that funded Augustenborg

Is Augustenborg a single project or an ongoing process? To an outsider, it is easy to see the area's development as a series of project-financed initiatives. But from property owner's MKB's perspective, this is one area of many. MKB has a constant presence in Augustenborg and for them development is an ongoing process. And if you live here, Augustenborg is your home and your life, regardless of how it develops.

It is clear, however, that significant funding from the local investment programme (LIP) kick-started the development of the Eco-city Augustenborg. The Eco-city and its sister project Bo01 in the Western Harbour, started an era where several large development projects in Malmö developed with support of external money from national and international funders.

As the concept behind the Eco-city emerged in the mid-1990s, there were a series of environmental investment grants to apply for. The grants gave both cause and effect. Their availability allowed some existing plans to be realised in part, but the grants were often not big enough on their own and required additional funds from the City of Malmö and municipal housing company MKB. But the way the grants were structured also encouraged applicants to develop ideas that fit into their framework, in order to secure finance.

The LIP grants that Augustenborg won were part of larger applications from the City of Malmö and its partners. The applications were coordinated by the Environment Department, but each partner made their own application. Peter Lindhqvist at the Internal Services Department was largely responsible for formulating the projects that formed the first application, in collaboration with Christer Sandgren from MKB.

Tables 1 and 2 show the details of the two LIP funding rounds that were granted to Augustenborg, according to the Environment Department's archives in Malmö. The applications were written by various stakeholders, but were coordinated and submitted by the City of Malmö. Once they had been approved, the city's municipal board decided whether the grants should be accepted. The tables below are taken from the decision documents that the City Executive Office produced. The amounts in brackets are the final costs according to Malmö City Audit Office and are the figures that were shared with the Swedish Environmental Protection Agency, which processed applications and granted funds.

Bengt Persson, PhD, landscape architect and former senior lecturer specialised in dissemination and cooperation at the Swedish University of Agricultural Sciences.

Projects linked to the Eco-city Augustenborg (figures from final report in March 2002 in brackets)	*Total cost, thousands of SEK*	*LIP grants, thousands of SEK*	*Other financing, thousands of SEK*
1. Project management, environmental management, quality assurance and project design	11,333 (11,458)	3,400 (3,400)	7,933 (8,058)
2. Local environmental management of stormwater	7,333 (10,115)	2,200 (2,200)	5,133 (7,915)
3. Local waste management	8,500 (8,638)	2,550 (2,550)	5,950 (6,088)
4. Environmentally adapted electric local transport	7,333 (9,894)	3,300 (3,330)	4,033 (6,594)
(5. unavailable)			
6. Environmentally adapted renovation of yards, squares and trafficked areas	11,333 (11,418)	3,400 (3,400)	7,933 (8,018)
7. Resource management	6,333 (8,112)	1,900 (1,900)	4,433 (6,212)
8. Environmentally adapted redevelopment to a media and cultural centre	1,212 (1,570)	400 (400)	812 (1,170)
9. Environmentally adapted regeneration of school grounds and parks	3,125 (7,298)	2,000 (2,000)	1,125 (5,298)
10. Recovery of cultural and historical conditions as part of energy project	15,000 (16,930)	4,500 (4,500)	10,500 (12,430)
(11. unavailable)			
12. Running an Eco-city	500 (500)	200 (200)	300 (300)
TOTAL	**72,002 (85,933)**	**23,850 (23,850)**	**48,152 (62,083)**

Table 1. Allocated funds according to government decision numbered 19980326 dnr M97/3891/9 on LIP grant of SEK 146,700,000 to the City of Malmö (with partners), of which SEK 26,350,000 for Augustenborg. The compilation of grants and co-financing is taken from the documentation for the municipal board (before the meeting and decision 1998-11-18) 1998-11-03 from the City Executive Office. The final amount is reported in brackets and is taken from the final report "Slutrapport LIP 1998-2000" from Malmö City Audit Office, submitted to the Swedish Environmental Protection Agency on March 25, 2002.

Comments on the outcome in Table 1 according to the Audit Report from the Malmö City Audit Office, 2001:

Action 2: The LIP application set a target to drain 90% of the area (81,000 sqm.) through local disposal. This was changed when more detailed investigations revealed that 60% of the area could be covered by the SUDS (sustainable drainage systems). The topography presented problems as inclines were not steep enough, or faced in the wrong direction, and the stormwater canals ran into electricity mains or district heating culverts. The result was that 40% of the surface was drained using sustainable urban drainage.

Action 3: In the time between when the application and goals were written and when the project was completed, the total amount of waste was reduced by half. The quantitative targets that 500 tonnes/year would be composted and 500 tonnes/year recycled could therefore not be met as the total amount was below those levels.

Action 4: There were fewer passengers than expected. One reason for this was that the electric train used a different payment system to other public transport in Malmö.

Action 7: This action was designed to reduce the use of energy and water in 1,600 apartments, in the school and in the industrial park. In the apartments, the consumption of electricity, water and hot water was to be reduced by 10% and the school and industrial park would reduce their use of non-renewable energy by 20%. The residential housing achieved reductions of 5%, but this was also including Action 10. External changes and changes to activities in the industrial park meant that the goals were both achieved and not achieved.

Action 10: The facade materials and stairwells of five apartment buildings were to be restored. When changing the facades, additional insulation was installed. This was meant to reduce energy consumption by 9%. But, as it is not possible to measure how much energy individual buildings use, it is impossible to conclude whether the goal was reached.

Projects linked to the Eco-city Augustenborg (figures from final report in March 2007 in brackets)	*Total cost, thousands of SEK*	*LIP grants, thousands of SEK*	*Other financing, thousands of SEK*
10. Energy efficient living	16,575 (3,096)	4,973 (929)	11,602 (2,167)
11. Renewable and recycled energy/solar thermal heating, solar cells, energy recovery from ice rink	22,500 (6,266)	3,375 (2,538)	19,125 (3,788)
12. Living and working in an Eco-city	3,350 (2,370)	1,525 (1,185)	1,825 (1,185)
14. Electric carpool, key management	64 (0)	32 (0)	32 (0)
17. Quality control, coordination and evaluation	3,100 (2,439)	1,178 (927)	1,922 (1,512)
TOTAL	**45,589 (14,717)**	**11,083 (5,579)**	**34,506 (8592)**

Table 2. LIP grants for Augustenborg between 2002 and 2005. Funding decision taken 2002-06-05 by the Swedish Environmental Protection Agency Dnr 751-463-02 Hi (M2001/4086/Lip). The final amount is reported in brackets and is taken from the final report "Slutrapport LIP 2002-2005" from Malmö City Audit Office on 2007-05-08.

Comments on the outcome in Table 2 according to the Audit Report from the City of Malmö's Internal Audit Office, 2007-05-08:

Action 10: Installation of individual metering in 1,850 apartments. Only completed in two buildings (100 apartments), and in addition a new local MKB office was equipped with environmental profiling regarding interior design and technical systems.

Action 11: Only 420 sqm of solar thermal collectors were installed, instead of the 1,000 sqm that were planned. The ice rink was twice the size of what had been planned, at 400 sqm. Solar cells were installed in accordance with the application.

Image by Ove Jonsson/Bilder i Syd

Anna Lindh announces the first LIP grants in 1998 in Augustenborg.

Action 12: Public education, using green ambassadors. Was tied to Action 10 as the "soft" part of the same target. However, as Action 10 deviated from the initial plans, the focus came to lie on cutting carbon emissions instead of investing in green ambassadors. The action has also supported initiatives by local companies and associations. Information on energy conservation has been spread to residents through several channels.

Action 17: Aims to coordinate ongoing initiatives and maintain the contacts in the area established by previous action. Taking care of field trips was another part of the action. Has maintained contact and collaboration with MKB. Collaboration with Malmö University.

Additional project financing in the areat

The application included the construction of a botanical roof-garden. That project did not get funding from LIP or co-funding from the City of Malmö. Instead, the project was granted SEK 7 million from the EU's LIFE programme. This, however, required the national government to provide as much money. The Internal Services Department then applied for funding from the so-called the billion-krona eco-cycle fund (Kretsloppsmiljarden) and was granted SEK 7 million. These applications were not handled through the Environment Department but by the Internal Services Department. It has been impossible to retrieve documented versions of these decisions, and other documents, from the City of Malmö's archives. Instead the information is based on an interview with Peter Lindhqvist from the Internal Services Department, conducted in February, 2017.

The first major project financing in Augustenborg was followed by many others over the years. You can read more on page 37 about funding from Vinnova or on page 144 about the GreenClimeAdapt and BiodiverCity projects, among others.

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The planned housing of the welfare state (Folkhemmet)

Tomas Tägil

Tomas Tägil, PhD, architect, senior lecturer LTH School of Architecture, Lund University, whose 1996 thesis was on the architect Hans Westman and regional characteristics. Is interested in the history of residential architecture.

Plans for Augustenborg first started being drawn up in 1945 as a district of peace and welfare, a vision of a safe and democratic society. It was also a sign of Malmö's quest to ensure the welfare and living conditions of new and old Malmö residents which combined the best of rural cohesion with the comforts and freedom of the modern city. All this may sound arrogantly heroic. Walking through Augustenborg today it is difficult to see these old dreams of a model society with the naked eye.

Augustenborg is similar to most other residential areas that were built in the late 1940s and early 1950s. But the transformation into an Eco-city in the 1990s and 2000s is on show. The district's history is important to understand today's Augustenborg. It is a story of the relationship between ideals and reality, about dreams of the future and setbacks, and about the connection between society and architecture.

Augustenborg was built between 1948 and 1952 and in many ways symbolised something new in Malmö's urban planning history. A single developer was going to construct an entire new district for the first time. It was also the first test for the new housing policy that had been introduced in Sweden between 1945 and 1947. Augustenborg was furthermore the beginnings of municipal housing company MKB's operations and the first large-scale neighbourhood unit in Malmö.

Friluftsstaden paved the way

The first mover was however not Augustenborg. The pioneer in Malmö was the builder Erik Sigfrid Persson who started to build Friluftsstaden (the Open Air Neighbourhood) during the Second World War. The first stage opened in the summer of 1944 with the living exhibition Vi bo i Friluftsstaden (We live in Friluftsstaden). Visitors could explore a new way of building a residential area with uniform terraced houses in a fenceless park and a single street that arched through the area. Another novelty was that the area had a community centre, with shops, a shared heat plant and small apartments for maids who would help the residents with cleaning, laundry or babysitting. The project was a close collaboration between Erik Sigfrid Persson and the Head of the Malmö City Planning office Erik Bülow-Hübe[1]. Friluftsstaden was one of the first neighbourhood unit built in Sweden. The urban plan was adopted in 1942, before neighbourhood unit planning had become a well-known concept.

Source: Stadsbyggnadskontoret i Malmö

Drawing for the general plan from 1945, established by Erik Bülow-Hübe.

The Malmö of Bülow-Hübe and Lindman

In many ways Friluftsstaden was a sort of feasibility study for Augustenborg. They share features such as uniform architecture, delimited areas and abundant greenery. In a sketch from 1945 which formed part of Malmö's general plan, Bülow-Hübe drew a district in Augustenborg where a similar softly winding street ran through the area. The street later became Augustenborgsgatan. Just as Köpenhamnsvägen divides Friluftsstaden into two halves, in Augustenborg Grängesbergsgatan would bring through traffic north to south, and back again. In the summer of 1946, the now retired Bülow-Hübe was succeeded by Gunnar Lindman, who joined from the consultancy VBB. He settled in Friluftsstaden, an area he both appreciated and used to show use as a role model[2]. Lindman took over where his predecessor had left off, working on both the general plan and the planning of the first major peacetime project, Augustenborg.

Malmö was to be expanded as a dense city with no separate suburbs, Gunnar Lindman said. That differed from Stockholm, where the city was planned around a series of suburban enclaves that gathered around the new subway system. In Malmö, there were no topographical obstacles or nature to consider, and the city could therefore be denser.

[1] Wittstrand (2007)
[2] Hårde (1986): page 122

The city plan for Augustenborg had already been adopted by the planning committee the summer that Bülow-Hübe retired, but it was at the time unclear who would build there. In November 1946, the municipal housing company Malmö Kommunala Bostadsaktiebolag (MKB) was formed. Chairman Axel E Svensson chose Augustenborg as the first project the new public housing company would embark on. It seems MKB asked for the entire district to be put under its responsibility, and this was granted.

MKB wanted to develop even more than was allowed under Bülow-Hübe's plan. Lindman's task was to revise the already adopted plan and compromise between his client's requirements and the plan's approach to light and greenery. A new city plan drawn up between 1947 and 1948 for the eastern part of the district allowed the buildings to be slightly taller than before. This time, planners adopted a so-called elastic city plan, which meant that the location and shape of the buildings was not drawn on the map. Development rights were instead regulated in a text that specified the maximum gross floor area, the heights of buildings, the number of floors and the distances between the buildings[3]. This flexibility allowed the developer to make changes. There was a non-binding illustration plan as an appendix to illustrate the plan's intentions.

Despite these changes a third city plan was needed and adopted in 1949. MKB wanted to build loft apartments. The reason the city plan was "thickened up", as Bülow-Hübe had put it, was the rapid population increase and huge housing shortage. From around 60,000 inhabitants at the turn of the century, Malmö had reached approximately 170,000 in 1945. When Augustenborg was built, the city was adding in the region of 4,000 inhabitants per year. New housing was also needed for those who had formed new households and for those in cramped and outdated inner-city housing. Augustenborg was to house around 5,600 people when it was built between 1948 and 1952.

Though Lindman met MKB's demands, the basic features of Bülow-Hübe's plan remained unchanged. The winding main street Augustenborgsgatan was still there, as was the central park and other public space. The most striking difference was a new square with shops and community facilities such as a heating plant and a daycare centre. These additions defined Augustenborg as a neighbourhood unit. However, Södra Grängesbergsgatan, the road that was meant to run north-south, was never fully implemented. It does not seem that a road for through traffic was ever built across the Augustenborgsparken park - it became a walkway instead. Avoiding through traffic went counter to the idea of neighbourhood units. Even in the north, Södra Grängesbergsgatan was split by the railway track that stretched to Ystad and ran parallel to Lönngatan until 1955.[4]

Neighbourhood units

Neighbourhood unit planning was the big new innovation in Swedish urban planning during the 1940s. Influential builder Erik Sigfrid Persson in Malmö may have become acquainted with the neighbourhood movement in the USA around the start of the world war. He had lived in Chicago in 1939 and 1940 and came into contact with the so-called Community Center Movement[5]. One of the movement's leaders was Clarence A. Perry, who in 1929 coined the term "neighbourhood unit" as part of the development of New York's regional plan. Perhaps Persson also visited the Radburn community in New Jersey, where a central car-free park formed the backbone of the city plan. But neighbourhood thinking was not new, it had permeated the garden city movement around the turn of the century. What the Chicago school did was to connect urban planning with sociology, that is to establish a relationship between man and architecture. Perry's 1929 definition of a neighbourhood unit in New York's regional plan had six points: size, demarcation, open spaces, institutions, shops, and the internal traffic network[6].

Size was determined by how many children New York City believed should go to each Elementary School, about 1,000. This meant that the area's population should be around 5,000 people. If more than half of the land was used for housing, a neighbourhood unit could, according to the area's standard, be fit into a square that measured half a mile on each side (about 800 metres). If the school was centrally located, children would have an appropriately long walk to school and the

National housing policy at a municipal level

Augustenborg was the first residential area in Malmö to be designed according to a new housing policy that was adopted in stages between 1942 and 1947. The back story is long, and is described in depth in other books, but the key decisions were:

- 1933-47: A government inquiry into social conditions in housing (Bostadssociala utredningen) included, among others, architect Uno Åhrén, the main proponent of neighbourhood planning. The inquiry grew in importance through Alva and Gunnar Myrdal's 1934 book Crisis in the Population Question (Kris i befolkningsfrågan). Led to support for so-called "barnrikehus", which provided accommodation to lower income families with many children.
- 1942: Introduction of rent controls and state-backed credit support. In order to obtain government loans, developers had to live up to a series of standards, including a lower limit to how small the homes could be. This became known as the Westholm Bible. Grants for community spaces were agreed.
- 1944: The Social Democrats' post-war programme. One issue dealt with was housing. The land and apartment buildings in the cities would be gradually transferred to municipal ownership.
- 1945-47: The investigation into social conditions in housing (Bostadssociala utredningen) published its final reports in stages. Part 1 from 1945 included Uno Åhrén's chapter "Planned community development" which advocated neighbourhood units and "community centres" to be part of the detailed planning of society. An appropriately sized neighbourhood unit had around 6,000 inhabitants.
- 1945-47: Proposals for new construction laws and a construction charter were presented in 1945 and approved in 1947. Therese allowed municipalities to decide where, when and how new buildings could be built. The municipalities were handed a "planning monopoly" and new buildings were only allowed if they followed an established urban plan. Comprehensive spatial planning was introduced with regional and general plans that had some legal force.
- 1946: A parliamentary decision allowed non-profit housing companies to borrow up to 100% of the cost of buying housing, cooperatives could borrow 95% and private actors 85%. The new rules favoured municipal non-profits run for the public benefit. By 1949, such organisations already accounted for 40% of the construction of new apartment blocks. It helped rationalise construction and large-scale operations. It provided new opportunities to build shared facilities, such as laundry rooms and nurseries, something that was based on Alva Myrdal's concept of easing housework and allowing women to enter the labour market.
- 1947: The housing supply act (Bostadsförsörjningslag) gave municipalities an obligation to plan the supply of homes and administer state loans. It also increased opportunities for municipalities to take decisions affecting land and the design of the new development (the flexible plan).
- 1948 Family housing allowances were introduced for families with at least two children who were housed in modern homes.

[3] According to §1: "The distance between the fronts of the buildings must not be less than twice the height of the tallest building". PL257, City of Malmö
[4] The tracks remained until 1972/73
[5] Hårde (1986), page 91-92
[6] Franzén & Sandstedt (1981) page 151 f

playground. The delimitation meant that through traffic would be routed around the neighbourhood unit and not dissect it. In Perry's America, the car was already informing planning decisions in 1929, and if traffic was routed outside the neighbourhood unit it preserved both safety and the area's identity. Open spaces mainly consisted of parks and recreation areas for play and games, both for children and adults.

Source: City of Malmö website. Historical maps.

The Malmö of Bülow-Hübe and Lindman. Illustration plan, Augustenborg 1947

Institutions such as schools, churches and theaters were important in Perry's vision. Schools were particularly vital and Perry believed they could also double as a community centre which opened to associations during the evening. The school building therefore became the neighbourhood unit's main community centre. In Augustenborg's city plan, there was a larger public area in the southern parts of the district. It was not until 1956 that the Augustenborgsskolan school was built there. But it was not the school but the shopping square that became Augustenborg's visual and real centre. This is how Sweden interpreted the centre of the neighbourhood unit, against Perry's idea that shops should be relegated to the edge of the neighbourhood unit, as customers would drive there. In Augustenborg, a detailed plan was drawn up for the central square and which shops would be housed in its 29 units. For a modern planner MKB's specificity seems odd. It wanted: seven dairy shops, three grocers, three butchers, two bakers, two tobacconists, two haberdashers, two hairdressers, one barber, and a crafts and toy store to name just some of the examples[7]. Perry's sixth point was an internal traffic system reserved primarily for residents. To avoid through traffic, streets should be lightly curved so their destination was hidden to drivers. Traffic should also be separated from pedestrians as far as possible. Culde-sacs that ended blindly were good because they created room for larger contiguous parks. Traffic separation was the idea that survived the longest from neighbourhood planning. Most new residential areas in the 1960s and 70s were designed to separate vehicles and people.

Compared to Norra Guldheden in Gothenburg (1944 to 1947), Årsta in Stockholm (1943 to 1945) and other well-known neighbourhood units from the 1940s such as Torsvikshöjden in Lidingö (1944 to 1947) and Rosta in Örebro (1947 to 1951), Augustenborg was more densely developed in accordance with the policy not to build suburbs in Malmö. However, Augustenborg never became as well known. It is not mentioned in the "Fyrtiotalets svenska bostad" (Swedish 1940s housing) collection which came out 1950, nor in international publication Sweden Builds (1950 and 1957). This is likely because Augustenborg was not completed until 1952, when the initial enthusiasm for neighbourhood units had already started to subside. There was no housing exposition and Augustenborg lacked Guldheden's spectacular clifftop location above Gothenburg or a skilled marketer like Uno Åhrén. The architecture in Augustenborg was also rather low-key, even a little anonymous. The houses were designed by Svenska Riksbyggen's architects in Stockholm and no named architects worked on the project.

[7] During a review in 1953 it is clear that the planned shops actually were realised. According to Pfannenstill (1953) there were seven diary shops, two grocers, two self-service shops, three butchers, two fish and vegetable shops, two florists, two bakers, two tobacconists, two haberdashers, two hairdressers, one barber, one cobbler, once electric appliance shop, and one kiosk. The line-up shows how small scale the business was.

Architecture for the majority

Augustenborg's architecture had typical 1940s characteristics such as brick facades, traditionally proportioned windows and gable roofs. The houses were rhythmically puntuated by gabled avantcorps along the broadside, which in traditional architecture could be called frontispieces. The architectural design was something completely different to the 1930s functionalism of Ribersborg but similar to other contemporary areas built in a 1940s Folkhem-style. It was modern and traditional at the same time. Nor was an eye-catching centre built in Augustenborg as it had been in Årsta in Stockholm. The district did not get experimentally designed apartments like Guldheden in Gothenburg or innovative buildings like Rosta's star house in Örebro. Augustenborg was simply low-key and ordinary. In light of Malmö's recent spectacular architectural designs such as Kronprinsen, Bo01 and Turning Torso, it is fair to wonder why Augustenborg was so ordinary. One explanation was probably that Augustenborg was largely more a political project than an architectural one. It was built for workers who wanted basic welfare and those who moved in were happy with what MKB marketed as "bright, spacious homes with ample storage space". In addition, the greenery, playgrounds and amenities were unlike the often cramped and outdated central housing that the newcomers came from. For these people,

Typical details from the 1940s: brick facades, traditionally proportioned windows and gable roofs. The houses were surrounded by greenery and in the middle the area was anchored by a park, Augustenborgsparken, with play areas for children of all ages. Image by MKB

Augustenborg was "so lovely", a quote that Bertil Aunér used in his title for a 2008 book about Augustenborg.

Augustenborg, housing policy and MKB

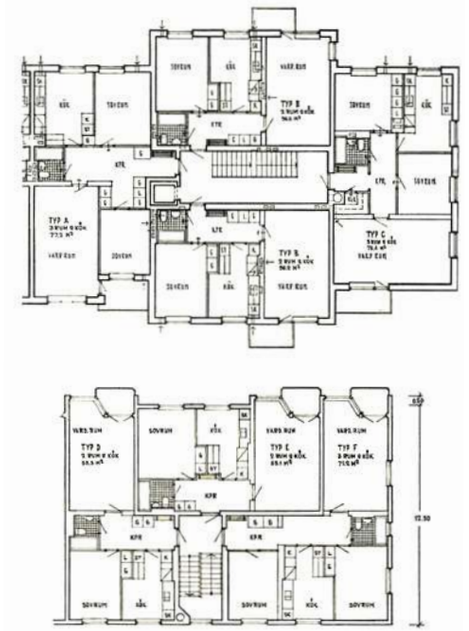
A new national housing policy paved the way for Augustenborg. A decision to allow the formation of public housing companies was particularly important. The proposal had been signposted well in advance and Malmö had prepared for its passing. A motion was put in front of the City Council

on 14 September 1945 to establish the forerunner to Malmö's municipal housing company, MKB - formally established on 17 November 1946. The new chairman would be Social Democratic City Council member Axel E Svensson, who had facilitated the construction of so-called barnrikehus (accommodation to lower income families with many children) in Malmö during the 1930s to provide accommodation for families with several

Excavation started in the fields of Augustenborg in February 1948 and the first tenants moved in on March 1, 1949. Construction ended in 1951 and the grand opening of the centre took place in May 1952. Image by Sydsvenskan/Bilder i Syd

children[8]. The business began on April 1, 1947 with the city plan for Augustenborg from the summer of 1946 already on the table. One could think that such a big project was too much for a newly started company to pick first. But MKB could count on support from both national politicians and those in Malmö.

First ground was broken in the western parts of Augustenborg in February 1948. The constructors then continued house by house eastward. The first houses were ready for their new occupants on March 1, 1949 and in 1951 construction ended before the district was finally formally launched



Pfannenstill (1953) includes drawings of some apartments in Augustenborg

in 1952[9]. A total of 34 buildings were erected, including six with six storeys, 12 three to four storey buildings and 16 three-storey constructions with or without attics. They had space for 1,538 apartments, of which 57% had two rooms and a kitchen and 36% three rooms and a kitchen. The population in 1952 was around 5,600 strong, just below the size chosen by Uno Åhrén as most suitable for a neighbourhood unit. That meant an average of 3.6 residents per apartment.

[8] Aunér (2008): page 23 f
[9] Aunér (2008): page 33

The apartments would be of different sizes, not only to reflect differently sized households but also to combat segregation. Since the two-room apartment recommended by the social conditions in housing inquiry (Bostadssociala utredningen) was the most common apartment size in Augustenborg, it can be assumed that households were usually formed of two parents and two children. Today apartments with two rooms and a kitchen are considered small for a family of four. But in the 1940s many families still all lived in the same room[10]. The new housing policy kept rents down. A newly built two-room apartment in Augustenborg cost SEK 95 per month[11]. Eventually, children grew up and moved out. Others upgraded to more spacious accommodation and from a peak in 1961 of 6,300 inhabitants, the population had halved by 1989[12].

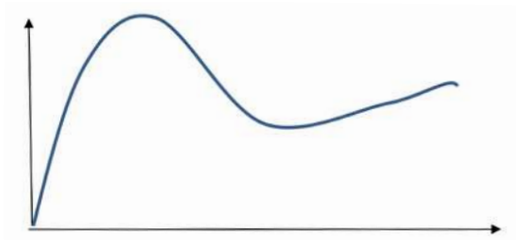


Figure 1. The number of residents in MKB's Augustenborg apartments between 1949 and 2018.

The apartment blocks in Augustenborg followed common practice in Malmö with fairly wide houses measuring 12 metres. This normally meant three apartments per storey, one of which was single-sided, that is to say windows only facing one direction. The depth of buildings was discussed extensively in Swedish housing circles at the time. In Stockholm, the city wanted so-called narrow blocks about nine metres deep, which provided better lighting but higher construction costs as only two apartments fitted on each floor. To assess the advantages and disadvantages of narrow blocks and deep blocks a committee commissioned the building of three apartment blocks in Dammfri based on the Stockholm, Gothenburg and Malmö models, respectively between 1950 and 1953. The latter was designed by planning manager Gunnar Lindman and his successor Gabriel Winge. It turned out that the Malmö model was cheaper to build, and the rest of the country switched to using "southern" block widths[13].

Boys doing craftwork and girls painting porcelain. From Pfannenstill (1953)

A key idea behind the neighbourhood units was that amenities and recreational areas should be easy to access. This idea was a common thread from Alva and Gunnar Myrdal in the early 1930s to the final reports from the government inquiry into social conditions in housing (Bostadssociala utredningen) between 1945 and 1947. Since Augustenborg was built by a single company, these issues fell to MKB. For some services, the company was able to utilise economies of scale. For instance, the district heating plant and the laundry which

[10] Nylander (2013) page 98
[11] According to Statistics Sweden, an industrial worker would be paid around SEK 4 per hour, meaning that rent took around 10% of an earner's gross salary.
[12] Aunér (2008): page 75
[13] Bebyggelseregistret, Swedish National Heritage Board (1999) and Tykesson & Magnusson Staaf (2009), page 45

were built in the centre of the district. Alva Myrdal believed it was important that housewives should be relieved of heavy housework and getting someone else to do your laundry saved a lot of time. Another issue was to provide childcare so women could work. Early on, Augustenborg had plans for a nursery, also by the centre. That this was a special feature was clear when Queen Louise attended the inauguration in 1952[14]. In addition, several common rooms were opened in the basements of the residential buildings. There was even a theatre (see A community theatre , page 127). Idyllic photographs from the 1950s show, according to the age's gender norms, boys doing woodwork while the girls paint porcelain or sew[15].

A central park that tied the area together was also the hallmark of the Swedish neighbourhood unit. In Augustenborg, the park curved slightly through the southern part of the district and bordered the site that was to become the Augustenborgsskolan school in 1956. Playgrounds were created for younger children and older ones had access to several games areas. The park could get lively as there were more than 1,000 children living in Augustenborg[16]. It was designed by city gardener Birger Myllenberg[17] and is part of the illustrations attached to the 1948 city plan. To only speak of the Augustenborgsparken park in this context, however, skews the picture slightly. In fact, it is difficult to differentiate parks from housing plots. The greenery flows between the houses and the courtyards. This was the original intention. The district would be "buildings placed freely in greenery"[18] as a brochure from 1950 states. The fluid boundary between park and plot was an idea developed in Malmö as early as the 1930s and the city plan's regulations stipulated that yards not be fenced off. That was the case in Augustenborg, fence-free planning had apparently become the norm.

In old photos from when Augustenborg was newly built, the district looks almost car-free. Car ownership was unusual in the area's early days. In Malmö, there were about 5,000 cars in 1947, or 28 per 1,000 inhabitants. A survey in 1953 showed that nearly half of all residents took the tram to town, the tram stopped on Lönngatan in the northern edge of the area. The survey further found that 13% took the bus and 35% cycled to the city. It is possible that the remaining 6% may have included someone who drove a car, but that is not apparent from the survey[19]. Nevertheless, cars were a factor in planning the area from the beginning. The city plan includes drawings of underground garages and the designers of the illustration plan drew out special parking spaces. In the end, more were built than originally planned. Planners realised in the 1950s that the growth of car ownership had been underestimated. The master plan for Malmö in 1956 included a major change. From 110 cars per 1,000 inhabitants previously, officials now planned for around 300 cars per 1,000 people by 1970, or around a car per household. In Augustenborg the number of cars would double. The authors of the general plan believed that Malmö would have to be adapted to increased car traffic in future. A district with Augustenborg's winding, narrow local streets had in just a few years become obsolete. Many years would pass before city planners began to question

Image by Gunnar Persson

Augustenborg was not built for extensive car ownership. When the area was built, most people took the tram, bus or bicycle.

[14] Aunér (2008): page 45
[15] Vi bygger och bor på Augustenborg (1950)
[16] Pfannenstill (1953), page 90 says there was a population of around 5,600 of whom 1,145 were children.
[17] Malmö 1862-1962 (1962): page 24, Persson (1986): page 68
[18] Vi bygger och bor på Augustenborg (1950)
[19] Pfannenstill (1953), page 19

Children playing on the Augustenborgstorget square a single car driving past. Image by Sydsvenskan/Bilder i Syd

the car's formative role in urban development. But the 1956 car ownership forecast proved fairly accurate by 1970. From then on it continued to increase to a peak of about 400 cars per 1,000 inhabitants, before declining slightly. At the same time, the number of parking spaces normally required per apartment has dropped to between 0.5 and one.

Augustenborg evaluated

The housing policy of the 1940s and neighbourhood planning were rooted in sociology. The neighbourhood unit was intended to create the security and belonging which would foster welfare and democracy. This was the Swedish Folkhem welfare state, and responsibility fell to the state and the municipalities. The architects joined in and advocated a new kind of urban planning to create neighbourhood settlements.

Augustenborg was a clear example of this. Everything was governed by the "righteous hand of the public sector" without any commercial interference. The municipality drew-up urban plans, issued building permits and allocated land. The developer was the newly created municipal housing company MKB, which built homes at cost. Politicians sat on the board and controlled the distribution of apartments to counter segregation. National standards were established to guarantee housing was modern, bright, spacious and practical. Government loans were introduced to keep rents lower and offer better housing standards. A municipal housing agency ensured new apartments were distributed fairly. Electricity, water, waste collection and public transport were handled by municipal enterprises and authorities also guaranteed access to meeting rooms, parks, playgrounds, ball fields, schools, nurseries and laundry facilities. Augustenborg was built without participation from commercial interests. The only private enterprises were the small shops, but even they were regulated as to what they could sell. It was a sort of planned economy but without compulsion. Completely different from the society we see today.

Intentions were pure. The goal was to create a welfare society with democratic and secure people. In that way it was a reaction to the dictatorships of the 1940s, whether fascist, nazi or communist. The neighbourhood units would be small communities, and not mass societies. It would be a modern form of the old rural communities living with its consensus democracy.

Everything was carried out in a very short time. Once the new housing policy had been introduced and districts like Augustenborg completed, the state and municipality began to ask themselves if the investment had paid off. They needed to evaluate the results. As soon as Augustenborg was finished, MKB commissioned Bertil Pfannenstill at the Department of Sociology at Lund University to perform a sociological study[20]. It was meticulously carried out and residents were sent a huge questionnaire asking about their views on the area and their homes as well as neighbours and amenities. As a sociologist, Pfannenstill was primarily interested in one question: "Have social measures in the housing policy contributed to a change in how people view their neighbourhood and their neighbours, even if they belong to different segments of the population?"[21] Exactly what the survey concluded is a little unclear. The area was new and not

[20] At the time there were no research councils or institutions, so public bodies had to turn to the universities.
[21] Pfannenstill (1953), page 6

yet properly established. Most seemed satisfied, some dissatisfied. No particular group cohesion around Augustenborg and the neighbourhood can be evidenced from the answers in the survey. Oddly, this was not noted, despite it being an important part of the neighbourhood unit.

Lennart Holm, who later became director general for the national planning agency, also failed to comment on the neighbourhood unit as a concept in his evaluation for MKB in 1958, five years after Augustenborg was completed. Holm's evaluation was intended to see how the housing situation and well-being had been changed, so as to provide a foundation for further public initiatives. About 200 households were interviewed and the questionnaires were processed in an early computer. The outcome was similar to what Pfannenstill had found in 1952. Contacts with neighbours were still limited and lower than in comparable neighbourhood units such as Rosta or Baronbackarna in Örebro. Material welfare had not boomed in Augustenborg. There were still relatively few cars, and only 6% of households had a television. Overcrowding was Lennart Holm's main concern in 1958. On average, nearly four people lived in each apartment. This was considered crowded as there were only two rooms in most apartments. He found that 18% of young people slept either in the kitchen or in the living room. The lessons to take from Augustenborg were best expressed by MKB director Sture Nyström, who wrote in the afterword: "It seems Swedes generally try to push down the cost of housing so they can afford cars, televisions, summer houses and foreign holidays. Such distorted investment priorities should be corrected through education."[22]

The inauguration of Augustenborg at the local square in May 1952. Image by Sydsvenskan/Bilder i Syd

In the new housing policy and neighbourhood units, architects had envisioned opportunities to shape questions of security, democracy and welfare through their buildings. Was there a debate? Did Uno Åhrén, a steadfast advocate of neighbourhood planning, meet any resistance? No, not much. There were exceptions though. Art historian Göran Lindahl used an opinion piece in Dagens Nyheter in 1951 to say neighbourhood planning was more governed by functional than social considerations[23]. Over time, doubts grew. In his 1967 book Svensk stadsplanering (Swedish Urban Planning), Kell Åström wrote: "By housing residents in small units that one individual could have an overview of, the authorities wanted to foster a community spirit. But this did not turn out as planned. Economic, social and technological developments were so clearly pointing in a different direction."[24] Another factor that removed the shine from the neighbourhood units was the social problems that arose after a couple of years, despite all the good intentions, as population turnover increased. In this sense, Augustenborg was no different.[25] The leisure and community facilities were not enough.

Research into the neighbourhood unit often refers to Ferdinand Tönnies' concept 1887 writings about Gemeinschaft and Gesellschaft. Gemeinschaft is characterised by positive attitudes towards each other. It is based on the softness and reverence, benevolence and respect found in kinship, friendship and neighbourliness - relationships that are intense and close. In old peasant societies, Gemeinschaft would be formed through joint work, or responsibility for the land. Gesellschaft is similar to Gemeinschaft but is distinguished in Tönnies's definition by being artificially constructed. Despite commonalities, citizens are separated from each other. They take care of themselves, maintain their integrity and view their neighbours with suspicion. In this definition Gemeinschaft is good, while Gesellschaft is evil. A neighbourhood without positive and close relationships represents Gesellschaft, not Gemeinschaft.[26] Projected onto Augustenborg, Tönnies's theory would be that the neighbourhood unit was intended to create a community, but that - according to Pfannenstill's 1953 housing survey - close ties were not formed between neighbours. Residents did not interact closely with one another. People did not form ties and comradeship through work, and complaints over annoying children and neighbours show that Augustenborg, as with other neighbourhood units, was more characterised by Gesellschaft than the Gemeinschaft that had been hoped for.

History is normally clearer in the rear-view mirror. The neighbourhood movement did not really come to an end until much later. The Million Homes Programme came in between, as did the reaction against it. In 1981, however, Mats Franzén and Eva Sandstedt published their doctoral thesis in sociology titled Grannskap och stadsplanering (Neighbourhood and urban planning). It was an ambitious and extensive study of how the neighbourhood unit was developed and built. The authors emphasised the need for theory to understand the phenomena, something they felt had been missing from previous research and throughout the historical phase.

The neighbourhood unit was in many ways built on romantic ideology, not hard research. Like Göran Lindahl in 1951, Franzén and Sandstedt concluded 30 years later that functionality had overtaken social considerations in the neighbourhood unit. This was in part because of limited knowledge of housing sociology.

Franzén and Sandstedt's reasoning can be applied to Augustenborg. Turning the district into a unit followed functionalist views of a functionally differentiated city in accordance with zoning theory, rather than a rural village. Why Augustenborg should feel separate to other parts of Malmö, like a countryside village, was never motivated. The size and dimensions of the neighbourhood unit was determined by tradition. The recommendation that a neighbourhood unit should have 6,000 inhabitants was based on school catchment areas. Such measures have however changed along with economic and political waves. The motivation behind cutting the neighbourhood unit off from the outside, while fostering internal ties was seen as social. The assumption that such planning methods would create social cohesion was based on what Franzén och Sandstedt would call pure assumptions, rather than scientific evidence. More specific conclusions were also drawn, including observations that the neighbourhood unit mostly catered to families with children, who only make up one part of society. In addition, the neighbourhood unit's design was adapted to cars, without any question. Finally, the authors said, the neighbourhood units like Augustenborg were planned by experts. The sense of community was demanded on high from politicians, planners, builders and architects.

Regardless of your views on the ideas behind neighbourhood units such as Augustenborg, they offer a fascinating story. Successful or not - the district's development was at least driven by ideological goodwill towards Malmö's inhabitants. At a time of intense discussion around housebuilding, which is now dominated by the market economy, a time when the public sector created the means to solve the housing issue seems very distant. Now 70 years have passed. Augustenborg has once again become a model district for an important social issue, that of sustainable urban design.

[22] Holm (1958), page 20
[23] Franzén & Sandstedt (1981), page 78-79
[24] Åström (1967), page 59
[25] Aunér (2010). City of Malmö website.
[26] Franzén & Sandstedt (1981), page 44-45

Augustenborg before 1948

The Augustenborg area traces its origins back to two farms - Augustenborg and Sofiedal - and the surrounding land that had been split from the village of Västra Kattarp in 1805. The Augustenborg farm was in the east and Sofiedal in the west. The name comes from merchant August Thomas Löhr who bought one of the farms in 1811. However, the farm supposedly had another owner named Carl Silow. Silow kept the western part for himself, where the school is located. During the 19th century, ownership passed from hand to hand several times. In 1821, dye-maker Johan Daniel Ruhe bought the farm. Ruhe's wife Sofia gave her name to the other farm, Sofiedal.

Sofiedals gård

The Augustenborg farm was bought by the City of Malmö in 1918 and today only the manor house remains. The Sofiedal farm was demolished in 1955 and the Augustenborgsskolan school was built on the site. The area is in the southeastern part of Malmö and its borders are the streets Lönngatan in the north, Ystadvägen in the south, Lantmannagatan in the west and the Kontinentalbanan railway line in the east.

Postwar Malmö

In 1940, during the Second World War, Malmö had a population of 155,506 inhabitants. Over a decade the population had increased by 35,000 as people flocked to the industrialising city, putting pressure on housing. There were significant problems with overcrowding. By the end of the war, for instance, half of the city's apartments had only one room and a kitchen. The net migration was especially high between 1946 and 1948. One explanation was that more people were starting families and birth rates jumped. As real wages rose, more pressure was put on the housing market.

The Social Democrats spent 66 years from 1919 to 1985 leading the city's development. Their strategy was to buy land, land ownership and steer the city's physical development. This had a major impact on future housing production.

Amid a global recession in the 1920s, there were major housing shortages and high unemployment in Malmö. At this time builders threw up emergency

Göran Rosberg is a former head of communications at the City Planning Office in Malmö. He was involved in the entirety of Malmö's transformation from an industrial city to a city of knowledge and experiences.

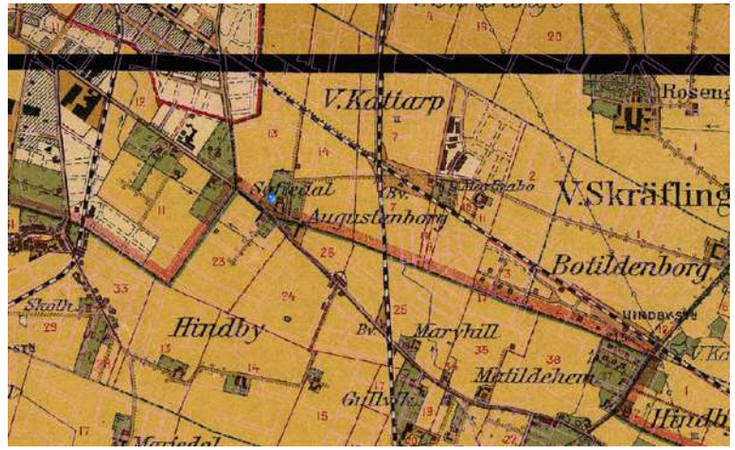


Image by City Archives, City of Malmö

District map of Augustenborg.

housing and cheap accommodation for workers. It was also then that some detached houses were built outside the city as part of the "egnahem" movement, which encouraged lower income takers to get their own home. At the end of the 1930s, however, housing production peaked and in 1938 around 3,300 apartments were completed. In 1946, Malmö's municipal housing company (MKB) was formed, followed two years later by the local housing authority which aimed to fairly distribute the newly built apartments. As an example, in 1954 there were 17,000 housing applicants waiting for a home. Malmö was an attractive city with many jobs on offer. The influx to the city continued to increase sharply. Its largest employer was the Kockums shipyard. In 1945, around 25,000 people were employed in the city's industry, one in five of those at Kockums. Other significant industries were the textile industry and the food industry.

After the Second World War, few houses were demolished. In the mid-1940s, Malmö was a fragmented city. The expansion of the inner city had been formed around neighbourhood ideas. In between there were enclaves of detached housing and some working-class neighbourhoods. There was also undeveloped farmland not far from the city centre.

A special housing renewal inquiry was appointed at the beginning of the 1950s. It was not until the late 1950s and 1960s that the demolition of the older housing stock, such as the Lugnet and Caroli districts, picked up speed.

The Folkhem

The idea of a "Folkhem" (people's home) was launched 20 years before Augustenborg was built, by the leader of the Social Democrats Per-Albin Hansson, who would later become known as the father of the nation. Augustenborg was MKB's first project and became a shining example of how this new welfare state could be built. The Folkhem was about more than just improving housing conditions in Sweden. It also aimed to create better living conditions, so the concept should be viewed in a social context. The goal was to create a welfare state. Alongside the housing policy, a new social policy included unemployment insurance, improved state pensions and a new family policy. In summary, there were three important building blocks that formed the Folkhem (see page 65):

- a government inquiry into social conditions in housing (Bostadssociala utredningen)
- new building laws which made planning a municipal monopoly
- increased municipal involvement in housing issues through public housing companies.

Alva and Gunnar Myrdal took a large part of the responsibility for implementing much of this. They were inspired by a study trip to the US, where they learnt about the so-called Chicago School's ideas about social change and the social life of cities. They also laid the foundation for the social conditions in housing inquiry, which presented proposals for regulations, financing, division of responsibilities and administration, based on political visions. The inquiry ran between 1933 and 1947, but the proposals could not be realised until after the end of the Second World War. However, a state subsidy was introduced for the municipalities to create the so-called "barnrikehus" which housed lower income families with many children. In Malmö, the Solgårdar foundation was formed, as the forerunner of municipal housing company MKB.

Production declined during the war but gained new momentum after the end of the war. Housing demand increased again, as people came to Malmö from the surrounding localities and region as well as migrants from abroad, fleeing the devastation of war. Housing demand also increased after the marriage age was lowered.

The social conditions in housing inquiry's final report recommended that municipal housing companies should be given beneficial loans of up to 100% of the cost of a new development. This discussion gave birth to Malmö Kommunala Bostadsaktiebolag (Malmö Municipal Housing Company), which was formed on November 19, 1946. Six months later, MKB was given a lease for the Sofiedal area. It became the housing company's first major investment.

Architecture in the Augustenborg neighbourhood unit

Tomas Tägil

Tomas Tägil, PhD, architect, senior lecturer LTH School of Architecture, Lund University, whose 1996 thesis was on the architect Hans Westman and regional characteristics. Is interested in the history of residential architecture.

The houses built between 1948 and 1952 in Augustenborg are "products of their time" in being typical of Swedish 1940s architecture. This style can be seen in the gabled roofs, traditional facade materials like brick or render, clear evenly spaced windows and delicate detail in carpentry and balconies. The houses are also built at an angle so they form courtyards, not closed off as in the pre-functionalist era, but fairly open so as to link with the park.

This architectural style has sometimes been seen as an intermediate period between the functionalism of the 1930s and the modernism that broke through gradually in the 1950s. In Malmö, this shift is evident when comparing Augustenborg and, for example, Lorensborg which was built between 1956 and 58.

The architects at Riksbyggen, who designed Augustenborg, certainly did not view their drawings as an intermediate period. Their more traditional design was instead a step away from the somewhat abstract functionalism of the 30s to popular expressions such as variety and cosiness. You could call it the embodiment of the attempts to build the "folkhem" (people's home) welfare state. Some critics called this architecture romantic, but it is largely realistic everyday architecture.

The architects behind Augustenborg weighed the desire for variety against uniformity. They used variety to provide friendliness and homeliness, and uniformity to architecturally link the area, which was the idea behind the neighbourhood unit. The angle of the roofs and their red tiles were common to all the buildings, while the size of windows and doors were uniform. There was little variety in the materials used in the facades. They were yellow scored brick, red scratched brick, and lightly coloured plaster.

The buildings line up, evenly spaced out, usually with the gables facing the street. But at the same time the heights of the buildings, from three to six and a half storeys, add some variety to the area's identity. Some buildings have a differing number of floors such as the corner houses that have both three and four storeys. Facade materials also varied across the same building. Some are adorned by both bricks and render. Generally, three-storey houses were plastered and four-storey houses had

Image by Marc Malmqvist/City of Malmö

Example of how an inner garden has been created in Augustenborg through the siting of the building

a brick facade. It means the viewer does not immediately grasp how few different types of building there really are. One of the models is a little more unique though. The tallest, six-storey, buildings that were placed between Augustenborgsgatan and the park had slightly protruding avant-corps, a kind of gable on their broadside to allow another attic apartment to be built.

Image by Marc Malmqvist/City of Malmö

Yellow scored brick is common in the area...

It is impossible to say if the avant-corps were designed to increase floor space, but they stylishly divide the buildings into more manageable scales. This effect was further enhanced by adding a brick facade to the avant-corps, while the rest of the facade was covered in light coloured plaster.

The balance between uniformity and variation in Augustenborg's architecture was controlled and low-key. The bricks were the standard post-war brick from Skåne's brickyards. The extruded facade brick is laid in monk bond pattern with two stretchers (long side) and a header (short side) in a row. Some expressive details are missing. Two buildings stand out. One is the nursery (now Augustenborgs preschool) which was built with a steeper roof and shutters were put on some of the windows.

The other building, which is more distinctive, is the angled line of shops along the square. With its pleated facade made from blue and white mosaic in a checkerboard pattern and its cantilevered roof with sloping pillars, the row of shops claims a special position as a central point in Augustenborg. In contrast to the restrained nearly anonymous design of the residential buildings, the row of shops has a bolder design and detail. The building's 1950s design has also been preserved well and even the lacquered wood has remained in its original state.

...as is red scratched brick. Plaster in bright colours is also part of the area's character. Image by Marc Malmqvist/ City of Malmö

Image by Marc Malmqvist/City of Malmö

The square still has its 1950s character.

The winds of change have swept through most of Augustenborg and large parts of its original character have been lost in later retrofitting. The government insulation subsidies that were introduced after the 1973-74 oil crisis were widely used by MKB. New insulation and corrugated metal cladding was installed on the houses with render facades during the latter part of the 1970s[1]. This also changed the appearance by pushing the windows deeper into the facade than before.

Image by Marc Malmqvist/City of Malmö

A new facade of corrugated metal cladding

However, the brick facades were not changed. This might have been because the plaster facades were more in need of maintenance or that they were easier to hammer nails into to put up the insulation.

In the 1980s, the next phase of changes began when the balconies were fitted with new fronts and railings[2]. Some balconies were also glazed. The remaining green plaster facades with white horizontal lines were painted in new colours.

The problem was that the original facades, which had been typical for their time, frugal and had light details, disappeared in the broad brush strokes of the repaint. MKB seemingly paid attention to this and in 1999[3] again renovated a couple of houses on Lantmannagatan, this time in the original simple style. The corrugated metal was removed and the facades were rendered. The basement floors were given new plinths so that the facade would not protrude as conspicuously as before. Above all, the balconies got new fronts and details in the style of the original appearance. Unfortunately, this then seems to have been discontinued.

Image by Marc Malmqvist/City of Malmö

Some of the balconies in the area were given a new look during the 1980s.

[1] Bostadsmiljöer i Malmö. Inventering Del 1: 1945–1955, page 50
[2] Ibid.
[3] Ibid.

Image by Sanna Dolck

Like a green exclamation mark, the tall environmentally friendly building Greenhouse stands out in the middle of the 1950s architecture.

The attempt to restore the four houses at Lantmannagatan was made at the same time as the Eco-city Augustenborg project started. Architecturally, this was made visible mainly in the careful design of the street environments and courtyards with their visible stormwater management.

Only a few houses have been added since Augustenborg was built. The Augustenborgsskolan school was built between 1954 and 1956 as one of many school buildings that were added in Malmö during that time. A parking garage with a house on the roof was built in the park between Norra and Södra Grängesbergsgatan. Most striking is the tall Greenhouse Augustenborg, which was built between 2014 and 2016 on the site of the old boiler plant, based on drawings by Kenji Miyazu at Jaenecke Arkitekter.

Greenhouse is a built manifestation of the ideas behind the Eco-city - a passive house with Miljöbyggnad Gold certification and high-tech energy-efficient systems, solar panels, sedum roofs and roof and balcony gardens. Architecturally, the building has expressive rounded shapes on its high-rise balconies and its complex roof landscape. More small-scale additions are the recycling houses built in the area to meet modern requirements for recycling household waste. Through the investment in the Eco-city, Augustenborg has again become a model, but in a completely different way than was the case when the district was built between 1948 and 1952.

The historic Augustenborg study circle

Marianne Oros, Clarie Andersson, Margit Pettersson, Britt Arildsson and Brita Ljungkvist are some of the members of the History of Augustenborg study circle.

Text and images by journalist Caroline Alesmark

They were the pioneers who arrived when the district had recently been built far out in the countryside enveloped by muddy fields. They moved in at a time when bathtubs and hot water were the height of luxury and convenience. They call their study circle "It's so lovely" and every fortnight they meet at Café Sommaren to talk about Augustenborg's history.

"It started as a study circle in collaboration with ABF (the Workers' Educational Association) and MKB about 10 years ago. Now there are only us left, and we are the last place to turn to, where you can hear what it was like. We have collected photographs, newspaper cuttings and brochures and written down what we remember," said Britt Arildsson, who moved to Augustenborg in 1950 when she was six years old.

She remembers horses and cows on the other side of Lönngatan, that planes flew over the area, and that caretakers kept track of adults, children and the lawns. She also remembers the fun children had here - there were playgrounds in each yard and in the basement of one building there was a doll factory:

"We kneeled down to peer through the window at the production line. Legs, arms and heads came out of metal molds," she said.

The files are passed around among the coffee cups on the table. They have all written down their memories. Recurring themes were that the area was newly built and rural, that it was muddy and that there were many children. Families with children were prioritised and moved to the area from the inner city.

"It was so muddy that cars got stuck and had to be rescued by tractors. I moved into a two-bedroom apartment with my husband and son in 1951 and still live in it. It had heating, hot water and a bath, I had never had that before," says Margit Pettersson whose apartment has an intact 1950s kitchen.

The local amenities were completely different to what they are today. In the early 1950s, for example, there were 27 shops in Augustenborg. There was

everything from fish and meat shops to a spettkaka bakery (a local delicacy), dry cleaners and bicycle shop. The area had 43 childminders. Today, only two of the original businesses remain - a hairdresser and the small theatre that was a cinema from 1954 into the 1970s.

Marianne Oros moved to Augustenborg as a 14-year-old with her parents and two younger brothers.

"Moving here was like coming to paradise. In the beginning I did nothing but do the dishes and bathe, I even bathed with my two younger siblings - put them on the toilet seat, rubbed them down and then took them to bed. And I wasn't used to washing dishes with hot water."

Marianne Oros and Clarie Andersson view an album that the study circle compiled.

Brita Ljungkvist still lives in her first apartment and said that the yard was one big muddy field of gravel when she moved into a three-room apartment with her husband and two children in 1951. There were horses on Almtorget and she sometimes worked in the vegetable fields with the gardener who owned the Augustenborgsgården farm.

"Once when my mother was visiting, she went out onto the balcony and said: 'You say you live in the city, but this is just the countryside…' There was nothing on the other side of Ystadvägen back then, just old villas. We were overjoyed to have such a large apartment, but we also wondered what we were going to do with all the space?" she said.

Clarie Andersson moved into a two-bedroom apartment with her husband and two children in 1951 after living in temporary accommodation with a shared toilet.

"It was incredibly luxurious to have a fridge, an ice box and a bedroom. Eventually the family grew and we moved into a two bedroom flat. One of the things I remember clearest was the demolition of the avenue that ran all the way to Lantmannagatan. It was sad to see all the lovely trees being cut down a year after we moved in. In its place came a playground, football pitches and eventually the school grounds. The Augustenborgsgården farm was still standing, and there were pastures that the pigs roamed in - all that later disappeared."

Margit Pettersson's kitchen at Augustenborgsgatan 21 has looked identical since she moved there in 1951. Augustenborg was built between 1948 and 1952.

As for the material they have collected, the group has considered contacting the City of Malmö's archives to get help moving forward. First and foremost, they want what they have documented to be preserved for posterity. *"It's so lovely" ("Det är så himla grant")* is also part of the title of a book by Bertil Aunér that was published in 2009 with the subtitle *People and visions in Augustenborg 1948-2008 (Människor och visioner i Augustenborg 1948-2008)*.

Text: Monika Månsson

Parquet floors, bathtubs and balconies

There has long been optimism and belief in Augustenborg's future. *Vi bygger och bor på Augustenborg (We build and live in Augustenborg)*, a booklet published by municipal housing company MKB in 1950, spoke of "bright, spacious apartments with ample storage space" which had parquet floors and linen cupboards, built-in bathtubs and balconies, but also "a magnificent park environment", "leisure activities for young and old", and last but not least, a shared laundry facility where housewives can wash or hand in their laundry.

In total, MKB planned to build 34 residential buildings, varying in height from three to six storeys, and encompassing 1,538 apartments which varied in size from single rooms with kitchenettes to three bedrooms with separate kitchens. On average the apartments had 61 sqm of floor space, with a range from 30 to 95 sqm.

But Augustenborg was much more than just accomodation. In the park strip that dissects the area, two small football pitches for young boys would be built, joined by two larger playgrounds and a pond. The planning also takes into account adults, and the booklet says that "modern humans have a certain need to spend their free time with some kind of hobby". MKB therefore included suitable leisure facilities in the basement where residents could play ping-pong, or do carpentry or needlework. Local amenities were important. In total 29 stores were planned for a new shopping centre:

7 dairy shops
3 grocers
3 butchers
2 bakers
2 tobacconists
2 haberdashers
2 hairdressers
1 barber
1 household chemicals shop
1 home store
1 florist
1 shoe shop
1 crafts and toy store
1 fish and greengrocer
1 self-service shop (selling groceries, charcuterie meats, fish and vegetables)

In order to explain how large-scale the Augustenborg of the future would be, MKB made a few slightly unusual analogies:

"All the floor space in the apartments measures 92,400 sqm. That could pave a five metre wide parquet and linoleum road between Malmö and Lund."

"If all the bathtubs were placed in a row, the unbroken chain would stretch from the Central Station to the Nobeltorget square."

"If all the stoves are placed on top of each other, the pile will be fifteen (15) times taller than the Petrikyrkan steeple."

Augustenborg was about much more than just ending the housing shortage. The area was a small piece of the new housing policy's jigsaw puzzle. The long-term goal was to "abolish overcrowding, raise the standard of fittings in housing and clean up unsound urban development".

Facts about Greenhouse

Greenhouse is MKB Fastighets AB's cutting-edge environment and sustainable lifestyle exemplar project in Augustenborg. The Eco-city Augustenborg has a long history of major investment in creating a socially, economically and environmentally more sustainable residential area. The area has run tests of many good ideas that have been developed together with residents. The desire to further develop the Eco-city initiative, while also addressing a need to increase population density in the area, paved the way to create Greenhouse and develop environmental issues as part of MKB's new-build.

Greenhouse was built on the site of the former boiler plant and central laundry, which was the heart of 1950s Augustenborg. To further develop the area's green heritage, urban farming apartments with green balconies were built vertically. It was a smart solution for a dense green city, that does not encroach on surrounding farmland. The green apartments unlock a way of life often reserved for those in more land-demanding housing, such as terraced houses. Having a vegetable patch on their balcony, means residents need to buy fewer imported vegetables, which is better for the climate and biodiversity. The social aspect of cultivation is the community it creates as residents find a shared interest despite their different levels of knowledge, backgrounds, age or gender.

Greenhouse is a unique project with great symbolic value that will further strengthen the area's sustainable profile. It has attracted huge interest with more than 3,000 unique visitors attending on technical visits in its first four years. Greenhouse has also been the subject of several scientific research projects, including one on sustainable lifestyles with researchers from the KTH Royal Institute of Technology (see page 89) and a project linked to daylight led by the LTH Faculty of Engineering and White Arkitekter, both with support from the Swedish Energy Agency's E2B2 programme.

When Greenhouse was built, MKB took many steps to ensure the construction process was as green as possible. Today, Greenhouse has a Miljöbyggnad Gold certification and is classed as a passive house by Feby.

About Greenhouse

Greenhouse's 14 stories include 56 apartments. Of these, 32 are one or two bedroom flats, 12 student rooms block-rented to the Swedish University of Agricultural Sciences, and a low-rise section with 12 two-storey apartments (with three or four bedrooms). On the ground floor there is a preschool with an environmental profile, a laundry room, a common room and a gym.

Frida Persson Boonkaew is a strategic project manager for sustainability at MKB

Image by Gugge Zelander

Greenhouse stands out in Augustenborg like a green exclamation mark.

The building was designed by Jaenecke Arkitekter, and built in a partnership contract with NCC. Construction started in 2014 and the house opened to residents in 2016.

Green growing apartments
Each apartment has a balcony of about 20 sqm with large in-built raised bed boxes for cultivation. The beds are eleven metres long across the front of the balcony, and are 40 centimetres wide and equally deep. The boxes have drainage holes and the balconies are equipped with taps and floor drains/scuppers. Half of the balcony is glazed, which creates different climates and extends the growing season. The balcony is joined by a plant workshop, a special room for looking after cuttings, repotting and similar activities. The floor plan is also important as it is possible to access the plant workshop directly from the lift and then out onto the balcony without entering the main living area.

If you live in Greenhouse, you have access to a cargo-bike pool, which encourages more sustainable transport. Image by Gugge Zelander

Shared gardening
The apartment balconies form the private part of growing-space in Greenhouse, but the building also sows the seeds of community. On the shared roof terrace there are areas to grow together, a dome-shaped glasshouse and opportunities for social interaction and recreation. On the 14th floor there is a shared orangery for storing plants during winter, but it also allows residents to meet and admire the view. The top of the house is home to MKB's smallest tenants, bees. Two hives produce honey and help pollinate the area's flowers. The building's residents share responsibility for, take care of and plan the shared growing areas and take care of the bees, with the help of a beekeeper.

Common areas and collaboration
There are several common areas in Greenhouse (the laundry room, the roof terrace, the glasshouse, the 14th floor, the basement and the common room) where the tenants can socialise. The common areas are enjoyed by the residents whose initiatives have filled the space. Greenhouse is created alongside its residents who are involved in the sustainability initiatives, hold meetings with each other and with their landlord. MKB has actively encouraged collaboration and pushes tenants to join the building's shared activities. There are many enthusiasts who arrange social activities for their neighbours including cooking together, opening their living rooms one evening a week or serving Sunday coffee to those who help look after the roof terrace.

The large balcony for each apartment with space to grow plants has become a hallmark of Greenhouse. Image by Frida Persson Boonkaew/MKB

Green renting
MKB has added several elements to the normal rental process to ensure tenants are engaged in growing, research and forming a community in Greenhouse. Everyone who wants to live here must fill in a questionnaire and take part in an obligatory information event. Then apartments are allocated through the shared queuing system in Boplats Syd. Alongside a rental contract, tenants sign a green supplementary agreement which obliges them to grow on their balconies, and commits MKB and tenants to jointly do their best to make Greenhouse a sustainable housing unit.

The bicycle - an obvious choice
Greenhouse's answers to the mobility question motivates residents to choose bicycles and reduces their need for a car. Secure bicycle parking, both indoors and outdoors, is easily accessible by a ramp and electronic lock or by elevator. When they go shopping, residents can borrow one of the cargo-bikes that are part of the building's cargo-bike pool. The extra wide lifts also have enough space to fit the cargo-bikes, so residents can unload upstairs. In the basement there is a bicycle workshop with tools and instructional videos to help with bike maintenance. There are lockable cabinets with electric sockets to charge electric bicycle batteries or store a helmet. There are also two parking spaces with charging posts in the garage.

Smart recycling house
Greenhouse was built on the principle that doing the right thing should be easy. Separating your garbage is a thought-out process from the kitchen to the adjoining recycling house. The recycling house is directly next to the entrance. Residents avoid heavy doors and awkward locks as the shutters which hide the bins are opened with an electronic key. The rubbish can then be thrown into separate compartments, something residents can do with one hand on their bicycle or pram. The recycling house has a green roof with dry meadow vegetation, which increases biological diversity.

To make source separation as smooth as possible, and part of a flow, residents also have access to compartmentalised bags with separate com-

partments for each type of waste. These separation bags are developed in Augustenborg together with residents and designed to fit in all kitchens. They are now available across all MKB's houses. The separation bags are very popular and cheaper and more user-friendly than the hard plastic alternatives that were used in the past. One of the advantages of the bags, is that they are easy to fold and can easily be taken away after use, meaning that residents do not have to return to their apartments after emptying their bags. Time is scarce and this small saving makes recycling something you can do on your way out the house.

Smart energy solutions

Greenhouse is designed to use as little energy as possible. The roofs of the high-rise building and the south-facing multi-storey apartments house 200 sqm of solar cells that produce around 33 megawatt hours of electricity per year. The solar power is primarily used on site, and is topped up with purchased wind power. When the solar panels produce more than is consumed by the building the surplus is sold to the grid.

MKB has signed a supply agreement for the entire property, which provides 100% renewable energy. Each apartment has a meter and MKB invoices individual households. But tenants benefit from avoiding the fixed network fees that each apartment would otherwise be forced to pay.

The radiators on the balconies are automatically switched off when the door is open. Each apartment has a "home or away" button where the tenant, like in a hotel, with a simple push of a button can turn off the electricity and switch the ventilation to saving mode when leaving the apartment. The residents have individual meters and charges for electricity and hot water use and behaviour-based technology.

Laundry room and eco-preschool

In a bright and inviting room on the ground floor is the laundrette of the future (see more page 96). There is also a preschool with an environmental profile, which tries to minimise chemical use.

Finances

From a business perspective, it would have been more profitable to construct a traditional building. Building Greenhouse in a more attractive part of Malmö with higher rents would have optimised profitability. But this is if you see Greenhouse as an isolated project. In fact, it is so much more. The background and profile of the Eco-city, and the fact that MKB is such a large player in the area (about 90% of Augustenborg belongs to MKB), provided the rationale behind Greenhouse's location. By investing in a truly sustainable cutting-edge project that can be marketed in the media as a role model, local pride and identity will hopefully be strengthened. Economically, the biggest gain Greenhouse has given MKB is through increasing the value of the rest of its Augustenborg portfolio. But it is also expected to make the area more attractive and desirable when new players move in. The Eco-city further strengthens its brand and MKB sells itself as a green housing builder working towards a more attractive Malmö.

Greenhouse – the climate smart flagship in Augustenborg

Misse Wester, Annika Carlsson-Kanyama

Misse Wester, PhD in psychology, professor at Lund University. Her research focuses on the opportunities and obstacles to human behaviour in respect of climate change.

Annika Carlsson Kanyama is a lecturer and researcher in industrial ecology at the Royal Institute of Technology in Stockholm. She has, among other things, calculated the environmental impact of consumption and explored drivers of climate smart consumption.

In the 1940s, the neighborhood of Augustenborg in Malmö was first developed. The area has transformed from being considered a rather rough neighborhood in the 1970s, to an area with a strong environmental profile (VA Syd, n.d.). Today Augustenborg is known for its sustainable urban drainage system, as well as their green roofs and vertical urban agriculture. Given the environmental profile of the area, it was not surprising that the municipal housing company, MKB, decided to construct their climate-smart building complex – Greenhouse – in this area.

We have followed a number of households before and after they moved into Greenhouse to gain better knowledge of their expectations on living in Greenhouse before moving in and their experiences after living there for a year. A particular focus has been how the households regard climate change in general and climate change mitigation and adaptation, focusing on the solutions Greenhouse itself has offered. In addition, we have calculated their greenhouse gas emission, measured as carbon dioxide equivalents, in order to investigate if their move to Greenhouse has reduced their overall emissions. In this chapter, we will focus the experience of living in Greenhouse and if the move to this house has affected household emissions that stem from consumption.

Households and climate change

There is a large body of research literature on household approaches to environmental impact and climate change, and many initiatives have been launched to achieve a more sustainable development in society. In Sweden, focus has been on three areas: Transportation, Food and Buildings. In particular, focus has been on energy conservation in the home, a sustainable system for transportation and to a lesser extent meat consumption (SOU 2005). In our analysis, we will focus on two specific areas: the experience of living in Greenhouse and if the move to a climate-smart house has affected household emissions that stem from consumption.

The apartments in Greenhouse are fitted with large garden balconies. Image by Frida Persson Boonkaew/MKB

The house is built and run in a manner that reduces energy use, conserved heat and water, thereby reducing the greenhouse gas emissions. In addition, households can get feedback on their hot water and electricity usage in order to be able to take active measures to reduce their energy usage. The ambition with Greenhouse was also to try to make it easier for the households to use bicycles to a large extent, thus helping to reduce emissions from private cars. One really unique feature of Greenhouse is the balconies or other spaces that can be used for cultivating plants. The overall reduction of greenhouse gas emissions from these small gardens were not expected to be great, but rather it was seen as one of the features that attracted residents with an interest in cultivation.

As a tool for analyzing the behavior of the residents, we rely on one of the most widely used models in the behavioral sciences for understanding human behavior, the theory of planned behavior (TPB). This model was introduced by Icek Ajzen in the 1990s and states that behavior – or the intention to behave in a specific manner – is influenced by three factors. First, the personal attitude towards the behavior; second, the social norm; and third, the control over or the ability to perform the specific behavior (Ajzen, 1991). Recently, research has examined the individual factors in more detail (see Klöckner, 2013 for a review). One example of a type of behavior is to recycle. Recycling waste is something that is very common in Sweden, where attitude is positive towards recycling, the social norm is to recycle (all my neighbors recycle) and in some cases it is a widespread habit. However, if there are no bins where glass, paper or metal can be deposited, the behavior becomes difficult to perform.

However, living is not only about reducing one's carbon footprint but also entails a social dimension. In this contribution, we will address some of the social aspects regarding living in Augustenborg that were important for our households.

Method and material

Originally, we selected 20 households that we intended to follow before and after moving into Greenhouse. All households agreed to be interviewed at two occasions, and also to submit an expense journal covering all household expenses for a period of fourteen days (items purchased often) and for a year (items purchased more seldom). This information (SEK for different items) were adjusted to a yearly consumption and then multiplied by suitable emissions factors (kg greenhouse gases per SEK) to get total emissions before and after moving (Carlsson Kanyama *et al.*, 2010). The total greenhouse gas emissions from each household were then divided by the number of persons in the same household, in order to get the emissions per capita and year.

Due to changes among the households, we ended up with 13 complete before- and after interviews with the households. Out of these 13 households, a total of 6 before- and after expense diaries were returned. The material presented will focus mostly on how the households perceived Augustenborg before moving in, how the smart functions had worked and how consumption related emissions of greenhouse gases changed. The 13 complete before-and-after interviews, together with the 6 complete expense diaries, makes it difficult to generalize our findings. Even if we have no reason to suspect that the households in our sample are vastly different from the others, our conclusions should be interpreted with some care.

Experiences of living in Greenhouse, Augustenborg

In the following section, we focus on how the residents experienced moving into Augustenborg generally and Greenhouse specifically.

All households expressed positive expectations before moving in. In short, two aspects held most allure for the prospective tenants – the expected social community with the others living in the house and the possibility to cultivate their own crops.

Perception of Augustenborg

All the households we interviewed before moving in, had an image of Augustenborg that was not completely positive. For most, Augustenborg was associated with an environmental profile:

> *"…and then, sure, living in Augustenborg [ ] it's pretty easy to be environmentally friendly where there you are given the opportunity to be environmentally friendly. But if you live in Möllan, for example, you have a completely different situation to actually make climate smart choices." (Household M)*

For some, the historical reputation of Augustenborg was known:

> *"Augustenborg doesn't have a great reputation among the older generation, you could say. But then Augustenborg has probably changed, I think. It's probably better now than what it was." (Household EO)*

Even if the reputation of Augustenborg was a bit negative, it did not deter anyone in our study from moving in. Some households were already living in areas where there was much social unrest and other problems, so for this group the move to Augustenborg was perceived as a new start. For some, moving into Greenhouse was seen as something very positive:

> *"Interviewer: So it's not like when you meet new people they say, 'Oh you live in Augustenborg'?*
>
> *Household CS: Well, you might say 'I live a bit away from Södervärn', that's what I say, so…*
>
> *Interviewer: Does it feel different now? Will you say 'I live in Greenhouse…'?*
>
> *Household CS: Yes, yes. Definitely!" (Household CS)*

Moving to a new building with other environmentally interested neighbors was seen as very positive. Still, some expressed a concern that the residents living in Greenhouse would be subjected to envy from other residents in Augustenborg:

> *"It might be kind of strange, that you build such a fresh new house, like, with really expensive rent and then it's another kind of area around. I don't know." (Household EK)*

In the beginning, the households experienced that there were some individuals, predominantly younger ones, that were making their way onto the Greenhouse premises. This caused some irritation but, overall, most households understood the curiosity over the new building complex. However, the feeling of being apart from the rest of the

Augustenborg area was still present after moving in among some households:

> *"But I don't know how the other residents in Augustenborg feel, but I think…some try to like 'these facilities [ ] are for all living in Augustenborg'. Because we are given a lot. We've been given a beekeeper course…a lot of support and such." (Household EI)*

Since Greenhouse is a flagship building, which certainly fits well into the overall environmental profile of Augustenborg, it might set these households apart from the other Augustenborg residents. Before moving in, many households were looking forward to interacting with their new neighbors in Greenhouse, taking part social activities such as plant-exchange, beekeeping, and social events. After the move, many did interact with their new neighbors in Greenhouse but did not take part in other activities that went on in larger area of Augustenborg. Instead, most were quite content to interact with their neighbors and keep to their own gardens.

Climate smart living

For most households, the feedback on energy consumption and hot water usage was initially seen as something interesting, but for various reasons the households usually stopped using it after a few weeks.

> *"Non-user friendly, I think. Now I have to confess that I haven't given it a chance in a long time, kind of a habit. [ ] I like the idea but I think they [MKB] need to do something about it so that it can be usable. (Household EI)*

However, this does not mean that the households are not trying to reduce their energy and water usage:

> *"Still, it's more that I try to save energy by turning off the lights and not have the heat up to high, try to think a little when I shop and not shower for too long […] but the [visual feedback], it kind of disappeared somewhere." (Household EJ)*

For a majority of the households, the technical solutions in the house was something that they did not consider in their everyday life in order to reduce their climate impact.

Household expenditures and emissions of greenhouse gases

As mentioned above, greenhouse gas emissions from consumption was calculated for six households, before and after moving to Greenhouse, based on expenditure diaries that covered all household purchases.

One common feature for all the households was that the costs for housing (rent, cost for water and electricity consumption) increased after moving – with increases ranging from 9 to 190%! This fact, together with very low emissions related to energy use in Greenhouse (wind and solar electricity, district heating based on renewables) contributed to a significant reduction in emissions for housing, from 1000 kg to 20 kg per person on average.

Since expenditures for housing were significant after moving, on average 42% of the households total expenditures, the overall emission intensity from all households' expenditures (including e.g. transport and food) decreased, see Figure 1. This overall reduction in emission intensity was between 26 and 45 %.

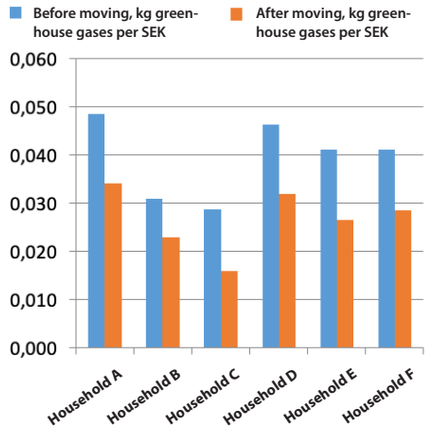


Figure 1: Emissions intensity for all expenditures for household A to F before and after moving into Greenhouse.

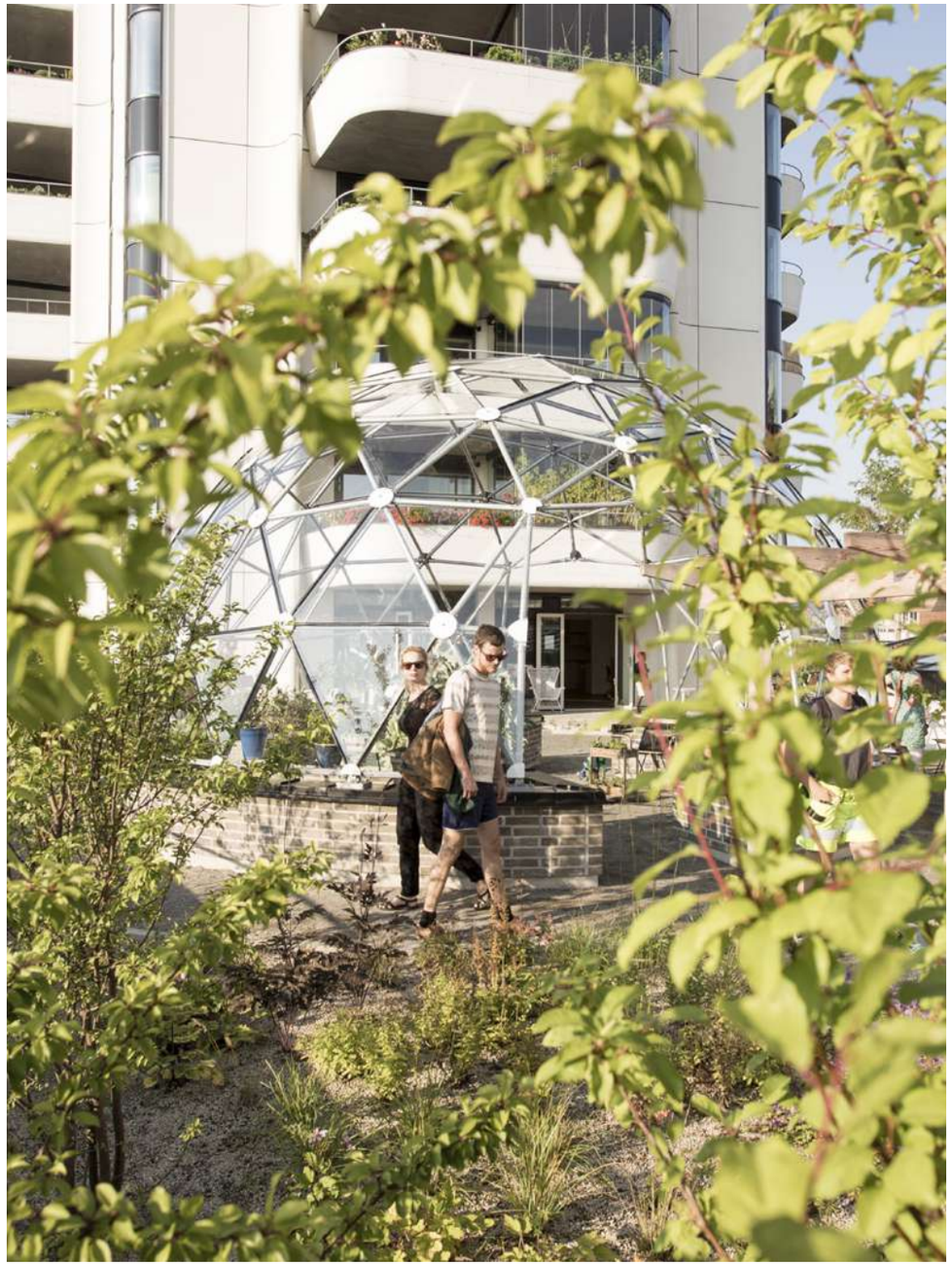


Image by Gugge Zelander

On the root garden there is space for shared gardening, which contributes to social cohesion in the building.

When looking at the changes in total greenhouse gas emissions, measured as kg of greenhouse per person and year (and not as kg of greenhouse emissions per SEK) the households showed less unanimity. Total emissions from household consumption decreased in four cases after moving, increased in one and remained the same in one. These emissions, measured per person, ranged from 3.4 to 7.6 tons per year after mowing, levels that remain too high compared to desired levels of 1-2 tons per year (e.g. Shrink that footprint. 2018, Carbon Footprint. 2018, WWF, 2018). Changes in emission levels only partly depend on the emission intensities of goods and services but also rely on total expenditures and household size. These goods and services can include vacation travel, using a car or choices of food. These factors cannot be influenced by a housing company, but is rather a question for policy makers and society as a whole. What Greenhouse provides – a low emitting housing option at a high price – is certainly an important step towards a low emitting society but not sufficient in itself. More products and services which today have high emissions intensities, such as read meat, petrol and air travels, needs to be de-carbonized for emissions targets to be met.

Conclusion

It would seem that Greenhouse is a welcome addition to the overall environmental profile of Augustenborg, and that the house provides a welcome addition to the area. However, there are some concerns that Greenhouse could be viewed as a building that provide some Augustenborg residents with special opportunities – setting them apart from others. Even if there are areas for cultivating in different ways present in all Augustenborg – as exemplified by the green walls – not everyone is given the opportunity to cultivate vegetables for their own consumption in their own apartment. The amount of support these tenants have been given from the municipal housing company (MKB) is also perceived to be greater than the average tenant living in other houses in Augustenborg, and this is something that could be perceived as unfair. Also, living in Greenhouse is more expensive compared to older buildings in the area, something that excludes certain socio-economic groups. This might lead to Greenhouse being perceived as housing for an elite group. These concerns however have – to our knowledge – not been expressed to the residents of Greenhouse but rather by them. This indicates that they are aware of their somewhat special situation. The perception of Augustenborg was something that the residents were aware of before moving in, but it seems the opportunity to be part of this special initiative outweighed any potential risk of stigmatization.

As most households appreciated the social aspect and interactions with neighbors in Greenhouse, can have a positive effect on the social bonds between residents. This in turn is good for strengthening the impact of the social norm, as this relates to influencing pro-environmental behaviors. Looking at the three determinants of behavioral intent as presented by Ajzen (1991) – attitude towards the behavior, social norm and personal control – the situation in Greenhouse can have a positive influence on all three. The households are already highly motivated to do something about their carbon footprint; the social norm is to behave in an environmentally conscious manner; the means to engage in these behaviors are present in Greenhouse itself – all of these will add to the increasing possibility of developing a sustainable life-style.

Looking at the overall reduction of greenhouse gas emissions, the construction itself in combination with energy from renewable sources, reduces emissions. In our view, this type of building is one promising way to construct residential housing in the future. However, our results indicate that trying to change individual households' perceptions and behavior in a short-term perspective is not feasible. The use of "smart functions" was limited within the households and residents' pattern of behavior did not change in a significant way after moving into Greenhouse. Instead, the introduction of smart features that conserve heat, energy and hot water that work regardless of what conscious choice the households make, is one effective way of climate change mitigation. In the longer run however, changes in behavior leading to lower greenhouse gas emissions from consumption certainly possible given interventions in e.g. legislation information and economic incentives.

It is important to remember, that even as promising as Greenhouse is in encouraging both sustainable construction and consumption, all actions take place in a larger context. If households still desire to have their own car, eat red meat or traveling by air when vacationing – this will have a great impact on the overall emissions. Greenhouse provides, in our view, one good example of what the housing sector can do in order to contribute to climate change mitigation, but more actions are still needed on a societal level.

Greenhouse has illustrated that households can find it attractive to substantially increase the overall costs for housing, such as increasing one's rent. Given that this house is close to carbon neutral this may contribute to decreasing the overall emission intensity of households' consumption patterns, a significant result. Also, by paying a high rent for a service with low emissions other, more emission intensive, purchases may be avoided. In Greenhouse, this new lifestyle was not considered problematic but instead contributed to increased quality of life. It is one conclusion from this project that constructing a house such as Greenhouse, is a promising way to build in the future.

As one household put it:

"I mean, what if everybody was given the opportunity to cultivate crops. Not everyone wants that. So then I think that of course, more should be given the opportunity to live like this. I don't know if that's a solution. But again, we need to build new houses. So why not build them like this?" (Household EJ)

Based on our results, we conclude that Greenhouse has contributed to strengthening the environmental profile of Augustenborg and has contributed to an overall reduction of greenhouse gas emissions. It is our hope that Greenhouse will continue to attract households to Augustenborg that share an interest in the environment, appreciate the social dimension of living in a house with neighbors with a similar interest in the environment and continue to contribute to the overall profile of Augustenborg. Greenhouse is one example of how social and environmental sustainability can be combined in a positive way.

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Laundrette of the Future

Caroline Alesmark is a journalist

Sometimes a laundry room is more than just a place to wash. Sometimes it is a testbed for environmental innovations, a social meeting place, a cog in the sharing economy. This has been the case in Augustenborg over the years.

When Augustenborg was built between 1948 and 1952, the residential area was equipped with a state-of-the-art central laundry room in the centre of the district. Residents could hand in, and later pick up their dried and folded laundry. Or they could do it themselves, and mangle it dry. There was room for many people at the machines at the same time and the laundry was a social gathering place.

Image by MKB

"With this modern equipment, the time it takes to do a big batch of household laundry - soaking, washing, drying and mangling - can be slashed to about three hours, compared to the 10 to 15 hours the same work takes in a conventional basement laundry room. This brings considerable time savings for the housewife." Vi bygger och bor på Augustenborg, MKB, 1950)

The site had a tall chimney and there was a reception where residents could place orders and pay for their laundry. In 1950, the price to do your own washing was 25 öre per kg (SEK 0.25) and for a full service it cost 60 öre per kg. The washing machines were large pots that were heated using gas and there was, among other things, a 11 kg machine and a 24 kg machine.

"The machines let out a 'pumpff' and made a banging noise. The laundry room was like nothing we'd ever seen before. Our mother was incredibly impressed that you could bring home folded and finished laundry. And the hot mangle was pure luxury, the wet sheets could be mangled - that's how wide they were, and two people could use the machines side by side," said one resident who moved in when the area was newly built.

In April 2010, Augustenborg took its next leap through laundry history. MKB called a competition to design a cutting-edge laundry room for apartment buildings, which incorporated innovative solutions, (see page 98). In 2012, the "Laundrette of the Future" was opened after an existing laundry room in an Eco-city basement had been converted. This allowed MKB to trial new technology such as biological water purification, extremely energy-efficient machines and new ideas about flexibility and user-friendliness.

"As a result, residents wash at the same time as their neighbours, use energy-efficient machines, automatic detergent dispensers, and the wastewater is purified and disposed of in Augustenborg's stormwater system," said Åse Dannestam who was project manager when "Laundrette of the Future" was built.

The Laundrette of the Future was further refined in Greenhouse when it opened in 2016. Here, developers considered the laundry room a social meeting place. The bright and airy room on the ground floor of Greenhouse has panoramic windows that overlook the courtyard, which provides a sense of safety. Above a sink is a kettle and mugs, instant coffee and tea bags. A large, high table in the middle can be used both to fold washing, and for social activities.

The laundry room has five washing machines, three dryers and two drying cabinets that can all be locked when in use. Environmentally friendly detergent is automatically dosed, something that is both economical and environmentally friendly. Fabric softener is optional.

"It is nice and bright and there are always several people washing at the same time. You book a wash time on your mobile phone, computer or on a touchscreen down in the laundry room - it is very convenient," said Emma Ivarsson who lives on the eleventh floor with her partner and daughter Kata.

Image by Caroline Alesmark

An important feature behind the Laundrette of the Future was to make the laundry a safe and social meeting place.

The Laundrette of the Future: Organic, energy-efficient, flexible, safe and stylish

In 2010 MKB, together with the municipality's Environment Department, the Institute for Sustainable Urban Development and Malmö Cleantech City, launched a competition to design cutting-edge laundry rooms for apartment buildings. There were eight entries and MKB chose to announce four winners:

- Architects Ida Mared and Christian Wilke's proposal Tvättstuga 2.0 (Laundry Room 2.0), which included proposals for flexible laundry room and a new booking system
- Alnarp Cleanwater Technology, whose ACT Natural treatment facility makes it possible to purify water from the laundry room and let it run off into nearby ponds
- Electrolux tumble dryer, with a type of dryer that uses heat pump technology and therefore consumes little energy
- Watreco, a local company with innovative water solutions, which can be combined for water purification.

In 2012, the first exemplar laundry room was opened in the Eco-city Augustenborg. Here, MKB could trial new technology such as extremely energy-efficient white goods with automatic detergent dosing or water purification which mixed wastewater with rainwater from the open stormwater system, before nutrients are captured in a rootzone. Other innovations were about using the laundry room more efficiently. The machines are in special laundry cabinets and residents only book the machines they need, meaning that several people can then wash at the same time. There were also efforts to make the Laundrette of the Future a pleasant and welcoming place that fosters increased security and wellbeing. Today, the Laundrette of the Future is the norm in MKB's new buildings.

Image by MKB

The Laundrette of the Future was created in a basement in the Eco-city Augustenborg

Text: Monika Månsson

There are many benefits to the Laundrette of the Future in Greenhouse:

- A social meeting place, where spontaneous contact is formed with neighbours
- More environmentally friendly washing
- Washing machines are of a higher quality and more energy efficient
- Residents share five large machines instead of each having their own in their apartments
- No wasted detergent
- The water cycle is closed-loop

The ideas behind the Laundrette of the Future - environmental, energy-efficient, flexible, safe and stylish - which were first developed and tested in the Eco-city Augustenborg, have today been exported to much more of MKB's portfolio in Malmö, includinging Bohus, Hermod, Holma, Stämpen and Trevnaden. MKB no longer builds traditional laundry rooms in new buildings, only the Laundrette of the Future.

Image by Caroline Alesmark

Emma Ivarsson, with daughter Kata, liked the digital system to book a washing machine. Although many people share the laundry room, the machine you have booked is locked to others.

Urban gardening in Augustenborg

The Eco-city Augustenborg is famous as a green district, with its blossoming roofs, attractive gardens and a world-class open stormwater system. In addition to this, there is urban gardening across the whole area, both on the initiative of associations and through support from landlord MKB. The benefits are manifold: home-grown vegetables, climate gains, improved biodiversity, but also social cohesion as neighbours are brought together. Everyone can garden, regardless of background, age and prior knowledge. And gardeners can reap both tomatoes and well-being.

In the Eco-city Augustenborg, there are several types of gardening, including:

- Growing in raised pallet-collar beds.
- Adopt a border
- Active growers' group for residents in Augustenborg. The group takes care of the micro-gardens on the square, and has its own areas with, among other things, a forest garden.
- Household managed areas, especially in Augustenborg's senior housing, where residents manage parts of the outdoor environment linked to their homes.
- MKB organises joint gardening sessions for enthusiasts throughout the year in Augustenborg.
- Greenhouse is a building adapted for gardening, and residents are also required to grow plants on their balconies. The apartments have large garden balconies and there is also a shared garden on the roof.
- Växtvärket has offices in the area and a cooperation agreement with MKB to garden in the area. Växtvärket is an association that works for and is passionate about children, sustainable cities, cultivation and playing through construction.
- There is a community garden designed and developed in a collaboration between local gardeners and MKB. The garden has both shared and private areas. Here, Augustenborg residents plan, grow, harvest and meet.

Jessica Persson worked as a strategic project manager for sustainability at MKB from 2018 to 2019.

Images by Frida Persson Boonkaew/MKB

Greenhouse in Augustenborg – Public good or municipal gentrification?

Martin Grander

Martin Grander, PhD, researcher at Malmö University. Thesis on municipal housing companies. He has studied Augustenborg and MKB's cutting edge Greenhouse project.

In recent years, densification projects in older residential areas outside the city centre have become more interesting for urban planners and housing companies. Adding new housing to homogeneous housing areas with low socio-economic status is ideally seen as something that can not only remedy the housing shortage but also reduce segregation by mixing both tenancy forms and household types (Musterd and Andersson, 2005; Holmqvist, 2009; Lindemann and Roelofs, 2020).

At the same time, there is a rich research flora on how such efforts can lead to gentrification, ie that existing residents are displaced as a consequence of higher rents resulting from the influx of households with greater financial resources (see eg Lees, 2008; Hochstenbach, 2017). Making significant changes to residential areas with an established history, character and clientele is thus not possible with a mere flick of the wrist. This chapter examines one such change, specifically the recent development in Augustenborg around the construction and establishment of the environmental exemplar project Greenhouse, which was completed in 2016 by the public housing company MKB.

Greenhouse Augustenborg builds further on the progression towards an environmentally sustainable district through the joint efforts of the municipality and the housing company in Ekostaden Augustenborg in recent decades. Greenhouse represents a new era in this development. With apartments designed for urban farming, solar panels, a cargo-bike pool and individual energy and waste measurement, the house aims to further develop the area's focus on sustainable living. Meanwhile, there are clear social aims in the initiative: meeting areas for residents, space and opportunities for community gardening and shared learning. In many ways Greenhouse represents modernity, just as Augustenborg did when it was completed in 1952 as the first residential area MKB built.

What happens when the old and the new Augustenborg meet? The new building has comparatively high rents and MKB has carried out a targeted selection process to find tenants. Greenhouse's socioeconomic makeup is therefore largely different to the rest of Augustenborg, where income levels are low and average age is high. How do existing residents view the new building in relation to their neighbourhood? Has the project added life to the area? Do Augustenborg's residents feel MKB is investing in the entire area? Has the exemplar project started to gentrify Augustenborg – ie, is the population being gradually replaced by one with more resources? Is it possible to change and renew while remaining grounded in, and respectful of, an area's character and existing residents?

Image by Sanna Dolck

The old Augsutenborg meets the new when Greenhouse was built in the middle of the city district in 2016. Greenhouse is a cutting edge sustainability project in a built up residential area.

The purpose of this chapter is to shed light on the Augustenborg residents' views on the changes that the establishment of Greenhouse has entailed. Based on quantitative and qualitative studies, attitudes and values are discussed with a focus on the meeting between the existing and the new. An extended purpose of the chapter is to contribute to a discussion on integrated urban development in times when many cities tend to appear increasingly polarised and segregated.

Context: Augustenborg, the modern

To understand Greenhouse and its relationship to its surroundings we first need to understand the birth of Augustenborg, its life, crises and renewal. The municipal housing company MKB's story very much starts with Augustenborg. After Malmö Kommunala Bostadsbolag (Malmö Municipal Housing Company) was formed, work started in 1948 on what was to be the first residential area that MKB built – Augustenborg. That MKB was chosen to develop Augustenborg was, however, not an obvious choice. Social democracy was split at the time between two factions. On one side the cooperative wing which favoured building co-operative or shared ownership housing. On the other was a socialist-municipal wing, advocating municipal rental housing (Billing and Stigendal, 1994). The cooperative wing wanted a majority

of Augustenborg to be co-operative housing, but the socialist-municipal wing was powerful enough to push through its vision and Augustenborg became a residential area principally owned by the municipality (Aunér, 2001). And so it has largely remained. Augustenborg was completed in 1952 by which time MKB had built around 1,500 apartments to a standard and with amenities previously considered luxuries. A central laundrette helped unburden the women who had been sweating at the washtubs. A local coal-powered district heating network provided the area with heat. Augustenborg stood for modernity.

But Augustenborg eventually became associated with social exclusion. After initially flourishing, the area saw a gradual slump in the coming decades. Unemployment rose and the in-moving population became more and more characterised by people without work and or born abroad. By the middle of the 1990s, Augustenborg was ranked among Sweden's poorest areas (Aunér, 2009). The answer to this negative development was Ekostaden (Eco-city) Augustenborg. The environment would become both a goal and a means to rejuvenate the area. But it stretched further than that. "Building a sustainable society can not just be about the environment, it must involve social relations and financial sustainability," one of the initiators said in an interview (Aunér, 2009, p. 77). The eco-neighbourhood initiative therefore came to involve a series of social projects and businesses. An indirect aim of the investment was to increase the area's attractiveness and attract more households with strong purchasing power. And the result was palpable. The socioeconomic situation improved considerably between 1995 and 2007. Employment rates and education levels increased much faster than the average and turnover of tenancy was reduced. A survey of living conditions (Stigendal, 2007) showed that community safety in Augustenborg was perceived as higher than any other part of the city district. Demographics had diversified. Augustenborg's reputation improved as the "middle class identity grew stronger than the working class identity", (Stigendal, 2007, p. 115). Positive results from the eco-neighbourhood spawned a desire to continue the project. In an Interview in 2009, MKB's property manager reflected on the future of Augustenborg: "In 10 years perhaps we will have built a house which does not require any energy – a passive house – with around 12 floors which will attract tenants who want to live in slightly larger newly built apartments" (MKB Fastighets AB 2009, p.7). Clearly, the ambition of attracting new groups of households to Augustenborg now became even more fixed.

Greenhouse in Augustenborg

An architect firm was appointed to design what could be a new residential building on the spot where the abandoned district heating plant and laundrette lay. The design was to be infused by the eco-neighbourhood's image and visions of sustainability. It would be the region's most climate friendly building, at the forefront of the development of a sustainable and compact city. MKB wanted to build upwards and try to attract new customers wanting larger apartments and with an interest in growing their own vegetables. They also wanted to build co-operatively owned apartments, which the company did not receive political support for. However, in order to put a clear mark on the house and create cohesion among its residents, MKB deviated from the general queuing system to public housing. Only applicants who were interested in and committed to urban farming could be offered an apartment in Greenhouse. The applicants also undertook to participate in research projects on cultivation and ecological sustainability.

The exterior of the house also deviates from the norm in Augustenborg. The architect developed a proposal where the high-rise building – which symbolically replaced the chimney from the heating central – was given soft and organic forms, a clear departure from previous architecture in the area. Modernity was reborn in Augustenborg.

Images by MKB and Marc Malmqvist/City of Malmö

Greenhouse is located in the same spot in Augsutenborg as the former heating station and common laundry room. It's a conscious decision, well in line with MKB's strategy of urban acupuncture - "lifting" an area through individual incision investments.

The construction of Greenhouse commenced in the late summer of 2014. In January 2016 the first tenants moved in.

Methods and materials

This chapter is based on data collected during an ongoing research project into MKB's social investments during 2014–2017. Data was obtained from both primary and secondary sources. A survey, focus groups and individual interviews with residents and representatives of MKB constitute the primary data, while literature on Augustenborg and Malmö constitutes secondary data.

A survey on residents' attitudes to Augustenborg, Greenhouse and the development of the area in general was distributed in January 2017 to all MKB households in Augustenborg except the residents of Greenhouse. The respondents could either answer on paper and leave the questionnaire in a mailbox at MKB's area office or fill in the questionnaire on the internet. The questionnaire consisted of a combination of questions with closed answer options and open-ended questions with free text fields. By answering the questionnaire, they participated in a lottery for cinema tickets. The respondents could also sign up to participate in a focus group on Augustenborg's development. A reminder was sent after two weeks. When the survey was completed, 214 people had responded, which gives a response rate of about 6% of all residents in MKB's stock in Augustenborg or 14% of MKB households[2] - with the reservation that the online survey may have been filled in by different people from the same household as the survey was addressed to individuals, not households. Of the respondents, 62% are women. 32% are under the age of 45, while the largest group of respondents is over the age of 65. Regarding employment, many of the respondents, 44%, are pensioners, while 33% are gainfully employed, 7% are attending university studies and 9% are jobseekers. The respondents are geographically evenly distributed over Augustenborg. The majority, 54%, have lived in Augustenborg for more than 10 years, while 16% have lived in Augustenborg for less than two years. Overall, the respondents have a good representation towards the total population. Usual checks for standard deviations and chi-squared tests have been performed where applicable. The standard deviations in attitude questions are in the range 0.97–1.56, which indicates a relatively small spread from the mean.

[2] The population in MKB's stock in Augustenborg was 3 548 people and 1 583 households (31 Dec 2017)

Interviews and focus groups were conducted in addition to the questionnaire study,. A first focus group was arranged by students at Malmö University, also living in Greenhouse. A number of residents in the house and staff from MKB participated in this. The second focus group was arranged by MKB and consisted of about twenty Augustenborg residents who, when submitting the initial questionnaire signed up to participate in a focus group, as well as a handful of residents in Greenhouse who registered interest in participating. In connection with the focus groups, six interviews were also held with residents in Greenhouse as well as in the rest of Augustenborg. Two more interviews with randomly selected residents in Augustenborg were conducted during visits to the area, which took place on four occasions during the day. In addition to this, individual interviews were also conducted with four employees at MKB.

The results of the study

The results of the study are divided into two themes. The first theme deals with the question of how the integration took place between the residents of Augustenborg and those who moved into Greenhouse. The second theme concerns issues of gentrification and urban development.

Co-creation – but only for the Greenhouse residents

The results of the study initially show that a common thread that seems to run from Ekostaden to Greenhouse is the idea of co-creative processes in area development. MKB employees who were interviewed explained that Greenhouse was always intended to be developed together with residents. The company has stressed that residents should engage in the building's sustainability concepts and communicate and cooperate around community gardening. But MKB also clearly wishes that tenants in Greenhouse would cooperate more broadly on sustainable development. There has therefore been a strong focus to engage the residents in creating the new building's social cohesion both before and after moving in. This has included interacting in person and in social media communities. The idea that the residents should shape the house together has also worked out well, which becomes clear in the interviews with the residents in Greenhouse. The participants in the workshops describe a large degree of social cohesion: "everyone has got to know each other very well after MKB's various events", says one participant.

However MKB failed to engage the rest of Augustenborg in the planning and establishment of Greenhouse. The interviews show that the existing Augustenborg residents were not involved in the planning of the new house. Nor have they been invited to meet the new residents. There was already a growers' network in Augustenborg which provides expert support when needed, but otherwise little was done to integrate the new and the old. A survey response testifies to this: "It has felt as if there has been quite a lot of fuss from MKB's side about the new house, but there is not much information that has reached us who live in the other houses ".

Interviewees from MKB are self-critical . "We started far too late. It was not until now, when everyone has moved in, that we started to consider meetings between the new arrivals and those who have lived in Augustenborg longer," said one interviewee who deals with social sustainability at the company. One reason could be that Greenhouse was not in the jurisdiction of MKB's usual local management team but, even for some time after construction finished, was part of the construction team. This has meant that the people working in the management of the area have not had contact with the newcomers and thus have not been able to facilitate meetings and conversations.

The results thus indicate that the integration between the old and the new has largely been non-supported by MKB. The focus has been on the newcomers to thrive in the area, rather than on the existing tenants feeling included. Despite this, there seems to be great potential for contact between the existing and new Augustenborg residents. There is a great drive among the new residents to develop Augustenborg together with those who already lived there when they moved in. This is evident not least in the response to increased social problems in Augustenborg. In recent years, drug trafficking has become common in the area, which according to the interviewees has a direct connection to the nearby residential area Seved, which previously had major problems with drug trafficking and social unrest and has received much attention from the municipality and police. Camera surveillance has been one part of ther change in Seved which has led to the drug trade having "moved across the street" to Augustenborg, several interviewees say. Drug trafficking has now taken place in the vicinity of the newly built house, and there have also been some concerns about outsiders hanging out in the stairwells. There have been requests for video surveillance of the house, but most of the interviewees believe that the problems should be solved in other ways and that the house should be as open as possible, as the project manager at MKB also testifies:

"During the construction phase and the first few months there were children and young people in the building almost every day. And we have noticed the tenants are very patient. They have helped take children up to see the view and then taken them back down."

The reception of Greenhouse

There is thus a potential in the sense that the residents of Greenhouse want to get involved in their new area. We also see this potential among those already living in Augustenborg. The survey which was sent to all households in Augustenborg apart from those in Greenhouse shows a large majority are positive both towards their area and recent changes. Of the respondents, 63 per cent entirely or strongly agree with the statement: "I appreciate that new residential buildings (Greenhouse) have been constructed in Augustenborg".

Attitudes to Greenhouse among MKB's tenants in Augustenborg (n=214)

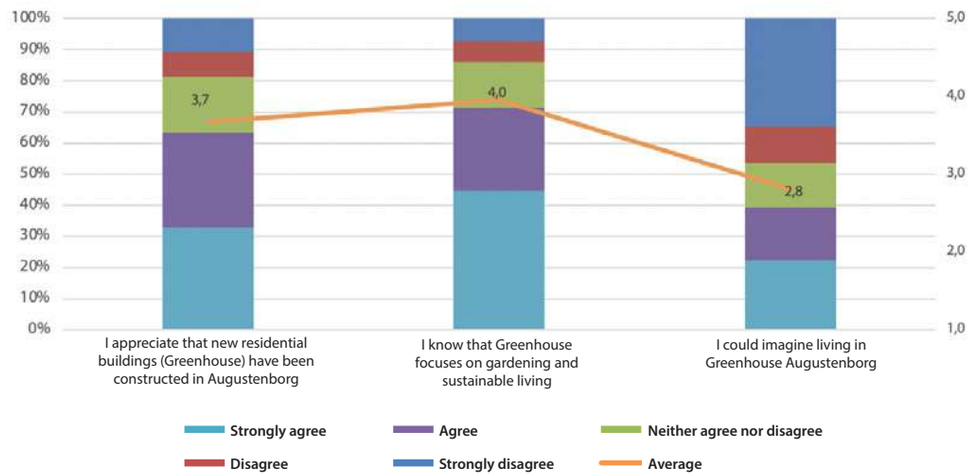

Figure 1: Attitudes to Greenhouse among MKB's tenants in Augustenborg

It is primarily new arrivals who have been attracted by the image that the eco-neighbourhood project established and which is further developed with Greenhouse. Many feel the building speaks to them and brings something to the area.

"It is very positive for the area. It attracts a more diverse population, perhaps more young people. It is great to have a building with a gardening profile."

"It feels good that there is new investment in an innovative construction project, it means that there is investment in Augustenborg at large, but also means more space for sustainability and community gardening."

However, no more than 40% of Augustenborg residents can imagine moving into the new house. Those who are most positive about the house being built are also the ones who to the highest degree can imagine living there. Young people are also more likely to imagine moving there. Of the participants below 36 years old, 91 per cent can imagine living in Greenhouse, compared to 24 per cent of those over 65. However, most people – regardless if they would like to live in Greenhouse or not – have one thing in common: they cannot afford it.

"I would really like to live in Greenhouse if the rents were a little more reasonable. I simply can't afford it. But if money and access to an apartment there were not issues I would have moved in pronto and started growing all the tomatoes and chillies in the world!"

A majority of respondents are therefore happy to see the new development and what Greenhouse has added to the area, while a smaller proportion can imagine moving in and most do not have the financial opportunities to live there. In fact, rents are the only thing that respondents highlight as negative about Greenhouse.

Greenhouse: for the common good, or municipal gentrification?

The reactions to the high rents can be discussed not only in terms of integration but also gentrification.

The architecture, choices of material and unusual character did of course not come cheaply. Building a house like Greenhouse in a less central area of the city involved strained investment plans as the requirements for return are higher than in central locations (Grander, 2019). The investment was calculated at what MKB described as "a significant undervalue". In 2011, the legislation for municipal housing companies had changed – companies must since then act commercially and demand a market return (Salonen, 2015). New construction calculated with an initital financial loss can consequently be argued to be in conflict with such requirements. At the same time, there are paragraphs in the preparatory work for the legislation (Government Bill 2009/10: 185) which justify municipal housing companies' individual investments that are not in themselves profitable, if they are judged to contribute to a positive development of the company as a whole. According to the interviews with the previous company management, Greenhouse was seen as just such a cutting-edge project where an initial loss could be compensated for in the long run "through an increase in value of the existing stock in Augustenborg, but also through increased attractiveness and demand when new players apply to the area." (MKB Fastighets AB, 2016, p.1, my translation). The decision to build despite the calculated loss was made in 2012 on the basis that Greenhouse was expected to generate both economic and social value, necessary for the continued development of Ekostaden Augustenborg.

Rents are approximately 45% higher than the existing area and somewhat above the average for MKB's new builds. It is clear Greenhouse is not aimed at the traditional Augustenborg resident, but at younger households with fairly good finances and an interest in growing things. MKB's strategy of urban acupuncture is based on "lifting" an area through individual incision investments. Such a strategy can in some way be seen as a departure from the public motto "good housing for all" which has characterised property building since the end of the war (Grander, 2018).

A few people say that investment in Greenhouse has created a gap between the new and the old. One respondent says that Greenhouse "...appears somewhat like a tower/fort for rich people, and I still don't know to what extent activities in and around Greenhouse will involve those of us who live in low-income apartments." Some of the respondents are also worried about the development and believe that the house can contribute to a gentrification process which means that the rents in the area will be increased in the long run.

"I appreciate that MKB is investing in the environment and sustainability. I am, however, a little afraid of the gentrification that construction could bring. Greenhouse looks exactly like the buildings in the Western Harbour and is priced comparably. I am afraid there is too much investment for rich people and sustainability has become a badge of honour, rather than something for everyone to share."

Some are thus expressing concern that Greenhouse is a first step in changing the character of the area and in the long run replacing the population that lives there today. However, the general perception among the respondents is that Greenhouse is an investment that actually contributes to the development of the area. Most people experience that MKB invests in the whole of Augustenborg and all residents, not just Greenhouse and those who live here.

Concluding discussion

Three conclusions that can be drawn from this study. The first is that Greenhouse has not been rooted very well in the existing community in Augustenborg, either during the planning, construction or after the house was completed. MKB has forgotten to involve the residents of Augustenborg in the changes in its eagerness to create strong social cohesion among the newcomers,. The question of co-creation has been unilaterally directed at those who have moved in. Favourable conditions have not been created for integration between the old and the new Augustenborg.

Despite this, Greenhouse is seen by the residents of Augustenborg as a welcome addition to the area, which is the second conclusion. This result may seem somewhat unexpected given that local engagement has been so deficient. In addition, few of the people of Augustenborg can afford – or actually want – to live in the new house. Despite this, there is a broad perception that the new construction adds values to the area and that the project benefits everyone. With Greenhouse, MKB has the opportunity to continue the renewal that began with Ekostaden – to build on both the green and the social development in the area. But to succeed, more people in Augustenborg need to be involved in the future area development.

The third conclusion is that Greenhouse balances on a fine line between area development and gentrification. There is no widespread concern among residents that Greenhouse will contribute to the area changing radically, that more resourceful people will move in and that rents will increase. The risks of gentrification seem to be secondary in relation to what the house adds to the area. At the same time, MKB's basic assumption for the construction of Greenhouse is that the financial loss made during the construction will be compensated through increased attractiveness and increased property values in the entire area. In the long run, this can also mean rent increases, as rent setting in Malmö is partly based on the attractiveness of an area (see Bergsten and Josefson, 2006).

Property values have also been raised in the area since construction, as shown by the company's annual reports. However, the statistics (see page 113) show that the trend for the socio-economic

indicators in Augustenborg is once again declining. This trend has been evident since 2008 but has intensified since Greenhouse was built. Greenhouse can not yet be claimed to have led to an increased influx of resourceful households to the area as a whole. Thus, densification projects such as Greenhouse do not automatically lead to general gentrification, at least not in the short term.

Finally, it may be of interest to discuss the possibilities for the development of so-called vulnerable housing areas. With Greenhouse, the municipal housing company MKB becomes a city-builder rather than a public housing provider. The question that then arises is of course whether there is any contradiction between these two roles. The study shows that new construction in areas with low socio-economic status is possible despite demands for business return. Financial losses in construction seem to be able to be reversed through increased property values in the relatively short term, which is why both municipal and private property owners have every opportunity to invest in all areas in the cities. Here, however, potential risks of gentrification and reduced access to housing in the lower cost segment must be highlighted in each individual project.

How Greenhouse will now develop – and contribute to the development of Augustenborg – remains to be seen. Many questions remain to be answered. How will the residents of Greenhouse and MKB succeed with their renewed ambitions to create integration in Augustenborg? Will Greenhouse in the long run become a magnet for a new target group looking to Augustenborg? If so, will increased attractiveness be reflected in rent increases in the rest of the housing stock? Greenhouse is a very rare example of how exclusive housing construction is carried out in areas with lower socio-economic status. Greenhouse Augustenborg must thus be seen as an important case to keep an eye on from a holistic perspective on area development, integration and gentrification.

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Development in living conditions in Augustenborg

Martin Grander

Martin Grander, PhD, researcher at Malmö University. Thesis on municipal housing companies. He has studied Augustenborg and MKB's cutting edge Greenhouse project.

There have been signs in recent years that Augustenborg has started to attract a new type of household (see page 102). Younger people, interested in urban farming and sustainable living, have begun to gravitate to the area. This trend began before municipal housing company MKB launched its cutting-edge project Greenhouse, but has been fortified by the investment. It is therefore relevant to ask if the area's character is changing. Whether more people with higher incomes are moving in and if that will push up property prices and rent in the long run, making the area unaffordable for those on lower incomes. That is to say what is often called gentrification (see, for example, Hedin, 2010; Lees, 2008).

To find out whether this process is ongoing, we can look for answers in the data on living conditions in Augustenborg over time. There are several indicators and measurement methods that can be used to study the development of an area - all bringing their own advantages and disadvantages (see Salonen, Grander and Rasmusson, 2018 for a breakdown of these). This chapter uses official data from Statistics Sweden, which is collated by neighbourhood divisions over a ten-year period. They include, among other things, employment rates, education levels, disposable income, household makeup, the foreign-born population and migration flows within the municipality. In this data, Augustenborg is one of Statistics Sweden's neighbourhoods. In the neighbourhood, alongside MKB's 1,597 rental homes, there are also 91 homes that are leased by private landlords, 53 homes in tenant-owner associations and six privately-owned single-family homes. It follows that 91% of Augustenborg's homes are in public housing. Augustenborg can be compared to two other areas where MKB dominates the property market: Holma in Hyllie and Örtagården in Rosengård. The statistics in this chapter cover all households in the districts, and not only those in rented municipal accommodation.

The story of Augustenborg is of a district that went from the pinnacle of what the Swedish welfare state could offer in the 1950s to a residential area with a poor reputation during the 1990s. The development of the Eco-city during the 1990s and

Socio-economic conditions in Augustenborg, Örtagården and Holma

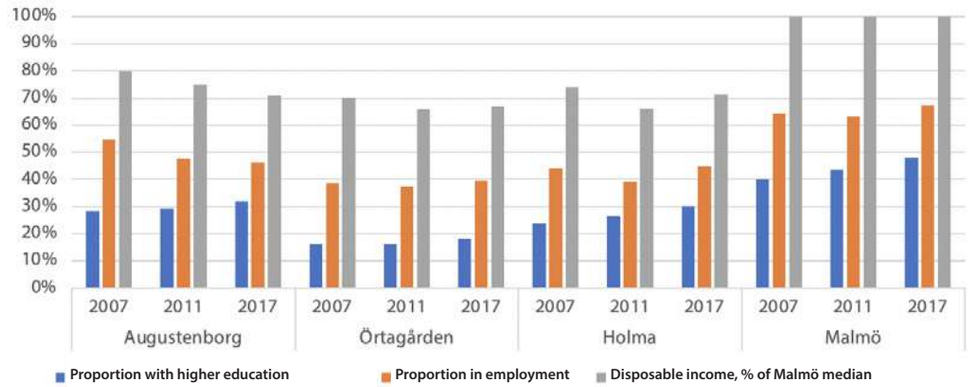

Figure 1: Development of socio-economic indicators in Augustenborg and reference areas

2000s has brought positive effects to Augustenborg. The residents became better off, or households with higher socio-economic status moved to Augustenborg in higher numbers. However, the statistics show that the improvement in living conditions has once again reversed. After 2007, progress has been worse in Augustenborg than in Malmö as a whole and also worse than in the comparison areas. This becomes clear when we look at the employment rate, disposable income and levels of education between 2007 and 2017.

As Figure 1 shows, Augustenborg started in a significantly better place than the comparison areas, but since then development has been less positive or even more negative. The reduced employment rate in Augustenborg is considerable - the proportion of employed residents was a full eight percentage points fewer in 2017 than 2007. In Malmö as a whole during the same period, employment rose two percentage points. However, it is worth remembering that employment rates are flawed indicators. They do not reveal what those who are not employed actually do. Low employment could simply mean that there are many students in the area. Augustenborg's population is rejuvenating. The proportion of families with children has increased by 25% over that decade and the proportion of elderly single people, traditionally a large group in Augustenborg because of the relatively high proportion of small flats, is decreasing.

The statistics also show that Augustenborg has a median income somewhat above those in the comparison areas, but that the increase in disposable income is smallest there in relative terms. The nominal (not adjusted for inflation) increase reached 11% during the period, less than half than in Malmö as a whole (25%). The median income in Augustenborg has fallen from 80% to 71% of the median for Malmö over the period. The declines in relative disposable income and the employment rate have remained constant. In other areas, development has recovered slightly after the 2008 economic downturn, as can be seen in the figures for 2011. The statistics also show that the proportion of foreign-born residents has grown more in Augustenborg than in other areas. This naturally coincides with a lower employment rate and a lower relative increase in disposable income.

Socio-economic index 2007-2017

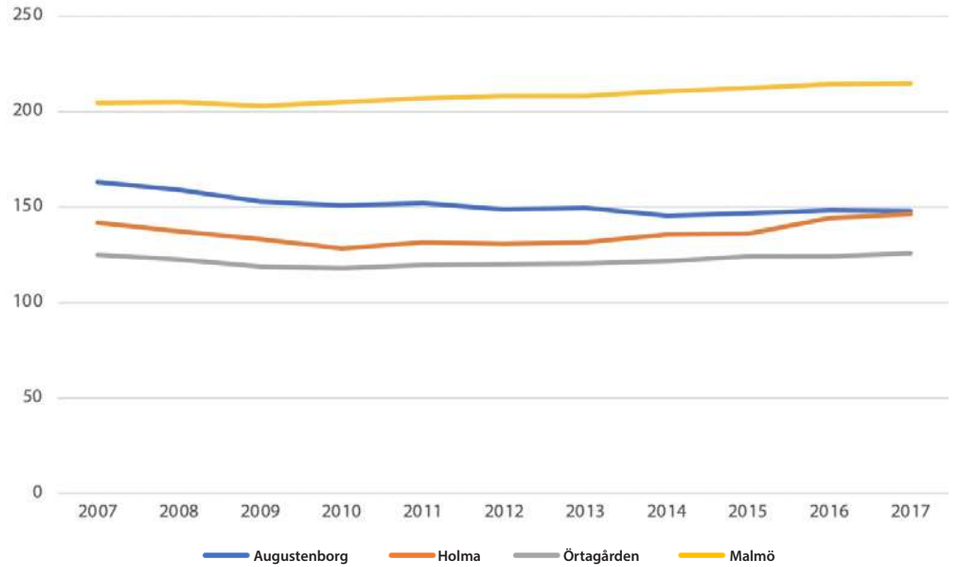

Figure 2: Development of the socio-economic index in Augustenborg and reference areas

A socio-economic index has been developed in Figure 2. This weights the employment rate, level of education and disposable income into a comparative figure that is used to describe the development of the areas. The analysis confirms that of the three, Augustenborg is the area that has seen the least positive development, even though it started in a better place. Augustenborg is becoming increasingly similar to the comparison areas. Meanwhile all three are improving slower than, and in two cases in the opposite direction to, Malmö as a whole.

The analysis therefore suggests that the positive trajectory in Augustenborg from the Eco-city project has been interrupted over the past ten years. Therefore, it is impossible to demonstrate that Augustenborg has gentrified, in fact the opposite seems true. Augustenborg is on the losing side in an increasingly segregated city.

However, it is possible to conclude that the residents are moving out of Augustenborg less often. Statistics Sweden's data on relocations show how households move within municipalities. The statistics can be useful to show how much of a pull districts exert when a household plans to move within the city. When moving to Malmö, it is reasonable to assume that less importance is placed on what area to choose. When options are limited, people will take the housing that is on offer to a greater extent. Of course, this also applies when moving within the city, but an internal relocation can to a greater extent be seen as an expression of how at home one feels in an area, and how attractive it is. Between 2007 and 2017 average net migration from the rest of Malmö to Augustenborg has been -32, that is to say 32 more people moving out of than into the district from other parts of the city each year between 2007 and 2017.

Image by Marc Malmqvist/City of Malmö

It is still unclear how the newly built Greenhouse in Augustenborg will affect the area. It may have both positive and negative effects on development.

However, things change in 2016, when net migration turns strongly positive (+69) for the first time since 2010. This is in part explained by Greenhouse, a new tower block in the district. The linear trend also shows that the pull of Augustenborg slowly increased over the decade. The statistics also reveal how the population got younger, and the proportion of households occupied by young families grew. This could cast more light on why incomes have not grown more. The new tenants in Greenhouse are presumably higher earners who are more likely to be in gainful employment than Augustenborg's existing residents. But this has not affected the district's overall socio-economic makeup. It is of course the case that the arrival of around 100 people with higher disposable incomes into an area with a population close to 4,000 will have no short-term impact on socio-economic development. But Greenhouse has clearly not led to more better-off households moving to the rest of Augustenborg as well between 2016 and 2017. Those coming to Augustenborg tend rather to have lower incomes than those who have moved away from the area.

Of course, it is too early to draw any conclusions about what impact Greenhouse will have on socio-economic development in Augustenborg. It remains to be seen whether Greenhouse's lofty social ambitions can improve living conditions in Augustenborg generally, and if it can generate so-called neighbourhood effects, as neighbours' socio-economic status rub off on each other (see for example Urban, 2018). The development should be followed closely over time and compared to other areas of Malmö, both those where investments have been made in new developments, as well as where they have not.

From district school to school in the city

Andreas Berg is a teacher and worked at Augustenborgsskolan between 2014 and 2016

The Augustenborgsskolan school is in many ways a product of its time. When the school was built in 1956, it was both a natural and obvious part of the Augustenborg neighbourhood unit. The school was to be part of the all-encompassing community amenities that the area offered. The fact that the building that today houses the school's health team was once the area's dentist clinic, shows how integrated it was in the community. The idea that school is one part of the amenities that should be available in a district or in a residential area is as relevant today as it was then, even though the school's social role and function has changed.

The school choice reform that was implemented in 1992 impacted Augustenborgsskolan and the surrounding area, as the number of students at the school who actually live in the district is believed to have decreased. The following year, the school's popular music classes were started, attracting students from other areas of Malmö. The influx increased the proportion of students who passed their courses and could go on to upper secondary school. The school also built a good reputation among many teaching students during the late 1990s and early 2000s, drawing them to apply for internships. However, today things look different as the school's reputation has deteriorated.

From 2018, the school catchment areas will be totally erased in the City of Malmö. It is difficult to say what impact that will have on Augustenborg. The school today faces completely different competition and economic forces than in the past; its attractiveness is based entirely on its reputation, a reputation that may not be linked to reality. Like Augustenborg itself, the school gets mixed reviews. Here, eye-catching headlines of an area in crisis mix with articles about Sweden's best teachers (Joakim Björkman was named teacher of the year by Lilla Aktuellt in 2017 after being nominated by the students in class 4A) and students whose good memories of the school are tinged with loyalty and nostalgia.

Over the years, several good investments have been made at Augustenborgsskolan, focused on physical conditions. In the Bo01 era, the school's eco building was constructed and the Eco-city's famous stormwater system runs through the schoolyard. The school also participated in the initiative Gröna

Image by Sanna Dolck

Augustenborgsskolan school was a natural part of the Eco-city Augustenborg from the very beginning. The whole area would work well as a large outdoor classroom for the school, but to establish ties between students and their immediate environment requires a concerted effort from many actors.

skolgårdar (green school grounds) and in Storstadsprojektet (the metropolis project). In the eastern parts of the Augustenborgsparken park, a sports area was built directly next to the school. But it is not only sports, play and water that has linked the school into its local community. Over the years, there have been countless collaborations between municipal housing company MKB and other actors in the housing area - projects with the opportunity to create pride in Augustenborg and a sense of responsibility for the area. For instance, students have committed to keeping the neighbourhood's recycling houses clean and tidy, in exchange for MKB sponsorship of their class fund.

As an outsider, it is perhaps natural to ask why the school is not always intimately connected with the Eco-city, its sustainable character and the development that takes place there. When asking those questions, it is important to remember that the school is not required to do so, either by its constitution or in the approach to schooling within the City of Malmö. In a 2017 conversation with Malmö's commissioner for schools Anders Rubin, he pointed out that the then political leadership has decided not to "point with their whole hand" in which direction individual schools should prioritise. This means that unless a headmaster decides the school should interact with its local community, or individual teachers themselves choose to create or take part in such a collaboration, it will not happen.

Parts of the Swedish Curriculum for the compulsory school (Lgr 11) make this type of collaboration possible and link to the goals and visions that are present in the ideas behind the Eco-city. In the curriculum one goal is that each student "has an insight into the local community, its organisations, cultural life and associations", and that for students "an environmental perspective provides opportunities not only to take responsibility for the environment in areas where they themselves can exercise direct influence, but also to form a personal position with respect to overarching and global environmental issues." It also states that "teaching should illuminate how the functions of society and our ways of living and working can best be adapted to create sustainable development." In many of the subject plans for compulsory school, there are goals and key content that build on these basic ideas.

However, there are probably not many schools in Malmö where the local environment is so easy to bring into a classroom. It is particularly obvious in social and natural sciences. Both history and the future come alive in Augustenborg, as the area itself is a cross-section of Sweden's 20th century history and a model for future solutions. In social sciences, students can trace the industrial history of old Malmö and the development of the welfare state. In the natural sciences they can, for instance, explore the green roofs, the Botanical Roof Garden, the stormwater system and Greenhouse, using them as starting points for wide-ranging discussions. And why not use the literature that has been written about the area and the cultural institutions in Augustenborg when teaching language and aesthetic subjects?

In this the school could play a major, or larger, role. If we toy with the idea of an Eco-school in Augustenborg's Eco-city, most of the points raised in the curriculum could be met fairly simply and concretely. The curriculum also states that the school should be "a social and cultural meeting place" which is only possible if it is allowed to integrate with its surroundings - by, for example, not only making the schoolyard but also the students a part of the stormwater system, by creating an urban culture for the school, by using the physical environment to teach students about Malmö and Sweden's modern history and development.

In a now inactive school website, one headline reads "Augustenborgsskolan - A school for sustainable development". This came after the school had decided to work towards the National Agency for Education's award of the same name. In addition to this, there have been and still are teachers at the school who do their best every day to create conditions for the students to gain a greater understanding of and a stronger connection to their immediate area and the opportunities that exist there. These idealists are needed and useful, but they cannot spark major change.

Image by Marc Malmqvist/City of Malmö

The school's musical focus has also shaped the area's playground. It was developed in close collaboration with staff at the school.

Fortunately, the school leadership realised this a few years ago when the school began a collaboration with MKB and waste company Sysav, which focused on the school's immediate surroundings and sustainable development. Head teacher Ulrika Prössler-Eriksson said that the project runs as a theme through grades three, six and eight. The youngest students learn more about Augustenborg based on maps and demographics and consider the connection between health and the environment. They also go on field trips to Greenhouse and the local recycling house to learn more about recycling and waste separation.

In year six, senior citizens are involved in the collaboration and help teach the students more about Augustenborg's history. They also get to study environmental projects such as the green roofs and the famous stormwater system, as well as tracking the water's route from Augustenborg's roofs and streets to the treatment plant in Klagshamn. In the final part, the year eight students study home economics and issues related to food waste and recycling and consider future challenges. The project's purpose and intention are commendable. However, it is possible to wonder if it provides context to the students who live in the school's immediate vicinity, while many do not live or spend spare time in Augustenborg. When the student's home and school are unconnected, these efforts risk becoming the same as any other school assignment.

Schools are only one part of a greater story, so it is not possible to simply transfer the responsibility for such development to the school leadership and staff. Instead more investment is needed from both the City of Malmö and external players. The school has a core mission that it will work hard to achieve, while Augustenborgsskolan, like many other schools in socially disadvantaged areas, struggles with faltering grades. If the school is to play an active role in local development, we need more than just a responsive school leadership and committed teachers. Political efforts, targeted resources and concrete mandates are needed from local school leaders, the National Agency for Education and Parliament to ensure students receive the best possible education in their local environment and in school. At that point, a bridge can be built between the student and their surroundings.

The school in the Eco-city

Augustenborgsskolan school was from the beginning a formal partner in the application for funding for the Eco-city Augustenborg, which ran between 1998 and 2005. One of the initiatives was to renovate the schoolyard and park. The transformation of the schoolyard - from essentially being just asphalt to a green area that is part of the sustainable urban drainage system - happened in a close collaboration between the students and landscape architect. The park is close by with its music playground and place for sports.

An eco building with several classrooms was also installed at the school. The building is completely recyclable and can be dismantled, with a green roof and motion-controlled lighting. Toilet waste is composted. There is also a recycling house for source separation.

The school was also part of the initiative for resource management, which aimed to reduce total resource consumption within the Eco-city Augustenborg: energy, heating and water. However, during the project the school was expanded and more students joined, so it is difficult to assess how well the school reached its targets.

Text: Monika Månsson

Gnistan – a unique meeting place for sustainable development and learning

Kerstin Sonesson

Kerstin Sonesson, PhD, associate professor at Malmö University and lecturer at the University of South-East Norway. She is a teacher trainer in natural sciences and sustainable development, with a focus on didactics.

Safija Imsirovic and Lorik Dzaka greet one of the rabbit hotel's soft, carrot-loving guests. Image by Marc Malmqvist

My first meeting with Gnistan and its director Safija Imsirovic happened by chance just before Safija was going to defend her master's thesis, a case study of Gnistan ("Gnistan's Ecology – a case study in the relationship between the individual and their environment" Imsirovic, 2017), at Malmö University. Later that day, I read what she had written about the activities at Gnistan in Augustenborg, and about its significance for the development of young people. It was a safe enclave in Augustenborg, a meeting space where children find joy and hope for the future and can learn about sustainability. Safija's thesis describes an organisation which is based on several dimensions of sustainable development. Adults who grew up with Gnistan speak of its importance during their childhood and adolescence. Many would like to return to Gnistan as interns or employees, or with their own children.

It seemed a perfect place to visit together with teacher students. Since then, I have visited Gnistan several times with international students on the Teaching for Sustainability course and alongside teacher students and their lecturers in the Nordic SPICA network who participated in the course "Vägar in i samhället i Malmö" (Paths into society in Malmö) in the spring of 2018.

This chapter is based on Gnistan, conversations with Safija Imsirovic, the study visits with teacher students and Nordic colleagues and our reflections after the visits. It also contains extracts from letters sent to Safija Imsirovic after our visits.

"I'm impressed with your ways of working." (Student from Greece)

Visiting Gnistan

At the start of our visits, Safija Imsirovic begins by telling us about the history of Gnistan. The name, which literally means "The Spark", is an abbreviation of "Gör något i stan" (do something in town). When her family moved to Augustenborg a few years after arriving in Sweden in the late 1990s, Safija Imsirovic discovered that many parents in the area, those born both in Sweden and abroad, were excluded from the labour market. They needed to free up evenings to study or to work unsocial hours. Therefore, there was huge demand for somewhere children and young people could be looked after and kept busy during certain hours. In a basement financed by municipal housing company MKB, Safija tried to plug some of that gap. She started it as a voluntary venture, working outside of normal working hours. A few years later, her project had won the funding it needed to start more organised leisure activities for children aged 6 to 14 (there is an interview with Safija Imsirovic on page 125).

Today, Gnistan is run by a non-profit association. It allows parents to leave their children in a safe environment where they will be kept busy, in order to look for work, employment training or study.

"Safija is a real source of inspiration for the future in a world full of conflict. As a teacher student, getting to know your organisation provides an insight into how one strong-willed person can change society for the better."

Children and parents were, and still are, required to sign a contract on which rules must be followed. Showing respect and consideration is important in all social interaction, and here too. The children at Gnistan are trained in how to take responsibility by participating in the decisions on purchases. They also act as hosts and tell visitors and new children about the rules and what happens at Gnistan. This teaches them how to explain what Gnistan stands for and how to build relationships with other people. Coming to Gnistan after school is voluntary. However, the children are not allowed to leave until a parent has called or picked them up.

"Gnistan provides the opportunity for a better future to many young people and their parents."

Those at Gnistan speak Swedish and celebrate Swedish customs with the motivation that it is important for people living in Sweden to adopt its language and culture.

"It was good to hear your thoughts on integration and ensuring everyone uses Swedish. You help the children develop their language skills, which opens doors to independence and self-confidence."

Indoor and outdoor activities

There are many different activities at Gnistan for the children to choose between. They can get help with homework, bake, play or engage in creative activities. There are also a variety of activities that teach children about the environment and the outdoors, as well as a rabbit hotel. Those who just want to "hang out" are welcome to just that.

"Gnistan is a place for creativity and open minds, a place where everyone can be themselves and where learning happens through play. It is very good that children who want to can do their homework at Gnistan and get help. I never had that opportunity as a child."

Just outside the building there is a garden with vegetable plots and flower beds. There are boxes for cultivation, berry bushes and a fireplace for cooking and sitting around. Most children and young people in Gnistan live in apartments and with little access to their own growing space. Here they can participate in the entire growing process: from sowing and planting to care and harvesting. It teaches the children how the food travels from farm to fork. The harvested vegetables are used as snacks and to feed the rabbits. The vegetable growing combines practical work with reward and learning. The children at Gnistan also take care of some other local vegetable gardens, which gets them involved in other activities and contributes to Augustenborg's wellbeing.

Weeds and plant waste are placed on the compost and decompose to produce nutrient-rich compost that can be spread on the vegetable plots. The practical work, that teaches children about vegetable production and environmental cycles, is a good example of the important combination of theory and practical work, learning by doing, that educational philosopher John Dewey called pragmatic education.

"What Gnistan offers is important for the families involved, but also for the entire community. In particular the emphasis on animals and nature. I wish we had something similar in my country."

Image by Caroline Alesmark

Growing vegetables is an important part of learning at Gnistan. The children can see the food's journey from farm to fork.

The rabbit hotel

Gnistan runs a rabbit hotel in a nearby building where the children help with the daily care of the rabbits. This is an important part of the set up. The children learn to take responsibility, empathy and the importance of their actions by caring for the rabbits, which are owned by no-one and everyone at the same time. At the same time, they gain an in-depth understanding of environmental cycles and sustainable development in practice, partly by growing food for the rabbits, mainly carrots and parsley, from early spring to late autumn. They later close the loop by spreading rabbit droppings on the vegetable patches to fertilise the crops.

"The thought behind the rabbit hotel is innovative and creative. I like the rabbit hotel because it allows children to do something practical that is rooted in reality."

The vegetable patches and the rabbit hotel teach children to cooperate and develop knowledge about natural cycles. They can play and cuddle with the rabbits, but at the same time are also responsible for looking after them by ensuring they have food, water and clean cages. Caring for the rabbits at the hotel provides good conditions for creative play and social interaction in other contexts as well.

In the democratic spirit, the children can share some responsibility for budgeting and buying consumables for the rabbits. Food and litter are exchanged for the bunnies born at the hotel. The rabbit hotel is a good lesson and insight into a small-scale circular economy.

"Gnistan helps the children develop empathy, gives them life guidance, and provides company in the afternoon in a meaningful way."

Environmental certification

The ambitious outdoor learning and informal education programme has led to Gnistan being certified by both Grön Flagg (the Swedish Eco Schools initiative) and Fairtrade. By incorporating themes such as consumption, health and lifestyle, the learning process deals with important issues. It gives children a chance to take responsibility for the local environment, and develop an approach to more comprehensive and global environmental issues. The holistic approach sparks many thoughts and ideas. One Nordic teaching colleague said: *New perspectives help me change how I work*.

When on a study visit to Gnistan, students meet Safija Imsirovic, a woman who came to

Image by Caroline Alesmark

Cute rabbits let the children in Augustenborg learn more about sustainable development in a down-to-earth way

Sweden as a refugee and whose enormous energy, professionalism and creativity spawned an organisation based on inclusion, compassion and sustainable development.

Understanding sustainable development

We humans are constantly impacted by encounters with others and with new places. We learn from what we see, hear and experience, and it leaves an impression on us. This applies to young and old alike. Often, we need to talk over and process new information and new experiences to be able to understand and develop knowledge about the concepts and phenomena that are new to us.

"We want to bring culture more into the classroom, and we have got good ideas to use in class."

The study visits to Gnistan have been highly valued. Based on the visit and activities at Gnistan, the "four-legged chair"[1] of sustainability and the global sustainability goals, we have reflected on and discussed sustainable development; the environmental, economic, cultural and social dimensions, and how these interact in the development of a sustainable society. These discussions have contributed significantly to a more holistic view and understanding of sustainable development and its complexity. Many students raise the important social dimensions of the work the organisation does, while others reflect the importance of practical work, which is too seldom prioritised during the school day. Several address how the activities at Gnistan and different perspectives on sustainable development are woven together to create something bigger.

For students to take part in and be inspired by good examples is an important part of learning, of creating understanding and to make abstract concepts such as sustainable development more concrete.

[1] The four-legged chair is an educational model to explain sustainable development. The model shows the importance of balancing economic, social, cultural and environmental dimensions of sustainable development and can help provide a better understanding of what sustainability entails. It is about several aspects, not only economic development or environmental issues but also about people and their needs. (Macer, 2004)

Text: Monika Månsson

Gnistan

At Gnistan, children and young people aged six to 14, gather for help with their homework, baking, creative work, to work in the vegetable patch and to join outdoor educational activities. Gnistan gives parents a route to studies and work and promotes integration in Malmö. Gnistan's ambitious outdoor and informal learning has led to certification from both Grön Flagg (the Swedish Eco Schools initiative) and Fairtrade. Gnistan is located at Lantmannagatan 64 and is open every day of the week between 2pm and 6pm.
www.gnistanmalmo.se

The rabbit hotel

There are many families with children in Augustenborg and most of the kids love animals, but many families are squeezed into crowded places and may not be able to afford pets. Therefore, Safija Imsirovic from Gnistan, Göran Larsson from MKB, Peter Lindhqvist from the Internal Services Department and Bertil Nilsson from the Fosie District Administration decided to open a rabbit hotel where children can spend time with rabbits. The rabbit hotel was inaugurated on May 19, 2007.

Text: Catarina Rolfsdotter-Jansson is an author, lecturer, moderator focused on sustainable social development

Research on Gnistan: Young people – problems or potential?

Gnistan creates a familial, creative and social context through democratic means, that promotes learning and social development among children while giving parents time to study or hunt for jobs. The model behind Gnistan has been steadily developed since 1997 and has been the subject of research, which has concluded that this way of working should be exported to other communities.

The researchers say Gnistan is a role model when describing the difference between problem-oriented and potential-oriented attitudes towards young people.

> "What Safilja Ismirovic has created is a unique, receptive and democratic social context. The children are seen as individuals and relationships are formed that would not be possible at school or in after-school educare. Gnistan weaves a safety net for children who perhaps have a weaker family context. It creates a sense of social belonging for children who might otherwise miss it. At Gnistan, children are part of something they feel they can influence," said Mikael Stigendal, a professor at Malmö University who has followed Safija Imsirovic's work for a long time.

Mikael Stigendal and his colleague Jonas Alwall have written the research report "Ungdomar – problem eller potential" (Young people - problem or potential). The report, which was not yet published at the time of writing this article, states, among other things: "It is possible to say that Gnistan solves three problems for the price of one. A simplified description like that captures the concept of Gnistan, that is to say the potential that it has. The Gnistan framework provides an opportunity to mitigate symptoms such as parents having difficulties applying for jobs, while at the same making it possible to better understand the experiences and everyday conditions that parents and children live with."
Mikael Stigendal believes that more Gnistan-style organisations are needed - perhaps not exact copies, but the ideas that form the core of Gnistan need to spread. But Gnistan struggles financially. A few years ago, the organisation was threatened with closure, creating a groundswell among parents, adults who went to Gnistan as children, and engaged locals who followed Gnistan's work. This led to Gnistan becoming an association in 2017. Since then, more parents want to enroll their children in the organisation while at the same time income has decreased. There are no resources left for Safija to train new educators in the Gnistan model.

That Gnistan has not been given the support it needs to spread to other parts of Malmö, or to other cities, is a waste of knowledge, Stigendal said.

> "In our eyes, investments in Gnistan can complement schooling. It can help fill the common void between school and home. It can inspire children and young people who do not feel at home in school to learn in other ways," said Mikael Stigendal.

He also said that organisations like Gnistan can be developed into important centres for furthering knowledge about life in the community, the district and the city. Collecting experiences and processing them into knowledge can further understanding about the mechanisms of exclusion and disenfranchisement.

> "Such understanding is absolutely necessary to create a sustainable city of the future."

"It's so inspiring to meet people like you. I admire what you do, discovering a social requirement and working to fill it. What Gnistan offers is important for the families involved, but also for the whole community. Especially the emphasis on animals and nature. I wish we had something similar in Iceland." (Icelandic university lecturer)

I believe that study visits to beneficial organisations can also inspire sustainable urban development efforts. A meeting space with strong ties to the district is worth visiting for other professional groups, not just teachers and future teachers. Those who work with school planning and urban planning have a lot to learn here. Innovation, creativity and good will have created an organisation that contributes to local sustainable development, which will hopefully spread further after international students visit.

"I wish there were more people like Safija and more places like Gnistan in the world. It would be a much better place."

Safija Imsirovic – the enthusiast who started Gnistan

Caroline Alesmark is a journalist

For around 20 years a 160 sqm basement has been a constant for several generations of children and young people in Augustenborg. Here is Gnistan, a meeting place that Safija Imsirovic has stubbornly steered through several reorganisations and past many obstacles.

The idea behind Gnistan is still the same as when it launched in 1997: parents need a safe place where their children will be looked after, while parents look for jobs, work experience or study, especially at odd hours. Educare can often not help, as only those in formal work or studies are entitled to a place. And sometimes parents need help with their children at unusual times. That was the case for Safija Imsirovic, who came to Sweden from war-torn Bosnia in 1992 with her husband and two small children. In 1997, they moved to the apartment in Augustenborg where they still live:

"I had my first job as a babysitter but was unsatisfied with my Swedish. There were adult classes in the evening, but I struggled to find someone who could look after my children. I thought that I could not be alone in this, and that many others also wanted to study in the evening, so I started knocking on doors."

She discovered that there were plenty of single mothers in the area who were struggling more than her. With help from property owner MKB, she found a space and opened Gnistan during the evenings. After her regular shifts as a babysitter, Safija Imsirovic looked after children while their mothers studied, supplemented their upper secondary school grades and continued their education. For many parents, Gnistan has provided a gateway to a life of work. Since 1999, Safija Imsirovic has worked full-time at the meeting place and today she has a network of alumni children from Gnistan who come back to help.

"I have a professional player from Malmö FF football club who is studying to be an estate agent. He is here on Tuesdays and Thursdays. Two girls studying economics come a few days a week, a guy who always used to come running with plasters is studying nursing and is here in the evenings."

Alongside Gnistan, she has done distance-training as a teacher and taken both a one and two year master's degree in education. To be able to help those who are interning, on apprenticeships and the like, she has also studied leadership and management training. She has never intended to use it in a workplace, just to share the knowledge at Gnistan.

Image by Marc Malmqvist/City of Malmö

If anyone personifies enthusiasm, it is Safija Imsirovic - as tireless and stubborn now as when she started Gnistan in 1997.

"I have kept filling my own rucksack. That's what I think is so wonderful: No matter where you come from or where you are going, you absorb things and relate them to what you already know. That way you incorporate both migration and inclusion - you include your own life and continue."

She is a living example of what is possible, but that everything must come from the heart:

"I am a devout Muslim, a woman and wear a veil. You have to be a part of development in a democracy, you have to roll up your sleeves and get stuck in. Nothing is served on a plate."

Gnistan is in many regards a success story. There have been many visiting field trips, and many awards, like Drömmarnas Hus Eldsjäl (Community leader) in 2005, the Swedish Municipal Workers' Union Democracy and Solidarity Prize in 2010, and the City of Malmö's Environment Award in 2002. Again, nothing was served on a plate. Gnistan has been led by several people and has been close to shutting several times. Since November 2017, it has been run as an association. Safija Imsirovic's goal is to spark more Gnistans because the demand and housing shortage in Malmö is greater today than when she started. More Gnistans would help more parents get out of their homes and onto the labour market and become self-sufficient.

"I have used this method for 20 years and it has brought success. If just one parent gets a job, that is a big win," Safija Imsirovic said.

A community theatre

It is 1993 and actor Åke Jörnfalk has retired from Malmö City Theatre after a lifetime of acting. One day, three gentlemen from the management of the housing company MKB come to him with an unusual offer.

"They must have thought I was a bit mad because they assumed that I was going to agree to this! To this day I still cannot really believe that I said yes, the concept was so unusual. The room we were in was in a bloody dreadful state. But I do not regret it for a second."

Chief executive Allan Karlsson, and his colleagues Lars Frimodig and Magne Larsson, had hopes to foster neighbourhood spirit in Augustenborg. At the time the area was showing some signs of negative development.

"They said we needed to build a community. Some of the elderly who had remained in the area were alone and isolated. They thought the neighbourhood was unsafe and needed to be reconnected to it in a new context. The area should be nice and pleasant."

Åke Jörnfalk's help was needed for one of the more far-fetched attempts to improve the neighbourhood. A basement theatre and - in every sense of the word - a local amateur theatre troupe, would be established for "the oldies" in the area. Teater Augusten was formed. Though he still had doubts, Åke got to work.

The basement of Augustenborgsgatan 10 was built in the spirit of the 1950s as a community space, already ready to stage plays. Until the 1970s the site functioned as a neighbourhood cinema, showing films to local residents. But the room fell into disuse and was primarily a place for MKB workers to get changed or eat breakfast. It stood empty for a while. The stage, auditorium and gallery could be restored, however, and Åke Jörnfalk invited curious pensioners and made plans for what they could rehearse.

"It was slow in the beginning, nothing was easy. Patience is needed, trust is not automatic. I was not demanding beautiful singing voices or stage confidence. But we found the right way. Many people need to express themselves. To dress up and make a fool of yourself. Imagine the contrast on stage for a person who has been repressed or kept down throughout their life."

The older people who joined Teater Augusten dared to flourish on stage. There were revues and entertainment for nearly 50,000 visitors. For 23 years,

Daniel Möller is a strategic project manager for sustainability at MKB

Åke Jörnfalk collected the neighbourhood's pensioners, 150 amateurs all in all. They chose plays and music, rehearsed and then arranged performances. Åke courted all of Skåne's pensioner associations, and soon bus loads of pensioners started showing up for the shows.

"From the beginning everything was to be done together – that was the key word and a goal that stayed with us all the way. The loneliness that comes with age was broken, as pensioners could meet and perform with like-minded people."

Until 2017, there was with other words a highly unique organisation in Augustenborg. What did that mean for the area? At times feverish activity in a previously abandoned basement. Droves of visitors flocking to the area from near and far. Neighbours who meet every week - and mess about, together. No neighbourhood theatre can single handedly help the entire area, but Augusten has always put on a show for anyone who wants to come and watch. And those who have acted together have formed uncommon ties. That MKB took the initiative is noteworthy and finding Åke Jörnfalk was essential. Such efforts, to gather people around a shared interest from scratch, require a driving force, an enthusiast who knows what's what, and can communicate it to others. He has kept his own enthusiasm alive through all the people he has met. Mutual forces propel social life.

"I would not have had so many autumn years, I don't think I would have lived this long, without the theatre in Augustenborg."

The play at Teater Augusten in 2002 was "The day when Gröna Linjen went to Dyrehavsbakken" with Greta Norman, Elsie Malmros and Irena Boromistza. Image by Sydsvenskan/Bilder i Syd

The theatre lives on

After the theatre Augusten closed its doors as its members grew older, new plans have emerged for the unique venue. In 2020, MKB hired a coordinator for the theatre. The goal is to refurbish the premises to a modern standard, while taking care to preserve the charm of its era. The hope is to create a living meeting place for performing arts and culture, to the benefit of both Augustenborg residents and the rest of Malmö. Local cultural associations, the city's institutions and organisations will be able to share the premises.

Text: Frida Persson Boonkaew, MKB

Gardens and green roofs

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Augustenborg's outdoor environment from the 1940s to the 2010s

Bengt Persson,
Ann-Sofi Högborg, Anders Folkesson

Bengt Persson, PhD, landscape architect with a focus on the history of 20th century residential gardens. He was a co-author of Svenska bostadsgårdar 1930-1959 (Swedish Residential Gardens, 1930-1959).

Ann-Sofi Högborg, landscape architect, Svenska Landskap AB. Her company worked on the project to regenerate the garden environments in Augustenborg between 1999 and 2001 .

Anders Folkesson, landscape architect. Formerly ran Mellanrum AB together with colleague Christer Göransson. Mellanrum was responsible for the project to design Augustenborg's blue-green infrastructure between 1997 and 2001.

In this chapter we draw a picture of how Augustenborg's outdoor environment has appeared at different points in history. It will demonstrate how the area has developed over time alongside changing trends and challenges. We start at a few different points in Augustenborg's history and development. The first is when the area was founded, and the ideals and design ideologies of landscape architect Birger Myllenberg. The second point is at the beginning of the Eco-city in the late 1990s and the shape of the gardens then. The responsible landscape architect Ann-Sofi Högborg and her colleagues carefully measured the gardens, which we compare to Birger Myllenberg's original design. The third stage is the restoration and development proposed by Ann-Sofi Högborg and colleagues and by Anders Folkesson and Christer Göransson, the landscape architects responsible for designing the stormwater system. Their proposal was implemented when some of the gardens were rebuilt in the first years of the 2000s. Finally, we examine how the gardens look today, including the changes that have taken place during the nearly two decades that have passed since conversion to the Eco-city Augustenborg.

An outdoor environment in the Folkhem spirit

Planning the neighbourhood unit Augustenborg had clear social overtones. The ideology that underpinned the neighbourhood units was one of promoting community and togetherness, as the district would offer everything needed for a good urban life. This was a model of a "Folkhem", a home for the people, which became the way democratic Sweden expressed the concept (see page 64).

During that time, the garden cities had become the urban planning ideal. It was the opposite of the earlier method which built homes in enclosed blocks with an enclosed and sometimes well-designed garden but surrounded by streets and traffic. In the garden city, outdoor environments were cohesive, following ideas of "house in the park" - from front doors through the gardens and the garden paths to the parks and schools, daycare centres and other amenities. It would be impossible to see boundaries between what was residential estates and what was parks, streets and cycle paths. Hundreds of areas like this were built across Sweden and still provide some of the best outdoor environments, context and residential environments.

Augustenborg is one of Malmö's best examples of functionalism. Ideas of light and air characterise the buildings, which have a clean and functional design. The outdoor environment was designed in a similar spirit, with large open lawns, beautiful limestone stonework, gravel paths and a variety of plants in the form of free-growing flowering shrubs, perennials and proud solitary trees. The outdoor environment was an important part of a larger puzzle, and one of the driving forces behind the hope of creating strong social lives.

The gardens provided plenty of space for gatherings, play and other functions. The design, construction and care of the outdoor environment were rooted in a competent and considered tradition, which ensured beautification, attention to detail and good craftsmanship.

The park (located in the southern part of the area, see map page 296) was large, contained much greenery, was attractive with combined uses and was easily accessible. The area was meant to be a piece of recreational nature, albeit stylised. Some old trees were preserved from the old farmland, partly to anchor the area in its history, but mainly to provide large and welcoming greenery. New trees were planted to complement the existing stock.

The square carried a high symbolic value as a centre for the entire district and showed great ambition in terms of design and materials. It was to provide a varied range of amenities, including groceries, hairdressers, post office, bakery and laundry around a shared communal space. Its design would support both shorter and longer social interactions, in accordance with the neighbourhood concept.

The street has a soft curve as it runs through a park landscape with no clear boundary between street space, gardens and park. Cars were still rare, meaning the road was not seen as ugly or dangerous, but was the unifying spine of the district backbone.

The 1940s landscape architects and other designers of residential environments worked to a series of basic qualities. They can be summarised as (see Persson & Persson, 1995, for a more in-depth description):

- the spatial dimension
- the (non)division of functions
- the vegetation

Birger Myllenberg designed Augustenborg's gardens. His basic principles and design were characterised by the ideals of the time, and how basic qualities were handled. But at the same time, Myllenberg's design has features that are clearly more continental - a design form that is heavily represented in Malmö and contrasts with what is sometimes called Nordic romantic functionalism (Nowotny & Persson, 1988), a more naturalistic and softer style that was applied pretty much everywhere else in Sweden at the time. Birger Myllenberg's 1950 drawings for Augustenborg lists, among other things, instructions on what to build and plant. The gardens are designed somewhat differently but follow the same basic concept. Analysing his design (see Figure 1) for what was then known as the Arla block (now Sommaren 2), and three gardens at Augustenborgsvägen 21-25 and Södra Grängesbergsgatan 44-46, reveals the building blocks used to create the good garden environments.

Two of the gardens we looked at are surrounded by buildings (but with openings to the northwest, southwest and southeast) with building entrances on the west and south sides. They have straight pavements and narrow flower beds along the fa-

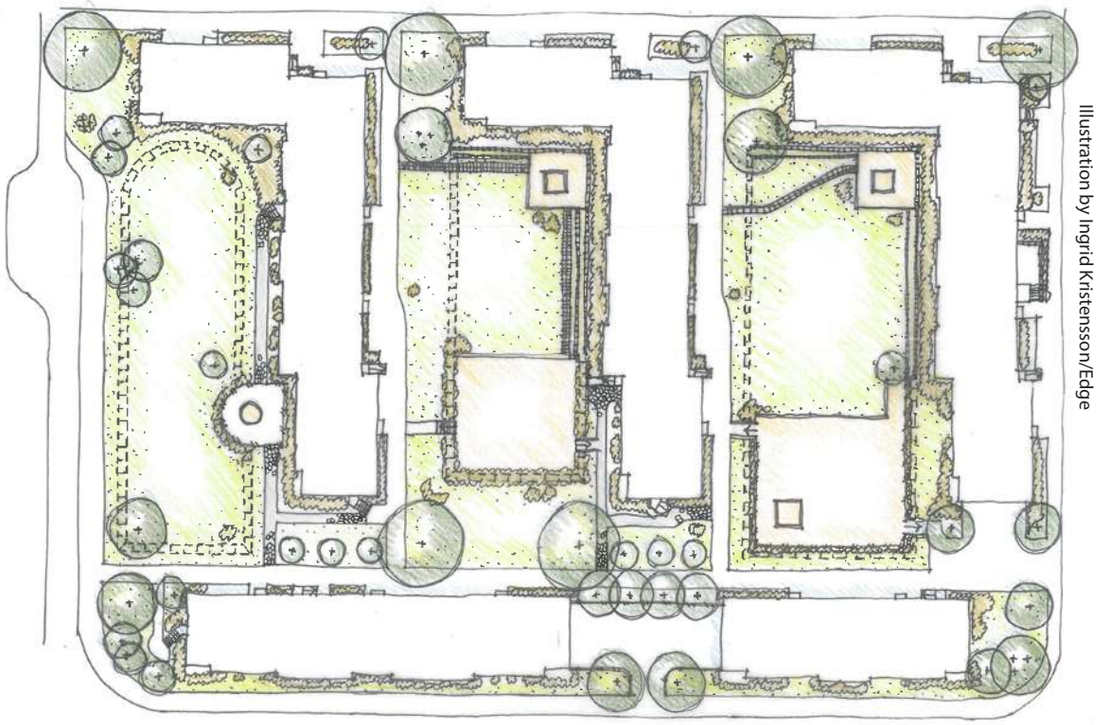

Illustration by Ingrid Kristenssson/Edge

Figure 1. Drawing based on Birger Myllenberg's plan from 1950 for the then Arla block (now Sommaren 2) which stretched between Augustenborgsvägen 21-25 and Södra Grängesbergsgatan 44-46.

cades to provide an efficient entrance and economy zone. The eastern and northern sides of the gardens have no entrances, making them calmer and more accessible for people who want to sit there, while they also get more sunlight. The third, western, courtyard has virtually no entrances, and has a more park-like shape in a nice western location.

A Spatial dimension is provided on a small scale by shaping the areas into so-called sunken gardens, which are slightly indented in the landscape, with a clear 30 to 40 centimetre slope. The three-storey houses provide the main spatial frame, but the edges are softened somewhat by the large trees in the southern and northern ends of the gardens. But Birger Myllenberg's design did not include large trees between buildings as we are used to seeing today. He only suggested the occasional medium-sized ornamental tree such as hawthorn or flowering apple or some large shrub such as laburnum. In one place there is a bird cherry that can become a large tree but does not remain today. Instead, he left a large open and spacious garden throughout the central area. It is possible he considered the gardens too cramped to house large trees without encroaching on the free space and the open courtyards which were typical of gardens at the time. Where space allowed, the large trees were a way to create a soft and flexible spatiality and downplay the dominance of the residential buildings. Without larger trees in the gardens, they probably felt a little too open, close to being bare.

The functional integration (or non-division) of Birger Myllenberg's proposal is a little simpler than was customary at this time in Sweden. The gardens' main areas are large contiguous lawns, and the two gardens with entrances on their west sides, have a sandpit and seating at the top of the northeastern corner, where the sun shines most. It is mainly there for parents and young children and not for adults without children. The spaciousness and garden character have been reinforced with a small limestone wall to replace the soft lawn which makes up the rest of the garden. The sandpit and seating area are not separated from the rest of the garden by more than one or two groups of three bushes each. It is otherwise spatially and functionally connected to the rest of the garden. At the southern end there is a larger sandpit, and the eastern yard has yet another sandpit. These play areas are surrounded by narrow hedges on the south and west sides but are not cut off from the open garden to the north. In the western garden, where there are no entrances, Birger Myllenberg has designed a small stage-like seating area and a small sandpit with a limestone wall. This is not an example of functional integration, but a nice part of the garden.

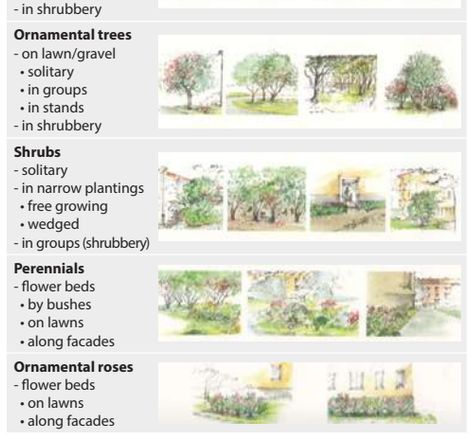

Figure 2. The green building blocks from Persson & Persson, 1995

The vegetation in Birger Myllenberg's drawings is also a little sparse compared to other prominent landscape architects of the time. In the book Svenska Bostadsgårdar 1930-59 (Persson & Persson, 1995) there is a model of the green building blocks that were used to plan residential buildings, see Figure 2. Several of these building blocks are found in Birger Myllenberg's drawings for the gardens we studied. But they are not particularly varied, and some do not exist at all, such as beds of perennials and flowers. The most common are narrow shrubbery along the house facades and in part by the large sandy areas. There are also solitary bushes and some small groups of ornamental shrubs. Large trees are found in short rows or small groups. Solitary ornamental trees are found in some places.

1997: The outdoor environment after 50 years – a snapshot before the transformation to Eco-city

Augustenborg was in 1997 on the threshold of a great renewal that would transform it into an Eco-city. By then, nearly 50 years had passed since the area was built. A lot can happen in a residential area during half a century. Some people move to other areas, while new people move in. People age and die, but new inhabitants are also born and grow up in the area. Apartments are gutted and renovated, new needs spark change in the physical environment.

Fifty years is also enough time for social ideas to change. By the end of the 1950s and start of the 1960s, efforts to solve the housing shortage had increasingly crassly changed what was seen as an acceptable living environment. Amid rational aspirations, ideas of well-being, aesthetics and craftsmanship had to take a step back.

During the 1960s, the ideas that underpinned traffic planning also changed. The very rapid increase in car numbers caused congestion and accidents and solutions to minimise negative consequences were needed. Traffic separation became common, as cars were completely separated from pedestrians and bicycle traffic. In this context it became common to feed cars into a residential area through a few dead ends, instead of allowing them to drive through the area.

The street spaces in Augustenborg changed - probably during the late 1970s - to some extent

in line with these new ideas. Elevated intersections were introduced in places where footpaths crossed Augustensborgsgatan and Södra Grängesbergsgatan. These intersections were paved with so-called SF stone, a vehicle-bearing concrete stone that was popular in the 1970s. At the central square, Augustenborgstorget, the driving surface at these intersections was narrowed by plant boxes and bollards.

The alterations in Augustenborg's street space clearly illustrate how improvement efforts can indirectly change the visual and architectural character of an area, and impact how it is experienced. Traffic was probably made safer, but the street was also cut off from the outdoor environment in general, from having previously run as an integrated element in a park landscape.

Many improvement efforts have similarly impacted the character of the residential buildings in Augustenborg. When external facade insulation was installed in the area - as a consequence of the oil and energy crisis in the 1970s - corrugated sheet metal became the dominating sight, replacing the coloured render. When mechanical snowploughs gradually replaced hand shovels, the rough but characteristic limestone slabs were replaced with asphalt, to ensure the plough did not get stuck on the ground. Once it became necessary to renew or supplement storage buildings, timber, play equipment among other things, the modern materials of the time took their place, such as pressure treated or painted wood in coarser dimensions.

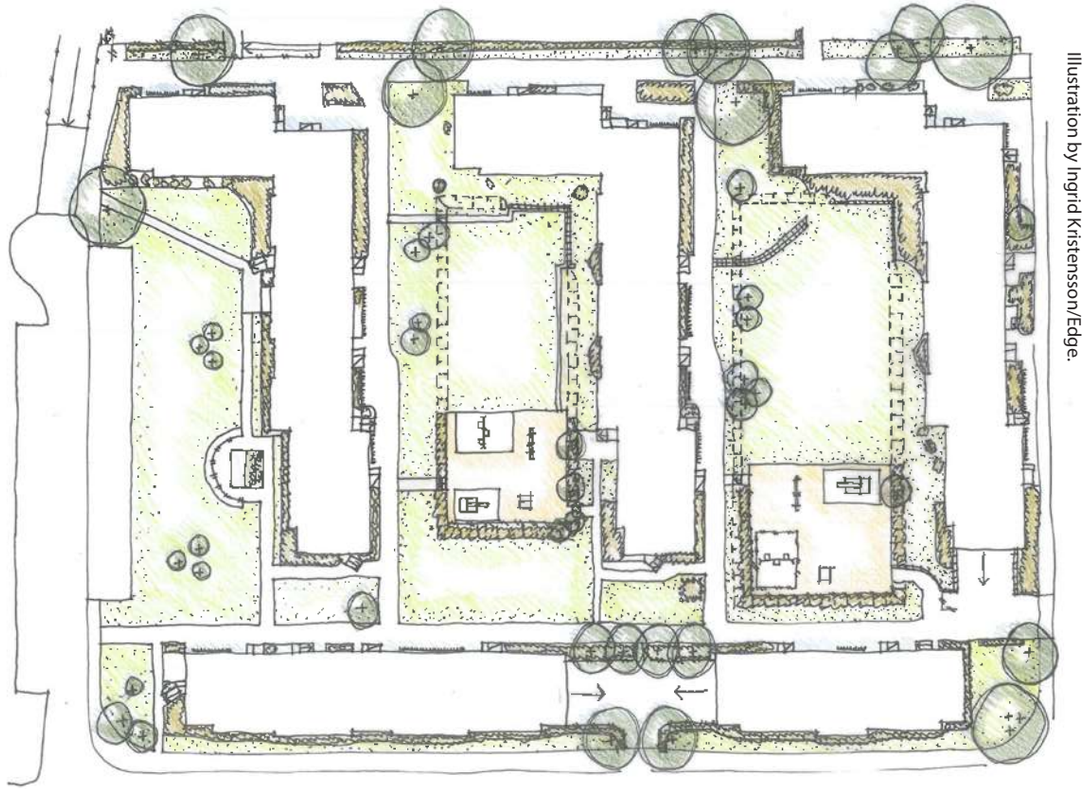

Illustration by Ingrid Kristensson/Edge.

Figure 3. Drawing based on Svenska Landskap's survey of the gardens in the Arla block in 1999.

There were probably no major changes to Augustenborg's outside environment during the 60s or 70s. However, much happened during the 1980s. By then the effects of previous decades' rationality focused housing construction as part of the Million Homes Programme had begun to breed dissatisfaction, social problems and segregation. The poor quality in planning and execution meant outdoor environments had quickly become run-down. Government funds were therefore made available for so-called environmental improvements, mainly of the areas built in the 1960s. These funds were very favourable and available to all homes. Augustenborg also applied for and received the funding.

In 1997, it was very easy to identify which parts of the gardens had been refurbished during the 80s, as their visual forms were completely different from the original features. Timber, benches and play equipment looked excessively robust, reflecting the thought that durability and rational construction take precedence over slender elegance.

Most of the renewal during Augustenborg's first 50 years was based on different design and character principles than those applied when the area was built. This was partly because of changing tastes but also a result of new materials and construction techniques. These were new times and new ideas, and no one created principles that could help old and new merge in a positive and deliberate way.

Many trees were planted in the gardens to make them more homely than what Birger Myllenberg's design had created. In the three gardens we studied closer, the most striking difference is the presence of trees. The trees shrunk the space, and fundamentally changed the large open gardens created by Birger Myllenberg. This change was further reinforced by moving the playgrounds and seating towards the centre of the gardens. These were previously by the corners and edges where they connected better to the whole and did not break up the space.

One special form of change is related to maintenance and care. This brings slower, creeping changes. Especially when it comes to managing vegetation.

The plants were growing in good conditions and had developed well when the Eco-city project started. In many cases they were beautiful, well-developed individuals. In Augustenborgsparken, the trees and shrubs were chosen and placed carefully from the beginning, even though the large trees remained from when the area was still farmland, which created well-defined and pleasant spaces. Plants, unlike hard materials, become more attractive as the years pass, something which was clear in 1997 in Augustenborg.

Over the decades, maintenance had become increasingly static and generally performed without expertise or empathy. It had mainly been aimed at maintaining the gardens' existing vegetation, not about managing and developing their qualities. Many dead plants had not been replaced. Many borders had gradually been depleted and disappeared. The process was likely slow, but gradually the absence of developmental maintenance made the character of the area feel increasingly unclear and made the space look uncared for. As a result, much of the area's original aesthetic values also disappeared.

1998-2001: Grand regeneration with an environmental flavour

On March 18, 1998 the Eco-city Augustenborg project started, aiming to make the area more socially, economically and environmentally sustainable.

The following objectives were set for the outdoor environment (from Idéförslag EKOstaden Augustenborg, 1997):

- Solve waste/stormwater problems
- Renew/enrich the residential gardens to increase well-being and social interaction
- Increase flora and fauna by 50%, increase natural experiences
- Reduce paved surfaces, switch from asphalt to gravel

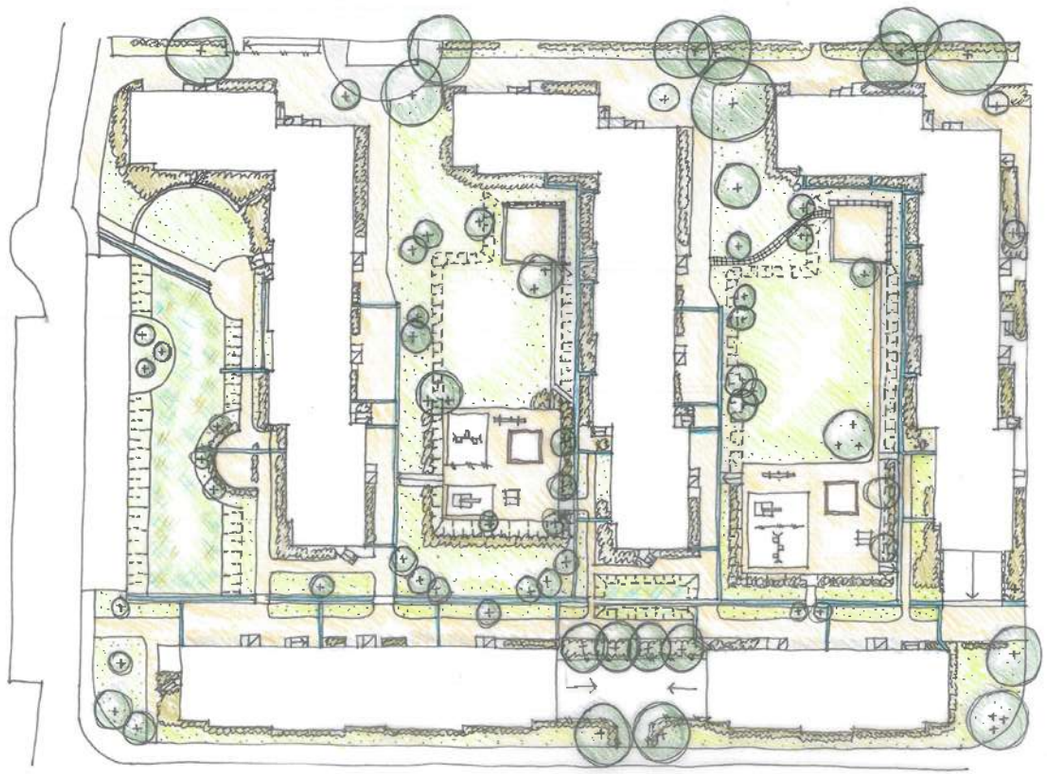

Illustration by Ingrid Kristenssson/Edge

Figure 4. Drawing based on Svenska Landskap and Mellanrum's work, from 2000, of the redevelopment of the Arla block's gardens.

- Restore the area's original character in general, recreate the cultural environment in a classic residential area
- Playgrounds need to be restored and refurbished
- Local waste management, transitioning to a system with several shared recycling houses with source separation
- An educational 'Music Garden' playground is installed in the park and its flora and fauna is increased by 50%
- Increased biodiversity.

There were also economic incentives:

- The need to solve flooding problems in local basements
- The opportunity to apply for government grants
- Municipal housing company MKB wanted to reverse the area's negative spiral in a way that would be economically beneficial, while providing a sustainable long-term platform to create a better local environment.
- Resource management and collaboration between the various operations in the area.

In 1998 and 1999, work began to reshape Augustenborg's outdoor environment alongside several other projects such as restoring facades and waste management. The driving force of changes to the outdoor environment was the City of Malmö (Streets and Parks Department, water utility VA-verket, Internal Services Department) and municipal housing company MKB. Svenska Landskap (gardens and the educational 'Music Garden' playground) and Mellanrum Landskapsarkitekter (a sustainable urban drainage system) were hired as consultants. Lars Landin was commissioned to renovate the schoolyard, but we do not address that in this chapter.

Augustenborg has 13 different residential blocks, each with between one and six gardens, a total of about 25. The area was split into six stages, including the school and Augustenborgsparken. MKB was in charge of the gardens, VA-verket took responsibility for the open stormwater system, while the Streets and Parks Department fixed the park and the streets and the Internal Services Department took care of the school.

As for the garden redevelopments, Svenska Landskap was tasked to improve the area by developing proposals to improve the residential gardens, in close collaboration with residents (especially through a number of consultation meetings), and adapt them according to needs and to increase biodiversity. The goal was to increase recreational opportunities, opportunities for play, improve the aesthetic experience and increase well-being. The assignment also involved recreating the character of the newly built Augustenborg which had been lost over the years in an environmentally friendly way. The work was carried out in close collaboration with Mellanrum Landskapsarkitekter, who were to transform the area's stormwater management into an open delaying system. The goal was to integrate the stormwater system into the design of the gardens.

Svenska Landskap's efforts were underpinned by the idea that a residential building that is beautiful, pleasant, cozy and well-functioning is an engine for socially sustainable planning. When the residential garden meets residents' needs for well-being, beauty, respect, different functions, people often spend more time there. It provides more opportunities for simple but important social contact. Adults meet adults, children get to know other children and adults, and adults get to know other people's children. Friendships and social networks are formed and strengthened. Security and well-being increase and anonymity decreases.

The area still had some very fine qualities, especially the well-grown, large and beautiful trees, as well as the residential gardens' relational structures. There were clear traces, but only traces, of the gardening tradition and the work during the 1940s and 50s. In other ways, the gardens had been uncared for, while their appearance and function were lacking, mainly because of negligence and inexpert maintenance.

Svenska Landskap was also commissioned to renovate Augustenborgsparken, which basically meant a restoration of the large but run-down playground, while Mellanrum was to design the management of stormwater in the park. The park is the area's collective recreational place, made for everyone. The old trees were magnificent, and the lawns functioned well. The lower part of the park was used for open stormwater management (see below).

Mellanrum's task from VA-verket, the sustainable urban drainage system, was meant to mitigate basement flooding caused by a combined sewage system which did not have the capacity to deal with heavy rainfall.

The flooding problem would be solved while also improving the area. The work would be coordinated with local residents. The assignment included a number of sub-projects in many, or nearly all, of the blocks, as well as Augustenborgsparken and Augustenborgsgatan.

A surface-level blue-green infrastructure was to be built in a largely flat area, which only had a low incline. The fear of causing basement floods meant that all canals and ponds were ordered to be made with waterproof bottoms so stormwater would not leak. It was an excessive fear that made the project more expensive. The soil is difficult for stormwater to infiltrate. The risk of it percolating through the soil to the basements is virtually non-existent.

The stormwater system's design was further complicated with respect to Augustenborg's typical 1950s features have a cultural and historical value. The sustainable urban drainage system would also have to respect the existing plant life around the district.

The Streets and Parks Department also asked Mellanrum to draw up proposals for a major redesign of Augustenborgsgatan, the district's spine. The street would be made more friendly to pedestrians while managing the large amounts of stormwater which run off the street and several connecting roofs which were difficult to drain in other open systems. The architects' radical solution would have changed the entire street area into a social space where pedestrians and social functions would be given priority over cars, creating a so-called shared space. However, this did not win support from the Streets and Parks Department, so Augustenborgsgatan stayed largely as it had been. Mellanrums stormwater proposals for this part of Augustenborg were also not followed. It had suggested using the streets as an open stormwater canal. Here stormwater was not managed as it had been in other parts of Augustenborg, but through a traditional separated system with drains connected to the city's stormwater pipeline network.

In 2000, a contractor was hired and groundwork for stage 1 began in the Arla block, and the blue-green infrastructure in Augustenborgsparken. The work was completed in accordance with the design, and the neighbourhood was given a significant facelift which was well received.

During the garden refurbishments, stage 1 was a pilot project. The experiences were used to review the finances to control costs and measure which measures were the best value for money. A "package system" was set up which meant that a minimum number of changes were made to each garden. The package was based on the wishes of residents from stage 1 and included a number of new benches, square meters of perennials, new solitary flowering shrubs, new small flowering trees, square meters of other new vegetation, square meters of removed asphalt replaced with gravel and concrete slabs, a certain amount of new lawn sowed, a certain standard for playgrounds, a barbecue and the necessary elements for stormwater management. These packages largely gave residents what they wanted. Everything was placed,

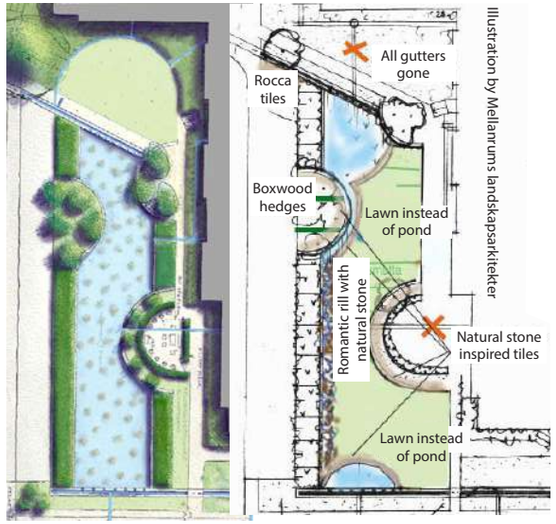

Figure 5. Large delay surface in the Arla block. The first design is on the left but was changed according to the design on the right.

selected and designed true to the area's 1950s character. The packages were priced, summed up and approved by the client.

The first stage of the open stormwater system (the Arla block and the system in Augustenborgsparken) was also a pilot for sustainable urban drainage management. It was shown to be too costly. In order to slash prices, Mellanrum was tasked to only create framework documents for stormwater solutions in the remaining blocks, and not provide construction design. The detailed design would be left to the contractor.

2002-2005: Continuing renewal but with a slightly different direction

After the first stages had been completed, some residents spoke out about the results. Many were happy to see regeneration, but some thought the stormwater system looked dirty and ugly when it was dry. Some complained of more mosquitoes. MKB's maintenance staff had not been trained to care for the stormwater system, so maintenance efforts did not ensure the upkeep of the system's condition and appearance.

From 2001, the landscape architects were replaced by a landscape engineer employed by the construction company which was to convert the remaining gardens and construct the stormwater system. Some of the Eco-city's ambitions and targets were abandoned. The sustainable urban drainage system's capacity was reduced from being able to handle a 25-year rainfall event to withstanding a once-a-decade event. The open system of visible gutters was replaced by a largely concealed system. The drainpipes do not run onto a splash stone but disappear into the ground. The ponds were made more ornamental. This has, among other things, impacted the delay capacity (see page 141).

The former central premise - that the gardens should be restored to regain as much of their 1950s character as possible - was abandoned. The participation of residents was sought more across the whole area, rather than garden by garden.

A central part of increasing the capacity to delay rainwater in the Arla block was the large delay surface on the westernmost of the three gardens which were built in stage 1. The sunken garden, which had already been built following Birger Myllenberg's design in 1950, was repurposed, and deepened somewhat to become a natural reservoir. To fit into ideas around open stormwater management, the area became a wetland that was flooded during rain, but when it was dry, natural conditions were allowed to shape the area, see the left drawing in Figure 5. The surface which is coloured blue could be flooded by rainwater and was then allowed to dry out when it had not rained for a while.

The wetland habitat was developed as intended, but care was needed to keep it free of debris and it housed a different type of plant life to what is common in neatly maintained residential areas. Sometimes the surface was covered in water, but other times it was dehydrated, and the vegetation became marsh-like.

As opinions were expressed about the appearance and character of the wetland, it was rebuilt after a couple of years. The wetland that flooded and dried out was replaced by two smaller ponds with fountains, and a paved stream running between them. Water was supplied from the water network and pumped between the ponds. The wetland was turned into a mowed lawn. The two canals that led rainwater straight from a nearby roof into the wetland were removed, see the right-hand drawing in Figure 5.

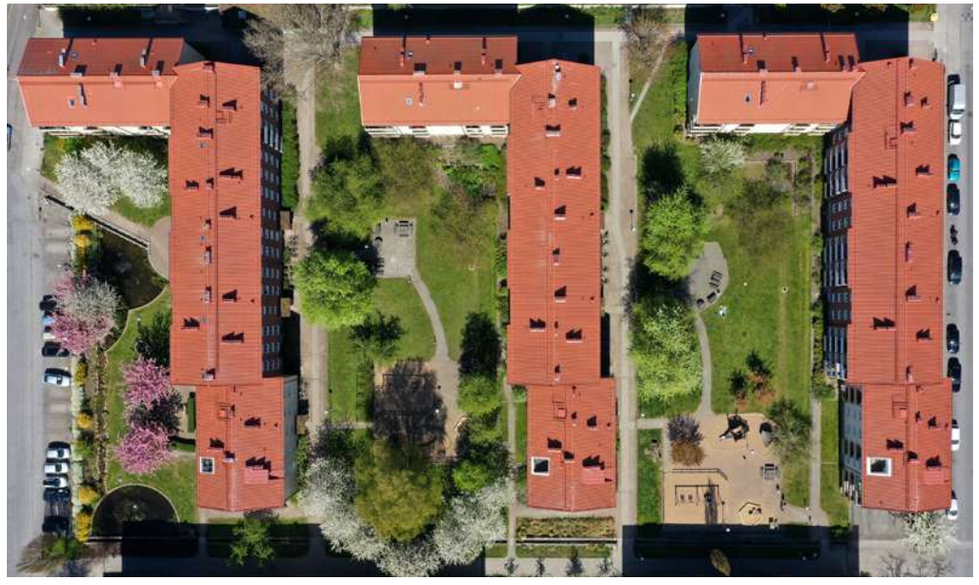

Image by Jonas Bengtsson/JB Media

The gardens in the Arla block as they looked in the summer of 2018.

Image by Bengt Persson

There are today groups of large trees that create a covered space which did not form part of Birger Myllenberg's garden design. Here there are seats which are separate from the playground, something else that Myllenberg did not envision.

Augustenborg's outdoor environment in 2018

Change has continued in the gardens and park in the years since the Eco-city project was completed in 2006. If we return to the three gardens where we analysed Birger Myllenberg's original design, not much still matches his drawings. If we then also compare today's reality with Svenska Landskap's proposals in 2000, the differences are smaller, but extensive nevertheless.

The spatial dimension is different, but the *sunken garden* remains and still creates room. In the middle and eastern gardens, an area has been filled in like a shelf in the northern end. It is hard to understand and changes the regular and rectangular concave *sunken gardens* by introducing a convex shape. There are now several trees that break up the space and define the gardens, but at the same time cut down the large open courtyard that Birger Myllenberg envisioned. In part of the gardens, groups of large trees offer covered areas which find no equivalent in Birger Myllenberg's design. The original had a seating area with a sandpit in two of the northeast corners. These have been removed over the years. Svenska Landskap's vision recreated the seating area, but further developed the playgrounds. These have again vanished and the playgrounds have moved to the middle of the garden. This further breaks up the entire area.

The (non)division of functions has changed to some extent. As in Myllenberg's time, the gardens mainly have room for play. But seating has also been added for adults who are not parents of small children, separate from the play areas. At the bottom of the central and eastern gardens, larger play areas remain as Birger Myllenberg envisioned. However, Myllenberg's proposed open gravel surfaces have instead become playgrounds with different play equipment. The rows of bushes that bordered the western and southern parts of the play areas are gone and have been replaced by low iron fences. It means that the play areas are integrated differently into the gardens as a whole, being more clearly separated. Myllenberg's open courtyard is largely gone, replaced by small lawns between the playgrounds for public use. A new feature is the blue-green infrastructure. It is well integrated into other parts of the garden and does not affect the (non)division of functions except in the western garden where the former wetland has been transformed into two ponds with a connecting stream. The ponds and the stream are completely new functions that transform the large space Birger Myllenberg created.

The vegetation is much more extensive than it was, but essentially still uses the same green building blocks as those of the 1950s. There were large trees in groups back then, although not inside the gardens as today. Shrubberies have been added to a couple of the gardens, something which was not present 70 years ago. At the time narrow or solitary bushes were used instead. The wide shrubs added in recent years do not bring any significant added value, but they do take up space, which cannot be used for other things. Another addition is the trimmed hedges in the western garden. They were not part of Birger Myllenberg's design, but otherwise featured in gardens built in the 1940s and 50s, although not very widely. The natural plantations of aquatic plants next to the ponds and the stream in the western garden are new elements that were foreign to the age.

Experiences and lessons learned

Augustenborg's outdoor environment has undergone continuous and sometimes more deliberative changes since being established. The style of the gardens that Birger Myllenberg designed only remains in part today. The basic properties of space, the (non)division of functions and the green building blocks have largely changed. From the formation of the Eco-city's stage 1 stormwater system in 2000, and the three gardens in the Arla block, some of the attempts to recapture the 1950s spirit remain. These include the stormwater canals and their surroundings such as the material and design of the slab pavements set in gravel that lead to the buildings' entrances. These are important details but do not determine whether the area's 1940s and 50s character has been preserved.

We have not been able to ask residents how they view their gardens today and how satisfied they are with them. The arguments and views expressed in this chapter are instead our professional and expert assessments. We are convinced that if Augustenborg's residential gardens had retained more of their original qualities, which were typical of their time, the gardens would be perceived as even better, and more attractive, versatile and pleasant than they are today.

Lessons from the stormwater system include the difficulty of installing it in a built-up area. The gentle slopes did not make things easier. Many costly special mitigations were needed. The redevelopment became costly. Difficult solutions (for instance the canal edges) had to be developed due to constrained space, which could have been avoided if the area was being built from scratch. But it must also be considered that many "pilot solutions" (such as tailor-made products) were developed during the project. A concrete lesson for us project planners (Anders Folkesson) was that we did not push hard enough to make the canals and ponds with open bottoms, which would have been significantly cheaper and better. We instead shied away from the argument that the bottoms needed to be waterproof to avoid the water seeping into basements.

Another lesson is the difficulties in making breakthroughs in street and traffic issues. It is difficult to shake traffic planners' obsession with cars. A major shortcoming of the Eco-city Augustenborg project was not including Augustenborgsgatan in a holistic solution. It was not integrated into the stormwater system or transformed into a shared space to benefit residents and not cars. Sadly even 20 years later it would not be much easier for such a design to gain support.

Biodiversity in the Eco-city Augustenborg

Annika Kruuse

Annika Kruuse, PhD, former project manager at City of Malmö's Environment Department. Thesis on ecology. Has worked with developments and innovation to foster biological diversity in Malmö.

This chapter is based on descriptions of the efforts to increase biodiversity which formed part of the major projects in Augustenborg. These were carried out from the late 1990s onwards and included biodiversity targets. I have studied reference to biodiversity in applications and final reports and find a development towards increased knowledge around urban ecology.

The beginning - the LIP application which mentioned the name Eco-city Augustenborg for the first time - was impressive in its breadth. It showed an ambition to improve many different parts of both ecological and social sustainability. It also includes biodiversity targets (see more on biodiversity on page 148) embedded in the projects that developed stormwater systems, gardens, squares, roads, the schoolyard and parks. The most repeated target is to increase the number of species of flora and fauna by 50%. But there are also targets to produce a more vibrant and natural urban environment and to foster an area for natural experiences. But that is as specific as the goals get. The application does not elaborate on where the starting position lies, how to create the increase or any timeframe for when the target should be reached.

In the LIP projects' final report, it is apparent that the biodiversity targets were not specifically addressed during implementation. Instead the focus has been on other important issues such as stormwater delay mechanisms, architectural qualities, resident outreach and recreation. In the final report for the sustainable urban drainage system, biodiversity is only mentioned as a possible way to continue the project, where potential research projects could evaluate biodiversity. The final report on gardens (the streets and squares section only dealt with the reconstruction of Augustenborgsgatan), and the schoolyard and park, refers to a review of biodiversity in these two projects, which was carried out by myself and then colleague Åsa Abrahamsson at the Environment Department of the City of Malmö. We were only given a couple of days for the assignment and carried it out in December. It was therefore based on a short field visit and a review of drawings and other documents. For the schoolyard and the park, the goal was to create natural environments on 20% of the surface area, and to increase the number of flora and fauna species by half. The review found that the target to foster natural environments was far from met, least of all in the schoolyard. In some of the park's small nature-like environments, common snowberries were allowed to dominate the bushes, which detracts from the experience of the natural environment. The number of species of flora (wild and domesticated) was nevertheless believed to have increased by 50% and created the potential for animal species to expand by 50%. During the redevelopment of the gardens, squares and roads, the areas were meant to become places that housed biodiversity fostering contact with nature. The amount of flora and fauna was meant to increase by at least 50% in the gardens and a cultural environment was to be created in a traditional residential area. Interestingly, the goals of creating contact with nature, and biodiversity seem to have been ignored in order to focus on recreating the cultural space. This is clear both from the final report and the chapter on outdoor environment in this anthology (see page 132). The review nevertheless concluded that the amount of flora did expand by 50%, above all among domesticated plants. Meanwhile the groundwork has been laid to enable a 50% increase in animal species as many of the plants produce nectar and pollen. Bat- and birdhouses have also been set up and aquatic environments have been created.

The LIP application included an ecological roofs project - today they would be referred to as green roofs. The project did not receive any LIP funding but was instead co-financed by the EU LIFE programme. This analysis is based on the LIFE project application, as the final report is unfortunately not available. The application said that the goal of the Augustenborg Botanical Roof Garden was to spread the use of green roof technology in Scandinavia. The most important motives for laying green roofs were environmental and technical, including delaying stormwater, energy savings from the cooling and insulating effect and protection of underlying roofing materials. One environmental issue that can be remedied by green roofs is biodiversity loss, and the application promises to lay almost 10,000 square meters of rooftop meadow. One measure to be used is the number of species of plants and animals that have been introduced to the area because of the project. The application states that the vegetation will include mosses, broad-leaved plants, herbs and grass. Green roofs were not very well known in Sweden at this time. There were few examples, and awareness was not as high as today. The thin light moss/sedum carpets were assigned huge environmental potential and much of the focus in constructing the Augustenborg Botanical Roof Garden was on evaluating different ways of building thin, large roof gardens and what effect that would have on stormwater volume and quality. This was partly because large parts of the roofs were unable to withstand the weight of thicker vegetation. Meadows were not created during the first decade. The history of Augustenborg's botanical roof gardens can be found on page 149.

The next major project concerning biodiversity in Augustenborg was Green Tools for Urban Climate Adaptation, GreenClimeAdapt. It ran from 2009 to 2013 in different parts of Malmö and tested methods of urban climate adaptation based on green solutions. Two of the projects were based in Augustenborg: Climbing plants to cool buildings and green facades and self-build green roofs.

The application for the green facades project mentions a number of expected benefits such as energy saving, air purification, protecting facade materials, reducing noise, and finally an increase in urban biodiversity, especially among insects and birds. Biodiversity is expected to increase in the systems. However, the ambition to increase biodiversity seems to end with these general statements. When describing the systems's design and choice of plants, biodiversity is not raised. The application mentions a count of certain animals (invertebrates and birds) to help with the project evaluation, but this is not mentioned in the final report.

When the application mentions the benefits of green roofs, it lists stormwater management,

Image by Scandinavian Green Roof Institute

Species have not been systematically itemised in Augustenborg, so it is difficult to draw definite conclusions what effect green solutions such as the green roofs or facades pictured, have had on biodiversity in the area.

cooling and aesthetics. To increase the green roof space, do-it-yourself solutions were needed because ready-made roofs are expensive and relatively heavy. The roofs should be lightweight, and based on straw, hemp or other organic materials with substrates and plants. The aim is to increase the use of green roofs among homeowners in the city. The results are to be counted in the number of installed roofs and irrigation systems.

The final report talks about establishing green roofs by sowing herbs and grass and spreading moss and sedum shoots, which is progress from a diversity perspective when compared to moss/sedum roofs. The results of the first four tests were measured by how well the herbs and grass survived, and how many weeds had flourished. The fifth test surface was initiated after the first four had been completed. It aimed to create a green roof with a working ecosystem and high biodiversity of herbaceous vegetation, while testing various substrates mixes. Several items were installed solely to promote biodiversity: furrows with natural stones, logs, whole bricks, small hills and a sand dune so that wild bees could nest. Variations in the amount of moisture was designed in. Two mixes of perennial herbs were developed. The result was a high level of biodiversity with 56 perennial and annual herbs. Here, biodiversity was for the first time at the centre of constructing a green space in Augustenborg, despite not being the main goal in the project application. The substrate and vegetation were also matched to ensure that the habitat was sustainable in the long-term. Microvariations in the depth of the substrate, its moisture and texture were created to allow a large number of plant species to survive, and in turn feed many different animal species. A number of possible wild bee habitats were created; based on the knowledge that insects do not just need food - they must have somewhere to live and hibernate both in adult and larvae forms.

The BiodiverCity project, which overlapped slightly in time, happened in Augustenborg and other parts of Malmö between 2011 and 2018. In fact, the aforementioned GreenClimeAdapt was partly carried out in the scope of BiodiverCity. The project aimed to increase the city's biodiversity, create products, services and processes for greener cities and create a permanent demonstration site to spread uptake of green solutions. Many sites in Augustenborg have formed part of the project including the so-called biodiversity roof at Augustenborgstorget, the limestone habitat and meadow roofs on the roof garden, a green facade at Augustenborgstorget, three areas to test ways of turning lawns into meadows, a compost biotope or habitat mound, a border for steppe habitat, and another for butterfly habitat. A maintenance regime has been developed to increase the long-term biodiversity in MKB's green areas. The final report presents the plant life of the different habitats that were either sown or planted, as a measure of increased biodiversity. The example with the most species is the biodiversity roof, where 66 different plant species have become established from seeds and seedlings provided by a Swedish supplier as well as seeds from dryland species collected locally in Malmö.

Greenhouse was built in Augustenborg between 2014 and 2016 (read more on page 84). There are many green spaces on the building's balconies and roofs, most of which focus on urban farming without explicitly mentioning biodiversity. On the roof of the adjacent recycling house, however, wild species have priority. MKB's material describing the sustainability aspects of Greenhouse states: "the green roof of the recycling house is designed to promote biodiversity. Surfaces with traditional succulent plants are interspersed with other types of plants. This creates different environments and microclimates, which increases the biological values on the roof ".

No large or systematic species surveys have been performed in Augustenborg as a whole, neither before nor after the projects in the district's green areas. It is therefore impossible to talk about Augustenborg's plant and animal diversity, and how it has developed. The term biodiversity is often used without precision, such as in the applications and final reports that form the basis for this chapter. Having said that, I still want to explore whether the Eco-city's biodiversity has increased during the projects. Biodiversity is variation in ecosystems, species and genes - see page 148. Ecosystems in Augustenborg are certainly more varied after a large number of previously missing habitats were introduced to the area. Meadows and meadow-like habitats have been added to land and roofs, as well as ponds and wetlands. They have not entirely replaced existing habitats, merely taken some of the space formerly given to lawns and non-green roofs. Species variation can easily be defined by the number of species in an area. It is highly likely that there are more species of plant in the area than there were two decades ago, for several different

reasons. This is partly because regenerating the gardens increased the number of species of garden plants substantially, while the establishment of new habitats brought a substantial increase in the number of regional wild plants - this is a matter of record. It is also in part because there is a larger variation in the types of habitat, which provides opportunities for more species to thrive long-term, while others that had not existed in the area before were transplanted or seeded there. But also because of the character and maintenance regime of many of these habitats. In the meadows, on the roofs and in the ponds, new species are given a chance to establish themselves without being removed as weeds.

The increased number of plant species provides more opportunities for animals who live off the plants and in turn act as food for insect-eating and parasitic animals. The introduction of regional wild plants allows more specialised animals to find food, while garden plants primarily favour generalists. The ponds with constant water levels ensure the supply of water, which also benefits many animal species.

More systematic work than what happened in Augustenborg is needed to create the right conditions for animals. This could help ensure there is food for both larvae and adults, providing habitats and potentially places to overwinter. Using surveys to identify the species that already exist in nearby areas, and make investments that would favour these, could also prove a winning strategy. One major limitation on how many species can find homes in Augustenborg is likely connectivity, that is the routes that organisms can take to spread. Another is the lack of similar habitats nearby from which organisms can migrate. If species are unable to find their own way to an area, it does not matter how good the conditions you create are, you will not increase the types of animal there. The conclusion is that the number of plant species has increased, and that the number of animal species has probably increased.

Text: Annika Kruuse

About biodiversity

The United Nations has defined biodiversity "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". The SLU Swedish Species Information Centre says the following on its website: "Biodiversity is often defined internationally as 'variability among living organisms in all environments and the ecological complexes of which they are part'. At the same time as global biodiversity is rapidly being lost, we are becoming increasingly aware of its significance to humans, and how we are highly dependent on natural ecosystem services. The Convention on Biological Diversity, had committed countries to prevent the loss of species, populations and ecosystems. Species are the central building blocks of biodiversity."

It is also possible to speculate about the third variable - genetic variation within species. By introducing plants that occur in the wild around Malmö and by collecting local seeds, conditions have been created to allow genetic exchanges between organisms, which can create genetic variation in local populations. The same applies to animals that have spontaneously migrated to the area. Plants that originate in other parts of the world, do not contribute to genetic variation in the same way.

The conclusion is therefore that biodiversity in Augustenborg has increased at a habitat, species and genetic level. This has primarily been achieved by creating nature-mimicking habitats using regionally occurring plants.

The Scandinavian Green Roof Institute – from industrial park to green roofs and academic research site

Jonatan Malmberg

Jonatan Malmberg was director of the Green Roof Institute in Augustenborg from 2012 to 2019. This chapter is based on archives from the Green Roof Institute as well as interviews with key people who drove the development of the Eco-city Augustenborg and the Augustenborg Botanical Roof Garden.

The Eco-city Augustenborg has several distinctive features. Besides the blue-green infrastructure and waste management, Augustenborg's green roofs, and above all the Green Roof Institute, are among the best known. The idea to establish a botanical roof garden was present in the first drafts of how to develop the Eco-city Augustenborg. An important motivation was the roof garden's ability to attract visitors to Augustenborg and to raise the area's status. Today, Augustenborg Botanical Roof Garden has been internationally renowned for 20 years. It was probably the first public demonstration site for green roofs in the world and is still the second largest (a similar facility was built in New York in 2007 and currently holds the title of largest demonstration space for green roof solutions). This chapter will not only deal with the development, and continued progress of the Botanical Roof Garden but also touch on how green roofs have been used in Augustenborg in general, where municipal housing company MKB has been the driving force and area manager.

Green innovations on municipal lightweight concrete

The 9,500 sqm Augustenborg Botanical Roof Garden opened to the public in 2001. The garden had been installed on top of existing single-storey buildings which housed offices, a garage, a metalworking workshop and a mechanical workshop. The activities in the buildings are run by the City of Malmö Service Department's Public Works team and the buildings and the property are managed by the Property Section. The buildings had not at all been designed to carry green roofs. Almost all roofs were made of lightweight concrete, which can take limited loads. A vast majority of the green roofs therefore have a substrate that is only a few centimetres deep. Even when saturated with water, they weigh no more than 50 kilograms per square metre. Such shallow beds do not hold much water and can usually only house drought-tolerant phedimus succulent plants such as sedum.

Image by Scandinavian Green Roof Institute

The roofs are constantly evolving. This is the so-called ruderal roof, photographed every ten years. Some of the limestones were later changed for a substrate that better retains water.

To make space for other green roof surfaces with deeper beds, one of the buildings was reinforced with steel beams at an early stage of the project. Over the years, different plantations have replaced each other: meadows, water features, raised beds and inspiration gardens with grass, perennials and shrubs. It was not until 2014 that some of the older sedum surfaces started being dismantled to make room for a so-called innovation exhibition. It was built on load-bearing beams which allowed the installations to be somewhat heavier. These exhibition sites are now rented to businesses for demonstrations of, for instance, green roofs combined with solar cells and vegetation create systems which can store rainwater.

The Botanical Roof Garden can be viewed from 600 metres of footbridges that run along the roofs. This lets groups visit the site without causing wear and tear. Since the roof garden opened in 2001, more than 2,500 guided tours have been attended by a variety of people from academia, politics, the construction industry, preschools and even occasional royalty such as Crown Princess Victoria who visited in the winter of 2011.

Driving market development

The Augustenborg Botanical Roof Garden is a key part of developing the Eco-city project but is also closely intertwined with the Swedish green roof market in the late 1990s.

The first commercial sedum roof in Sweden was built in 1991 on the SEB bank's head office in Rissne. It was installed by Sweden's first sedum roof developer, Per Nyström. The responsible landscape architect was Pär Söderblom, who explained that permits and planning rules were not suited to green roofs and that clients were also very hesitant. They feared that sedum roofs would catch fire, fly off or damage the waterproof membrane underneath. To reduce his clients' prejudice and increase their understanding of the roofs, Pär Söderblom wrote a popular scientific publication in 1998 entitled "Sedumtak i Sverige – Utvecklingen 1991 till 1998" (Sedum roofs in Sweden - the Development from 1991 to 1998). The publication proved popular and word of Pär Söderblom and Per Nyström's work reached the Internal Services Department in the City of Malmö. At the time, in the late 1990s, the department was working to make the Public Works service site and industrial park more environmentally sustainable. Pär Söderblom and Per Nyström later became heavily involved in Augustenborg's green roof initiatives.

Service site at the environmental cutting edge

The Public Works service site is located in the southern part of Augustenborg and split from the residential area by Augustenborgsgatan. The site attracted very heavy traffic, including both stone handling and vehicles to maintain the roads in winter. The noisy environment meant that the site was a cause of controversy at the end of the 1990s, and there were proposals to move it to the Fosie industrial area. The potential move would be costly for the Public Works team. Peter Lindhqvist, who was then responsible for development and deputy business manager of Public Works, was in 1996 assigned to find a way to improve the facility's chances of remaining in Augustenborg. Peter Lindhqvist won support from management to gain a certification and develop the service facility into a cutting-edge environmental industrial park as part of the strategic efforts to stay in Augustenborg (see a more detailed description on page 16).

The innovator Peter Korn has demonstration sites with different substrates and unusual species. Image by Scandinavian Green Roof Institute

Gunnar Ericson, Street and Parks Department, and Peter Stahre, water utility VA-verket, sat on the Public Works' customer advisory council. Gaining a certification as well as the concept of a cutting-edge environmental project aroused their interest. Peter Stahre believed that the cutting-edge project should be extended to all of Augustenborg, not just the municipal engineering site. The district has long had a bad reputation as a troubled and run-down area. In addition, its residential basements were often flooded because the combined sewage and stormwater system was too small. Peter Stahre's vision was to slow the journey of rainwater above ground and demonstrate how stormwater can be locally managed. Early on the team speculated that sedum roofs could interact with open stormwater systems and help delay the rainwater.

Meanwhile, two other actors had started to discuss Augustenborg's future: Bertil Nilsson at the Fosie District Administration, who was a former headmaster at the Augustenborgsskolan school, and MKB's then area head of property Christer Sandgren. These five men - Peter Lindhqvist, Peter Stahre, Christer Sandgren, Bertil Nilsson and Gunnar Ericson - agreed to work together to develop Augustenborg into a sustainable cutting-edge project.

Financing the Botanical Roof Garden in Augustenborg

In February 1998, the City of Malmö submitted a major joint application for the Government's local investment programme (LIP), which was launched as part of the government budget in April 1997 (Prop. 1996/97:150). The application included twelve different projects, one of which was the Eco-city Augustenborg. In turn this part of the application was split into 14 projects to convert a district built around 1950 which included apartment buildings, industries and service facilities. Behind these 14 projects were the Internal Services Department, the Fosie District Administration, VA-verket, the Streets and Parks Department and MKB. One of the projects was to install green roofs on the Public Works' service buildings.

Green roofs were still uncommon in Sweden but had broken through more in Germany. The market had been developing since the 1970s and several German municipalities subsidised green roofs, included them in building requirements or used them as a compensation measure for development land. But the green roofs were rarely open to the public. Peter Lindhqvist said that during a holiday in Germany he tried to get onto a green roof:

"There was nowhere I could see any of the roofs I read about. So during that trip to Germany, I was struck by the idea that if we get financing for green roofs in Augustenborg, no one should have the problems that I had. Instead there will be a demonstration site so people can walk, see and feel the green roofs."

In April 1998, the LIP fund winners would be announced. The decision of Social Democratic minister Anna Lindh to announce a visit to Augustenborg was naturally a good sign, and sure enough, the government had approved the application for the Eco-city Augustenborg but rejected some parts of it. After the announcement at the square in Augustenborg, Anna Lindh wanted to talk to the Eco-city's project manager, Peter Lindhqvist. When asked what project he was personally most interested in, Peter said it was "the green roof project!" - blissfully unaware that it had not won LIP funding. In total, funding was granted for nine of 14 projects in Augustenborg. This included a themed playground, regeneration of the school yard and Peter Stahre's vision of a sustainable urban drainage system.

Alongside the LIP application, the Public Works section had applied for green roof funding from the European Union's LIFE programme. Unlike the LIP application, the EU approved the application. But the EU required that half of the project's SEK 14 million budget be co-funded.

No co-financing was available for the EU LIFE project from the management of the Internal Services Department or the City Executive Committee. At the last minute, Peter Lindhqvist found out that money was still left in the billion-SEK environmental investment Kretsloppsmiljarden, which predated LIP. An application to that scheme was granted. Funding had therefore been secured for a research and demonstration site for green roofs in the summer of 1998.

International centre of green roof knowledge

Landscape architect Pär Söderblom, who helped inspire the engineering unit to invest in green roofs in Augustenborg, had retired and was living in Stockholm. He explained that when Peter Lindhqvist got in touch to ask him to manage the project, he could not say no. Pär Söderblom therefore became the project manager of what would probably become the world's first research and demonstration site for green roofs (at least we are unaware of any others).

Pär Söderblom was from the beginning instructed to allow both academic research and popular science demonstrations on the roofs. A collaboration was launched with the Swedish University of Agricultural Sciences (SLU), Lund University Faculty of Engineering (LTH) and the Royal Institute of Technology (KTH). Per Nyström's company Nordiska Gröntak (which later became Veg Tech) was the most knowledgeable about the systems that were to be built. This was indispensable for the success of the project, but also governed where different surfaces and different systems would be placed. Even though nearly all the Public Works' roofs were to be covered by green roofs, opinions differed over how to best use the surfaces of the Botanical Roof Garden. The large area that researchers had laid claim to was reduced in size. Demonstrations of various solutions were placed closer to footbridges and the conference room, which was built for the project's outward-facing activities.

The first seminar of the green roof project was held on May 11, 1999, the same day that the first sedum roofs were installed on the Augustenborg

Image by Scandinavian Green Roof Institute

The roof garden is not only a research facility, but also allows displays and testing of different types of green roof.

Botanical Roof Garden. While green roof experts held lectures, onlookers could see the roofs turn green before their eyes as pre-grown sedum carpets were laid out.

The roof garden was officially opened on April 25, 2001. Just under a month later, on May 17, the Bo01 housing expo launched, and some of its visitors also came to the Eco-city Augustenborg to see the botanical roof garden. By then, many new recycling houses had also been fitted with sedum roofs, financed by MKB, which drew inspiration from the roof garden project. The Internal Services Department placed green roots on nearly all of the buildings that formed the neighbouring Augustenborgsskolan school.

Peter Lindqvist said that the many green roofs on recycling houses and school buildings around the Eco-city provided educational value. They highlighted the district's sustainable redevelopment. Augustenborg's bad reputation during the 1990s meant anything that would improve its image was welcome. Even better if it attracted visitors from other districts.

Malmö University started in July 1998, during the beginnings of the Eco-city project. Lindhqvist said this provided a unique opportunity:

"We said that we needed something academic in Augustenborg as well, contrary to the opinion of the City Executive Committee, which believed that it should all be on Universitetsholmen. Alongside the [founding of Malmö University], we wanted to start the Green Roof Institute. It would be an academic environment to improve the image of Augustenborg and attract visitors."

In 2001, the International Green Roof Institute was founded to manage and run the work at the Augustenborg Botanical Roof Garden and organise field trips to the district. One goal was that the institute could create a hub for international scientific knowledge exchange about green roofs. From 2001 to 2005, the institute organized annual conferences and seminars with international guests, and in April 2002, it also published the International Green Roof Journal. The magazine was the first of its kind and published four issues, in large part thanks to the voluntary efforts of Violetta Lindhqvist, Peter Lindhqvist's wife. Another important part of creating an academic environment was to enable the first doctorate focused on green roofs in the Nordics. The position was awarded to Tobias Emilsson. In 2006, he completed his doctoral thesis, mainly based on experiments performed at Augustenborg Botanical Roof Garden.

The activities at the Botanical Roof Garden sparked great interest among international researchers and others interested in green roofs. Peter Lindhqvist said that some of the most experienced and prominent professors from Germany were very impressed when they visited during an international research seminar. They struggled to understand why they had not thought of starting an international centre for green roofs, despite being involved in the market so much longer than the Swedes.

Alongside the academic activities in Augustenborg, there were many outreach events. In 1999, the City of Malmö helped start the non-profit Scandinavian Green Roof Association. Once the roof garden had been completed the association was renamed the International Green Roof Association. The association also launched an award for green roofs in 2001, which has been handed out every year since to Scandinavian green roof projects.

A mixed research environment

Studying green roofs requires an interdisciplinary approach. Various research disciplines highlighted different aspects and results through the experiments and demonstrations in Augustenborg. At the roof garden, researchers studied different ways of establishing roofs, the composition of plants, the amount of runoff when it rained, how nutrients leaked from newly laid sedum roofs, the development of mosses and the impact of green roofs on the buildings' waterproof membrane.

Image by Scandinavian Green Roof Institute

Splendid flowers also promote biodiversity in the area. Wild thyme is particularly suitable for some roofs.

Much of the research was funded by money from Byggforskningsrådet (the Building Research Council) and later Formas and came with some performance targets. The EU LIFE project, which paid for half of the roof garden, was about demonstrations, and focused on seminars and spreading information. Everyone involved had high ambitions for the project, but their goals sometimes differed. Those with something to sell needed good results and as little negative publicity as possible. When trying to prove the long-term viability of green roofs, parts of old ones were removed, for example from SEB's roof which was laid in 1992. The old bits of green roof were put on show in Augustenborg. Researcher Tobias Emilsson said that the desire to foster a particular image of green roofs could run counter to other aspirations:

"They wanted to show how the roof gardens are viable long-term and wanted to show how nice old roofs are… So they picked pieces of older sedum roofs from SEB. But because those coverings contain a lot of moss, they were fertilised to look 'like they should be'."

Fertilising and caring for sedum roofs was not particularly controversial, but the systems were in the meantime being marketed as practically maintenance-free. Meanwhile, one study showed rainwater that runs off a green roof is less clean - especially if the roof was fertilised - when compared to a regular roof. Tobias Emilsson hypothesised that the market was new and therefore more suspicious than it is today. There were no margins that would allow negative results. Even older roofs needed to look lush

and flowering. But from a scientific perspective, it was important carpets not to be fertilised, so that the development of the vegetation could be followed longer term without maintenance measures.

The Green Roof Institute had high ambitions that relevant research would be carried out across several disciplines. Pär Söderblom led the work and kept in regular contact with the researchers. The emphasis was on the plant- and substrate-focused research that SLU conducted, mainly as part of Tobias Emilsson's doctor's thesis, and the stormwater research that was carried out at the Water Resources Engineering division at LTH. There was a desire to cover even more areas and many smaller projects were carried out. These were intradisciplinary, interdisciplinary and multidisciplinary. Among other things, they included ongoing surveys of the fauna on the roofs, and a major inventory of natural migration of mosses.

Research meetings were held annually at the roof garden until 2006. After that, they ceased. One reason was that the EU LIFE funds had run out so there was no longer money to pay for Pär Söderblom's project management and coordination. Instead, he joined as the unpaid chief executive of the Green Roof Institute from 2003. Another reason activity declined was a perceived saturation of research into green roofs. Tobias Emilsson said that some thought they had exhausted what the roof garden could contribute to their fields. This included LTH's research into rainwater retention on sedum roofs. Meanwhile, Formas and other funders changed direction, leaving fewer green roof grants to be applied for. Researcher Nils Cronberg also speculates that researchers may have tired after more than six years' work, and that the project was ahead of its time:

"In retrospect, it is clear that the project with green roofs was cutting-edge, not least given all the focus that is today placed on what are now called ecosystem services. The research on green roofs and other urban environments in Augustenborg was largely about ecosystem services, though the term was not launched until 2005 (in the UN's Millennium Ecosystem Assessment report) and was therefore not part of the discourse."

Perhaps greater foresight from funders and academic leaders could have helped maintain and deepen the broad, interdisciplinary collaboration. After 2006, the non-profit Green Roof Association and the Green Roof Institute were unable to maintain their academic profile. It took years for a collaboration to be resumed with SLU, and even that was smaller than before. The Green Roof Institute slowly became more of a special interest group.

Image by Scandinavian Green Roof Institute

It is normally difficult to see and experience green roofs because they are too high up. Here a solution has been to build several walkways on the roofs.

Still standing after 20 years

Activity slowed at the roof garden when the many research projects came to an end. Malmö University started a module on green roofs in 2003, which was partly taught in Augustenborg. The course moved to SLU in 2006, where it was taught until 2010. In 2018, the university again started a distance learning course on green roofs. At the time of writing in 2019, the course is being held through a collaboration with establishments including the Green Roof Institute.

In 2005, the institute changed its name from "International" to "Scandinavian" Green Roof Institute. The name change was partly sparked by new working methods, which focused more on Scandinavian exchanges, and in part due to external pressure. The International Green Roof Association (IGRA) had been launched in Germany. The Germans were a little worried about the competition and said that it might be more "interesting" if Augustenborg institute drove development in Scandinavia. The German association also launched its own international award and held several of its own international conferences for several years, but eventually closed in 2018.

When the EU LIFE project ended in 2003, there was no stable source of income for the institute and Augustenborg's botanical garden. The institute's external activities slowed, and far fewer seminars and events were held. However, there was a gradual increase in the number of technical visits as interest grew in the Eco-city Augustenborg and the world caught up with its green roof. Louise Lundberg, who curated the roof garden between 2003 and 2011, says it began with occasional guided tours and soon over one hundred groups were visiting each year. According to Louise Lundberg the Eco-city and the roof garden seemed to market themselves, and a steady stream of visitors arrived from Sweden and the rest of the world.

Between 2004 and 2012, the Scandinavian Green Roof Institute was mainly funded through municipal agreements and some money from MKB. Since 2012, Eon and VA Syd have also made contributions, by supporting the Green Roof Award, water tours for preschool classes in the roof garden, and field trips for schools and universities.

Climate adaptation and urban ecosystem services

Today, time and development have caught up with much of what happened in Augustenborg. There is now an established discourse, from both politicians and municipal planners, about urban ecosystem services and the need for climate adaptation and blue-green solutions. The increased interest in green roofs and other blue-green solutions has given the institute a new lease of life. Since 2012, its turnover has steadily increased by broadening service offering. New project financing has been found and the number of members has expanded. Since 2012, Mats Ola Nilsson, MKB, has served as managing director (unsalaried position), which has guaranteed a welcome continuity in management.

In 2017, the association changed its name from the Scandinavian Green Roof Association to the Scandinavian Green Infrastructure Association. The decision was taken to reflect today's focus on seeing everything as "urban ecosystem services" rather than concrete solutions.

The projects have been enabled through funding calls from Vinnova and the EU, in large part because of the City of Malmö Environment Department's goal to include the Eco-city Augustenborg in various developments and maintain the function of the roof garden. MKB has also played an important role in continuing to foster green roof innovations in Augustenborg. Together with the institute and SLU, MKB has assessed various maintenance routines for sedum roofs. There was initially no maintenance. But after eight to ten years, some roofs were in markedly poor conditions and maintenance began in 2013 by trailing sustainable fertiliser, among other things. That year MKB also installed a green roof with an unusually diverse range of species at the Augustenborg square. MKB's new construction project Greenhouse, completed in 2016, included a shared garden on the third-floor roof terrace. This was a different type of green roof to three centimetres of sedum.

The vast majority of field trips to the Eco-city Augustenborg are still arranged by the successor to the Green Roof Institute. The visits to the Eco-city Augustenborg start at the roof garden and fol-

Image by Johanna Sörensen

The recycling houses in Augustenborg are fitted with green roofs.

low the water's path down and out through the area, as Peter Stahre envisioned. At the moment, there is no indication that interest will decrease in Augustenborg and the Botanical Roof Garden. On the contrary, interest is increasing as awareness grows of the benefits of blue-green solutions. In 20 years, no better role model has been built in Sweden that could compete with the Eco-city Augustenborg. Instead, the Eco-city is still a leader among role models for environmentally regenerating a district.

Text: Jonatan Malmberg

Green roofs in the Augustenborg district

Green roofs are today a natural part of the Augustenborg district, and not just at the Augustenborg Botanical Roof Garden. But visitors who come expecting to see green roofs on all Augustenborg's buildings will presumably be a little surprised.
Those who look up will see that tiles dominate the roofscape on the typical 1950s gabled roofs. The steep slopes and tall building mean that green roofs have never been an option there.
Instead, it is the majority of the gently sloping roofs that are covered by sedum mats and other types of vegetation layers. They have been installed on all the area's new retirement housing, on most of the school's buildings and on the area's ancillary buildings such as the recycling houses for neighbourhood recycling.
Augustenborg's green roofs are not just sedum. An underground garage is covered by a public park with grass lawns and bushes and on the square's shops there are so-called habitat roofs with ruderal land qualities. And when Greenhouse, the environmental cutting edge housing project, was completed by MKB in 2016 there was a large amount of shared roof garden three storeys up. Augustenborg's green roofs cover 4,000 sqm, not including the roof gardens.
All in all, these give Augustenborg an unusual amount of green roof space for Malmö, even if first impressions say otherwise. But the main attraction for those interested in green roofs is still the botanical roof garden on the industrial buildings which house the Internal Services Department's activities.

Moss on green roofs

Why should you have moss on roofs? Do they not deface and cause damage?
It is not an entirely new question. Carl Linnaeus considered this when he visited Skåne. He wrote that some zealously clear all moss from their thatched roofs, but that farmers in the region think the moss is good and prolongs the roof's life.
The vegetation of modern green roofs, such as those in Augustenborg's roof gardens, mainly consists of succulents (the Sedum genus) and mosses. Moss has several properties that allow it to survive on roofs, and in many cases provide great benefit to humans in an urban environment.

- When flowering plants absorb water, they do so mainly through their roots, which requires the soil to be moist. Mosses allow water to take a shortcut through their stems and leaves. This means that mosses absorb the first rain that falls on the roofs. Only with some delay does the water reach the soil, to saturate the flowering plants. During moderate rain, therefore, the moss is mainly responsible for water retention. Moss can also absorb moisture from the air during the night (dew). When the sun shines on the roofs, the mosses ability to retain the water is limited, which balances the humidity between day and night and provides some cooling effect.
- Mosses have no roots and absorb almost all nutrients directly from rainwater and airborne particles. To survive on this lean diet, they act as ion exchangers that very efficiently absorb available nutrients. They also absorb heavy metals, microparticles and other environmentally hazardous substances that may be present in the air. Mosses can therefore be likened to urban purification filters.
- The mosses are physiologically active, photosynthesise and therefore produce oxygen even close to freezing temperatures. This means they remain green and visually attractive even during the cold part of the year, during autumn, winter and spring.
- However, they may be dry and inactive during dry spells. They survive drought because the cells are able to lose almost all the water without dying. They can also survive the roofs' high temperatures during hot and dry summer periods. During rain it only takes a few minutes for the mosses to unfold their leaves and regain their green luster. At molecular level, repair mechanisms restore the cell functions damaged by drought.

Nils Cronberg, PhD, senior lecturer in biodiversity at Lund University. Researches mosses, their life cycles and reproductive biology.

Many people view mosses as an anonymous green covering, a sort of stage floor in the theatre of the forest. But there are in fact many species, over one thousand in Sweden alone, which all look different, varying in colour and shape, which you can see if you get close enough. Many mosses cannot survive in the demanding urban environment, but Augustenborg's roof gardens are home to a surprising number of species. These are some of the most common:

Great Hairy Screw-moss
(Syntrichia ruralis)
Watching the twisted moss transform in a few seconds is magical. It metamorphosises from dried tangles into proud upright stems with open, yellow-green, rounded leaves each with its white hair-point. The Great Hairy Screw-moss can withstand extreme drought and heat and has relatives that grow in deserts.

Redshank
(Ceratodon purpureus)
Redshank is a dominant species, which grows in unremarkable tufts until it expels a myriad of spore capsules that are first green and then turn the roofs red for a part of the early summer before fading into a brownish-yellow hue. Redshank is also common on roadsides.

Bonfire-moss
(Funaria hygrometrica)
Bonfire-moss specialises in living in fire-ravaged areas, a coloniser which moves from burn site to burn site. It lives in patches on the green roofs and is identifiable through its distinctive pear-shaped spore capsule.

Bristly Haircap
(Polytrichum piliferum)
Bristly Haircap has leaves that are stiff and needle-like, with a transparent leaf-tip. In Augustenborg, it has gained a foothold on a roof covering that was created by spreading a thin layer of fine shingle on clean mineral wool. The male shoots have a cup-like structure ("moss flower") which turns a beautiful orange-red in spring.

Whitish feather-moss
(Brachythecium albicans)
This moss is a lawn and roadside variant durable enough to survive on roofs. It grows in creeping, feather-like branched shoots with an identifiable pale green color.

Silver-moss
(Bryum argenteum)
The shoots are dense and the leaves slicked upwards around the stems. They have a silver sheen because the leaf-tips have no chlorophyll, turning them whitish. Silver-moss is a cosmopolitan which likes to grow in the cracks between paving stones. Across the world, people step on silver moss every day without noticing it.

Green roofs, stormwater and sustainability – Augustenborg as a research site

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The green roofs in Augustenborg are a substantial, visual result of the Eco-city refurbishment. The roofs early attracted researchers' attention and several studies on stormwater performance, water quality, biodiversity, etc. have been conducted on or in relation to the green roofs within the neighbourhood. This article aims to tell the research history of Augustenborg after the refurbishment and to report all substantial research results from the area.

The idea that green roofs can be used as an integrated part of an open stormwater system, which address multiple technical problems at the same time as they create interesting outdoor environments and improve the neighbourhood image, was central to the Augustenborg development as an Eco-city. Green roofs were showcased on most of the accessible and visible roofs in the neighbourhood and could, as such, be seen as a physical manifestation of a changed approach to urban development. At the time of the development of the Augustenborg project, the experience and knowledge was comparably low in Scandinavia. Even so, there were few international demonstration and research installations in place.

During the 20 years following the Augustenborg refurbishment, the importance and urgency of the developed stormwater concepts have become even more apparent. Blue-green infrastructure is seen as a way to mitigate the negative effects of urbanisation and to adapt to a forthcoming changing climate, even though definitions and system limits vary. There is now evidence that blue-green infrastructure is indeed multifunctional (Lerer *et al.*, 2015) with both environmental and social functions. As such blue-green infrastructure is a concept for landscape planning, integrating urban vegetation with stormwater control in a decentralised manner (Liao *et al.*, 2017, O'Donnell *et al.*, 2017).

The green roofs were a fundamental part of the Eco-city development but their function and role in the stormwater system is also dependent on the other system components and green installations such as swales, channels, ponds and floodable land (fig 1).

Figure 1. Situation plan of Augustenborg stormwater system, including green roofs, swales, channels, brooks, ponds and floodable land. Illustration by Johanna Sörensen

The Eco-city development in Augustenborg was the starting point of research on green roofs in Sweden and among the first research sites internationally. In this paper, we will review the role of green roofs in the stormwater system and the development of a green roof research environment in Augustenborg followed by other research related to the Eco-city development. We will focus on the knowledge generated in relation to stormwater performance, water quality and biodiversity, but also in relation to technical development and maintenance, as well as sustainability. Our goal is to give an overview of the research activities that have taken place in the area, including studies that were only published in reports and thesis works.

Developing a research environment in Augustenborg

The green roofs were an important symbol for the refurbishment of Augustenborg and some pioneer research on green roofs were conducted within the neighbourhood. The initial research work performed on the green roofs were as such a part of a larger research program on urban soil and water. The main part of the activities was closely linked to the Augustenborg botanical roof garden (see page 149). There was a broad interest in both the technical and the societal changes that take place when an existing combined sewerage system is upgraded and separated by use of blue-green infrastructure. This project was also early in its focus on co-design processes, in which there was an aim to involve the citizens in the design process (Krantz & Hjerpe, 2002). Still, the main part of the research as reviewed below was focused on the environmental and technical performance delivered by the blue-green solutions.

Green roofs have been installed in Augustenborg on a number of different buildings throughout the neighbourhood, as a part of the blue-green infrastructure (fig 1). The largest individual installation was done on the Augustenborg botanical roof garden (ABR), with a total of more than 9500 m² of different types of green roofs. While some roofs were constructed as flowering meadows and ornamental gardens, almost all installed roofs are of an extensive type using approximately 3–4 cm substrate and drought resistant succulent vegetation (a more in-depth description is given at page 172-173). The main reason for installing thin green roofs were the fact that they were either installed on existing buildings or on light buildings used for collecting recycling material.

Stormwater performance of green roofs

The main reason for green roof installation in Augustenborg was their expected influence on the stormwater runoff dynamics, but their function and performance had not been tested in Sweden before.

Image by Karin Oddner

One of the article's authors, Tobias Emilsson, at the Augustenborg Botanical Roof Garden ten years ago. At that point he predicted a bright future for green roofs: "There are significant pressures on city planners to create more dense cities while maintaining quality of life, where greenery is an important element. To achieve this, we have to build greenery on walls and roofs." (Quote from the text Ekostaden Augustenborg – på väg mot en hållbar framtid.)

There were some German studies available before the onset of the Augustenborg project indicating that there could be substantial reduction in runoff volumes even on rather shallow substrate depths (Liesecke, 1993, 1994; Knoll, 2000). The investigations were reporting stormwater performance on an annual basis both from installations on existing buildings and from lab experiments.

The green roofs in Augustenborg were instrumented to get a more in depth understanding of how the system influence stormwater runoff both on a longer and a shorter time frame. These studies were carried out on extensive sedum-moss covered roofs. There were initially some thicker roofs installed for research purpose but the data collection was for various reasons not followed through. The first results from the experimental setup on the thin roofs were published in Journal of Water Management and Research (Tidskriften Vatten) in 2002 (Bengtsson, 2002) and the results showed that the even the extensive green roofs had a substantial effect on the stormwater runoff as compared to a hard surfaced area. It was found, that the thin green roofs with an extensive vegetation cover, which was used in the experimental set, had a storage capacity of up to 10 mm water. The effect on the runoff is largest when rain is falling on a dry roof. During larger and longer rain events, when the maximum storage capacity is exceeded, runoff equals rainfall on an hourly and daily basis. Still, there is an effect on shorter time spans. The annual runoff from the test rigs showed a 50% reduction in runoff, which is similar to earlier German research. Most of the runoff reduction occurs during summer months, as evapotranspiration is the governing process. For small rainfall events, no runoff occurs, while the retention effect is limited for extreme rainfall and for consecutive events.

There was a rapid increase in international green roof research focusing on stormwater runoff during the early 00s. Lars Bengtsson *et al.* published 3 articles focusing on different aspects of runoff (Bengtsson, 2005; Bengtsson, Grahn, and Olsson, 2005; Villarreal and Bengtsson, 2005). The total runoff and the monthly water balance were analysed in Augustenborg, as well as the storage on the roof during storm events (Bengtsson, Grahn & Olsson, 2005). After dry periods, runoff was initiated after 9–10 mm of rainfall, corresponding to the field capacity in the roofs. The storage however increases a little with rain intensity. During some periods the evapotranspiration is almost equal to the potential one (ibid.). While the return period of runoff from hard roofs corresponds to the same return period as for rainfall, the return period is much longer for a green roof. A one in 1.5-years return period for the green roof runoff corresponds to a 0.4-year runoff, and runoff with a 0.5-year return period corresponds to a 0.1-year rainfall (Bengtsson, 2005). In parallel with the experiments in Augustenborg, a unit hydrograph was produced at a test rig in Lund (Villarreal and Bengtsson, 2005). The unit hydrograph can accurately describe the response to any rain event. Several different roof slopes were tested and found insignificant for the runoff response (ibid.). The reason is that the time to fill up the storage is much longer than the time for the saturated flow to move down the roof.

The real effect for design parameters of stormwater systems have been difficult to establish. The main problem with the most common types of green roofs is the fact that they lose their influence and performance as they become gradually more saturated with water (Bengtsson, Grahn, and Olsson, 2005; Lee *et al.*, 2013). The stormwater performance is small when systems are saturated. The ability to restore the capacity, a process in large driven by weather variables, is crucial for the effect of green roofs on stormwater runoff. Thus, rainfall dynamics in combination with local climate and system build-up will determine the retention and detention characteristics of the green roofs.

By modelling the stormwater system in Augustenborg, Villarreal *et al.* (2004) found that in the absence of the green-roofs, peak flows to the pond would increase by 64, 37, 27 and 13% for return periods of 1/2, 2, 5, and 10 years respectively, and that the volume of the inflow hydrographs would rise 52, 30, 26, and 18% for the same return periods. They conclude that the pond complex must be larger to offer the same level of retention and attenuation without green roofs. The model parameters for the green roofs were based on monitored data from the similar test rig in Lund (Villarreal, 2007).

Numerous similar research sites have been developed all over the world, where individual green roofs have been instrumented and monitored. The key questions have been the continued investigation of the influence of different design aspects such as substrate design (De-Ville *et al.*, 2017; Stovin *et al.*, 2015), substrate thickness (Elliot *et al.*, 2016), slope (Getter *et al.*, 2007), and vegetation system (Johannessen *et al.*, 2018), but also effects on hydrology (Lee *et al.*, 2013) and local climate (Onmura *et al.*, 2001) has been investigated.

During the last years, there has been a new generation of research on stormwater related research questions in Augustenborg. The new direction of research in Augustenborg is moving away from performance of individual components and have instead focused on the overall effect of the stormwater system, especially flooding (Haghighatafshar *et al.*, 2017; Sörensen & Emilsson, 2018). By analyses of insurance data, it was shown that

Augustenborg has a lower flood risk after refurbishment, compared to other similar, nearby areas without blue-green infrastructure. This can be explained by the disconnection of stormwater from the previous combined sewer system (sanitary and storm drainage in one pipe) in combination with the use of large volumes for flood control in the stormwater ponds, concave shaped green areas, etc. (Sörensen & Emilsson, 2018). One necessity for the low flood risk in Augustenborg is that the area is not situated along any of the main, combined sewers (Haghighatafshar *et al.*, 2017), as areas close to those are more affected by flooding during intense rainfall than other areas (Sörensen & Mobini, 2017). The blue-green infrastructure in Augustenborg is beneficial also for downstream areas, as the peak flows out of the area is reduced by ~80% (Haghighatafshar *et al.*, 2017). It should be noted that the explanation for the large peak flow decrease is most probably not the green roofs, but rather the detention and retention capacity of the ponds, in combination with the regulation of the outflows (Villarreal *et al.*, 2004).

Different solutions affect the urban hydrology in different ways (fig 2). While the main function of green roofs is evapotranspiration and to some extent retention, other solutions, like ponds, wetlands, and floodable land, are more effective during extreme rainfall when retention in large-storage solutions is the most important hydrological process (Villarreal *et al.*, 2004; Sörensen & Emilsson, 2018).

Stormwater quality of green roofs

The combination of an open stormwater system with open channels, canals and ponds together with a newly renovated neighbourhood with newly established vegetation in fresh soil as well as green roofs proved challenging from a maintenance perspective. The ponds and canals required repeated cleansing from debris but primarily from algae growth (Söderblom, 2004). The question was raised if this could be attributed to the green roof maintenance in the form of fertilisation.

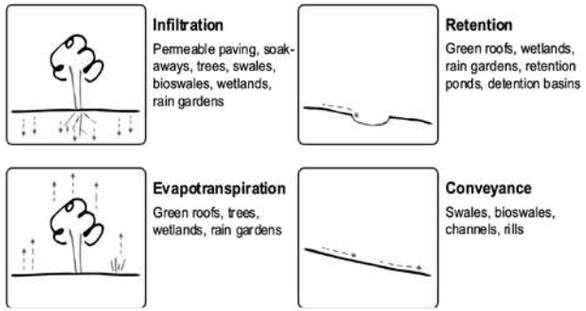

Figure 2. Hydrological features of blue-green infrastructure, including infiltration from different surface and basins, evapotranspiration from vegetation, retention in ponds, basins and on green roofs, and slow conveyance in swales and channels (from Sörensen, 2018). Illustration: Johanna Sörensen

Fertilisation of green roofs is commonly done and generally follows the German guidelines from FLL (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau). These suggest a yearly application of 5gN/m2 during the first years following establishment (FLL, 2018). The general recommendation is to exclusively use encapsulated coated fertilisers, but in practice several different combinations of coated and conventional fertilisers has been used.

A few pilot studies were performed on green roofs in Augustenborg and in in-vitro experiments showing that improper fertilisation of thin green roofs can cause reduced quality of the runoff water (Czemiel Berndtsson *et al.*, 2006, Emilsson *et al.*, 2007) Using conventional fertilisers on extensive green roofs will give rise to rather high nutrient concentrations in runoff water. The thin and porous nature of the substrate, in combination with the low growth rates, results in loss of the main part the fertiliser the first six months after the application (Emilsson *et al.*, 2007). The problem is aggravated on newly established surfaces that are fertilised. Unfertilised roofs can on the other hand act as sinks for nitrogen as they are getting older (Czemiel Berndtsson *et al.*, 2006). The effect or release of other nutrients as well as seasonal effects and aging are less clear but highlights the importance for having quality substrates and components in the build-up that does not have negative effects on storm water quality (Czemiel Berndtsson, 2010, Karczmarczyk, Bus & Baryla, 2018, Buffam *et al.*, 2016).

Biodiversity

The use of green roofs for improving the urban biodiversity was seen as generally interesting at the time of the development of the ABR. Still, it was neither central to the design or selection of systems for the installation nor to the initial research program that was developed at the site. Instead, the main part of the installation were extensive green roofs that were not modified to increase biodiversity value. At the time of installation, there were not much information about green roof biodiversity and only few in depth studies about performance. Still, the large redevelopment of the neighbourhood and the large installation of green roofs opened up to some interesting questions in relation to urban biodiversity.

A separate section at the ABR were installed as intensive systems with thicker substrates and a more varied plant mix. Again, this was a decision made from an aesthetic standpoint rather than from biodiversity. The increased discussion about the possibility and potential for green roofs to support biodiversity later lead to the development of a ruderal section on one roof. The ruderal roof was designed as an aesthetically pleasing analogy to a spontaneous established natural vegetation community commonly arising on bare soil or abandoned urban sites.

The main habitats in the Augustenborg area can be characterised as extensive sedum-based systems. These thin systems are very dry during the summer and almost without any moisture for several days or weeks during June to August. The extensive green roofs had low invertebrate biodiversity during the initial years following the installation as compared to what would have been found in natural habitats. There was a gradual increase over time, but local climate and vegetation system design was seen as more important with shaded areas showing higher diversity. The studies on habitat quality and biodiversity were never published but shows similar results as later research from other sites. Using higher vegetation, including herbs and grasses, will improve biodiversity on the roof (Ohlsson, 2002, 2001, Sandberg, 2010). Using systems specifically designed for biodiversity can increase the value if they are designed to retain some moisture and use appropriate plant and substrate material. There were several attempts made to increase the research effort on biodiversity on green roofs in Augustenborg, but most were done in an extensive manner in existing projects.

There have been a few inventories made on the biodiversity of the green roofs and the surrounding neighbourhood. There were some tendencies that the ABR did increase of avian and invertebrate biodiversity. The lack of structures for hiding and

Image by Sanna Dolck

Examples of green roofs at the Augustenborg Botanical Roof Garden

nesting could in this case have been limiting the habitat quality of the green roofs. As in many other experimental setups, it was difficult to establish a baseline for biodiversity in the neighbourhood. The complete renovation of the neighbourhood also made it difficult to ascribe certain results to the green roofs (Ohlsson, 2002, 2001).

Research shows that taller vegetation, including herbs and grasses, improves the roofs' biodiversity. Image by Scandinavian Green Roof Institute

Later international research has moved forward, particularly in relation to invertebrate diversity on different types of green roofs. In general, green roof biodiversity is driven by a bottom-up approach where system heterogeneity in substrate thickness, substrate components and vegetation structure is translating into higher invertebrate diversity. There has also been a particular interest in the influence of building height on the development of roof diversity. In general, ground diversity is higher as compared to roof habitats but it is linked to both installation factors as well as later colonisation. The effect of green roofs on general invertebrate diversity was thoroughly reviewed by MacIvor and Ksiazek (2015).

Technical development and maintenance

The main part of research on green roofs internationally has been focused on the environmental performance of different types of green roof installations. The research installation at Augustenborg was a first step to develop new knowledge on system design, system long-term development and maintenance requirements.

There was an interest in developing knowledge about what type of substrate and vegetation that could be used. The Swedish market was and is still to a large extent based on prefabricated vegetation mats and imported substrate material using lava and pumice. The use of recycled materials such as crushed brick has been more common in Germany and southern Europe where direct establishment of the vegetation on the roof using cuttings and plants also has been more common. (Emilsson & Rolf, 2005)

The Augustenborg experimental site included a section where the conventional prefabricated vegetation mats were compared to direct establishment using cutting material and plug planting. The prefabricated vegetation mats are a clear advantage in the installation phase as the establishment time is minimised and the installation is convenient. All establishment methods were seen as successful from a biological and technical standpoint, given that they managed to achieve a high plant cover within the first years (Emilsson & Rolf, 2005; Emilsson, 2008). The establishment method also has some implications for vegetation design as certain species were promoted when planted as plugs as compared to installed in a vegetation mat.

The total environmental performance of green roof is linked to both the environmental output of the system but also the quality and embodied energy in system components as well as resources need to maintain the system function over time (Bianchini and Hewage, 2012; Bozorg Chenani *et al.*, 2015) There were several exploratory projects investigating energy efficiency of green roofs as well as the durability of the roof membrane (Björk *et al.*, 2004). There were some indications that the protection of the membrane from temperature fluctuations and UV light could increase the life span of the membrane. Using green roofs for isolation has been seen as important in some climates and with another type of building practice (Castleton *et al.*, 2010). This has not been the case in Sweden as most buildings due to local regulation already have sufficient layers of isolation.

Installation, development and maintenance of green roofs is not only related to technical quality of the system but also to expectations, desires and ideas about the aesthetics and delivery of values for the people that interact with the system. Some initial investigation was used on digital photographs from Augustenborg investigating peoples' perception of different types of green roofs. This is a field that has lately received a lot of attention. The results from Augustenborg showed that the preference was linked to both sociodemographic and environmental background but that there was also a higher interest for carefully designed surfaces with more colour and variety (Fernandez-Cañero *et al.*, 2013).

Besides the scientific studies of green roofs in Augustenborg, several student projects have been conducted here. An early student work investigated the noise reduction of green roofs, where it was found that in very light weight structures, green roofs can have an effect (Lagström, 2004).

Sustainability

Ludzia studied the sustainability of different technical solutions in the blue-green infrastructure in comparison with their traditional counterpart in another student work. She found that green roofs were better from a technical and environmental point of view, compared to traditional roofs, while they were worse from an economic and social point of view (Ludzia *et al.*, 2014). The installation of the green roofs and the stormwater system in Augustenborg also changed the perceptions of the area, according to Krantz & Hjerpe (2002). They found that inhabitants do not consider themselves as users of underground drainage systems but often take the function and service for granted. When the system instead is constructed on the surface, like blue-green infrastructure, the inhabitants change their mind-set and consider themselves as users.

Conclusion and outlook

The research in Augustenborg has changed over time. The development of the roof garden was accompanied with large research grants that made it possible to explore fundamental aspects of green roofs and green roof technology over several years. The last years have shown an unprecedented interest in the potential of green areas for urban rehabilitation and the green roof research has taken another direction focusing more on system quality, green innovation and on discussing how better and more appreciated roofs, for man and animals, can be installed. The direction of the activities at the botanical roof garden has also changed into a stronger focus on green infrastructure in general, where green roofs are one important component among many others.

The development of urban drainage over time has necessitated more and more perspectives to be included in parallel, from early focus on drainage and hygiene to amenity, climate change adaptation and resilience thinking (Brown *et al.*, 2009). The research focus follows this development and there is currently a strong focus on resilience and climate change (Sörensen *et al.*, 2016). This interest is also visible in the research conducted in Augustenborg. During recent years, studies related to pluvial flooding has used Augustenborg as a case. The stormwater system in the area is still somewhat unique, as very few areas of this size has been refurbished with blue-green infrastructure, also termed Sustainable Urban Drainage Systems (SUDS). It is more common to use such techniques in new developments or as small, single solutions. When Malmö was heavily flooded

in, 2014, an opportunity to study how SUDS in relation to flooding appeared. This has only been possible by modelling before as both these kinds of systems and such extreme events are rare (Sörensen & Emilsson, 2019).

Developing a sustainable city or sustainable neighbourhood that fulfils the needs and expectations of all inhabitants and interests is not an easy task. The use of multifunctional green spaces such as green roofs and other blue-green solutions can be a way forward. The work that has been carried out in Augustenborg shows that it is possible to move a neighbourhood in a more sustainable direction using a multitude of approaches and technologies. Green roofs have a role to play in the future sustainable city, but they will not accomplish it on their own.

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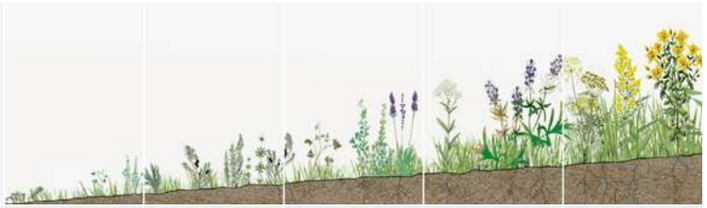
The art of building a green roof

The Augustenborg Botanical Roof Garden has been an engine of green roof development in Sweden. The Scandinavian Green Roof Institute (SGRI) and several other partners, have together produced Grönatak-handboken (the Green Roof Handbook)[1]. To illustrate how green roofs can be built, below are some excerpts from the Green Roof Handbook.

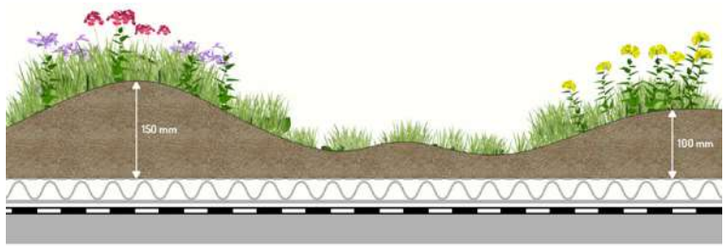
Illustration: Martin Grane

Bengt Persson, one of this anthology's editors, has compiled a selection of excerpts from Grönatakhandboken (the Green Roof Handbook)



Formation and expression	Barren alvar	Rocky steppe and alvar	Flowering dry meadow (partly covered by vegetation complemented by sedum)	Flowering meadow with grassy patches (fully covered by meadow and grass)	Flowering meadow with a lot of grass
Substrate depth	Greater than 30 mm	Greater than 80mm	Greater than 100 mm	Greater than 120 mm	Greater than 150 mm
Vegetation	Moss, common houseleek, some sedum	Sedum, some herbaceous plants	Herbaceous meadow plants, sedum, some grass	Herbaceous meadow plants and grass	Herbaceous meadow plants, grass, and some woody perennials

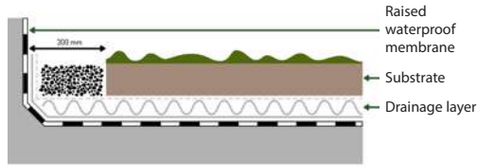
Which vegetation can be established and which develops gradually, depends primarily on the thickness of the substrate/soil. How sunny/shady it is on different parts of the roof and the availability of rainwater also have an effect. A thin, or extensive, green roof should normally not need any irrigation.



An illustration of how a green roof can look when the plant bed's depth is varied.

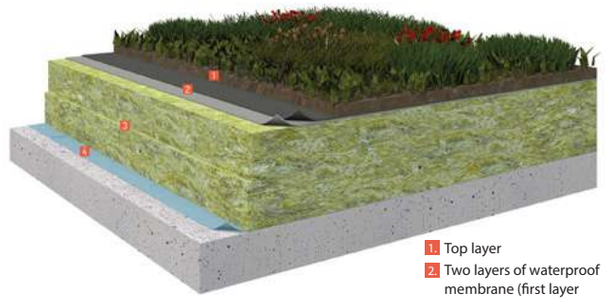
[1] See gronatakhandboken.se for various publications in the handbook. The project was financed by Vinnova.

This is how a finished sedum carpet looks from underneath. Image by Jonatan Malmberg.



There are many technical procedures that must be closely followed when laying a green roof. This illustration shows one way to install drainage against surrounding walls, by installing draining materials (capillary breaks), alongside the wall.

This is how green roofs are usually built on heated buildings. It requires insulation. This system installs waterproofing, to prevent leakage through the roof, in two layers directly under the plant bed. If the building is a garage, or other unheated room, no insulation is needed, but waterproofing is always required and must be installed correctly to prevent leaks from developing after a few years.



1. Top layer
2. Two layers of waterproof membrane (first layer mechanically attached)
3. Mineral wool insulation
4. Vapour barrier

1. Covering
2. Fibre canvas
3. Draining insulation EPS
4. Drainage shaft
5. Root protection made from PE film that can be replaced by bitumen
6. Waterproof layer
7. Primer

The Green Roof Handbook provides good detail on how to construct difficult parts of green roofs. This shows a safe and waterproof drain installation. Drains are always needed on roofs to remove excess water so that it does not leak down into the building below.

The Eco-city's classroom

Text and photo by Caroline Alesmark, journalist

Since the Augustenborg Botanical Roof Garden opened in 2001, around 40,000 people have visited from around the world. But in Malmö the roof gardens are not very well known. The hope is to attract more school children and teachers to learn more about complex issues such as ecology and climate in a highly tangible way.

"Many preschools come here, as well as high school classes, university students and researchers, but not so many primary school students - we would like to change that," said Jonatan Malmberg, former project and development manager at the Scandinavian Green Roof Institute.

In 2017, the roof gardens received SEK 100,000 from the Sten K Johnson Foundation to develop a learning platform, "Ekostadens Klassrum" (the Eco-city's Classroom). The content is based on urban solutions found in Augustenborg, such as green roofs and open stormwater management. The target group is middle and high school students and the platform must be free and accessible to all.

"We are a centre for urban ecology and green-blue solutions. A display like this takes time to create, we can develop a gold mine here. Today we are world famous, but less well-known in Malmö's schools."

Augustenborg's roof gardens have long provided learning spaces for children and young people. The first educational content was produced in 2007 to 2008, around the same time as the water walks started. In both cases, the target group was preschool children. Children have been able to play an audio game almost since the beginning of the project. The children can listen to a story about a worm who thinks it is cozy to live on the sedum roof and about insects and birds that thrive in the greenery in the middle of the city. In 2013, the Augustenborg Botanical Roof Garden produced an animated film, with support from the City of Malmö. It follows the water drop Hanna and her friends through the whole cycle: from a falling raindrop which flows into the sea and ends up in a cloud and drifts back towards land.

Jonatan Malmberg, the former project and development manager at the Augustenborg Botanical Roof Garden, wants more visitors from Malmö's primary schools.

But perhaps the most effective educational aid is still the roof gardens themselves:

"The most striking thing is that something happens to people when they get up on the footbridges. The adults, certainly, but especially the children. The preschool children become completely enchanted, watching them is magical. Perhaps the preschool children are so strongly taken by it because it is something they have never seen before: 'Things are growing on the roof, it's wrong, it's crazy,'" says Jonatan Malmberg.

More information on training material

Ekostadens Klassrum was developed by the Scandinavian Green Roof Institute, with the support of Sten K Johnson Foundation and VA Syd. The training material is available here:
www.ecourse.se/ekostadens-klassrum

"Ekostaden Augustenborg - en dagvattenvandring" can be found here:
https://www.vasyd.se/Artiklar/Avfall/Ekostaden-Augustenborg

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Augustenborg's stormwater system

Marianne Beckmann

Marianne Beckmann, head of the Network division at VA Syd (formerly VA-verket Malmö). Has worked on stormwater issues for 20 years in Malmö and has led many tours of the Augustenborg stormwater system.

Augustenborg is regularly discussed in a narrow, but global, circle of stormwater enthusiasts. It boasts several good examples of how to introduce a blue-green infrastructure into a built-up urban area. The district, which was developed between 1948 and 1952, has for nearly 20 years had sunken surfaces, canals, ponds and ditches, all of which replaced previously flat ground and a traditional drainage system of hidden pipes. This makes Augustenborg unique, even as it generally looks like many other areas built in the period.

An old-fashioned innovation in rainwater management

Malmö has long been at the forefront of sustainable stormwater management, in part thanks to Peter Stahre's work while at Malmö's water utility VA-verket (which today is part of VA Syd). Peter was a person with many ideas, great curiosity and infectious enthusiasm, who persevered to help create a cross-departmental stormwater collaboration. Crucially the water utility was given a seat at the planning table. This laid the foundation for a now established way of highlighting stormwater management in the early parts of planning.

The guiding principles in sustainable stormwater management include being able to adapt to the significant variations in volume and content of stormwater while considering social elements such as recreation and aesthetics (Stahre, 2006). By managing the stormwater at surface level - delaying the rainwater close to its source, diverting it, and designating areas that can be flooded when needed - even urban environments can handle heavy rainfall without pipes overflowing. The system also has the added benefit of creating increased biodiversity and educational and recreational values.

Why Augustenborg?

The first ideas about sustainability in Augustenborg came from the city's Internal Services Department, which ran a garage and warehouse in the area. Through strong ties to municipal housing company MKB, the Streets and Parks Department and the VA-verket water utility, the project quickly started to encompass more than just the garage and warehousing. Everyone wanted to take a big leap together and improve the environment in Augustenborg.

The Eco-city Augustenborg project aimed to increase the area's sustainable development, be it economic, social or environmental. VA-verket saw an opportunity to further develop its plans for sustainable stormwater management.

Throughout the 1990s, VA-verket had built several blue-green infrastructures, mainly in new developments in Malmö's outskirts. This had been part of the inter-departmental cooperation that had been implemented around the detailed planning process. It had also introduced methods to slow the flow of water in built-up areas, such building a pond at Olof Hågensens Allé and a swale along Vanåsgatan. Here engineers managed to reduce the risk of basement flooding by superficially slowing the rainwater's path.

In Augustenborg, several departments got involved and the ambitions were considerably loftier. In their hands they had a unique opportunity to apply the principles of sustainable stormwater management to a whole district's built environment. Compared with the efforts at Olof Hågensens Allé and along Vanåsgatan, where no major changes were made beyond the streets themselves, Augustenborg offered new opportunities to test ideas on a larger scale and tie many components into a whole. Augustenborg sits on the border between the dense inner city and sparser residential areas, so the new systems would be more urban than those in newly developed areas on Malmö's outskirts.

Augustenborg's sewage system was built according to the standards of the 1950s. It was a combined system, which collects stormwater and wastewater through the same pipes. The downside to this is that during heavy rain the system can overload. risking an outflow of wastewater in nearby basements connected to the system. In Augustenborg, flooded basements were a common problem, and there was a huge need to relieve the sewage system. Traditional solutions could have been used, but those responsible instead chose to try new ideas and methods for sustainable stormwater management.

The way the area was built, with open courtyards and "houses in the park", was well suited for a new way of diverting stormwater above ground. Although the area's flatness was a clear challenge.

From conventional to experimental

Several initiatives in the Eco-city project involved stormwater management. The theoretical part of transforming the system was a project called *Open stormwater management in a built-up district,* which was funded by MKB, the Streets and Parks Department, the Internal Services Department, the VA-verket water utility, Byggforskningsrådet (now Formas) and VA-forsk (now Svenskt Vatten Utveckling). The application to Byggforskningsrådet (the Building Research Council) lists three challenges that the project is designed to overcome:

1. Environmental stormwater management - to manage stormwater locally as far as possible. Augustenborg's rainwater would be diverted away from the combined sewage system to reduce the risk of basement flooding. The next step was to separate the pipe network outside the area, so that the stormwater that needed to be diverted, despite the open system, would not be routed to pumping stations and sewage treatment plants, but instead led directly to the recipient which is Malmö's canals.
2. To foster increased social and environmental sustainability by creating an interesting and varied urban environment where stormwater is given space and through design can contribute to well-being for the residents and increased biodiversity.
3. To develop the sub-components of the stormwater system so they can later be implemented in other more densely populated parts of the city, but also newly developed areas. Augustenborg was to be a national and international inspiration.

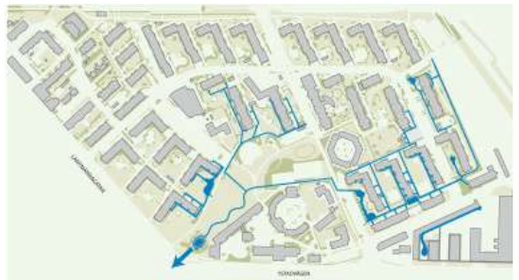

Image 1. Stage one, southern section. Illustration by ISS Landscaping (from presentation by Joanna Theland).

Stormwater would be locally managed by delaying the raindrops' journey through the city's landscape. For this, the builders laid green roofs, and installed gutters, canals and delay ponds at ground level. Work was planned for areas owned by the Internal Services Department (the engineering unit's workshops were covered in green roofs and a botanical roof garden was created), in MKB's residential gardens, in the schoolyard and in the park. Two new open waterways would also be built, one in the south and one in the north. There was an agreement to see the opportunities rather than limitations. The conventional approach, which accounts for property boundaries and connection points, would be thrown out during the expansion and the work would focus on shared solutions. Throughout the Eco-city Augustenborg project holding a dialogue with residents was vital (Stahre, 2008).

The stormwater system was changed in stages. It started in the southern part of Augustenborg, where water flows east to west before being diverted into stormwater pipes in the southwestern part of Augustenborg and taken to Malmö's canals. See Image 1.

In stage one, ambitions were very high, in both design and capacity terms. Those responsible wanted to preserve (and to some extent recreate) the area's period character, which is also clear in the design of the stormwater system, which followed a rather strict form. The overarching vision was of a water system which was visible throughout, from

Image 2. The drainpipe and gutter in stage 1, southern section. Image by Lars-Erik Widarsson and Ulf Thysell.

Image 3. The '50s-style concrete canal. When the picture was taken in 2002, railings had not yet been installed at the canal crossings. Image by John Dolocek.

Image 4. "The cube canal". Image by Elisabet Rudenholm.

the bottom of drainpipes to open gutters and canals. Rainwater would come off roofs and follow the drainpipes into open gutters, which created a difference in level in the pavement, see Image 2.

The gutters run to a concrete canal, see Image 3. The canal was designed to mimic the 1950s design that was to be recreated and was large enough detain a so-called 25-year rainfall event, of the type that happens on only one day in each quarter century.

Image 5. At the end of the system a large pond slows the water's journey. An overflow mechanism that leads into the pipe network in the street beyond is visible at the far end of the pond. The picture was taken in 2016 shortly after the surrounding vegetation was cleared and cut down. Image by Stefan Billqvist.

The journey continues through a wet pond, which slows the water's path, to another canal, with concrete cubes along the bottom, see Image 4. The cubes symbolise a stylised stream. The canal's irregular bottom creates vortices which help oxygenate the water, while vegetation could be established on the bottom (Stahre, 2008). The water then flows into a meandering swale before being collected and delayed in a pond at the southwest corner of the district. Here, there is also an outlet connected to pipes in the adjoining street.

When the southern section was completed, stage two - the northern section – began, see Figure 6. The section runs along Lönngatan and in the northwest ties into the drainage pipe network outside the area. By the time planning and implementation started, parts of the original management team had been replaced and the objective had in part changed (Delshammar *et al*, 2004). The capacity was reduced to only manage a so-called 10-year rainfall event - while the designers abandoned the austere 1950s look and integrated the open waterways more into natural appearance,

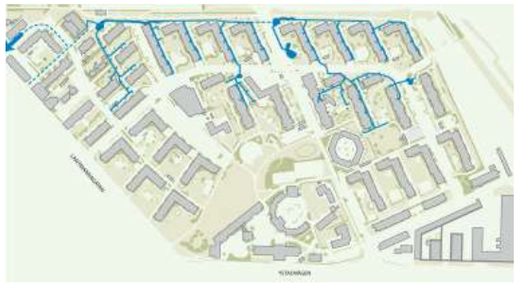

Image 6. The northern section. Illustration by ISS Landscaping (from a presentation by Joanna Theland)

see Image 7. This was probably a combination of wanting to reduce costs, while thinking a grassy swale was more appealing than a concrete canal.

In the same way, roof runoff was "hidden" in the northern section, as the drainpipes were directed straight into the ground, and connected to nearby swales, see Image 9. Just as with the latticed gutters, you must look closer to understand how the stormwater is handled. It looks like a conventional system but is still a surface system with large capacity. In this stage, less focus was placed on including residents, but instead MKB did more in the gardens than during the first stage, which were also upgraded to handle stormwater at surface level (Delshammar *et al*, 2004).

Alongside the construction of the new stormwater system in Augustenborg, the network of pipes outside Augustenborg was redesigned to lead stormwater from the district into Malmö's canals, meaning it no longer put strain on downstream pumping stations and sewage treatment plants.

The last stage in the transformation of the stormwater system involved laying a new pipeline along Augustenborgsgatan. Conventional pipes under the street were the preferred option here due to the topographical challenges of the area, but the outcome was exactly the same as in the open system. The pipes diverted the rainwater away from the sewage system. That way rainwater does not end up putting strain on Malmö's pumping stations and treatment plants, but instead runs harmlessly into the city's canals.

Image 7. Stormwater swale along Lönngatan. Image by Ulf Thysell. The gutters here were given lattice covers, rather than being open, making the stormwater system less visible in the urban environment, see Image 8.

Image 8. During stage two, which developed the northern section, the open gutters were replaced by latticed gutters, and the gravel with asphalt. Image by Ulf Thysell

Image 9. In stage two, the northern section, it is less obvious that the drainpipe deposits its water above ground. Image by Ulf Thysell.

A.

B.

C.

Image 10. The pond at Södra Grängesbergsgatan. A. Newly built pond 2002, image by John Dolocek. B. The pond a year later, image by Ulf Thysell. C. Redesigned pond in 2012 which had the same holding capacity but was differently designed and had a pump to circulate the water, image by Leif Runeson.

Lessons learned

The Augustenborg project was characterised by a willingness to try new ideas and push boundaries. Through the residential area, in gardens, a new canal system led water from the drainpipes through gutters. Playgrounds and green areas in the residential gardens were designed to handle and retain stormwater. A stormwater swale was built along a cycle path. It was a full-scale experimental workshop, where boundaries and regulations were no restraint and test first and adapt later was the guiding principle.

The result is an area which is globally renowned among stormwater enthusiasts, and still today attracts visitors from near and far to explore how a sustainable urban drainage system can be integrated into a semi-urban residential environment. But of course, the experimental spirit has meant some parts are adapted over time, as they have been discovered to work less well. Among these were some accessibility angles that were not considered at first when the focus was on creating an innovative stormwater system. These have subsequently been remedied (Niemi *et al*, 2004).

One reason the Augustenborg project started in the first place was the clear commitment to the stormwater issue from several players in the municipality, who shared an ambition to try something new, exciting and better. Augustenborg was ripe for change, as property owner MKB wanted to increase the area's status, water utility VA-verket had new ideas about sustainable stormwater management which suited MKB, while the Service Department was as interested in investing in its properties. There was an enormous desire to try something new, to take the issue of open and sustainable stormwater management one step further, and this made it possible to focus on the possibilities instead of being limited by obstacles.

Now that twenty years have passed, parts of the stormwater system have changed, after the limitless and permissive culture also brought problems that were discovered during operations. A change that was made rapidly was the design of the pond by Södra Grängesbergsgatan. In its original form, algae started to grow as nutrients entered the water stream, which was also poorly oxygenated, see Images 10a and b. The pond was remade, while maintaining inertia in the system and not changing the amount of flooding it could deal with. A circulation pump was installed to combat algae formation and make the outdoor environment more pleasant, see Image 10c. Fresh water is pumped into the system by MKB for aesthetic reasons at times of low rainfall (Eliasson 2018).

Making the stormwater's route from the roofs across the area visible, a feature that had been so important during stage one in the south, had already disappeared when the northern section of the system was built. Over time the appearance of stage one has also changed as the original drainpipes and gutters have been replaced by drains that are connected to latticed gutters which do not create an indentation, a little bump, in the ground. Maybe this is because it increases accessibility and decreases operating costs.

The management of the blue-green infrastructure has sparked discussions and changes. From the beginning, the operations were meant to follow the spirit of the Eco-city: a group of local residents would be hired to care for the stormwater system in their neighbourhood. However, this never came to fruition (Söderblom, 2004). The stormwater system is currently managed by a contractor hired by the Property Management, Street and Parks Department, but paid for by VA Syd. There is still some uncertainty about which areas MKB is responsible for, and which fall to VA Syd (Eliasson, 2018). See more on experiences from managing the system on page 193.

In stage one in particular, the southern section, a lot of time was spent engaging with residents. At the same time, time was limited and the project was complex. The amount of influence that residents could really have was therefore very limited (Delshammar *et al*, 2004). In addition, the meetings were not very well attended, making it doubtful how much they represented the views of the community at large (Krantz *et al*, 2002). In general, communicating with customers and residents is significantly more prioritised today than it was 20 years ago, and there would have been a different level of communication and conversation if a similar project was carried out today.

Image 11. From traditional to sustainable stormwater management (Stahre 2004).

How do we proceed?

As noted earlier, Augustenborg's outdoor environment became a kind of experimental workshop because four players were willing to work together to solve the stormwater problems, and push boundaries together.

Since Augustenborg's stormwater system was rebuilt, Malmö has faced several heavy rainfall events, which the system has clearly handled well. This demonstrates how much capacity is provided by a system that slows the water and directs it to controlled flooding areas. It is therefore part of ensuring Malmö can withstand heavy downpours. The lessons from Augustenborg, and from other areas with sustainable urban drainage systems, have therefore been considered in subsequent projects to plan and manage rainfall. There is a clear awareness that several municipal departments and the water utility need to work together to develop sustainable stormwater solutions in a built-up urban area. Together we must make room for the water. However, most other districts have many more property owners and other stakeholders than Augustenborg, which makes it difficult to copy the area's stormwater system directly.

Although the quality of stormwater was considered when building the open system through Augustenborg, the project almost exclusively focused on managing heavy downpours. Today, quality is much more at the centre. This is in part because of the EU Water Directive and environmental quality standards and, above all, the higher standards of stormwater quality that will be demanded going forward. The solutions in Augustenborg are clearly part of how to manage stormwater, but improvements must still be made.

The transformation of Augustenborg's stormwater system is still unique and may continue to be so going forward. It was a special initiative which was allowed to challenge engineering, design and financial norms. The experience from both the project's successes and the parts that need improvement has informed VA Syd's later work. The schematic picture that Peter Stahre drew to demonstrate the transition from conventional to sustainable stormwater management, see Image 11, is still valid. Stormwater management encompasses both water quantity and water content, and its aesthetics when it is diverted above ground. But the emphasis must be decided for individual projects, not least amid common discussions on multifunctionality. In a densifying urban environment, which is accommodating more and more people, multifunctionality becomes increasingly important. So as not to get lost during operations, the system's main purpose needs to be clarified. Is it a meeting place, an area designated for stormwater handling or a meadow for pollinating insects? Is the rain garden by the street primarily a stormwater treatment plant, a street decoration or a traffic safety measure?

The route of stormwater through Augustenborg

Anders Folkesson

Text and images by Anders Folkesson, landscape architect. Formerly ran Mellanrum AB together with colleague Christer Göransson. Mellanrum was responsible for the project to design Augustenborg's open stormwater system between 1997 and 2001.

A blue-green infrastructure, such as in Augustenborg, is based on a few simple principles. There must be a slope (albeit gentle) for the water to flow. The water must remain in place as long as possible by being deposited in ponds. There must be enough capacity in the system and an overflow mechanism when full. It must be taken into consideration that streams increase in size, the further downstream the water enters the system. These simple principles must be applied to an applied design to create a functioning system and a good living environment for residents.

The stormwater system begins as soon as the water enters the drainpipe. In the past, these pipes led directly down into an underground network (and the stormwater combined with wastewater in a combined sewer). In the open system, the drainpipe empties onto a "drainpipe stone"; a carefully designed "bowl", which reduces the splash of water against the facade, and converts the violent vertical water flow in the drain pipe into a calm, horizontal flow that follows the shallow v-shaped gutters away from the facades.

The V-shaped gutters are shallow, to make the pavements more accessible. The pavements by the facades carry a lot of traffic, and pedestrians and bicycles must be able to cross the water without being hindered.

The V-shaped gutters lead to U-shaped gutters, which in turn take the water to a larger canal.

The larger gutters and canals are covered in perforated metal where they cross walkways and cycle paths.

When the gutters turn, the water must fill a small "bowl" before being directed to the next part of the route, which creates a small break in the water's journey.

When shallow gutters are insufficient for the water flow, they lead into deeper, U-shaped gutters. Large sections of the U-shaped gutters have little onion-shaped nodes on their base. These make the water move in a pulsating swing from side to side, which oxygenates the water and carries gravel and other particles with it that would otherwise accumulate on the bottom. This so-called onion gutter, and other parts like drainpipe stones, were specially designed for Augustenborg.

The stormwater system in Augustenborg looks slightly different in different parts of the district, but around the Arla block all the U-shaped gutters lead into a "canal" made of concrete elements about 60 centimetres deep and 90 centimetres wide. The canal has a slight incline from south to north and runs through the entire block in a straight line. It can handle very large water flows. It also acts as a delay mechanism as at the northern end water is prevented from flowing further unless it reaches a certain depth. Not until the canal is filled does the water overflow into the pond beyond.

Part way along the canal there is also a small "wetland pool", which further helps to delay large flows of water. A series of round overflow holes about halfway up the canal wall divert any water that runs above that line into the wetland, where it remains even after the flow in the canal has subsided.

This wetland captures some sediment and, above all, its rich vegetation absorbs some of the water's nutrients.

The canal's far end leads into a pond. It flows into the pond through several U-shaped openings at the top of the barrier. When the water rises high enough, it flows into a delaying pond. This was originally a large, open pond area. At that time large amounts of a type of sedge, Carex elata, was planted. The grass grows in large, robust tufts that stay green even in winter. The grass was meant to absorb nutrients while covering the bottom of the pond where sediment and debris easily accumulate. Having the grass covering the bottom of the pond was also important because during dry weather all the water may disappear, leaving maximum capacity for the next rainfall.

However, during a later redesign the pond's surface was significantly reduced - and therefore its delaying capacity. The large single water surface/ delay surface was replaced by a couple of smaller ponds with fountains, that were connected by a stream. These ponds are refilled during dry seasons and water is pumped between them through the stream. This "ornamental pond" design was not part of the plans for the original large pond, but the permanently flowing water is a feature that is certainly welcomed by local residents.

When heavy rains fill the pond, water overflows into the next canal, which leads to Augustenborgsparken. The overflow goes through holes in the side of the pond even here. Given that the outflow should always be larger than the inflow, these holes are larger than the earlier ones, so that the pond never bursts its banks and threatens to flood the basements of nearby buildings.

Perspectives on new stormwater systems

Lars Bengtsson

Lars Bengtsson, professor in technical water resource education, Lund University Faculty of Engineering. Has researched precipitation, stormwater, cleaning and other elements of hydrology in Malmö, Sweden and internationally.

The conventional way to manage stormwater is to divert it from the city as fast as possible. The water was seen as a problem, not a possible resource. But whichever way you look at it, stormwater can still cause major problems. Large pipes are needed, but they mostly just stand nearly empty. Heavy rains can still cause flooding despite large drains, if the capacity to divert water is hampered by sediment or if roots block parts of the pipes or if the water's surface-level route towards the pipelines is cut off. It is difficult to predict where floods will happen and what consequences they will have.

As early as the 1970s, solutions such as soakaways, ponds and infiltration surfaces were being tested. These methods have found renewed relevance in the last 20 years and formed part of the blue-green systems in urban planning. Blue-green systems are multifunctional, providing biodiversity, local climate impact, and recreation and contact with nature. Augustenborg is a neighbourhood with a blue-green profile. Its hydrological qualities have been basically mapped by Bengtsson *et al* (2004) and more functionally by Villareal *et al* (2004). Blue-green systems try to mimic natural hydrological systems (Stahre 2004). The goal is to reduce peak flow, increase rainwater absorption and reduce the total runoff, at least the surface water runoff. Stahre (2008) has described various elements in nature-mimicking stormwater systems.

History

Long ago, mainly in countries which battled with long dry periods, rainwater was considered a resource. Rain that landed on roofs and hard surfaces was collected and saved. This still happens in China, India, Central Asia and on many islands, among other places. In paved cities, however, stormwater soon became a problem. Every morning, rubbish, and perhaps even human wastewater, was thrown into the street. Rain or maybe some "sanitation worker" would then take care of the waste. In Pompeii, it is clear how the less than hygienic system worked. Waste was thrown into the street. Small bridges had been built across the streets, because they were not suitable to walk on. In the evening, the water flowed downstream along the streets. Eventually, many cities started to build open sewer systems along their streets. In large cities, the smell of the sewers became unpleasant and unhygienic. In 18th century Paris and London a system of underground tunnels was built and heavily polluted stormwater was directed towards them. The water was then carried towards

the Seine or the Thames. During the 19th century, underground stormwater sewage systems were built in most major cities.

In the late 19th century, flushing toilets were installed in some parts of larger cities. They were connected to the existing network that had originally been built only for stormwater. This combined system now transported wastewater to lakes and waterways. Septic tanks were installed early on, but it was not until the late 1950s and 1960s that better treatment plants started to appear. During the 1980s, the treatment plants were improved by building several steps into the process to separate nutrients. When the pipes were full, the excess would overflow into a waterway or a ditch, but sometimes this was not enough and water from the combined pipes was forced up into basements. In order to limit the environmental impact from wastewater discharges, separate wastewater and stormwater pipes started being laid around 1970. Despite this there is still a need for large stormwater pipes that sit largely empty most of the time.

Heavy rain or reduced drainage capacity can also lead to flooding even when the systems are separated. It is difficult to know where floods occur. This is particularly difficult when new areas need to be connected to an existing system. Local stormwater management has been seen as an alternative to drainage systems. A lot of practical experiments were performed in the 1970s, largely supported by Byggforskningsrådet (the Building Research Council). Recommendations for local stormwater disposal were issued in 1983 by VAV, the organisation now known as Swedish Water. Roof water was led onto grass, soakaways were installed, as were infiltration surfaces on a larger scale. Ponds were built, mostly in downstream areas, both reducing peak flow and letting pollutants settle.

However, sometimes projects were not fully thought through. Soakaways and expelling roof water onto lawns did not work on clay areas. Large ponds looked unwelcoming during dry periods, were dangerous for children and attracted unwanted animals. Whatever the system used, they needed to be cared for. A new approach, regarding the local systems as multifunctional features, sparked a renaissance 20 years ago. The ambition is now to combine green areas into stormwater systems. The stormwater must flow slowly to avoid large flow peaks and water should be kept in the city so it can feed vegetation.

There will always be floods, no matter what kind of stormwater system has been built. When very heavy rain falls, or when the system's drainage capacity is reduced, flooding will be impossible to prevent. At such times, the rainwater leaves the system (a minor system or a conduit system, which can, however, be blue-green) and instead makes its own natural path (major system or out-of conduit system), steered by the topography and slopes of the city. By managing the slopes, the water can be directed to places where flooding will not cause serious harm. Despite some research and real-life examples - mainly in Canadian cities in the late 1980s and highlighted in Sweden (Bengtsson *et al*, 1993) - it has taken until today for such dual systems to be included or at least discussed when planning a stormwater system. Lener *et al* (2017) mention this alongside alternative stormwater solutions in a study of Copenhagen.

Blue-green water management

Blue-green stormwater systems are multifunctional. They provide recreational and aesthetic value. From a hydrological point of view, they also imitate rural conditions. Surface runoff is reduced through absorption and total runoff is hopefully also reduced by increased evaporation, which allows the water balance to mirror more closely that of natural areas. The most important thing, however, is to significantly reduce peak flow. This can be achieved by delaying, or holding water in the city:

- at source using roof vegetation (green roofs) or with drainpipes releasing the water onto lawns
- locally in soakaways or small ponds
- by slow moving flows in ditches or pond systems
- downstream in larger ponds or on large infiltration surfaces

Image by Scandinavian Green Roof Institute

In Augustenborg's sustainable urban drainage system, the water travels slowly through canals, ditches and ponds, through greenery and surfaces that can withstand floods.

All these solutions exist and are used in Augustenborg. Increased water and greenery benefit plants and wildlife. It gives a better overview of where floods happen and what consequences they entail than pipe-based systems. However, there are disadvantages, largely the surface space needed to pursue blue-green solutions, the danger posed to children by ponds and unwanted insects and birds that are attracted by the system. It can also look messy when it is dry, and hygiene is sometimes worse than when the system is fully run through pipes.

Functions in different parts of blue-green systems

Below are rough calculations of how different parts of blue-green stormwater systems work.

Green roofs

Intensive green roofs are roof gardens, and not viable as just part of a stormwater system. The motivation to build these should not just be to manage rainfall. Extensive green roofs are almost maintenance-free. The vegetation on extensive green roofs is thin, often sedums, and can only store 10-15 millimetres of rain. None of the water evaporates in winter, so all rain and meltwater runs off. In summer, around four millimetres of water can evaporate every day. This means following rainfall it takes three to four days for the reservoir to be back at full capacity. When more than 10-15 millimetres of rain falls, the excess therefore runs off (Bengtsson *et al*, 2004). Across the year, when 600 millimetres of rain falls, around 500 millimetres of this runs off, according to measurements from Augustenborg, while the entire reduction of 100 millimetres happens during the summer.

Infiltration surfaces

There is no surface runoff from grass areas, unless the ground is very muddy or the downpour particularly large. However, when water from large hardened surfaces runs off to infiltration surfaces, this produces the same effects as a large downpour. Permeability decreases as the soil becomes waterlogged. If you lead water from hardened surfaces with an area nine times the size of the infiltration surfaces, 50 millimetres of rain become the equivalent of 500 millimetres. How fast rainwater is absorbed by the ground depends on the soil and the initial conditions. In VAV's recommendations (VAV 1983), topsoil is described as being able to absorb 25 millimetres per hour. This would mean that over one day more than 500 millimetres of water would be absorbed. Permeability is lower in urban grassy areas. But over a few days large amounts of rain can still be absorbed.

Evaporation - water balance

Infiltration surfaces are designed to reduce surface runoff and reduce peak flow. The aim is to create an urban water balance that is more in line with that of natural areas. To achieve this, the total

runoff from the city must be reduced. This is only possible if much more water evaporates from urban green areas than natural areas outside of the city. Admittedly, because water is directed towards infiltration surfaces there is more of it available to evaporate than in natural areas outside the city. Yet this only has a marginal effect, not least because as the ground gets wetter, more of the water is percolated and seeps into the groundwater. The groundwater flows slowly out of the city, but some is collected in the pipe networks, as has been shown in Danish studies, Kidmose *et al* (2015).

Ponds

Different types of ponds are effective ways of managing and reducing peak flow during short intense downpours. During prolonged rainfall, large ponds can be filled to the top, so the outflow matches the inflow. However, prolonged rainfall is significantly less intense than for short downpours. In medium-sized upstream ponds, which take water from large paved surfaces, the outflow during very heavy rain can quickly equal the inflow. During long, repeated heavy rainfall, the leveling effect therefore decreases or ceases altogether.

Slow movement

Peak flow is best reduced in stormwater systems by using infiltration surfaces (large surfaces or drain pipes that lead the water to grass) because that reduces runoff. Since rain intensity varies across a rainy season, peak flow can be flattened by delaying and extending the transport time (time of concentration). This can be achieved using a series of small ponds, transporting the water in ditches and small canals instead of faster pipes. Traditional dimensioning would count on a maximum rainflow with a duration corresponding to the time of concentration.

Dual-system flooding

Floods will always occur. For traditional pipe systems, elevation must ensure the flood water is directed towards places where it does little damage. When dealing with flooding, the benefit of the blue-green systems is that everything happens above ground, making it clear from the outset what areas are likely to flood. The system is able to cope quite well with some flooding. Nevertheless, it is necessary to have a plan for how to handle water that falls outside the blue-green system.

Central areas

Blue-green solutions are best suited to areas outside city centres and ideally suited to areas under construction. In central locations, green roofs can be installed, stormwater can be led towards large parks, more vegetation can be planted along streets, and some hardened surfaces can be removed. From a perspective of an entire city however, green roofs have little hydrological impact. The roof runoff is only somewhat reduced, by at most half during the summer. Even if 10% of all hard surfaces in a city were green roofs, the reduction in city-centre run-off is extremely small. A larger number of plants can increase evaporation, but again taken across an entire city centre this plays only a minor hydrological role, though it may improve the urban climate. The most effective method would probably be to reduce the amount of asphalted surfaces and replace them with permeable asphalt, tiles or gravel (Winston *et al*, 2016). These surfaces require maintenance to remain functional. During heavy rain, there will still be surface runoff, albeit reduced.

Blue-green solutions can still have a role to play to improve hydrological conditions in city centres. The centre is usually downstream in a water catchment. Upstream measures to reduce the inflow from drains leading to the centre reduce the risk of flooding in the centre.

Conclusions

Stormwater management is today moving towards blue-green multi-use systems. The systems work well during medium rainfall but may require large spaces to handle large prolonged rainfall. These systems also require plans for how to handle flood water.

Managing a blue-green stormwater system. Experiences from two decades

Anna Bernstad Saraiva

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Augustenborg was MKB Fastighet AB's first residential area, built for modern families in the spirit of post-war welfare. The Eco-city project in the late 1990s and early 2000s, initiated a process which, in MKB's view, is far from finished. MKB wants to constantly build on the Eco-city by using Augustenborg as a testbed for innovative environmental projects that can be applied elsewhere in its portfolio as well. The clearest example is Greenhouse Augustenborg, which allowed MKB to test innovative construction technology and apartment designs that provided unique opportunities for urban farming. The Eco-city is also still ongoing through the daily management work to look after and continuously maintain the many systems aimed at reducing environmental impact which were installed almost two decades ago.

This chapter maps the experiences from one of these systems - the management of stormwater - from the perspective of the property owner and manager. It is based on interviews with several people who worked for MKB in Augustenborg, and who in different ways were involved in the blue-green infrastructure over the years. The chapter starts by exploring the forces at MKB which drove the development of a sustainable urban drainage system, and later explains the challenges they faced when establishing and managing the system.

Conditions and alternatives

Even though Augustenborg was initially built with good access to amenities and links with the rest of the city, social problems eventually developed in the area. As a result the population turnover was high, and the area gained a bad reputation. Alongside the social problems, there was a clear tangible engineering problem as basements frequently flooded, inconveniencing residents. After a major storm in the mid-90s, a vast swathe of the south-eastern part of Augustenborg, which was being used by the Service Department to store and repair the City's vehicles, was found to have funnelled large amounts of stormwater into the residential area, contributing to the basement floods. There had already been a discussion within the City of Malmö over whether to move these functions further out of the city. But MKB's then area head

of property Christer Sandgren, who was based in Augustenborg, believed such a move would not benefit the area. The large workplace brought life and movement to the district and was important to keep there (Sandgren, 2018). Peter Lindhqvist, a Service Department manager, was also not interested in moving. This shared interest was the seed from which the Eco-city grew.

When the stormwater system is suddenly made visible and forms a part of people's everyday environment, totally new demands are placed on how it is managed and cared for. Image by Sanna Dolck

MKB had two main goals during the Eco-city project: to increase the area's appeal and to reduce the risk of basement floods. To tackle basement floods, bosses had two main options. They could separate wastewater from stormwater by building a new underground drainage network, or they could split rainwater out and direct it straight from drainpipes and hard surfaces into an open stormwater system. The second option would also make the outdoor environment greener and more varied, increase well-being for the residents and, in the long run, improve the area's appeal. Keeping stormwater in a surface-level system therefore met both goals.

Designing the stormwater system and outdoor environment

Malmö's water utility VA-verket was also positive to the idea of local stormwater management in Augustenborg. Peter Stahre[1] had worked at the utility since 1984 as an expert in stormwater management and was the project's driving force. A landscape architect's office provided the design and was tasked with liaising with residents about planned changes. While the open stormwater system was being planned, resources were also being invested to renovate the area's gardens. This process placed great emphasis on involving the residents in the development of the area and fostering a sense of pride, identity and a profile that would bring more outsiders to the district, where they would feel at home and hopefully stay. The landscape architects that MKB hired to design the gardens were therefore also asked to hold an active dialogue with residents about their desires, while also presenting ideas and proposals at large meetings in the area. Different architects were hired by MKB and VA-verket to design the gardens and the stormwater systems, but they still collaborated and at meetings with residents the plans were presented together.

[1] Peter Stahre died in 2009 and, according to other interviewees, played a major role in forming the open stormwater system in Augustenborg.

According to Christer Sandgren, there was an awareness at VA-verket that the stormwater system should be seen as a pilot project. There was no information on how much care and maintenance would be needed over time. VA-verket (or at least Peter Stahre) seemingly believed that the cost savings of an open system, compared to building underground pipelines, were so great that they justified increased operating costs. Based on this, VA-verket took responsibility for maintaining the stormwater system during the warranty period.

The stormwater system was constructed in two stages. Lessons had already been learnt from the first stage when work started on the second. By that time, different views had emerged on how maintenance costs should be handled after the warranty expired. VA-verket wanted those responsible for maintenance in each area to take over when the warranty ended, while landowners assumed that maintenance would remain VA-verket's responsibility as it operates underground stormwater pipes. During this time a new area manager was appointed by MKB (Sandgren, 2018).

As a result, the system's design was reassessed, and focus was increasingly on how it would work after being put into operation. A contractor was hired to design and plan this stage. Unlike in phase one, where several actors agreed that future management and care were not the focus (Sandgren, 2018; Folkesson, 2018), more emphasis was placed on these considerations in phase two. As well as being able to handle rainwater, the system needed to be easy to maintain and not bring excessive operating costs for those responsible for local maintenance.

Responsibility for maintaining a blue-green infrastructure

When water that was previously transported in underground pipes is brought to surface-level, it sparks questions about who is responsible for managing the system. Experience from Augustenborg shows that it no longer obviously falls to the water utility (VA-verket). In Augustenborg, the system's maintenance has been managed as part of the outdoor environment by the relevant property owner. Despite the fact there are only a few different managing organisations in the Eco-city Augustenborg, splitting care and maintenance responsibilities is relatively complex. The system leads water away from paved surfaces on municipal engineering land (part of the City of Malmö's Internal Services Department) to plots owned by MKB and in part on to municipal parkland. The area is also home to pavements and cycle tracks which are owned and managed by the municipality. Water runs off these paths and into open stormwater canals on built plots but also public water and sewage systems. The Property Management, Streets and Parks Department manage pedestrian and bicycle lanes as well as park areas, while VA Syd (formerly VA-verket) manages general water and sewerage facilities and is responsible for their care. Meanwhile, MKB owns and is responsible for maintaining the part of the system that is located on its property.

When the water is brought to the surface, boundaries between the water supply system and the outdoor environment also blur. In Augustenborg, managing the stormwater system has become an integral part of managing the area's outdoor environment, a task that falls to contractors. When the system's first stage was completed, the Streets and Parks Department and MKB used different local contractors. This meant that the bordering areas risked being overlooked and different levels of care might be given to different parts. It also created a risk that residents would not understand how the outdoor environment was managed, which in turn worsens engagement between daily users and the manager.

Based on the idea that increased collaboration would benefit residents, VA-verket the Streets and Parks Department and MKB signed a collaboration agreement in May 2004. It was based on using the same contractor to maintain areas owned by both MKB and the Streets and Parks Department in Augustenborg. The agreement also meant that MKB would coordinate engagement with

residents and the contractor on behalf of the Streets and Parks Department and VA-verket. Finally, VA-verket promised to maintain pipeline outlets and inlets and to develop maintenance instructions for the stormwater system. The agreement would be followed up once a quarter and extended annually if agreed by all parties.

A supplementary agreement in existing procurement rules allowed the Streets and Parks Department to use the same contractor as MKB. An analysis of the collaboration by academics at the Swedish University of Agricultural Sciences (SLU) from 2007 concluded that the partnership worked well, and facilitated communication between residents, customers and contractors. Using the same contractor also created a more cohesive impression of how the area was managed and improved the quality of the Streets and Parks Department's areas beyond what had been ordered. This is because MKB had high standards of care for its areas, meaning maintenance staff were permanently based in the area. When urgent measures were needed in the areas controlled by the Streets and Parks Department, they were addressed more quickly than before. And when, for example, lawns were being mowed, no lines were drawn between what was owned by the Streets and Parks Department and what was owned by MKB. The requirement from MKB for frequent care set the standard.

The collaboration agreement did not tie the parties to share a maintenance contractor in the future, but only applied to current procurement. There was therefore no plan how the collaboration would continue when contracts went back to tender. Over the years new contractors were hired in different procurement rounds. Those individuals who drew up the agreement had for various reasons left their organisations, and in time the agreement was forgotten. However, it has not been terminated by either side. At present, MKB would like to see an agreement that clearly defines areas of responsibility and a renewed dialogue on cooperation on procurement of maintenance (Strömbeck, 2018).

Adjustments and maintenance over time

A fundamental difference between underground and open stormwater systems is that the latter must function even when there is little rain. From a water management perspective, this is a secondary consideration - instead the focus lies on the system's ability to divert and delay large water flows. From a management perspective, attention is needed during the vast majority of the year, when water levels in the system are far below the 20-year rainfall events which the system is large enough to handle. Ironically, therefore, water shortages are one of MKB's biggest challenges in Augustenborg.

The fear of basement floods probably drove the decision to design all canals and ponds with impermeable bottoms so stormwater would not leak into the cellars. From a water management perspective, this seems an exaggerated fear that made the project more expensive. From a management perspective, this has probably been essential for maintaining a functional system while providing an aesthetic and recreational value even in periods without torrential rain.

Dry canals are quickly viewed as dirty and dull by residents in the area. Image by Johanna Sörensen

No care instructions had been ordered from the stormwater system's designer. According to the designer there was a lack of awareness of how to maintain the system, and that there would need to be an acceptance that ponds occasionally dry out. From a management perspective, there was an initial view that the system would largely look after itself. A couple of years after the first stages of the system were completed, residents had complained about some parts of it (Larsson, 2018). The publication "Uppfattningar om öppen dagvattenhantering i Augustenborg Malmö – Utvärdering efter några års drift" (Perceptions of open stormwater management in Augustenborg, Malmö - An evaluation after some years of operation") (Delshammar *et al.*, 2004) explains what happened based on interviews with 15 residents from the area:

"Among the problems of the stormwater retrofit were primarily littering in the ponds and canals, vandalism and bad odours coming from stagnant water. Some residents are put off by dry canals and ponds."

The maintenance staff that worked in the area during the first years after stage one was completed also described algal blooms and bad smells caused by stagnant pond water (Larsson, 2018). The manager believed these problems were unacceptable, and a number of changes were implemented. As a result, the large pond in the Arla block was split into two smaller ponds that were connected by a canal. Water was pumped from the lower to the higher pond, and then flowed back down in the canal. A fountain was also installed in the pond that was on higher ground to oxygenate the water and ensure it did not stagnate. The grassy area that leads to the ponds was also sloped, letting the water level rise significantly before causing any problems, and ensuring the ponds can still house large volumes of water. Most of the time, however, there is much less water, so the overflow mechanism is not required. The design can therefore handle both downpours and long periods of drought. This need for flexibility is probably one of the largest challenges in the design of open stormwater systems.

The large Arla pond was divided into two smaller units that are connected by a canal. Image by Marc Malmqvist/City of Malmö

One factor that reinforced the perception in MKBs management that the designers of the system intended for it to "look after itself", was the high degree of automation they included, for example, in how ponds were refilled. However, it later became clear that an overreliance on advanced technology had created vulnerabilities. Only a few years after the system was built, large parts of the mechanisms were broken. The advanced technology was also expensive, so broken components were not replaced. About a decade after the system was installed, there was a push to fix this. Sonny Larsson, a water expert who had worked at MKB since 1980, led the work to refurbish the ponds. The goal was to create a system that was cost-effective from a management perspective. Broken automated systems were replaced with simple and robust ways of oxygenating and circulating water in and between ponds. But some parts of the system could not be fixed. One such example

was the pump in the so-called salmon ladder that runs along Lönngatan, which moved water from a nearby pond and to the top of the feature. The bottom of the salmon ladder is permeable, and the pump essentially drained it when it was switched on. Fixing this, and other similar problems in the initial design was judged to be too resource-intensive (Larsson, 2018).

The evolution of maintenance efforts

The extensive efforts made about ten years after the system was commissioned came with an increased understanding that this was not a self-maintaining system, but that it in fact has extensive maintenance needs. Suchun Huang had been employed by MKB to care for the compost machines in the Eco-city Augustenborg's recycling houses. In 2007, a decision was made to remove the compost machines. This coincided with upgrades to the stormwater system and the transition to more manual management. Suchun Huang was appointed as a property maintenance officer who focused on the outdoor environment and was given responsibility for the ponds. Much of the management of the Eco-city's ponds is now performed by in-house staff at MKB.

Today, Suchun Huang spends about a quarter of her work hours maintaining the ponds and the rest supervising the recycling houses and the care of the rest of the outdoor environment. However, the time the ponds demand is unevenly split over the year. During the spring, the fountains are taken out and installed in the ponds. All hoses are checked and broken or worn out parts are replaced. All oxygenation balls are cleaned. During the summer, a lot of time is spent removing algae from the ponds and keeping them free from debris. During the autumn, the strainer screens for the water to the pumps are washed and when winter comes, fountains are removed to avoid freezing (Huang, 2018).

Pond management developed over the years, as knowledge increased. Oxygenation and circulation techniques that were installed over time have reduced the algal blooms but have far from completely stopped it. Putting on waders, getting into the ponds and fishing out the algae is therefore still a part of the maintenance routine.

Image by Marc Malmqvist / City of Malmö

Fixing the pump in the so-called salmon stairs was one measure that was believed to be too resource-intensive

Shortly after Suchun Huang took over responsibility for the ponds, she noticed some ponds contained a stringy algae that was much easier to catch than the gooey algae that dominated most of the ponds. She then tried transplanting the stringy algae to other ponds. It outcompeted its rivals and over time increasingly dominated more and more of the ponds. As a result, removing algae was far less time consuming. Pond fish also help to keep algae away and reduce maintenance needs. The first year that fountains and pumps had been installed in the ponds, they were removed and stored during the winter - for fear they would otherwise freeze. Because the ponds were built to be shallow for safety reasons, they froze down to the bottom, killing many of the fish that had been released during the recent investments. Since then, only fountains are stored over winter. The pumps continue throughout the year to stop the bottom of the ponds from freezing (Huang, 2018).

Image by Marc Malmqvist/City of Malmö

Biological purification using InterAct.

The presence of algae varies greatly between ponds. It is difficult to say why as there are no obvious reasons for the difference. Some ponds also have a layer of sludge that is significantly thicker than others. However, removing sludge and sediment from the ponds is too costly and difficult. In one pond where the sludge omits a bad smell, MKB has recently installed a biological treatment plant. This plant (InterAct) uses bioblocks with a large active surface area which allows microorganisms to thrive and break down organic material. Nutrients can then be absorbed by the aquatic plants that also live in the bioblocks. The effect of the treatment plant will be evaluated in the coming years.

Outsourced and in-house maintenance

For MKB's staff to spend so much time managing the outdoor environment in Augustenborg is unique. In MKB's other residential areas, it has outsourced the management for several years.

Contractors are procured in accordance with the Swedish Public Procurement Act and the agreements are time-limited. The contracts normally run for two years, with a potential two-year extension. The framework of how the outdoor environment is managed is therefore largely set in the tender documentation used during procurement. Minor changes and additions to the management duties can be made during the contract period, as part of a dialogue between client and contractor. Major changes, that involve more time or new equipment, may increase maintenance costs and require additional agreements. MKB has a tradition of frequency-based maintenance specification - this includes the parts of outdoor management in Augustenborg that are contracted. Knowledge of the type and frequency of maintenance that a blue-green infrastructure require is therefore very important when drawing up tender specifications for maintenance contracts. This creates a need for good communication between managers with practical knowledge, and those who write the tender documents. In Augustenborg, communication

between the area managers and the central procurement office of MKB has largely gone through Åse Dannestam, the project manager for the Eco-city Augustenborg, who was hired by MKB in 2007. With her help, data has been developed and refined over the years, all while the client's knowledge has increased.

For Augustenborg, there are also special instructions on how to manage the outdoor environment, based on the unique conditions created by sustainable urban drainage system. These require the contractor to clean open gutters once a month and latticed drainage gutters are cleaned three times a year. The cleaning removes debris, leaves and other items that accumulate in the system. Litter must be removed from all ponds once a week. Furthermore, there is a major spring and autumn clean every year. In April, dried plant material is cut down and collected. Vegetation around and in the ponds is thinned in July and August, when about half of the plants are removed. The remaining plants are removed in April the year after.

The competence and knowledge that has developed over time within the management of the Eco-city Augustenborg is in many ways invaluable. According to Sonny Larsson, all the area's ponds are unique and must be treated differently to function properly. Over time, the pond manager has learned how to care for them. Using in-house staff who are committed to the area and have time to build internal competence has therefore been an important factor for success. There are also difficulties associated with hiring a contractor because the turnover of people is higher and this means that knowledge does not build up over time.

Throwing water in the lake?

The ponds in the area create recreation opportunities for residents and visitors. They also create local habitats for many fish, frogs and aquatic birds. Because the rainwater evaporates and leaks in parts of the system, it is topped up with fresh water when there is little rain. This is mainly done by filling the ponds at Södra Grängesbergsgatan. There have been attempts to find alternatives to using fresh water. One of the neighbourhood's buildings leads its laundry water into the stormwater system. The water is cleaned by a biological treatment system developed by Alnarp Clear Water. The building's washing machines use automatic detergent dosing systems which have been approved by Astma- och Allergiförbundet (the Asthma and Allergy Association) and meet the criteria for the Swedish Society for Nature Conservation's "Bra Miljöval" ecolabel ("Good Environmental Choice"). After launching in 2013, tests for nitrogen, phosphorus, Chemical Oxygen Demand (COD), Biochemical oxygen demand (BOD), pH and the presence of bacteria were performed several times in the first year. Using these test results, the Environment Department allowed the washing water from the laundry room to continue being discharged into the stormwater system. But because getting permission to release laundry water into the stormwater system is cumbersome and requires investments in pumping technology, no more laundry rooms have been connected.

Cost/benefit from a managerial perspective

There has never been a complete assessment of the costs and benefits of Augustenborg's open stormwater system. It is still too difficult to perform, because long term care and maintenance costs remain uncertain, and many benefits are not financially tangible.

The investment into Augustenborg in the late 1990s and early 2000s were partly financed by money from central government and the EU. But these external funds only covered 15% of the total, estimated at about SEK 200 million. MKB contributed about half the remaining money, while the rest fell to the City of Malmö and water utility VA-verket (Rolfsdotter-Jansson, 2009). The blue-green infrastructure cost approximately SEK 35 million and was paid for by MKB and VA-verket. Some of the stormwater costs covered combined investment which also benefited the outdoor environment.

The expense should be weighed against the fact that nearly all the residential gardens were remade during the project period. There was good reason to do this, as the gardens were rather run down. But it was also necessary to create artificial slopes in the otherwise flat area. Augustenborg's lack of natural slopes increased costs (Andersson, 2019).

From a managerial perspective, however, the cost of the stormwater system in the Eco-city has gone from being almost negligible - because VA-verket was responsible for maintaining the combined underground pipe network - to increasing cost to maintain the outdoor environment. The cost of contracted maintenance rose approximately 10%, while in-house work rose in cost by around 25%. For minor maintenance measures (replacing pumps, grills on smaller canals and so on) there is an annual budget, which sets aside around SEK 100,000 per year for smaller maintenance of the stormwater system. Larger measures, such as re-casting gutters, are carried out as individual projects which leads to a total maintenance cost of around SEK 150,000 per year (Strömbeck, 2018).

Augustenborg is therefore an area whose outdoor environment MKB invests extra heavily in. Compared with other similar parts of Malmö (Nydala, Kroksbäck and Segevång, where MKB owns large contiguous areas and most of the outdoor environment), spending on the outdoor environment in Augustenborg was on average 34% higher over the three years 2015 to 2017 (based on data from MKB's financial system, autumn 2018).

The benefits include reduced flooding costs, increased customer satisfaction, marketing values and social benefits caused by increased urban biodiversity.

It can seem easy to invest in measures that will reduce the cost of floods. But despite the large sums invested in Augustenborg through the Eco-city project, the flood problem has not ceased completely. This is mainly because the sewage system is still the original one from 70 years ago, which can be penetrated by roots or filled with fatty deposits. However, floods caused by heavy rain have clearly subsided. The property owner's biggest savings are apparent during a downpour similar to the one during the end of August 2014, when Augustenborg fared relatively well compared to other similar areas in the vicinity. This also benefits the water utility by reducing the risk that mixed wastewater and stormwater would overflow at the treatment plant. Increasingly stringent demands to reduce overflow create a need for new investment and increased capacity to handle large amounts of rain in a short time.

At the same time, there are major benefits to designing the system in an aesthetically pleasing way, which creates a pleasant outdoor environment all year round. Those who remember Augustenborg's worn gardens, hard-packed soil and broken play areas of the 1990s, believe there is significant added value to be gained from a nicer outdoor environment (Larsson, 2018 and Sandgren, 2018). Based on MKB's customer survey in 2017, Augustenborg's residents value their outdoor environment more than the average area in its portfolio[2]. It is, however, difficult to price this because customer satisfaction is impacted by many factors. The marketing value provided by the investment in Augustenborg is high, and has benefited everyone involved (the property owner, VA Syd and the municipality), but it is also difficult to put a monetary value on.

The complexity of attempts to estimate the costs and benefits of an open stormwater system is apparent. Long-term costs are often unknown. It is difficult to put a monetary value on the benefits. In addition, costs and benefits often do not always impact the same people or organisations.

[1] 91% of the residents of Augustenborg say they believe the design of the gardens and local environment are fairly or very good, compared to 87% on average among MKB's clients. 86% of the residents in Augustenborg say that access to benches and tables is fairly or very good, compared to 80% across MKB's clients. 87% of the residents in Augustenborg say that choice of flowers, bushes and trees is fairly or very good compared to 83% across MKB's residents.

Image by Marc Malmqvist/City of Malmö

One major benefit of the open stormwater system is its aesthetically pleasing, green and pleasant environment, which tenants appreciate.

Why is the stormwater system in Augustenborg still quite unique?

The stormwater system in Augustenborg is largely the result of some highly motivated officials who were operating in fortuitous circumstances such as being able to win external support, operating at a time when interest in environmental issues was growing, and that several issues that needed attention could be remedied with the same investments, with high alternative costs. It may today seem next to impossible to implement a similar project in another area. But it should be easier today, if the lessons learned in Augustenborg are applied.

Much of the benefit in Augustenborg was by being the first area to do this, and by packaging the investments as part of a larger environmental initiative. This guaranteed publicity and attention. This was a large part of the municipality's and MKB's motivation, while the alternative costs and the desire to experiment largely drove the VA-verket water utility. Many Swedish municipalities today say they need large-scale investment in their water and sewage network in coming years (VA facts, 2016). Where combined waste- and stormwater systems need to be replaced, the cost of alternatives may make a case for open systems. But to motivate such investment today, the actors will likely need additional incentives. In existing housing stock, the municipal water utility has an important role in providing price incentives, while municipal planning officers can create incentives for such features in new establishments. To challenge current regulations and structures can be regarded as a natural part of development, where new lessons and insights create a need for change.

Instead of putting a price tag on the benefits from an open stormwater system and comparing it to the cost in a cost-benefit analysis, we can turn the question on its head. This way we can build on the lessons learned in Augustenborg. That way cooperation frameworks and financial incentives can be created to foster the investment interest needed to ensure the stormwater system in Augustenborg stops being as unique as it is today.

Lessons learned

After almost two decades of managing the system in Augustenborg, we can conclude the following:

- This type of system cannot be purely designed from a water utility's perspective. A broader approach is necessary. Imitating natural processes when managing stormwater can be problematic in a residential area. There is a risk of friction between the natural environment and perceptions of a good living environment. This is especially important in existing areas, where the environment ends up looking different to how it did when residents moved in.
- When open stormwater solutions are integrated into initiatives to improve the outdoor environment, which also create recreation and education opportunities, then value that is created can justify the costs.
- The design must be flexible to work even in drier times. This is important for residents, but also for pond wildlife.
- System maintenance must be part of the equation during the design phase, in order to achieve resource efficiency.
- Clear agreements should be signed between property owners to distribute operation and maintenance costs. The property owners should coordinate how to instruct in-house and contracted staff in how to maintain the system. If possible, the same contractor should be hired by all parties.
- Consulting with residents on how the outdoor environments are designed brings great advantages, but there are also challenges involved in coordinating resident engagement during slow processes such as procurement and gaining building permits. It is also sometimes challenging to fit it around the limits of financing and legislation, such as fire safety or accessibility.

Remarks on efficiency of blue-green stormwater systems – Augustenborg, Malmö in focus

Salar Haghighatafshar, Henrik Aspegren, Karin Jönsson

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Henrik Aspegren, PhD, deputy director at VA Syd and adjunct professor in water engineering at the Faculty of Engineering, Lund University. Has worked to develop urban ecosystem services.

Karin Jönsson, PhD, lecturer in water engineering at the Faculty of Engineering, Lund University. Currently also researches stormwater from a broader urban infrastructure perspective.

Blue-green stormwater solutions or stormwater control measures (SCM) are defined as implementations within the broader context of Nature-based Solutions (NbS) (Zölch *et al.*, 2017). SCMs intend to manage urban runoff through natural processes on the catchment surface. These processes mainly consist of detention/retention, storage, slow transport, enhanced infiltration and evapotranspiration. Raingardens, green roofs, wet/dry ponds, permeable pavements, and swales, each can be examples of a SCM. The implementation of SCMs for the urban spaces has been done in different ways. These different implementation strategies can be categorized through a scale-perspective as suggested by Haghighatafshar *et al.* (2018b). A graphical presentation of the different implementation scales is shown in Figure 1 which illustrates the following scales:

- Microscale: discrete single SCMs.
- Mesoscale: a group of interconnected SCMs implemented in a catchment, i.e. blue-green systems as used in this chapter.
- Macroscale: multiple blue-green systems on the entire infrastructure for urban drainage which can lead to the broader concept of Sponge City (Liu *et al.*, 2017). The concept of Sponge City—initiated by the Chinese Central Government in 2013—integrates urban water management into planning policies and design so that the cities can deal with extreme precipitation and drought situations as well as maintaining discharge quality of rainwater and promoting rainwater reuse (Zevenbergen *et al.*, 2018)

The number of studies regarding the microscale evaluation of SCMs is quite abundant. Researchers have extensively investigated single SCMs such as green roofs, raingardens, etc. However, meso- and macroscale studies are relatively rare which can be due to scarce examples of fully established blue-green implementations at these scales. Moreover, design and implementation of meso- and macroscale blue-green systems require a close collaboration of numerous interorganizational and cross-disciplinary actors, such as water engineers, streets and parks authorities, real estate developers, landscape architects, etc. since these systems have to comply with not only hydraulic and hydrologic objectives, but also with aesthetic as well as social-ecological functions within the framework of urban planning. In order to accelerate this collaboration, better knowledge and understanding of the foundation of mesoscale and macroscale blue-green systems are required. In addition, practical and unsophisticated models, to be used by both water engineers, architects and urban planners, are also required to boost a better communication among the engaged partners.

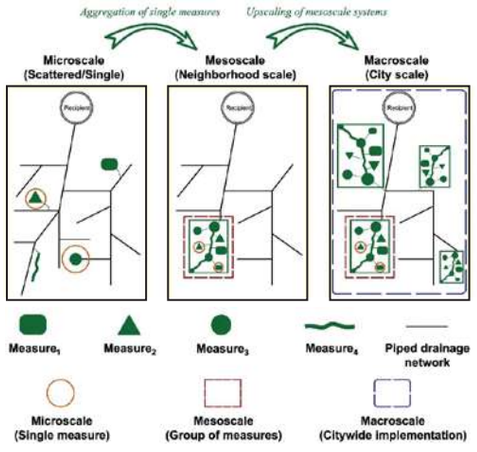

Figure 1. Different levels of implementation for blue-green stormwater measures/SCMs; Adapted from Haghighatafshar et al. (2018b). Note that this schematic illustrates the interactive aspect of blue-green systems with pipe networks. However, blue-green systems can be directly linked to recipient through blue-green transport elements.

Augustenborg in Malmö has been a unique demonstration site for a mesoscale blue-green system. The area incorporates diverse types of SCMs[1] in two separate blue-green systems. Based on investigations, the number of flooding incidents reported to insurance companies from Augustenborg have been relatively fewer than from its surrounding neighborhoods (Sörensen and Mobini, 2017, see also Basement floods in Augustenborg and Malmö (Sörensen, page 214)). Such reports from Augustenborg backed by the commonly accepted perception that "the model used in Augustenborg works" provided the incentive for this study to have a closer look into the processes, context, dynamics and potential benefits of Augustenborg as well as mesoscale systems in general.

In this chapter, focus lies mainly on the evaluation of blue-green systems at mesoscale, through a case-study performed at Augustenborg, Malmö, with regards to:

1. Dynamics through which a group of interconnected SCMs at mesoscale interact with each other within a blue-green system (conceptual approach).
2. Flood mitigation capacity with mesoscale blue-green retrofits. Interactions between blue-green systems and the entire urban drainage system with respect to:

    a. local level (within the boundaries of the retrofit).

    b. catchment isolation and its downstream effects.

Methodology

The presented work is based on a case study (Augustenborg, Malmö) through in-situ monitoring of rainfall-runoff as well as 1D/2D hydrodynamic simulations in MIKE FLOOD by DHI (DHI, 2017). 1D/2D hydrodynamic models simulate both the flow in pipe systems – through 1D pipe network representations – and the flow on catchment surface – through 2D digital elevation model representation – as well as the interactions

[1] About 75 different installations were identified by a Climate Café workgroup as introduced to Climate Scan; visit https://www.climatescan.org/map

and water exchanges between pipe system and catchment surface. This modelling methodology was selected for the study to acheive a more detailed understanding of surface flows and floods – based on the Digital Elevation Model of the area – along with pipe flow. However, it should be noted that although 1D/2D modelling approach is appropriate and useful for neighborhood-scale simulations, it is very time-consuming and computationally expensive for city-scale simulations (Elliott *et al.*, 2009; Freni *et al.*, 2010; Haghighatafshar *et al.*, 2018b; Jayasooriya and Ng, 2014; Krebs *et al.*, 2014; Locatelli *et al.*, 2014).

The drainage system in Augustenborg consists of three catchments as illustrated in Figure 2. Two of them are drained via blue-green retrofits (Northern and Southern retrofits) and one via a separate stormwater pipe-system. All three systems are eventually drained into a separate stormwater sewer network – constructed in Jespersgatan-Lantmannagatan-Lindgatan in 2001-2002 – through the points where the flowmeters are installed; i.e., Connection Points (Figure 2). This separate stormwater sewer network leads the total discharge from Augustenborg to Malmö canal (Haghighatafshar, 2019).

- The Southern retrofit was constructed 1999-2001. When the Southern retrofit was constructed, the ambitions were very high, and the idea was that the stormwater should be visible. The system was designed to accommodate a rain with a recurrence period of 25 years.
- The Northern retrofit was constructed 2002-2003. When the Northern retrofit was planned the water visibility approach was less pronounced and the system was designed to accommodate a rain with a recurrence period of 10 years.
- The separate stormwater pipe system (local pipe-system in Figure 2) was constructed in 2003.

The discharge from all the three catchments consequently eventually enters the downstream stormwater network via their respective connection points. From this point of view the Augustenborg area represents a fully separated system. Figure 2 also shows the location of the flowmeters and the rain gauge in Augustenborg. Details of the employed methods for measurement of rain and flow are presented in (Haghighatafshar *et al.*, 2018a & 2018b) and Haghighatafshar (2019).

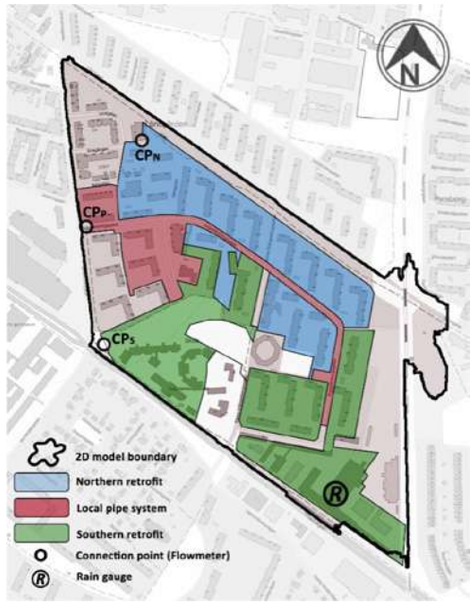

Figure 2. Catchments in Augustenborg and their drainage systems; adopted from Haghighatafshar (2019).

The rainfall-runoff data collected from the catchments in Augustenborg was used to calibrate the 1D/2D hydrodynamic model of the area (Nordlöf, 2016). The input parameters to the MIKE FLOOD model are presented in Table 1.

Considering the Swedish climate and the event-based nature of the modelling in this study, losses through evapotranspiration were presumed to be negligible during the rainfall. It was also assumed that the parameters given in Table 1 are static parameters whereas all rates and coefficients are mostly dynamic and may face substantial variations during and after a rainfall event. Moreover, there are other error sources associated with rainfall and runoff measurements too, which are discussed by Haghighatafshar (2019).

Table 1. Input parameters for the MIKE FLOOD runoff model – Adopted from Haghighatafshar *et al.* (2018b) with permission.

	2D model parameters				*1D model parameters*	
Land use	**Manning's *n**** *(s/[m^1/3])***	**Infiltration rate** *(mm/h)*	**Storage volume in infiltration layer** *(mm)*	**Leakage rate**** *(mm/h)*	**Surface runoff velocity** *(m/s)*	**Runoff coefficient** *(-)*
Grass	0.67	10	15	0.036	n/a	0
Sand and gravel	0.50	30	25	0.036	n/a	0
Paved areas	0.025	0	0	0	0.1	1
Green roofs	0.67	120	45	0	n/a	0

* *Initial values for Manning's n for overland flow were adopted from Gustafsson and Mårtensson (2014).*

** *Leakage rate is the rate at which the infiltrated water is drained into the groundwater/deeper soil layers, and thus is removed from the model.*

Results and discussion

SCMs as constituents of blue-green systems (interactions)

The dynamics of the interactions among different SCMs in a blue-green system are studied and presented in Haghighatafshar *et al.* (2018a). A conceptual model for blue-green systems is introduced based on monitored rainfall-runoff data. The presented conceptual model takes catchment connectivity into account for different drainage systems. The results show that a conventional catchment drained via a pipe-system behaves relatively solidly (i.e. has high connectivity). This means that at different rain depths, the area of the surfaces that contribute to runoff (runoff-equivalent impervious area – REIA[2]) remains more or less constant (Figure 3a). However, it should be noticed that all monitored rain depths in the study are considered as mild rainfalls of the same order of magnitude (up to 30 mm). Therefore, there is a high possibility that in case of more intensive rain events, additional surfaces – within catchment boundaries – connect and contribute to runoff.

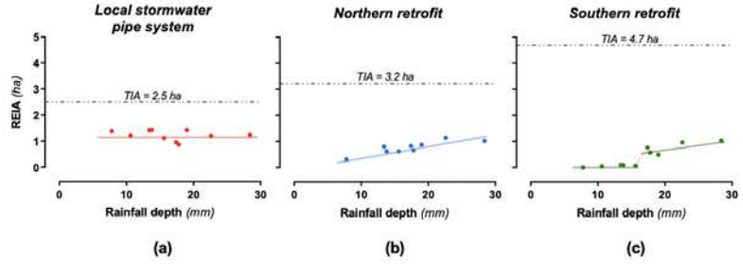

Figure 3. Behavior of three different catchments in Augustenborg with different types/setups of drainage systems with respect to REIA; a) pipe system, b) Northern retrofit, c) Southern retrofit. Total impervious area (TIA) of each catchment is also shown in the diagrams. Adopted from Haghighatafshar et al. (2018a).

[2] For details regarding the distinction between REIA and EIA (Effective Impervious Area) see Haghighatafshar (2019).

The catchments drained via blue-green systems (i.e. Northern and Southern retrofits) are observed to have a varying connectivity depending on the rainfall depth. However, the dynamics through which the connectivity develops are different for each catchment. Catchment connectivity (represented with REIA) in Northern retrofit tends to increase gradually as the fallen rain depth increases (Figure 3b). On the other hand, the Southern retrofit is seen to be nonreactive (zero connectivity) to rain depths up to a certain level (about 17 mm in this case) while an abrupt jump in connectivity is noticed as soon as the rain depth exceeds 17 mm. The difference in behaviors of the Northern and the Southern retrofit was explained by different spatial distribution of SCMs with different retention capacities in these systems. Figure 4 together with Table 2 show how a runoff is developed and generated in two catchments with different distributions of SCMs under different rain depths. In this hypothetical example, the total retention volumes of the two systems are identical, while the distribution/order of the SCMs is different. As seen in Table 2, the discharge from Scenario X increases gradually as the rain depth increases (similar to observations for the Northern retrofit) while the discharge from Scenario Y occurs first when the rain depth exceeds 5xR (similar to the Southern retrofit).

The presented conceptual model, in a hydraulic and hydrologic context, provides a basic criterion for designing blue-green systems of multiple SCMs. From a retention standpoint, scenario Y is definitely preferable over scenario X. This is because scenario Y can hold back the runoff for a longer time and this delay could provide enough

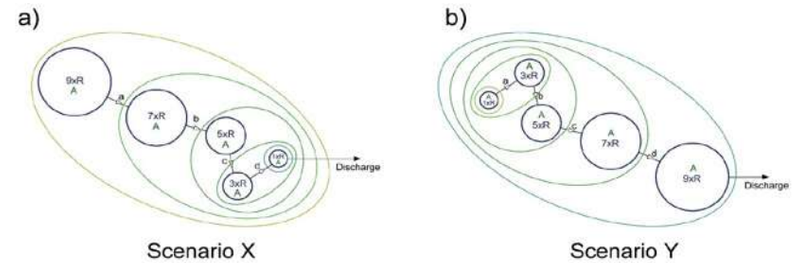

Figure 4. Conceptual illustration of two hypothetical setups for construction of blue-green systems with different components. Note that all the shown mini-catchments have the same contributing area, i.e. A, while the size of the circles represents their retention capacity, R.

Table 2. Response matrix of the conceptual model in the case of scenarios X and Y (see Figure 4).

Rain depth (mm)	Scenario X			Scenario Y		
	Active links	*Discharge (mm)*	*Contributing area*	*Active links*	*Discharge (mm)*	*Contributing area*
<1xR	-	-		-	-	-
2xR	-	1xR	A	a	-	-
3xR	-	2xR	A	a, b	-	-
4xR	d	4xR	2xA	a, b, c	-	-
5xR	d	6xR	2xA	a, b, c, d	-	-
6xR	d, c	9xR	3xA	a, b, c, d	5xR	5xA
7xR	d, c	12xR	3xA	a, b, c, d	10xR	5xA
8xR	d, c, b	16xR	4xA	a, b, c, d	15xR	5xA
9xR	d, c, b	20xR	4xA	a, b, c, d	20xR	5xA
10xR	d, c, b, a	25xR	5xA	a, b, c, d	25xR	5xA

time for the receiving structure (in this case the sewer network) to regain some of its hydraulic capacity before the discharge is initiated from the system. However, there might be occasions at which a relatively rapid discharge from the blue-green system is preferred over a longer delay. It is important to design the configuration of blue-green system in a way so that the discharge from the blue-green system does not coincide with the peak flow in the receiving pipe network. Unprecedented flow coincident in the complex network of pipes has been found to lead to deteriorated flood situation even after implementation of blue-green retrofits (Haghighatafshar *et al.*, 2019). Therefore, depending on the hydraulic profile of the pipe-network, either scenario X or Y could be advantageous.

The suggested conceptual model for mesoscale blue-green system is also employed to schematize the Northern and the Southern retrofits in Augustenborg. In order to simplify the schematization, it is assumed that the area contributing to each SCM is the directly connected impervious area (DCIA[3]) only. The total retention capacity of each SCM is also considered to be the sum of rapid infiltration depth (S_inf^i) and the storage depth in the freeboard (S_fb^i) of the SCM. Consequently, the effective retention (R_e^i) of a SCM in a mesoscale blue-green system can be calculated accordingly:

Equation 1.

$$R_e^i = \frac{(S_{fb}^i + S_{inf}^i) \times A_{SCM}^i}{DCIA^i}$$

Based on the data presented by Haghighatafshar *et al.* (2018a), Figure 5 shows the Northern and the Southern retrofits in Augustenborg schematized according to the introduced conceptual model via employment of Eq. 1. As seen in Figure 5, some SCMs contribute much more to the retention of stormwater. These solutions are found to be mainly ponds (wet and dry), obviously because of their relatively large overall retention capacities. Canals, ditches and swales contribute insignificantly to the overall retention capacity of the mesoscale systems, although they are substantial elements for providing linkages between the ponds and different basins. These SCMs are also important not only for aesthetic aspects of the entire blue-green system but also for other numerous benefits such as heat-island mitigation, quality treatment of runoff, biodiversity, amenity, air quality, etc. It should be noted that these findings are strongly connected to the case-specific design introduced to Augustenborg. Therefore, different designs and or even different contributing areas to these systems would result in different findings and conclusions.

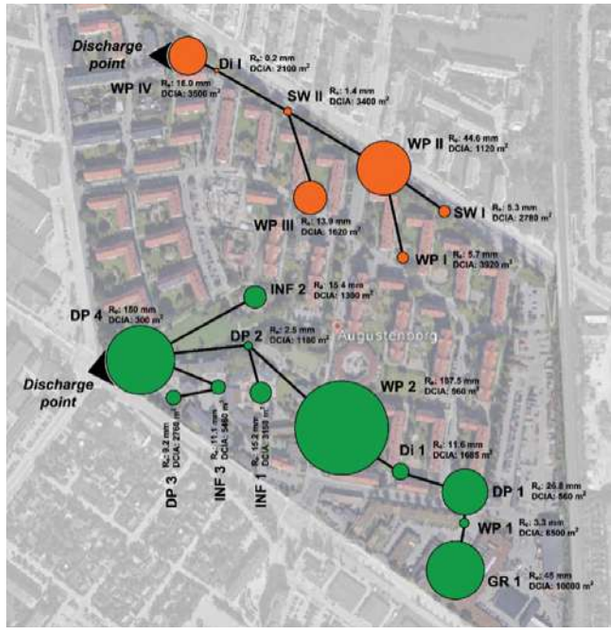

Figure 5. The stormwater system in Augustenborg according to the suggested schematization. The size of the circles is only an indication of the effective retention of the SCM (not to scale). WP: wet pond, DP: dry pond, GR: green roof, Di: stormwater ditch, INF: infiltration basin, SW: swale.

[3] Note that DCIA determines the amount inflow to the blue-green system, while REIA is an imaginary area calculated based on post-retention discharge at the outlet.

Based on the illustration in Figure 5, it is interesting to note that the Southern retrofit provides a larger retention capacity than that of the Northern retrofit. This difference reflects the different design criteria during the construction of these two blue-green systems as presented in section 2 of this chapter.

Blue-green systems as part of an urban drainage system (flood mitigation)

The focus in this section is the efficiency of blue-green systems for flood mitigation. Simulation results show that Augustenborg can efficiently manage extreme storms through the train of retrofitted SCMs (Haghighatafshar *et al.*, 2018b). However, it is also discussed that in order to fully understand the role of blue-green systems, they need to be studied in a broader infrastructural context.

Figure 6 presents a schematic illustration of the retrofitting process in Augustenborg. As seen in the figure, the retrofitting process first isolated the catchment area from the rest of the drainage network. However, this isolation, depending on the discharge recipient, can be regarded as either a semi separated blue-green retrofit or a fully separated blue-green retrofit. Semi separate blue-green retrofit in this context is a blue-green retrofit which is connected to the combined sewer network downstream. In contrast, a fully separated blue-green retrofit is drained into a separate stormwater network or directly into a receiving water body. Blue-green systems within a combined sewer network, are in constant interaction with the surrounding sewer systems. Through the perspective of the retrofitted blue-green system, it is somehow the "catchment isolation" that mainly protects the catchment against basement flooding since the area is solely responsible for handling the rainfall that falls within its boundaries. This is opposite to the process that takes place in pipe-systems (Figure 6a), in which the flow is aggregated constantly along the drainage network as it propagates from upstream towards downstream. Therefore, there are two different sides to blue-green retrofits, i) local capacity for flood control, and ii) downstream effects. Finally, in Figure 6c the existing stormwater system in Augustenborg is illustrated. It is obvious that the blue-green retrofit still plays a role in general flood mitigation, but basement flooding via the sewer network will be a function of the hydraulic head in the pipe network depending on the flow dynamics in the sewer system built surrounding and in the catchment.

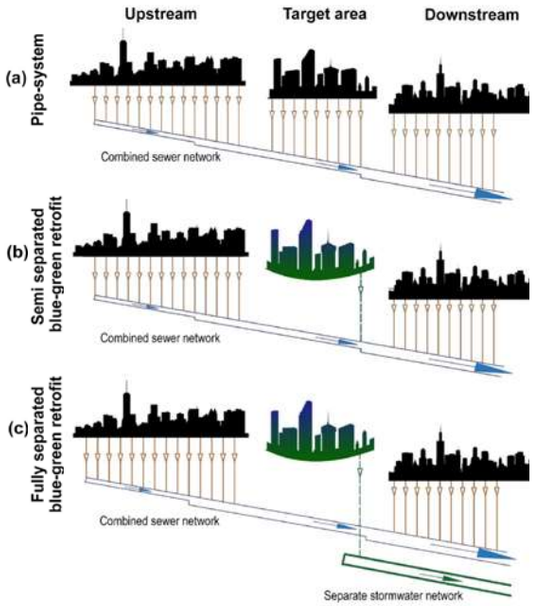

Figure 6. Schematic comparison of stormwater flowlines in case of (a) conventional combined sewer system, (b) semi separated blue-green retrofit and (c) fully separated blue-green retrofit.

Local capacity for flood control

In order to provide a better understanding of the implemented blue-green retrofit in Augustenborg according to Figure 6b with respect to basement flooding (within the framework of a combined sewer system), two 2-dimensional distributed hydrodynamic models were built in MIKE FLOOD to achieve a more comprehensive overview of both surface flow and pipe flow in the area. The models represented the cases before and after blue-green retrofit in Augustenborg. In this chapter, the case standing for the conventional stormwater management (before blue-green retrofit) is denominated as "Pre-retrofit" while "Post-retrofit" is the case when blue-green systems were retrofitted in Augustenborg. Both models simulated the cloudburst which struck Malmö on the 31st of August 2014 with more than 100 mm in less than 6 hours (Hernebring *et al.*, 2015). Figure 7 shows the flood-maps for both pre- and post-retrofit cases. As seen in Figure 7, the flooded surfaces in the pre-retrofit case are broader. The water has surrounded buildings and has covered the streets. It should be noted that in a real flooding incident in Augustenborg the surficial extent or depth of flood can be much smaller since a considerable proportion of the flood would be accommodated in the basements, which is not included in the employed model.

Although the post-retrofit case presents a higher potential for handling local floods, a mass balance over the stormwater systems in the abovementioned cases shows that a considerable volume of runoff generated in the upstream catchments, still has to pass through the underground pipe network in the retrofitted area (Haghighatafshar *et al.*, 2018b). Depending on the magnitude of the rainfall, the generated flow in upstream catchments can potentially cause basement flooding in the retrofit area, if backwater valves are not installed. In case of a semi separate blue-green retrofit, there is also a serious risk that the flooding problem is shifted downstream in the aftermath of retrofitting the target catchment. Therefore, from a sustainability perspective, it is advisable that the process of retrofitting blue-green systems is prioritized in areas where the sewer system is not overloaded (e.g. upstream catchments of the drainage network). This is also in line with findings of Zischg *et al.* (2018) who reported that retrofitting blue-green systems in the flood-prone areas is not the most efficient strategy and does not necessarily alleviate the flooding issue in the catchment. Alternatively, a fully separated blue-green retrofit (see Figure 6) via a dedicated pipe system or more desirably through a series of blue-green transport elements would be a safer solution.

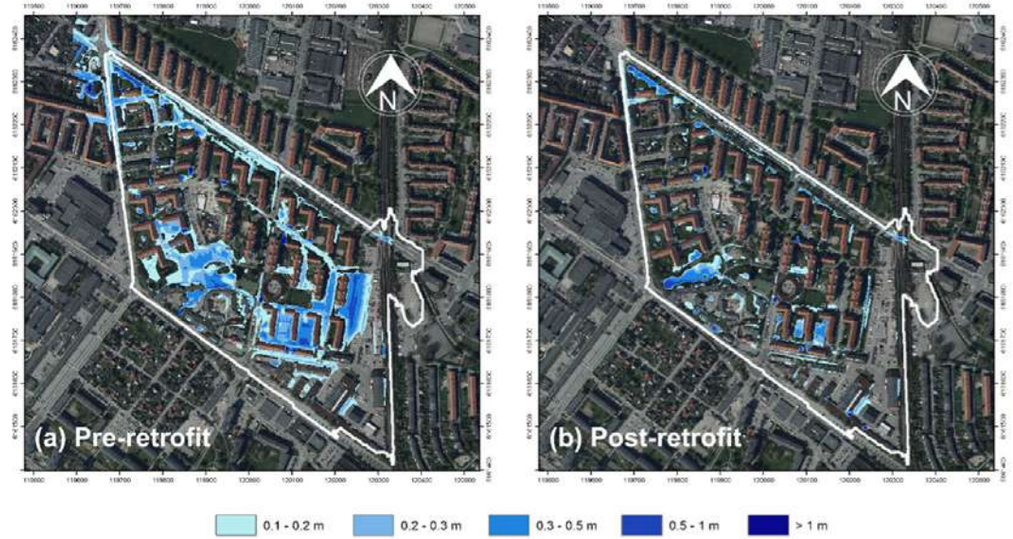

Figure 7. Flooding in Augustenborg for pre-retrofit (a) and post-retrofit (b) scenarios.

Downstream effects

As discussed earlier in this chapter, the discharge from a blue-green system occurs as the result of exceeded retention capacity in the system. This flow is observed to be lower (both in intensity and volume) and is subjected to a longer delay in initiation and lag-time. A model approach was adopted in order to quantify the effect of a levelled-out flow from a blue-green-retrofitted catchment. The methodology was to simulate the pipe-bound catchment with a hypothetic rainfall which would generate a similar discharge to that of the Southern retrofit in Augustenborg under a 100-year storm Chicago Design Storm (CDS) (Keifer and Chu, 1957). The results showed that the discharge from the Southern retrofit for a 100-year storm can be equivalent to the discharge from a conventional urban catchment connected to a pipe-system, for a 6.5-year rainfall with 2 hours duration. More details are available in (Haghighatafshar *et al.*, 2018b).

Although the downstream effects of a 100-year storm are minimized in case of blue-green retrofits, it arises new and quite complex types of questions from the perspective of the landowners. Why should the upstream landowner solely bear the cost of retrofitting while the downstream neighbor would also benefit the consequences? Who should try to coordinate a dialogue between the upstream and downstream neighbors to resolve such issues and how? What is the fair proportion for splitting the costs? All these are valid and important questions that need to be addressed.

Conclusions

Retrofitting blue-green stormwater systems in a catchment, disaggregates the catchment into a number of discrete mini-catchments. These mini-catchments are connected to each other depending on the design and the rainfall depth. Runoff development regime and eventual discharge from such catchments were found to be functions of spatial distribution of SCMs with different retention capacities.

Regarding the evaluation and implementation of blue-green stormwater systems it is recommended that the performance of these systems must be defined within the broader context of urban drainage through a citywide perspective, in which all possible hydrological interactions between urban drainage structures and flow dynamics are taken into consideration. Consequently, it was demonstrated that implementation of blue-green retrofits in flood-prone catchments does not necessarily solve the flooding problem. There is still a risk of flooding in case of a stronger rain event if the catchment is a part of a combined sewer network.

Based on the results and discussions provided in this chapter, it is recommended that blue-green retrofits shall be primarily prioritized in upstream areas of a combined sewer catchment. In that way, the reduced and lagged flow from the retrofit benefits all parts of the sewer network lying downstream.

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Basement floods in Augustenborg and Malmö

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The overall topography and structure of the drainage system determines the spatial pattern of basement floods during heavy downpours in Malmö (Sörensen & Mobini 2017), see Image 1. During heavy rainfall, water rather quickly enters the large sewers, which transport water from all corners of Malmö to the treatment plant outside Spillepengen. Properties within 100 metres of one of the large, intercepting pipes run a greater risk of basement floods compared to those further away (ibid.). Along these pipes, where there were once ditches and watercourses, flood reports are concentrated during intense rainfall. And residents living in an area where wastewater from kitchens and bathrooms is mixed with stormwater — a combined sewage system — can expect flooding more often than if their house were connected to a separate system with different pipes for stormwater and wastewater (Mobini *et al*. 2020).

It is possible to reconstruct an area and remove the combined system. That is exactly what was done in Augustenborg. By connecting drainpipes to an ingenious system of ditches, canals and ponds, flood risk has been reduced in the area (Sörensen & Emilsson 2019). In the park and the yards, large quantities of water can flood the grass without making any harm to surrounding buildings. Green roofs and other green surfaces capture the first drops of rain, the water's journey into the sewers is slowed by the ditches and canals, while ponds and concave scaped lawns take care of large water volumes.

All in all, the blue-green infrastructure helps reduce flood risks both in Augustenborg and to a certain extent in downstream areas. The big advantage is that stormwater never reaches the combined system, so the risk of sewers overflowing and pushing wastewater into basements through drains in the floor, is minimal.

However, when the blue-green infrastructure was built in Augustenborg, its designers were not considering extreme rainfall. The system was built to cope with everyday rain. The system happens to work well even during heavy downpours, but water can still flow directly from the street via ramps and into some of the basements. This could be prevented by installing a small bump between the street and the ramps. That way no rainwater would reach the basements in Augustenborg, either off roofs, drains or the street.

In many ways the stormwater system in Augustenborg is sadly still unique. Few other large areas have rebuilt their combined sewer systems in a similar way. It is possible to wonder what Malmö would look like if similar stormwater systems were built across the city. No one wants to clean up a sewage-logged basement. And it would surely be nice to see more beautiful canals, playful and winding ditches, and lovely ponds, wouldn't it? On that issue, we have much to learn from the stormwater system in Augustenborg.

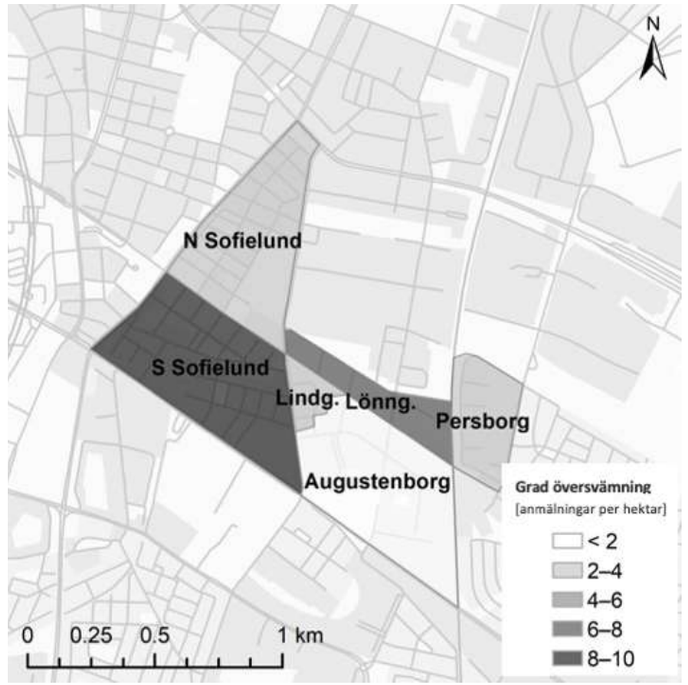

Illustration by Johanna Sörensen

Image 1. The flood magnitude (number of flooded properties per hectare) in Augustenborg and five comparable areas on August 31, 2014. High flood magnitudes are shown in dark grey and low in light grey.

Recycling, energy and mobility

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Augustenborg's waste management – revolutionary or not?

Anna Granberg, Bengt Persson

Anna Granberg, former project officer for the Eco-city Augustenborg. Worked with social processes and information around the introduction of the new waste management system in the Eco-city Augustenborg, 1999 to 2001.

Bengt Persson, PhD, landscape architect and former senior lecturer specialised in dissemination and cooperation at the Swedish University of Agricultural Sciences.

Sweden's waste community was already entering a new phase in the 1990s, while the ideas for the Eco-city Augustenborg were being shaped. In many of the country's apartment buildings, including those in Augustenborg, most waste was thrown in garbage chutes, a Swedish invention patented in 1934. It was simple and highly comfortable to use for residents, putting waste management just a few metres away from their front doors. Nearly all waste went down the same chutes, and no spaces or devices were needed in the kitchens for source separation. Legislation on extended producer responsibility, and therefore responsibility for collecting packaging, came into force in 1993 (prop. 1992/93:180) and widespread collection began in 1995. But this was mainly done using shared collection points around the cities, and not by separating waste categories in homes and residential areas. So far, the responsibility for recycling had primarily fallen on individual consumers and not on landlords and housing companies. In Svenska Renhållningsföreningen's (Swedish Sanitation Association) annual report from 1999 on waste management in Sweden, it said that recycling stations for packaging were being established in cities, but that progress had been sluggish. The association also wrote: "To complement recycling stations, municipalities are increasingly collecting recycling from residential areas, so-called local collection near each home."[1] The efforts in Malmö and the Eco-city Augustenborg were part of this trend.

Source-separated waste was collected close to some homes in Sweden at the end of the 1990s. But in Malmö, Augustenborg was the first pilot project. Facsimile of the cover of Svensk avfallshantering 2000 (Swedish waste management in 2000).

Grant money as an enabler

A collective environmental regeneration of Augustenborg had been on the cards for some time when in 1997 applications opened for the government's billion-SEK environmental investment fund Kretsloppsmiljarden. A new waste management model was one of the basic ideas that underpinned the work, and the Kretsloppsmiljarden scheme was split into four areas, including waste. An innovative local waste management system using recycling houses in gardens therefore fit well into the grant opportunities.

Kretsloppsmiljarden was a precursor to the LIP grants (support for local investment programmes that increase environmental sustainability) which became an important source of funds for the Eco-city project. The regulation on LIP grants from 1998 (SFS 1998:23) contained seven types of initiatives that could apply for funding, including efforts to "increase repurposing, reuse and recycling". Malmö and Augustenborg were not alone in developing new solutions for waste management. There were similar projects in many parts of the country, but Augustenborg was one of the most comprehensive. Across the country, almost SEK 700 million was paid in LIP grants to waste management projects. The waste management efforts in Augustenborg were titled "Local waste management" granted SEK 2.55 million in LIP funding out of a total of SEK 33.7 million for Augustenborg as a whole.

[1] Svensk avfallshantering 2000 – Årsskrift från RVF – Svenska Renhållningsverksföreningen. Malmö (2000): RVF and RVF Service AB.

Waste vacuum collection in Bo01

While the Eco-city was regenerating an existing residential area, the City of Malmö was building a brand new sustainable residential area in the Western Harbour, which would become known as the area for the Bo01 housing expo. The designers of the Bo01 area developed a completely different system to manage household and organic waste. They chose an automated vacuum collection system as the main waste management tool. This worked well in a large-scale newly built area. The hatch where locals dump their rubbish is reminiscent of the old garbage chutes and residents get no direct feedback about what happens to their waste after it has disappeared into the pipes in the ground.

This is what it looked like: the JORA JK5100 S composter. Image by Joraform AB

Augustenborg's composter-equipped recycling houses

In Augustenborg, a more transparent and perhaps slightly more human system was chosen. In gardens across the area, 13 recycling houses were built, located so residents would have no further than 200 metres to walk to one of the buildings. Each recycling house allowed residents to separate

Image by Johanna Sörensen

One of the 13 recycling houses in Augustenborg, designed to seem safe and inviting.

out nine categories of waste. Organic waste was managed by composters in each recycling house, a tried and tested method with a high likelihood of success. The other eight waste fractions were:

- clear glass packaging
- coloured glass packaging
- paper packaging
- plastic packaging
- metal packaging
- newspapers
- batteries
- residual waste

In Malmö, residual waste is burned by Sysav at its district heating plant.

Attempts at large-scale composting at district or city level, had not yet proven successful in the Nordic countries. Small-scale local composting, like what was chosen in Augustenborg, was on the other hand a more tried and tested method. Local management also cuts out the need for some transportation, even though only a small part of the end compost product was used in Augustenborg itself. Because of the large amounts of organic waste processed in the machines, the compost was not always ready to use when it was removed from them. There were also some contaminants, mainly plastic bags, that needed to be cleaned out before it was ready for use. Post-composting and cleaning were handled by the outdoor maintenance contractor, who was responsible for the composters. They then used most of the compost in their own construction and maintenance operations across Malmö. Only some of this came back to Augustenborg. Small-scale composting is generally educational, as residents see the organic waste being transformed into compost that can be used for soil improvement.

Resident participation in design

Early on it became clear that MKB, which owns the property, and the Fosie District Administration, which was responsible for the project, wanted residents to be involved in the entire Eco-city process, including waste management. The project organised a bus trip to Bergsjön outside Gothenburg to look at its recycling houses and composting system. The visit proved popular and the bus was almost full with Augustenborg residents. Excursions were not exactly part of everyday life for many residents. It was very important for the participants to witness the system in person and understand how it worked in other areas. In Bergsjön, they had for some years been using the JORA composter that would be installed in Augustenborg. One takeaway from the visit was that residents thought the recycling houses were a bit small, dark and cramped.

Working with architect Gisli Kristjansson, who won the competition to design the recycling houses (see page 229) and who was commissioned to draw them, a series of meetings was held to develop a good design and floor plan. Many residents perceived Augustenborg as unsafe, and it was important they could feel safe entering the recycling houses. Bright colours were chosen for the inside of the houses and a row of windows were installed on the short side, and windows on the door allowed people to see in and out. There were also doors on both sides of the buildings. Karin Persson was an important adviser in designing the composting system. As a composting consultant, she was the guarantor that the solution would work well. She was a persistent enthusiast and practitioner who helped the project throughout and ensured that those maintaining the compost and MKB's property maintenance staff were given enough training.

Uneven uptake despite community participation

It was natural to install green roofs on the recycling houses to make them more inviting, but also to mark them as being for recycling and not smelly old garbage houses. The green roofs also brought great symbolic value to residents and confirmed that the Eco-city's "brand" would be extended to the recycling houses. To find the best locations, the movements of residents to and from bus stops and amenities were studied and discussed locally. Because the composters had a limit on the load they could take, residents were keen to find optimal locations for the recycling houses to ensure people did not go to the "wrong" recycling house. It was important that the maximum number of people who use a composter was not exceeded.

Intensive communications on site at launch

Fosie District Administration (through Anna Granberg) was responsible for providing information on how the systems worked when the recycling houses were launched. At that time, it was clear which residents had insufficient Swedish, so written information was prepared in different languages. Staff who spoke the area's most common languages were also hired. Anna Granberg personally met almost 2,000 residents in Augustenborg in face-to-face information in the recycling houses. The sessions were held at different times of days and evenings to allow as many people as possible to take part.

Of course, it took a while before people got used to going down to the yard and the recycling houses with their waste. Some were very displeased.

In the beginning, people threw bicycle locks and many other things in the composters. Together with Karin Persson, waste samples were taken before the project began, and repeated after it had been running for a while. The analysis showed that the recycling houses led to cleaner waste fractions and increased separation. A full-time compost attendant was hired to take care of the composters in the beginning so the processes would work well. And they did.

A break during the transition from project to maintenance

A key argument in favour of a new waste management system in 2001 was maintenance. MKB's experience of the old garbage chutes had been poor. The chutes were often clogged and wardens had to spend a lot of time cleaning them. When waste management moved into the gardens and the chutes were closed, residents of course thought things had got worse, because they could no longer dispose of rubbish just outside their front doors. One way to get them onboard was to use the old garbage chutes to pull broadband wires to all households. Waste management costs decreased when collections in each stairwell were replaced by 13 recycling houses. However, two years later all this had been forgotten when there was talk of how expensive the composters were to take care of. The composters added a new maintenance step, which meant supervision and regular emptying. Because the system was chosen before the buildings were designed, they could be tailored to fit the composters and to facilitate maintenance. However, the demand for the recycling houses and composting machines proved to be very uneven. Some machines did not suffice for the amount of waste that residents produced.

Two memories stand out for Anna Granberg:

"A couple of IT guys who worked nights and slept during the day were the most difficult to reach. When I finally got hold of them, it turned out they only ate pizza, so I showed them where the cardboard recycling bin was."

"There was a single mother who was very negative at an event. 'Why should we do this rubbish?' she shouted in a rage. Later she joined one of the future workshops we held and went on to become the chair of the electric car pool and one of the best ambassadors for the recycling houses and the Eco-city Augustenborg. 'Single mothers need an electric car pool!'"

In 2003, two years after they were introduced, an MKB investigation argued for removing the composters and replacing them with containers which combined organic waste with residual waste for incineration[2]. The findings were criticised by the Eco-city's project management and by compost consultant Karin Persson for being poorly substantiated. They agreed with MKB that something new was needed for the compost (instead of phasing it out). Everyone saw two problems: Firstly that no one took responsibility to tell newcomers how the waste management system works, and secondly that management of the recycling houses fell to MKB's contractor which took care of the outdoor environment, while MKB's own maintenance staff were not involved in operation or spreading information. There was also a need to better divide the capacity of the composters between the recycling houses so they were adapted to the amount of organic waste that was disposed of in each recycling house. No record exists of what (if anything) was done to improve the situation, but in 2008 the composters were removed and replaced by a system where organic waste was collected for large-scale biogas production. More on that in the next chapter.

[2] En kortfattad utredning om kompostering på Augustenborg, collated by Håkan Andersson, MKB Fastighets AB, 2003-06-30. Accessed in the City of Malmö Environment Department's archive

Waste management in the Eco-city since 2008

Anna Bernstad Saraiva

Anna Bernstad Saraiva, PhD. Worked for MKB Fastighets AB from 2013 to 2014 as a project manager for the Eco-city Augustenborg as well as being an environmental project manager between 2017 and 2020.

Augustenborg's Eco-city project took a holistic approach to environmental issues and addressing how to dispose of Augustenborg residents' waste was important. Until the 1990s, all waste was thrown in garbage chutes. Residents who wanted to separate at source were sent to recycling stations outside the residential area, in line with the system which is still administered by FTI (the packaging and newspaper collection organisation). Having a property owner enable source separation of packaging and newspapers adjacent to the property and in the same place where residual waste is disposed, had not been widely trialed in Sweden at the time. With a philosophy that "doing the right thing should be easy", municipal housing company MKB Fastighets AB wanted to offer source separation of packaging and newspapers and local composting near each home, as part of the Eco-city project. This was an important part, fostering a greater understanding of waste and materials cycles among residents who could deposit organic waste for composting and have access to the soil it produced.

This chapter describes the system of local source separation that was established in Augustenborg during the Eco-city project and how it has developed since 2008. The chapter also describes how the efforts in Augustenborg have affected MKB's work with waste issues more generally. For a description of the development up to 2008, see page 218.

Waste management infrastructure in Augustenborg

As part of developing the Eco-city in the late 1990s, 13 recycling houses were built in the local courtyards. At the same time, the garbage chutes were closed in all residential buildings. That way residents were forced to go to the recycling houses where household waste was separated. Initially, the houses could handle nine different types of waste: glass (clear and coloured), paper, plastic and metal packaging, newspapers, batteries and residual waste. Organic household waste was treated in composting machines, one in each recycling house. The 13 recycling houses were distributed so no household would be more than 200 metres away from one. Each resident had a key which accessed one of the houses.

When disposing of hazardous waste, electronics and bulky waste (for instance furniture) Augustenborg's residents were referred to the municipality's recycling centre. The recycling centre is about ten kilometres from the district, which meant residents needed a car to recycle the waste. Only one in five local residents owned a car at that time. Bulky rubbish (for instance sizable electrical waste) was therefore often left in recycling houses, basements or dumped outside. Such incorrect procedures left time-consuming and difficult waste disposal to the local property managers, and large costs for property owner MKB. A few years after the recycling houses composting machines had been introduced, maintenance costs became high. The collection system therefore needed to change.

One of the recycling houses in Augustenborg. Image by Sanna Dolck

In 2008 MKB, VA Syd and Sydskånes avfallsaktiebolag (Sysav) launched a project to evaluate and develop the Swedish model for household waste management, focused on increasing source separation of several different kinds of household waste. A study was looking into what waste households produced and how they separated it. Another important goal was to influence how people recycle waste, both by improving opportunities to source separate additional types of rubbish as well as through information campaigns aimed at households. Researchers launched a full-scale and long-term case study in Augustenborg. Lund University (the Water and Environmental Engineering Division at the Department of Chemical Engineering) took responsibility for monitoring and evaluating the waste management system in the area, the impact of new solutions that were introduced during the Eco-city project, and finding opportunities for further improvement.

Several new solutions were introduced: the composting machines were removed, and food waste was instead sorted at source in paper bags and later handled in separate waste bins in the recycling houses. The collected food waste would then be used to produce biogas and the nutrients would be recovered. An on-site system for collecting bulky waste was also introduced. Households could dispose of bulky rubbish in a mobile sorting unit free of charge once every month. Source separation of electrical waste, hazardous waste and grease and oils was introduced in each recycling house.

Collecting hazardous waste is challenging because it comes with high safety requirements, while property maintenance staff and waste collection staff must still have good access and working conditions. A cabinet with a flexible one-way barrier for depositing hazardous waste (including light bulbs) was trialled in Augustenborg. The cabinet was designed so that the tenants could not remove the drawers (and the hazardous waste). The locked cabinets could only be opened by the maintenance staff who checked and separated the hazardous waste every week. Electrical waste was left in open metal baskets (1.5 cubic metres). The baskets were emptied at MKB's request by VA Syd, while the cabinets were emptied by Sysav Kemi.

Image by Marc Malmqvist/City of Malmö

The recycling houses had both cabinets for collecting hazardous waste and baskets for electrical waste.

Many of Augustenborg's residents come from cultures where fried food is common. The old pipe systems in the houses and the area meant that blocked pipe were an increasing problem. Households were therefore given the ability to separate fats and oils in 1.75-litre disposable plastic jars. There were picture guides on the lids which showed how grease and oils should be handled. Residents could leave the jars in open boxes in the recycling houses. Households could pick up new jars in the recycling houses.

The changes that were made in the area were followed up through several analyses of waste composition. They concluded that the separation level, that is to say the proportion of material that should be and is separated (such as packaging, newspapers, food waste, electronic or hazardous waste), was in several cases lower than the national average. It should be remembered that areas where there are clear financial incentives to increase separation are included in the national average. This has never been done in Augustenborg. The focus here has been to provide information and facilitate source separation by offering it in full in the recycling houses. The results showed this was not enough.

When compost machines were removed and food waste was instead sorted into paper bags for biogas production, space was freed up in the recycling houses. This cleared room for cabinets and baskets for hazardous and electrical waste. However, it did not do anything about the lack of space in apartments to separate at source there. In-depth interviews with a few local households showed that although many were theoretically positive to source separation, they often thought that waste management in their own apartment was impractical and unhygienic. This was especially true of food waste. The container which held food waste bags from VA Syd was often placed on the bench next to the sink, a limited space in Augustenborg's small apartments which was mainly used for cooking (Åkesson *et al.*, 2009). 70% of the households that separated food waste at source said that a "lack of space in the kitchen" was the main reason for not sorting food waste, according to a 2008 survey evaluating the changes in waste management (Bernstad *et al.*, 2012).

Master's students in the product design course at Malmö University were invited to develop a concept to improve waste separation in small kitchens. The winning design was a metal hanger for food waste bins and a set of two reusable plastic bags for sorting four types of waste (paper, metal, plastic and glass packaging). To ensure all households in the area received the new equipment, a door knocking campaign was launched to help residents mount the hangers and containers on the insides of their sink cabinets and personally give them a kit for collecting packaging materials

separately and some paper bags for food waste. Alongside the new equipment, MKB's staff also spoke to residents about the environmental benefits of source separation and recycling and answered their questions. Following these experiments in Augustenborg, the equipment is now standard in all MKB apartments.

Image by Gugge Zelander

The bag for collecting food waste hangs on the inside of the sink cabinets.

During the trial period when residents could sort grease and oil into 1.75-litre disposable plastic jars, many households instead elected to use other types of containers, mainly PET bottles. The disposable cans were therefore replaced by funnels, and households were encouraged to use these to pour grease and cooking oils into PET bottles and leave them in the recycling houses. These funnels are now also available in MKB's other residential areas in Malmö.

Bulky waste is now collected every week in the area, and none of the residents are more than 500 metres away from a disposal point. Landlord MKB also provides trolleys to transport large items from homes to containers.

Waste management in Augustenborg today

The residents in the Eco-city Augustenborg have since the early 2000s been able to separate household waste. At the moment, 13 different waste categories (clear and coloured glass, paper, plastic and metal packaging, newspapers, batteries, food waste, electrical waste, hazardous waste, bulky waste, grease and oils and residual waste) are recycled within 200 metres of homes. An annual survey of the Eco-city Augustenborg's residents find they are generally more satisfied with the recycling opportunities and the standard of recycling houses than residents elsewhere in Malmö. However, there have been no analyses of waste management since 2012, meaning we do not know what waste volumes and source separation look like today in the area.

Developing new waste collection infrastructure

Earlier studies show that convenience is one of the most important factors that can increase household waste separation (Ando and Gosselin, 2005). This is in many cases more important than knowledge, environmental considerations and financial incentives. An important step to improve convenience is to understand the context in which households sort their waste during a daily routine and what is important to facilitate these routines.

In interviews with households in Malmö, residents usually dispose of household waste when they are on their way out, rather than making a separate trip to the recycling house. Therefore, there are several reasons why it could be difficult to dispose of waste in an enclosed recycling house, for instance if someone has a bicycle or pram that must be left outside. This also becomes an issue if special containers are used to separate the waste in an apartment, meaning the resident must return upstairs to drop off their containers before leaving home. The feeling that you get dirty when separating waste could also prevent residents from recycling while on the way out.

Image by Frida Persson Boonkaew/MKB

The recycling house in Greenhouse Augustenborg

An interesting new trend is increased connectivity through apps and social media where people share personal achievements. Improving your personal records and achieving goals will win you "likes" from peers on social media, and can stimulate the individual and challenge friends, which spreads the behaviour.

Based on these experiences, the municipal housing company MKB is now looking into the how to change recycling houses' design. The most important change is that waste can be sorted into different categories from the outside of the building (see picture above). Each waste hatch needs to be opened with an electronic key, so passers-by cannot dispose of their waste there. There is also a scale under the container for residual waste. This can provide direct feedback to households on how they handle waste: less residual waste indicates more separation and a lower environmental impact. The electronic key also allows waste to be linked to individual households and statistics can show how much waste was put in each category in a month, for instance. The statistics can spark friendly competition between neighbours and get likes on social media. The residual waste statistics can be included in the meter reader which shows residents their hot water and electricity use and provides feedback. A small part of the recycling room is set aside for hazardous waste and electrical waste. This room has a tap for residents to wash their hands if necessary. This increases the chance of a detour to the recycling house when residents are on their way out.

Greenhouse - Augustenborg's densification project

Greenhouse Augustenborg was opened in March 2016. Several of the project's environmental innovations required collaboration between a large number of actors. This caused major challenges

when designing the recycling house. The digital systems in the recycling scale were not compatible with the systems in the rest of the building, and the interface that had been developed specifically for the project was not sufficiently user-friendly. Residents can get real-time information about how much residual waste they deposited on a screen above the residual waste hatch. The hope was to let them monitor their residual waste on a monthly basis. But technical problems meant it was impossible to measure the amount of residual waste per household per month. There have not yet been any detailed analyses of the system which could shed light on how much source-separated waste is produced by residents in Greenhouse or how they separate it.

Lessons learned and a view to the future

A survey of Greenhouse households at the end of 2017 showed that many liked the idea of being able to track their waste production over a month, and some had been frustrated over not being able to do this. This shows that people are interested in the ideas which underpin Greenhouse's recycling system and how they combine convenience and personal feedback.

In Vallastaden (Linköping), the amount of unsorted waste and sorted food waste a household produces, is individually measured and linked to the fees for waste management. A weight-based vacuum system creates financial incentives for the residents in apartment buildings. In this case, the system combines weight-based fees with real-time feedback to households. There has not yet been a follow-up study of the system, but previous results have shown a 20% reduction in the amount of unseparated waste (Dahlén, 2009). Although such systems may be effective in some scenarios, they are normally impossible to install in existing areas. The system would also require a degree of social control to avoid fly-tipping.

Continued investment to increase comfort, starting inside homes, is one of MKB's focuses going forward. It is also looking at how to use people's desire to replicate what others do:

- The source separation kit that was tested in Augustenborg has now become the standard in MKB's new-build apartments and is also given as a moving-in gift to new tenants on handover. Security and visibility are keywords in the design of new recycling houses. This means, among other things, the buildings often have two entrances/exits and large glass sections.
- By creating a sense that most residents handle their waste correctly, the chance of individual households joining in increases. Special efforts are therefore made to model "good waste behaviour" by cleaning the houses frequently, and using the motto "whole, clean and tidy" in all of the waste areas.

Recycling houses – an architectural design competition

Bengt Persson, PhD, landscape architect and former senior lecturer specialised in dissemination and cooperation at the Swedish University of Agricultural Sciences.

The ambitions for managing household waste were high in the Eco-city Augustenborg. The goal from 1998 was that 90% of the area's waste would be separated at source[1]. This would mean 500 tonnes of household waste were composted and 500 tonnes recycled or reused every year. To make separation and recycling work for households, two conditions had to be met:

- flexible, pleasant and hygienic equipment was provided in kitchens for residents to separate at source
- well-placed, pleasant and flexible spaces were provided in the yards where residents could leave their sorted waste

Figure 1. The winning proposal August from Gisli Arkitektur AB, proposal by Gisli Kristjansson and Pekka Kärpää. The glasshouse was never built but the rest of the proposal became reality.

1 Application to the Local investment program, LIP, 1998

The plan was to build ten recycling houses for MKB's buildings, and to collect and remove the waste with electric vehicles. The recycling houses would be equipped with composters maintained by specially trained personnel. This was estimated to provide six permanent long-term jobs in management of the system.

MKB was responsible for the waste project and for producing good and attractive recycling houses. To introduce a creative process into the design, the company organised an open architectural competition.

MKB has not archived the results of the competition, so there is no information about how the assignment was set, who participated or what the submissions were like. But the winner was architect Gisli Kristjansson from Gisli Arkitektur AB. Gisli Kristjansson was helped by landscape architect Pekka Kärpää to design the location and outdoor environment.

Gisli Kristjansson said the focus was on environment, environment, environment. They simply gave it their all, which won the jury's approval. Since many recycling houses were needed in the area, it was not possible to simply use one model, as needs and dimensions needed to be adapted to different locations. All recycling houses were of the same height and had the same roofing materials. However, they were of different lengths and the facades were made from different materials depending on where they were situated. Residents were also meant to have input into the facade materials that were used, and by extension how each house looked.

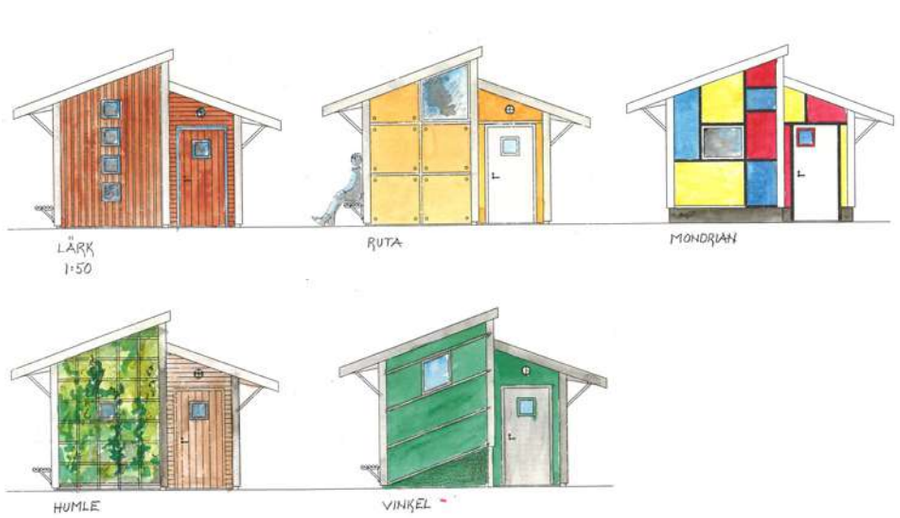

Figure 2. Five suggested facade materials and designs that residents could choose for the recycling houses. From the winning proposal by Gisli Arkitektur AB.

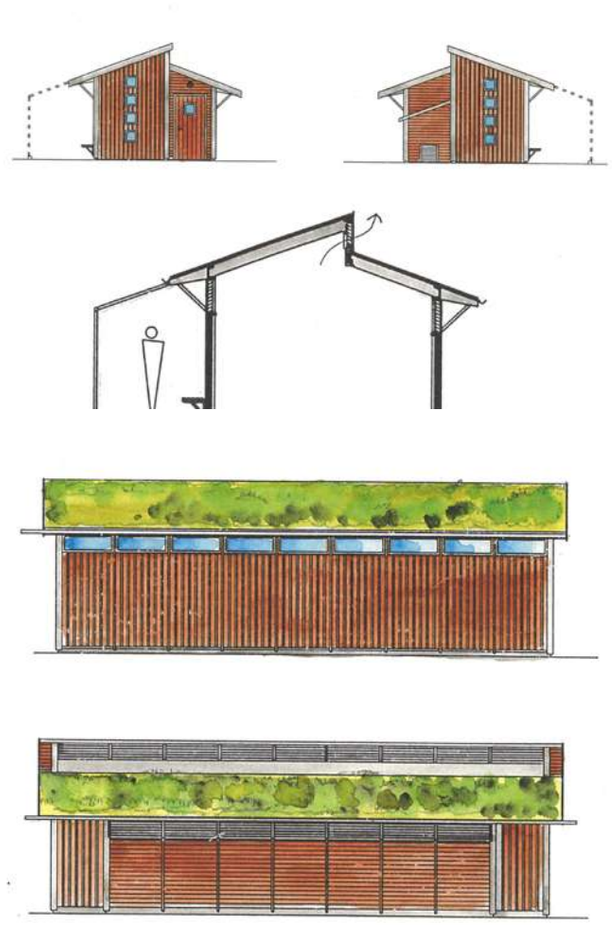

Figure 3. Gisli Arkitektur AB's main proposal from the architectural design competition. The recycling houses were largely built to its specifications. The recycling houses were so well-done and welcomed that Gisli Kristjansson won the City of Malmö's Urban Development Award in 2002.

However, in the end all the facades ended up looking the same. The reasons are unclear, but the facades were built with the same material. However, the sizes still vary based on how many residents each house was meant to serve.

Green roofs were a given in Gisli Arkitektur's proposal. The green roofs, it was argued, were pleasant to look at, increased biological diversity, kept the temperature more constant inside the buildings and reduced noise, primarily from glass recycling. But they also knew that a key jury member was an aficionado of green roofs. The houses were to be built of wild Swedish wood that had not been tortured in monoculture plantations.

After winning the competition, Gisli Kristjansson and his office were selected to place, dimension and design the recycling houses. Gisli Arkitektur worked hard to find the best location and dimensions for the recycling houses to ensure the walk from homes to the recycling houses would be as short as possible. Ideally, the houses would be alongside the natural routes that people took to the bus, car park, etc. The sites also needed to be optimised for transporting the source-separated waste to the area's common collection point. A group of residents were involved in the process which, among other things, went on a field trip to Göteborg to examine good waste management solutions. The big challenge, once the houses had been built, was making source separation work. Staff were on hand in all the houses to help residents with their recycling.

The houses were designed to accommodate composting machines which would treat organic waste. However, the machines did not make a finished product, instead post-composting was required before it was ready to be used for soil improvement, or ground cover. The transport from recycling house to the post-compost was meant to be handled by the contractor responsible for outdoor maintenance.

Together with competition organiser and client MKB, a brief for the design and function of the recycling houses was compiled. The process showed empathy with the daily problem residents encountered, in trying to put the right waste in the right place. The attempted solution was to make waste management meaningful and enjoyable. Location was naturally a key issue in optimising the solution and maintaining morale and commitment. The recycling houses had entrances at both ends to make it easier to use them when going from A to B. The extra exit also provided increased security if someone or something scared or threatened residents. The houses had windows in the wall and doors to improve safety and pleasant lighting during the evening and at night. Another important detail was to put a roof over the doorway, so residents did not have to leave their rubbish on the wet ground when they opened the door.

The compost machines were removed in 2008 and organic waste was instead collected to produce biogas at a central location, see page 219 about the usefulness and shortcomings of the compost machines.

Text: Bengt Persson

Reporting on the recycling houses

Karin Lindén and Marina Botta published a compilation of the LIP projects in 2006 (Vidén, Sonja and Botta, 2006). They summarised how the new waste management scheme turned out:

> "Waste management was improved by putting waste receptacles for source separation in all MKB's 1,600 apartments. In 2000 the first recycling house to collect separated waste and composting was completed. Detailed information was given to the residents, through among other things, leaflets that were available in seven languages. A collaboration with the homecare service was launched to help the elderly whose mobility was impaired. In total 14 recycling houses were built, including one at the school, where rubbish was disposed of in well-marked containers. The separation has worked fairly well, but newcomers constantly need training. The design of the recycling houses fits into the area and provided the daylight, lighting sensors, easy-to-clean surfaces, etc. that residents had wanted. They were built with carefully selected materials and had sedum-covered roofs, which help absorb stormwater and provide greenery. The sorted waste is transported by electric vehicles to the area's collection centre."

A corresponding description can be found in another report written by Jenny Stenberg and Liane Thuvander in 2005 from the Swedish Environmental Protection Agency (Stenberg and Thuvander, 2005):

> "In the recycling houses, you can separate paper, cardboard, glass, metal and plastic. Furthermore, the organic waste is disposed of separately and pre-composted in local composting machines. It is then sent to a post-composting plant. Some of the compost is used for vegetation in MKB's area and by the residents for pots, balcony boxes and plantations. The Augustenborgsskolan school has also been able to compost and students have built a recycling house in clay and straw (cob). In 2002, a new system to collect electronic waste and environmentally hazardous waste from local companies was introduced. There are also plans to allow residents to separate bulky waste, textiles, electronics and environmentally hazardous waste at source. A swap shop is also in planning."

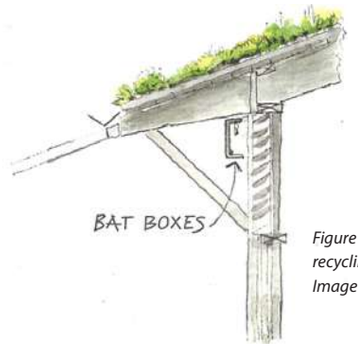

Figure 4. Bat boxes were to be integrated into the recycling houses to increase biological diversity. Image by Gisli Arkitektur AB.

Neighbourhood source separation of waste from the perspective of Augustenborg residents – was it good and easy?

Anna Bernstad Saraiva, Susanne Ewert, Greger Henriksson, Lynn Åkesson

Anna Bernstad Saraiva, PhD, project manager in environmental development MKB Fastighets AB. Her thesis was on the environmental impact of household waste manage from a lifecycle perspective, using Augustenborg as a case study.

Susanne Ewert is a PhD student in ethnology at Lund University. She has, among other things, worked on a case study into waste issues in Augustenborg, which this article is based on.

Greger Henriksson is an environmental ethnologist and senior lecturer at Division of Strategic Sustainability Studies, at the SEED department of the Royal Institute of Technology in Stockholm. He researches environmental issues and patterns of action in everyday life, usually in collaboration with engineers, natural scientists, authorities and businesses.

Lynn Åkesson, professor of ethnology at Lund University. Has researched waste issues. Was the project manager for the case study on waste issues in Augustenborg which this article is primarily based on.

The environmental sustainability of Swedish waste management depends on people and businesses correctly separating a large portion of their waste. Sörbom (2003) found that Swedes generally are positive to separating waste at source. This is perceived to have environmental benefits and should be done where possible. Participation in source separation is not only dependent on this perception, but also practical circumstances, accessibility, proximity, convenience, having the required knowledge, and an ability to integrate it into daily routine (Ewert *et al* 2009; Henriksson *et al* 2010). Therefore, conditions for sustainable waste management are fairly good in Sweden, at least when measuring values and intentions. In Augustenborg conditions are especially good due the introduction of a more comprehensive neighbourhood collection system at the turn of century, ahead of the standards at the time. Neighbourhood collection of waste was further developed in 2008.

Largely residential, Augustenborg was built between 1948 and 1952. Today the area has around 1,800 apartments and 3,000 residents. Small by today's standards, most apartments have one, two or three rooms. In 2008-2009, when empirical data was collected for this study, young adults aged between 18 and 40 were overrepresented in the area. 48% of tenants were born abroad. However, earlier studies (Sörbom 2003) have shown no particular correlation between national origin and interest, or willingness, to separate waste at source.

As part of the Eco-city project in the early 2000s, when changes such as the open stormwater system were put in place, property company MKB organised household source separation into metal, glass (coloured and clear), plastic, and paper packaging, newspaper, food waste (in compost machines) and residual waste. This was housed in 13 recycling houses. Each served 100 to 200 households which were given an electronic key to open their assigned recycling house.

Now, it is important to point out the level of novelty of this system. In the 1990s, the Agenda 21, signed at the UN high level meeting in Rio de Janeiro in 1992, was implemented in Sweden through many local projects, founded by the Swedish EPA. The concept of waste reduction and recycling was recognized in several of these local projects. However, source-separation of household waste close to the household was still very un-common in Sweden. Although source-separation of several packaging materials had been introduced as a part of the environmental legislation in 1998, the common approach that households were directed to public sorting hubs, placed rather randomly over the city. Thus, we argue that the system presented in Augustenborg was radical and in the development front in Sweden when introduced in the early 2000s. At the same time, it should be remembered that the habitants in Augustenborg had not chosen to live in this particular area of the city due to the eco-profile. Several of the inhabitants had lived there since the construction of the area in the 50s. Others had found a new home here after coming to Sweden as refugees in the 90s, as this was an area with many empty apartments at that time.

The compost machines, earlier installed in all recycling houses, were removed in 2008. Since then, residents instead collect food waste in paper bags which are placed in brown bins in the recycling building. The moisture-proof bags should be placed in an open and breathable container. Containers and bags were distributed to households and new bags can be collected from the recycling houses. The food waste is then collected by the refuse collection vehicle and is used to produce biogas and bio-fertiliser. When the system changed, households in Augustenborg were given written and/or oral guidance how to separate food waste. Removing the compost machines freed up space to separate hazardous and electrical waste.

Aim

This study describes how Augustenborg's residents utilise and experience the waste management system introduced in 2008. It also explores how to introduce sustainable waste management systems based on the experience, utilisation and perception of local waste management. The primary questions are:

- Which terminology and categories do residents use to discuss waste in everyday life? How do these categories work in practice when waste is separated, and how do they become learnt behaviour and routine?
- How well does source separation work? How much is separated, and is it separated correctly?
- How do residents' thoughts and actions on source separation function in a system designed by technical and professional actors? How do we best describe the correlation and conflict between the system and its terminology, in relation to the categories and habits that the residents themselves have and use?

Theoretical and methodological starting points

An important starting point of our analysis is people's perceptions of order/disorder; cleanliness/dirtiness; and what should be saved/disposed of. These rest on general, cultural values and daily habits (Douglas 1966; Hawkins and Muecke 2003; Thompson 1979). The study examines how people view these and other concepts and their actions in daily waste management (Ling 2012; Jiang 2010; Mayne & Murray 2001; Martin 2013; Rathje and Murphy 2001). Studies of cultural attrition (Åkesson 2006 a and b; Åkesson 2008), of cultural conditions for product longevity (Gregson, Metcalf and Crewe 2007 ; Hetherington 2004; Åkesson 2012) and the role of habit and agency (Campbell 1996) are also important starting points for this analysis.

Image by Susanne Ewert

The rainwater, that used to cause problems in the residential area, is now led into an sustainable urban drainage system with ponds and canals which also contribute to a beautiful outside environment.

The empirical evidence mainly consists of qualitative interviews and observations. Interview questions are based on everyday household waste management. In line with established qualitative methodology practice, interview subjects were regularly permitted to digress from the topic before returning to the prepared questions. Digressions create a better understanding of the line of questioning and maintain individuality in each interview. The interviews therefore do not follow a strict formula, but each question was answered. Quotes are direct quotes, but to aid readability, small words have been added or removed. Unnecessary repetition or slips of the tongue with no impact on meaning have also been excluded. Interviews were recorded and lasted 30 to 60 minutes. Field observations are another common part of a cultural analytical methodology. This study followed participants' daily waste management. Interview subjects in Augustenborg were chosen at random from a list of tenants with the aim that half should have non-Swedish backgrounds and include a diverse range of ages.

To compare information provided by households to their daily separation practices, the composition of waste was analysed on four occasions. The analysis was performed in the winter and autumn of 2008 and 2009, after organic waste separation was changed from composting to bag collection for biogas production. Analysing waste composition can provide detailed information on how households separate at source. It shows not only what proportion of waste is separated, but also the proportion of recyclables disposed as residual waste, and information on the quality of the separated materials. By analysing waste composition, it is possible to calculate the following key figures:

- Specific waste mass (kg/household and year)
- Separation levels (by percentage of weight), defined as the weight of separated recyclables over the total mass of recyclables (correctly separated, incorrectly separated, and unseparated in residual waste)
- The proportion of incorrectly separated waste (by percentage), defined as the weight of the waste in one category (for instance plastic packaging) which does not belong there, over the weight of all waste in this category.

To provide information for a consistent evaluation, and in order to follow development over time, it is vital to use the same method to analyse the waste on each occasion. In all analyses for this study waste was chosen, treated and stored in the same way. The same sorting categories or subcategories have been used for all analyses.

Both relative and absolute criteria for the choice of analysis materials have been developed. Petersen (2004) said 450 kg to 950 kg of material should be analysed. Nordtest (1995) recommends selecting at least 5% of the population in an area for analysis of detailed waste production, and 100-200 households to analyse waste composition. However, conclusions are more reliable in some waste categories than others. If there are few objects in a category, each is more important to the assessment. Hazardous and electronic waste are examples of this as they are generated in small quantities.

Everyday language and its effect on separation behaviours

In interviews it was rare for the suffix 'packaging' to be mentioned when discussing the different categories of recyclables. Instead, as one interview subject put it, "I have one [container] for household waste, one for plastics and one for metals. And then I have a paper bag where I dispose paper waste, that is to say cardboard, and a basket on the floor for newspapers". Everyday language deals with the material rather than the packaging. Many view plastic packaging as particularly complex. "Yes, plastics are a little tricky … Because there are many plastic objects in our household. Bowls, tubs and toys - everything. And then you think this is plastic and should be recycled as such. However that is not the case, I know that. But I find myself asking: What is this? Should it be recycled as plastic? And you have to wonder: Why should this plastic toy not be recycled? ... I think that is odd".

One participant said he puts dishwashing brushes in the "residual waste" section, but when we ask him why he becomes uncertain, observing: "The bristles are also made of plastic". As the whole brush is plastic the subject starts wondering if it is "to do with bacteria … germs". In other words, the subject does not seem to be aware of, or consider, that household source separation is mainly focused on packaging. He takes the correct action but for the wrong reasons. Consequently, it is not the knowledge that the brush is not a package which means it is sorted as residual waste. As the subject is unaware where to dispose the brush, it ends life - as all unknown objects - in residual waste, which just happens to be correct. The habit can therefore be described as both consequential and problematic.

The newspaper category may be considered simple, however many find the ban on envelopes illogical. "Yes, you're not meant to put envelopes and stuff into the newspaper recycling. But it's easily done - I mean it is paper." Another subject puts the odd envelope in the paper category. "You are meant to put it in residual waste, but that feels wrong." Even though the subjects know envelopes should be put in residual waste, perceptions create different actions and envelopes end up in paper recycling.

One could imagine Swedish language knowledge would impact an individual's ability to understand instructions. From studying at least two households with members born abroad we cannot conclude that a non-Swedish mother tongue impacted comprehension or interest in recycling. Nationality did, however, influence the amount of food waste a household produced. Those with a foreign background were more likely to create more food waste due to a habit of cooking from scratch, which creates more vegetable leftovers and other organic waste.

Household material hierarchy

Several interviews highlight that different materials and packaging are afforded different status in source separation. One subject says: "I'm sometimes a little lazy. Never with paper, but sometimes

plastic packaging ends up with the other rubbish." Another participant said: "It feels unnatural to, for instance, throw glass into the normal garbage." But cardboard or paper is sometimes seen as best suited to the residual waste. "If you have an old carton of yoghurt standing around which needs throwing away, it can easily end up in the 'combustibles' section. I don't see a problem with that. It is combustible." The interviews indicate different motivations for some materials being regarded as more important to recycle than others. For some, plastic and paper packaging is often dirty, so requires more effort to recycle. Others know residual waste is burned and that, for example, plastic and paper are then turned into energy. Packaging made from mixed materials presents a further challenge. "You try to be smart by removing the plastic from the paper, but some products make that impossible. It is just stuck, and you feel you have failed in your duties as a source separator when the manufacturer has made it impossible to separate the materials." Mixed-material packaging therefore creates uncertainty and is often disposed of as residual waste. Added to uncertainty is the added effort such packaging requires. "I just don't have the energy for the extra work needed to separate some products." Packaging with mixed or difficult-to-identify materials creates uncertainty and a feeling of wasted energy for the householder. That feeling causes perceptions which mean source separation is no longer beyond reproach.

In the different categories for recyclable packaging, everyday language impacts how the waste is separated. For instance, when plastic is found in the newspaper recycling, which in itself is an easily separated waste stream, it's possibly because the newspapers were delivered with plastic wrappers. These are seen as less important when separating waste. Image by Susanne Ewert

From clean water to dirty waste

Many participants think about the consequences of rinsing dirty waste with clean water. "That is one thing I've questioned, and that I think is crazy: You are asked to use loads of clean water to rinse out milk cartons, glass jars, glass bottles and juice cartons which means I waste clean water - drinking water." How well packaging should be cleaned before separating is in partly linked to the question above. This is mainly an issue for plastic and, to a certain degree, cardboard packaging. One subject believes this offsets any benefit: "I think the whole point of recycling disappears, especially as many people rinse packaging in warm water. You might as well throw it in the normal trash, because all the benefits disappear … it costs more to rinse out a packet of yoghurt than to recycle it, so to say." Suspicion towards the rules for source separation reduces the feeling that recycling is completely positive, which is an important motivator for households to separate their waste.

A new regime for food waste

When the disposal of food waste was changed in Augustenborg, households were asked to use paper bags when separating waste at home. Many thought putting food in a paper bag made the bag leaky and wet. Therefore, several subjects created their own solutions, such as using two paper bags at a time.

Another subject uses a paper bag inside plastic bag: "We use a plastic bag even if we have one of those paper ones." The thought of a leaking paper bag changed the habits of one subject: "Now I peel potatoes rather than rinsing them. And the ones that are very dirty - I get them from my neighbour because she has an allotment - I put them in water and let them drip dry." But in practice the system works as intended for households. "It has gone well. Not a single leak," one subject says. Though it works well in many cases, there is much uncertainty over placing wet and/or sticky food waste in a paper bag. One subject was unaware of the new regime, and still uses plastic bags: "Oh right, well we haven't been given that. I have transparent blue bags for my food waste." But the plastic bag is just temporary storage. In the recycling house, the food waste was emptied into the brown food waste containers. This behaviour is in keeping with the earlier composting system where the food waste was emptied into the machine.

Several households experience discomfort when separating food waste. Words like 'stinking', 'unhygienic' and 'disgusting' were used on several occasions - often related to the frequency of disposal, which interviewees say is higher compared to other recycling. Households are recommended to change bags two to three times a week, but the bag is filled at different speeds based on a range of factors, such as the size of the household, eating habits, etc. Interviews show that many households in Augustenborg believe they create little food waste, meanwhile they dislike disposing their bag 'unnecessarily', without filling it properly first.

Image by Susanne Ewert

There are 13 recycling houses in the residential area, some with or some without windows. Here, residents can separate packaging made from paper, plastic, glass and metal as well as newspapers and food waste.

Table 1: Separation levels and the proportion of incorrectly separated materials in recyclable waste in the Augustenborg area. Averages from four studies of waste composition.

Waste category	Separation level (%)	Incorrectly separated materials (%)	Separation level, national average (%)
Clear glass packaging	73	5	94
Coloured glass packaging	83	11	
Metal packaging	38	30	67
Plastic packaging	40	32	31
Paper packaging	55	29	52
Newspapers	70	5	89
Food waste	25	4	13

Some households, therefore, do not separate food waste to avoid leaving it to start smelling, which forces them to take the bags out more often. One subject believes she has to take the bag out every day, which is too often for her. This incompatibility between the new regime and her habits means she completely avoids separating food waste. For other subjects, frequent disposal works well: "I cycle each day and it is not a problem for me to take the bag with me on the way to work each morning."

Waste in Augustenborg from a quantitative perspective

Four studies on waste composition assessed how the population separated waste (Table 1).

The results from the studies of waste composition show separation levels were above the national average for paper and plastic packaging and food waste, but below for glass and metal packaging and newspapers. Despite good conditions for source separation in Augustenborg, separation levels were generally no higher than nationwide. Meanwhile, far from all waste is correctly separated. The levels of incorrectly separated waste vary heavily between the categories - from 4% in food waste to 32% among the plastic packaging. This means a third of waste believed to be plastic packaging was not, and should have been placed in a different category, or disposed as residual waste. The proportion of incorrectly separated materials is almost the same for metal and paper packaging.

Discussion and conclusions

Inspired by theories of cultural values and daily habits (Gregson, Metcalf and Crewe 2007; Hawkins and Muecke 2003; Hetherington 2004; Thompson 1979) we argue that Augustenborg residents' attitudes to source separation can be described on a scale with satisfaction at one end and uncertainty at the other. Satisfaction from doing the right thing was identified as key to successful source separation. This feeling can be clouded by uncertainty, especially with regard to packaging versus material; difficult to identify mixed materials; what happens to waste once it has been disposed of; poor separation by some people or groups; and doubts over environmental benefits.

Regarding our research question about levels of recycling and correct separation (in accordance with the official regulations), the highest levels of recycling were found in the glass and newspaper categories. They are also those with the lowest amount of incorrectly separated waste. This supports interview results which indicate that certain waste categories are seen as more important than others, i.e. have relatively high culturally grounded value (Gregson, Metcalf and Crewe 2007; Martin 2013; Åkesson 2012). We believe this value should be seen in the context of historical and practical circumstances. Newspapers and glass were the first categories for which responsibility were placed on the producers, and therefore have the longest record of being source separated and recycled in Sweden. These categories are also seen as relatively easy to separate compared to others, which can be seen as more arduous and 'disgusting' to handle.

Based in our theoretical starting point that material categories are culturally constructed (Douglas 1966; Martin 2013; Thompson 1979) we note that many interview subjects are unaware that source separation mainly concerns packaging. To them, separation based on material seems more logical than separation based on packaging type. Everyday language also makes people think about material rather than packaging: "That is metal, and the other one is plastic". The uncertainty regarding the difference between packaging and material recycling, found in interviews, we see as clearly reflected in the results of the waste composition analysis. We argue that this uncertainty should be seen as related to the low levels of overall recycling and high levels of incorrect recycling in some categories. This points towards larger uncertainty in some categories (plastic, metal and paper packaging) compared to others (newspapers and glass packaging). If uncertainty around separating certain materials means they will be separated to a lesser extent, it should be considered that the amount of potentially recyclable material could increase by 15% after a shift from offering only recycling of packaging to instead offer recycling of the corresponding categories of materials (Bernstad *et al*, 2011), with reference to a previous study that indicated that sorting and collecting materials (so called material streams) could become widespread in Sweden (SEPA, 2007). Based on the interview results such a shift could also lessen uncertainty among households.

Image by Susanne Ewert

Household food waste is sorted into brown paper bags which are then deposited in brown containers in the recycling houses. Above the containers there are examples of what can be put in the paper bags, and what does not belong there.

Several interview subjects were skeptical about putting food waste in paper bags. Culturally grounded, general perception and experience (Jiang 2010, Ling 2012) of paper bags can therefore create obstacles. Households seem unaware these bags are designed to withstand moisture, and not leak or break. On average 25% of food waste is separated, which is low compared to other categories. On average, households separated 0.78 kg of food waste each week, but a further 2.45 kg was dumped in residual waste. This contradicts interviewees who claim to only create small amounts of food waste, though there are differences between households. The proportion of separated food waste is therefore low, as is the level of incorrectly separated waste among the food waste, only 4% (by weight) on average. That means that although far from all households choose to separate

food waste, very few other items are disposed of in food waste bags. Plastic bags wrapped around paper bags, and plants and soil, were the two main groups of alien items in food waste. The first category demonstrates a fear of dirty and dripping paper bags, which was brought up by several interview subjects. The second shows residents have not heeded guidance from when the system changed away from composters towards biogas production. The attention and care to prevent leakage and smells from food waste point towards a limit to what is acceptable. People try to avoid trails of leakage and smells from food waste and do not accept it from neighbours. This seems a cultural indicator of cleanliness (Jiang 2010). People are revolted by the thought of it. To reduce the risk of leaking and smells, households need to establish and maintain specific habits (Campbell 1996) for managing food waste. This, we conclude, is reflected in lower separation for waste categories which require rinsing, or threaten to create foul smells, compared to more culturally acceptable categories. When new systems for source separation are introduced, developers should therefore not only consider teaching people to dispose waste in the legally correct category, but equally consider the space needed in daily habits and mindsets - habits founded on cultural perceptions about how valuable different types of waste are, which words and terms are most useful to separate them, and how much time and energy is perceived reasonable for a household to spend on waste management.

The municipal housing company MKB held a day with various themes around caring for the environment. This is a demonstration of how apples are pressed before being digested to create biogas. Image by Susanne Ewert

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Ivan and the horse – Malmö's sheer horsepower

Soothing hoofbeats and an occasional snort have echoed between Augustenborg's buildings since 2010. For many, the sight of a large Ardennes horse with carriage in tow, through the urban environment, is highly unexpected. Ivan Varga and his horse Helmer are a familiar and popular part of the leafy Eco-city. Since the project "Sheer Horsepower" was launched on April 29, 2010 Ivan has picked up rubbish and emptied bins across the area. Ivan's last horse Bango was a true local celebrity, but Helmer is also galloping towards popularity among the area's children and adults.

For Ivan his mission is about much more than waste management:

"The horse contributes as much to the environment as to social life. I have close contact with the children and the residents, and my job is very, very social - to spread love, talk and entertain the people in the area."

The initiative to pick up rubbish with a horse and cart was born in the Holma district, when the garbage truck was no longer allowed to drive into the car-free area. An article about using horses in waste management caught Ivan's eye and he contacted MKB to suggest a collaboration. The municipal housing company ran with the idea and Ivan started transporting bulky rubbish in Holma, which he still does to this day. A little while later, MKB started the project "Sheer horsepower" in Augustenborg. Today, Ivan has three horses in a stable in Malmö, and the task has been extended to collecting bulky waste in the Rosengård district.

There are many benefits to having a horse "binman". Alongside collecting bulky waste, emptying bins and picking up rubbish, the horse and cart helps to strengthen the local social environment. Ivan likes to spend time talking to the residents, and young and old dare to pat the horse. Ivan often brings a bucket of carrots and likes to challenge the slightly more confident children to feed the horse. Local children know the horses' names and often take photos with them. Another benefit is that the vegetable patches run by leisure centre Gnistan in Augustenborg can collect manure from Helmer. MKB also uses the horse and cart for other activities around Malmö.

Jessica Persson worked as a strategic project manager for sustainability at MKB from 2018 to 2019.

Image by the Scandinavian Green Roof Institute

Ivan and his horse have been a welcome feature in Augustenborg for many years.

Gröna Linjen – emission-free public transport

Bengt Persson, PhD, landscape architect and former senior lecturer specialised in dissemination and cooperation at the Swedish University of Agricultural Sciences.

The trackless electric train Gröna Linjen (Green Line) was one of many projects within the Eco-city Augustenborg[1]. It ran between 1999 and 2002 and allowed Augustenborg residents to reach other districts and the amenities there without first going to Malmö's city centre to change buses. The idea behind Gröna Linjen was developed by Internal Services Department development manager Peter Lindhqvist and MKB area head of property Christer Sandgren. It came after Sandgren conducted surveys and held neighbourhood meetings with the residents of Augustenborg in 1996 and 1997, to ask what they wanted or were missing in Augustenborg.

The survey found that locals wanted a post office, a health centre, a pharmacy, an alcohol store, a bank and more. Peter Lindhqvist and Christer Sandgren began to contact these institutions to attract them to Augustenborg at the square, or at least a small shop at MKB's service office. It was central to the long-term development of Augustenborg's appeal to improve access to basic amenities. But there was a total lack of interest in establishing such services in Augustenborg, which was rather catastrophic. Instead, Peter Lindhqvist and Christer Sandgren started to examine where amenities could be found nearby, and how to connect to those areas so they could be accessible to people in Augustenborg.

Peter Lindhqvist had seen a trackless train in Calahonda in Spain (though it was diesel-powered) and believed it could connect Augustenborg with amenities in surrounding districts - from the university hospital at Södervärn to Hermodsdal. The emission-free electric train became one of the most prioritised projects in the City of Malmö's application for LIP funds (Local Investment Programme), approved by the government in 1998. Minister Anna Lindh came to Augustenborg and revealed the happy news.

Peter Lindhqvist and Christer Sandgren scanned the international market for manufacturers of electric street trains but could only find diesel or gas-powered examples. The solution came closer to home. An inventor in Varberg, Helmer Larsson, was making small electric trains by converting electric service trucks. These were used, for instance, to drive visitors around factories. Volvo's Gothenburg factory was one of the places that used one of Helmer Larsson's

[1] This article is mainly based on Peter Lindhqvist's own story of the rise and fall of the Green Line.

Image by Thomas Löfqvist/Bilder i Syd

Gröna Linjen had seven main stops by squares and district centres. The drop-off at Facklan was Sweden's first indoor stop, something that has since become increasingly common for electric buses.

trains. Peter Lindhqvist contacted him about developing a train for Gröna Linjen, but his company went bankrupt before the LIP grant was won, and some parts of the financing completed.

The focus turned to Cheltenham in England, where a diesel-powered train transported motorists from park-and-ride car parks on the edge of town into the city centre. One important takeaway was the presence of conductors on the trains. They were a welcome feature and helped the elderly and other travelers who needed support and assistance. But before contacts deepened with Cheltenham, the inventor from Varberg showed up in Sibbarp in Malmö. He brought a train which he had salvaged from the bankruptcy and drove visitors to view the construction of the Öresund Bridge. He said he could build the electric train to Augustenborg if he was given access to a workshop, equipment etc.

At this time, money from the disbanded Employee Funds was available for industrial development centre projects (industriella utvecklingscentra, IUC). A couple of staff members at Lund University were given money from the funds but lacked ideas of how best to use the finance. To develop the train for Gröna Linjen a new company called Street Train Sweden AB was launched as part of IUC Skåne. Claes Brismar from the Lund University Faculty of Engineering became managing director and Helmer Larsson technical manager. The initiative was granted SEK 20 million, which was an extremely modest budget to develop a new kind of vehicle for a new type of transport service.

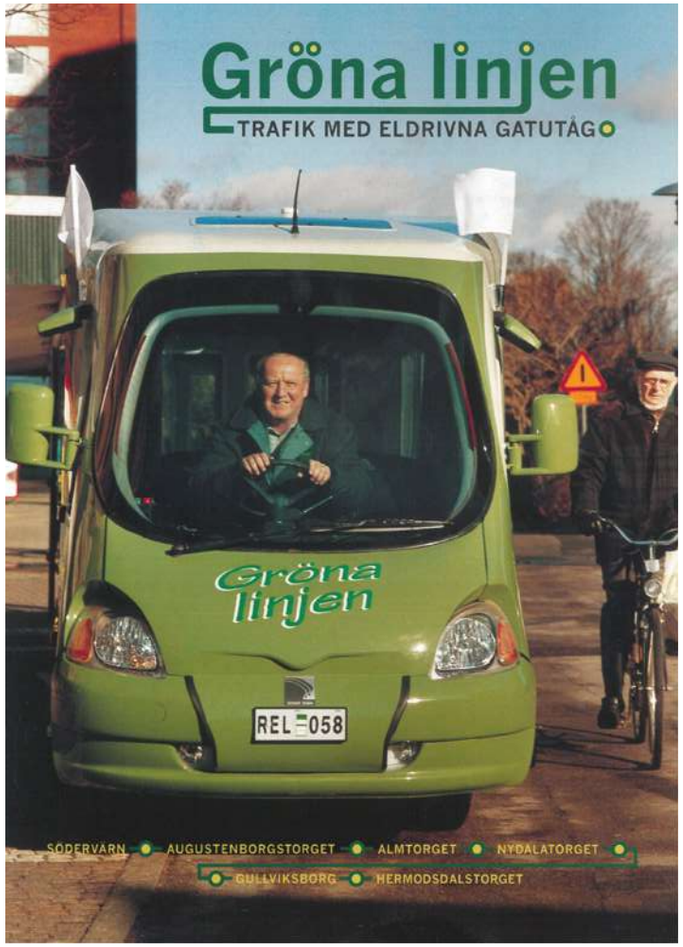
One interesting issue was whether the train would be classed as a car, a truck, a tractor or something else. Internal Services Department transport manager Thomas Landqvist had contacts in the County Administrative Board and was told that the vehicle would be considered a tractor train (a tractor with several carriages) and could therefore reach speeds of up to 30 kilometres per hour. The train concept was thereby given type approval. However, the Streets and Parks Department set the maximum speed limit on pavements and bicycle paths at 15 kilometres per hour to prevent serious injuries, although that restriction meant cyclists overtook the train and caused unnecessary risks. There were however no accidents during the three years that Gröna Linjen ran.

The driver's cabin needed to go through a crash test to get the vehicle approved. But there were not enough funds to destroy a whole train just for that. The County Administrative Board instead approved a plan to install the undamaged rear-end from an already crash tested Opel at the front of the train to serve as a certified driver's cabin. The technical challenges had therefore been ticked off and the train was ready to start driving. But who would be behind the wheel?

Some of Malmö's bus drivers struggled with the stress of regular city traffic and were on sick leave for burnout and in some cases lost their jobs. Some of these were asked to become drivers for Gröna Linjen and became a key in its success story. Five previously stressed-out bus drivers enjoyed their new calmer job, travelling at 15 kilometres per hour. Some were sent love letters from passengers, given gifts on their birthdays, and formed new friendships. Taking inspiration from Cheltenham, young unemployed people were hired as conductors and service staff on the trains, tasked with aiding those passengers who needed help.

The timetable did not allow the train to stand still while charging. Instead, replaceable battery packs were charged at the indoor bus stop at Facklan. Twice a day, used batteries were replaced with fully charged ones in just two minutes. There were also staff facilities for drivers and conductors at Facklan.

During the three years that Gröna Linjen ran in Augustenborg and nearby districts, it carried 300,000 passengers. However, it did not cover its operating costs, and needed support like most other local public transport. Gröna Linjen was never really accepted by Region Skåne (who ran public transport in Malmö), even though it initially supported the project. Tickets had to be sold separately and were not included in the cards used by other public transport in the region. Then, when it was time to raise new funds for the project in 2002, Peter Lindhqvist went on sick leave. With no key driving force to find funding, Gröna Linjen was discontinued. Since then, residents without a car or other transport options in Augustenborg have to take the bus into Malmö city centre and swap to another bus to reach amenities in nearby districts.



Gröna Linjen was an odd but welcome part of Malmö's outlying neighbourhoods during its three years of operation. It did not compete on speed, but increased accessibility and provided a friendly atmosphere and very good service to travellers. Facsimile of an information brochure published by Gröna Linjen in 2000.

From coal to wind power

Technical innovations and new energy solutions have been a common thread during the development of Augustenborg. It started with a coal-fired heating plant and has progressed to the cutting-edge Greenhouse project. The list of energy innovations that have been tested and implemented in Augustenborg could be very long, see page 255.

Looking back, many of these efforts appear neither particularly exciting nor innovative. But once upon a time they were brand new, and the spirit of experimentation that prevailed in Augustenborg in the early 2000s, allowed new things to be tested. The experiments were often not the first of their kind, but they were early adopters. Even today, municipal housing company MKB uses Augustenborg as a green testbed, somewhere to test new solutions that, if they work, can be expanded to the rest of its property portfolio.

But it started with coal power. When MKB boasted about its new residential area in the publication Vi bygger och bor på Augustenborg (We build and live in Augustenborg), one of the main subjects was the "hypermodern heating station by Särlagatan". It distributed heat in underground pipes throughout the new district. The plant consumed three tonnes of coal per hour. The popular communal laundry room was connected to the heat plant, see more page 96.

Image by Scandinavian Green Roof Institute

MKB now has two solar arrays in Augustenborg. One at Greenhouse and another at the Särla block (pictured).

Monika Månsson works as a project manager at the City of Malmö's Environment Department.

The Eco-city Augustenborg

In the mid-90s, plans started to be drawn up for what would become the Eco-city Augustenborg. The planners wanted to use this environmental re-generation as a goal in its own right, but also as a tool to benefit development of the whole area. This meant environmental targets were themselves high, but planners also saw an opportunity to achieve social and economic benefit from the environmental push. Energy issues were included in several initiatives from the Eco-city's two applications for LIP funds, see a summary on page 56.

During the first phase, 1998 to 2001, there was for instance an electric-powered local transport, which became known as Gröna Linjen (the Green Line, see page 246). Throughout the period Augustenborg's electric car pool was also developed on the initiative of local residents.

The application also included resource management targets (for the industrial area, a school and in MKB's residential buildings). Some examples of measures were energy-efficient light fixtures, the transition to electricity certified by the Swedish Society for Nature Conservation, sensor-controlled occupancy lighting, converting ventilation systems, switching to electric cars, and educating tenants on energy saving. The City of Malmö's final report on the LIP funds makes clear how hard it was to see if the targets were met, as, even if the resource-saving measures have been successful, activity in the area has increased significantly during the project period. Targets were both achieved, and not achieved, the auditors concluded.

Another measure in Augustenborg was an attempt to restore several facades and stairwells. As Tomas Tägil said in Architecture in the Augustenborg neighbourhood unit (page 77), MKB diligently used state subsidies to install additional insulation after the oil crisis of 1973–74. Additional insulation and a metal facade were installed on plastered-facade buildings in Augustenborg. But in the late 1990s, the plan was to restore five of the houses, remove the metal facade and replace it with a thin render over 80 millimeters of insulation. This would both improve the architecture and save 9% energy.

Image by Marc Malmqvist/City of Malmö

When insulation and a sheet metal facade was added to the rendered houses in the late 70s, the windows were set deeper than before, changing the appearance.

The next application for LIP funds, for 2002 to 2005, put energy even more in focus. One measure aimed to create energy-efficient housing and install individual meters in 1,850 apartments. However, auditors concluded that these were only installed in two buildings (100 apartments) and in MKB's new local office, which was environmentally adapted. However, the project became a sort of starting point for MKB's attempts to more efficiently control indoor temperatures. It taught the company that distribution meters did not save additional energy when combined with the strategy that MKB already had in place, which saved as much energy for less effort. MKB instead later introduced indoor temperature sensors throughout its portfolio, contributing to better and more efficient operational optimisation and large annual energy savings. Since then MKB has introduced individual metering and fees for hot water in more than half its homes, which also brings large annual energy reductions. In terms of learning and development, the project sparked important energy investments.

There was also an interest in local production of renewable and recycled energy and solar thermal systems and solar cells. The targets were never really reached: the solar thermal site ended up being only 420 sqm instead of the 1,000 that had been planned, while the solar cells lived up to what had been projected in the application. There was also a proposal from the school children at Augustenborgsskolan. When discussing the development of the Augustenborgsparken park, many of the children wanted an ice rink. Today there is therefore underground piping that absorb solar heat during the summer, and in winter remove the heat from the ground. This, combined with a cooling machine, can create an outdoor skating rink. The ice rink became twice the size of what was planned, at 400 sqm.

In this second round, there were also several "soft" efforts to increase residents' knowledge about and commitment to energy and climate issues. This included information initiatives, low-carbon lifestyle coaching for tenants, and support for local initiatives by associations and companies.

Wind and sun

Around 2008, the City of Malmö was becoming increasingly interested in trialling small urban wind turbines, to complement the big ones in the Northern Harbour. Two smaller wind turbines were bought from the same manufacturer to be set up in Sege Park and at the Augustenborgsskolan school. In the spring

Image by Marc Malmqvist/City of Malmö

A real-time display showing solar energy production in Augustenborg. Showing how energy is produced and used is important to knowledge and commitment.

of 2009, one of the wind turbines was installed at the school. It was meant not only to produce electricity, but also to serve as a learning aid for the school, allowing students to track how much electricity was being produced on a display. The wind turbine also served as an important visual reminder of how important sustainability was in the Eco-city.

In windy Malmö, there were high hopes that urban wind turbines could be an important part of increasing the proportion of renewables in the city's energy mix. And it needed to happen rapidly: the City of Malmö's environmental programme for 2009 to 2020 had ambitious targets. Malmö would become Sweden's most climate-smart city. By 2020, the City of Malmö itself would be a climate neutral organisation and by 2030, all of Malmö's energy supply would be 100% renewable.

The urban wind power project therefore carried many hopes and dreams on its shoulders. But it was dealt a killing blow in November 2009 as the wind turbine in Sege Park was installed, and only a few hours later the heavy blades came loose and fell to the ground. Fortunately, no one was hurt, but since Augustenborg's wind turbine was of the same brand, it was immediately stopped for safety reasons. After that, Malmö's experiments with urban wind turbines were paused and never really took off again.

Image by Kristoffer Hellman/Bilder i Syd

One of Malmö's two urban wind turbines was installed at Augustenborgsskolan, in the heart of the Eco-city.

Greenhouse

The innovation and sustainable energy focus in Augustenborg, has now been placed on Greenhouse, see more page 84. The district has come full circle: Greenhouse was built on the site that formerly housed the coal-fired heating plant. MKB wanted to build a house that fosters sustainable living among tenants. The building is a passive house with photovoltaic panels on the roof. Other examples of energy-aware thinking in Greenhouse include a building-wide electricity supply contract, renewable district heating and home/away buttons in apartments, like in hotel rooms.

MKB hopes to test and assess new solutions in Greenhouse and apply those that work to the rest of its property portfolio. An example of this is that MKB began to ask for renewable district heating in all its newly built homes and then gradually introduced it in the existing portfolio, as its supplier's capacity increased. MKB only uses renewable district heating since 2020. As the network's largest buyer, the company has helped increase the rate of change in the entire network. The trial of an electricity contract which encompassed the whole building - which means that MKB supplies its customers with power, including from the solar panels - has been welcome and smart. This solution has been scaled up and metering will in future be applied in all new buildings, with solar panels also being tested in all projects.

Foto: Kani Lam/Augustenborgs botaniska takträdgård.

Greenhouse from above, with a clear view of the solar cells and the roof garden.

Text: Monika Månsson

Energy innovations in Augustenborg

Some examples on energy innovations that have been tested and implemented in Augustenborg:

- Individual metering and charging for hot water usage
- Individual temperature sensors
- Tests of various water-saving mixer taps and shower heads
- First MKB-run area which installed LED lighting outdoors
- Occupancy LED lighting in all stairwells and basements
- Low-carbon lifestyle coaching for tenants
- CLICC climate living cities concept (and a focus on the climate impact of customers)
- Photovoltaic arrays
- Urban wind power
- Visualisation
- Renewable district heating contract
- Certified Passive House

Augustenborg today and tomorrow

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Participative evaluation of Sustainable Urban Drainage systems with ClimateCafé Malmö

Floris Boogaard, Guri Venvik

Floris Boogaard, professor at the Hanze University of Applied Sciences Groningen, Holland, has launched tools to increase climate adaptability including ClimateScan and ClimateCafé.

Guri Venvik, PhD, geologist at the Geological Survey of Norway (NGU). Works on projects surrounding geology in the urban environment and management of surface water connected to ground water, such as ClimateCafé Malmö.

Malmö is well known within the field of urban hydrology, as the city was a pioneer in integrated water management (Stahre 2008). In 1998 the Augustenborg neighbourhood was refurbished due to its reoccurring problems with flooding and damage caused by water (Niemczynowicz 1999). The project "Ekostaden" (Eco-city) included many initiatives implementing nature-based solutions (NBS), such as swales and rain gardens for infiltrating surface (storm) water into the ground (Climate Adapt 2016) (Figure 1). International stakeholders want to know if these NBS still function satisfactorily after 20 years and what we can learn from the "Augustenborg strategy" and apply in other parts of the world. To quote the German philosopher Georg Wilhelm Friedrich Hegel, "we learn from history that we do not learn from history."

Augustenborg is an ideal location to demonstrate the sustainability of NBS, test the functionality for infiltration of surface water in swales, map the build-up of potential toxic elements (PTE), and test the water quality after 20 years operation. This evaluation is done in 2019 with the international, participatory and multidisciplinary method 'ClimateCafé and the results are presented at the international seminar Cities, rain and risk, June 2019 in Malmö (Boogaard *et al*. 2019).

ClimateCafé is a field education concept involving different fields of science and practice for capacity building in climate change adaptation. Over 20 ClimateCafés have already been carried out around the globe (Africa, Asia, Europe), where different tools and methods have been demonstrated to evaluate climate adaptation. The 25th edition of ClimateCafé took place in Malmö, Sweden, in June 2019 and focussed on the Eco-city of Augustenborg. The main research question - "Are the NBS in Augustenborg still functioning satisfactorily?"- was answered by interviews, collecting data of water quality, pollution, NBS and heat stress mapping, and measuring infiltration rates (Boogaard *et al*. 2020).

The main aim of ClimateCafé Malmö was to exchange knowledge in the field and raise awareness on climate adaptation in an urban area where NBS have been implemented. ClimateCafé Malmö took place on the 11th and 12th of June 2019, with the participation of 20 young international professionals, which included students and employed professionals (national, regional, and local governments, companies and NGOs). The workshops were guided by international experts from The Netherlands, Brazil, Norway, and Portugal. This interdisciplinary approach should encourage implementation of nature-based solutions, with the holistic knowledge of its functions, challenges, and possibilities and raise international awareness on climate adaptation. Table 1 shows the details of the participants and their thoughts about climate adaptation and ClimateCafe.

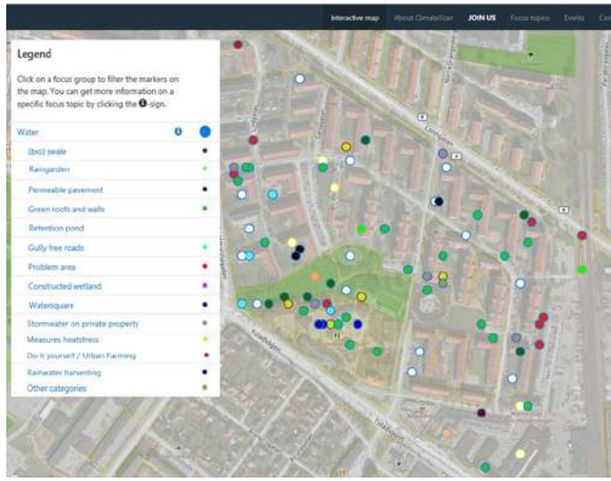


Figure 1. Map of Augustenborg, showing nature-based solutions (NBS) that have been mapped and evaluated during ClimateCafe Malmö (source: climatescan.org)

Countries	Background	Field	What are your thoughts about climate adaptation?	How did ClimateCafé improve skills about climate adaptation?
		Stormwater quality	Need to educate people	More knowledge about climate adaptation (discussions)
Sweden (7)		Civil engineering	Need more studies, more knowledge	More knowledge about climate adaptation (new techniques)
Sri Lanka (1)		Water resources engineering	Important due to climate change (e.g., disasters)	Networking (people from different backgrounds/countries)
Indonesia (1)	PhD students (5)	Environmental engineering	It's a challenge	
Czech Republic (1)	Masters students (7)	Landscape architecture	Ongoing field with a lot already happening	Spread the knowledge known to hometowns
Romania (2)	Bachelors students (1)	Groundwater engineering	Important topic to spread to other stakeholders, e.g., municipalities	Experience theory on field (by measurements)
Latvia (6)	Professionals (7)	Urban drainage system	Do not have a strict opinion, need more time to verify if climate is changing	Inspiration for future studies by solutions already applied on field
China (1)		Water management	Necessity of more resilient cities	
Belgium (1)				

Table 1. Participants of the Malmö ClimateCafé, background and questions asked during the event for storytelling. A total of 50% of the participants were woman (SDG 5).

Materials and general method

ClimateCafe started with a field trip at the Scandinavian Green Roof Institute and the Augustenborg Eco-city to discuss adaptive strategies implemented (Figure 2).

ClimateCafé Malmö consisted of six workshops including storytelling, climate adaptation mapping, soil quality mapping with a portable X-ray fluorescence (pXRF) instrument, water quality measurements using water drones (ROVs: remote-operated vehicles) and hydraulic efficiency evaluation by a full-scale flooding test of a swale (Figure 3).

Taking part in data collection within all workshops provides insight, creates awareness, and builds capacity within multidisciplinary fields of climate adaptation. All the measurements were conducted by the participants, supervised by experts in those particular fields, therefore assuring that beyond the gathering of data, discussions about climate adaptation and tools took place in the various workshops (Figure 3). The aim of each workshop followed by the method used are described in Table 2.

Figure 2. Above: Introduction to the green roof institute by Helen Johansson (Sweden) Below: discussions in the field with Guri Venvik (Norway) in a swale.

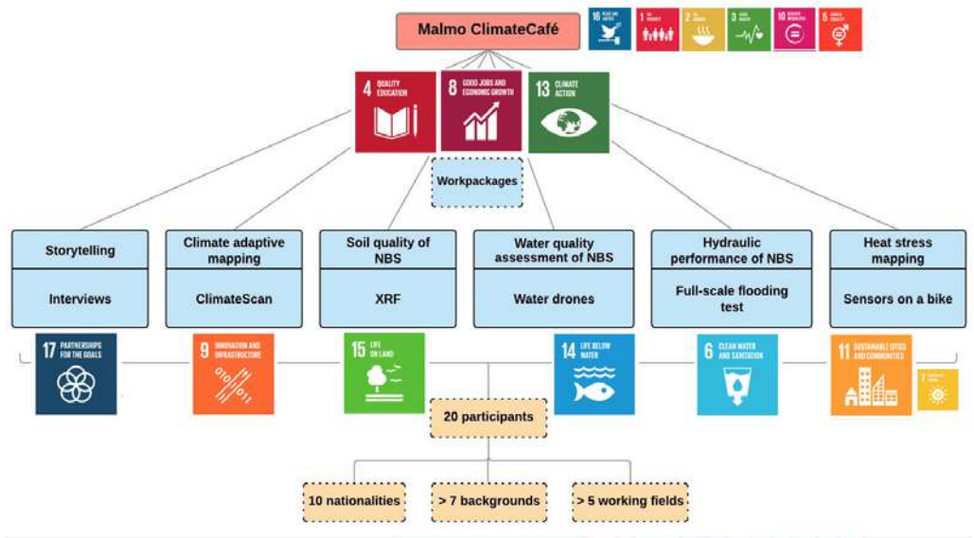


Figure 3. Flowchart of workshops included in ClimateCafé Malmö, which are related to the UN's Sustainable Development Goals (SDGs).

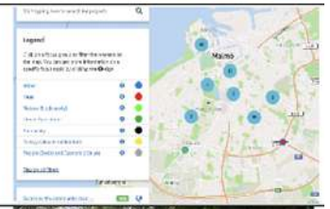
	Workshops	Workshop aim	Method	
1	Storytelling	To enhance discussions regarding climate adaptation UN SDG #17: partnership for the goals, #4: quality education, #11: sustainable cities and communities	Interviews with ClimateCafé participants, different stakeholders (government, industry, academia, and civil participants) and inhabitants of Augustenburg brought multidisciplinary viewpoints together and created new shared values that benefit Augustenborg to optimize the ecosystem services.	
2	Mapping climate adaptation on ClimateScan	Mapping of existing urban resilience projects and sustainable climate adaptation. UN SDG #13: climate action, #11 and #9: innovation and infrastructure.	Climate adaptations were mapped on the open-source tool www.climatescan.org	
3	Soil quality of NBS	To assess the built-up of potential toxic elements in the NBS in the study area UN SDG #6: clean water and sanitation, and #15: life on land.	A portable X-ray fluorescence (pXRF) instrument was used to measure the build-up of potential toxic elements (PTE) in the topsoil of rain gardens and swales after 20 years. A new method for cost-effective insights into the environmental performance of NBS.	
4	Water quality assessment of NBS	To scan water quality in this neighbourhood, and gain insights into the spatial variability of water quality between different ponds. UN SDG #14: life below water and #6.	The (surface) water quality of all ponds in Augustenborg was measured by underwater drones with cameras and sensors.	
5	Hydraulic performance of NBS	To gain more insight into the hydrological performance of NBS in the study area. UN SDG #6 and #13	Full-scale testing of swales was conducted using sensors, resulting in detailed measurements of the infiltration capacity of these nature-based solutions	

Table 2. Methods of the ClimateCafé Malmö workshops.

Methods and Results

Storytelling

Method: Storytelling

Storytelling, by the means of interviews, is a way of collecting data from participants of ClimateCafe and citizens of Augustenborg. This creates engagement at a local level for topics such as climate adaptation (Moezzi *et al*. 2017). Storytelling has already been proven as an effective tool to discuss and build capacity among climate change (Harper *et al*. 2012).

Several residents of Augustenborg and every ClimateCafe participant was interviewed and recorded regarding the different topics in the workshops. The footage was analysed and cross-checked with post questionnaires sent online to the same participants to check how ClimateCafé is helping to build capacity related to climate adaptation (figure 4).

Results

Table 1 summarizes the origin and background of participants in ClimateCafé Malmö, as well as their knowledge about climate adaptation and how ClimateCafé may help them raise their awareness. The views of the participants were published in detail in the scientific journal Sustainibility (Boogaard *et al*. 2020) on the evaluation of ClimateCafe method itself, so the focus in this chapter is on the conducted semi-structured interviews with inhabitants of Augustenborg.

Talking to several young people playing near their school showed that most of them are aware of the basics of the water system in Augustenborg. They can show how the water will run during heavy rainfall from the (green) roofs to the gutters into the water-squares and bio-swales. Besides being aware of the hydraulics of the systems they also are in some extend aware of stormwater quality issues 'I will not swim in the water-square due to pollution'.

This knowledge base is partially due to the fact that their parents were involved 20 years ago in the reconstruction of Augustenborg. Also, the visibility of the surface water system can help explaining the insights of the inhabitants. An employee of the Green Roof Institute remembers the 31 August 2014 when Malmö was hit with about 100 mm of rain in 3,5 hours and remembers flooding in several places in the city but didn't recall any severe problems in Augustenborg.

Figure 4. Storytelling at the Green Roof Institute with Helen Johansson (Sweden) and Ana C. Cassanti (Brazil) on a green roof in Augustenborg.

Mapping of climate adaptation measures

Method: Mapping with the ClimateScan tool

To collect, distribute, and share knowledge, the open access, web-based ClimateScan adaptation tool www.climatescan.org was used. This tool helps policymakers and practitioners to gather valuable data for a rapid appraisal at the neighbourhood level, mapping specific climate adaption measures at specific locations with information. ClimateScan is a citizen science tool giving the exact location, website links, free photo, and film material on measures regarding climate mitigation and adaptation. NBS related to stormwater infiltration, such as swales, rain gardens, water squares, green roofs, and permeable pavement are some that improve the liveability in cities as presented at international seminar 'Cities, rain and risk', in Malmö (Boogaard *et al*. 2019).

Results

During the two days, over 175 NBS were mapped on www.climatescan.org (Figure 5) by the participants through uploading with the ClimateScan App in the field. The mapping included a short description, the location (GPS), category of NBS, and pictures. For some locations, additional information, documents, and websites for further information were added later using a computer.

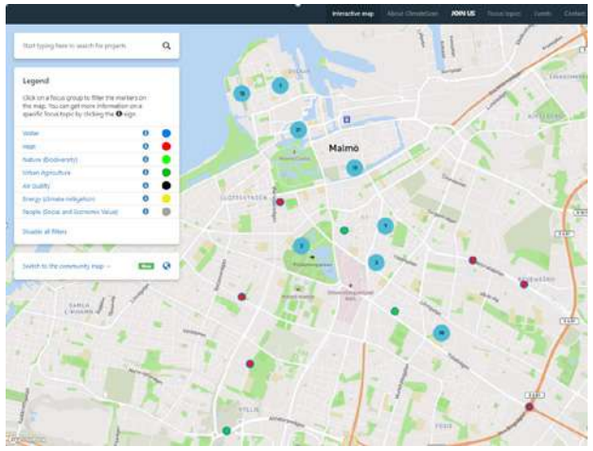


Figure 5. ClimateScan for Malmö city: more than 175 NBS mapped (from which 87 in Augustenborg) on the open-source nature-based solution platform www.climatescan.org.

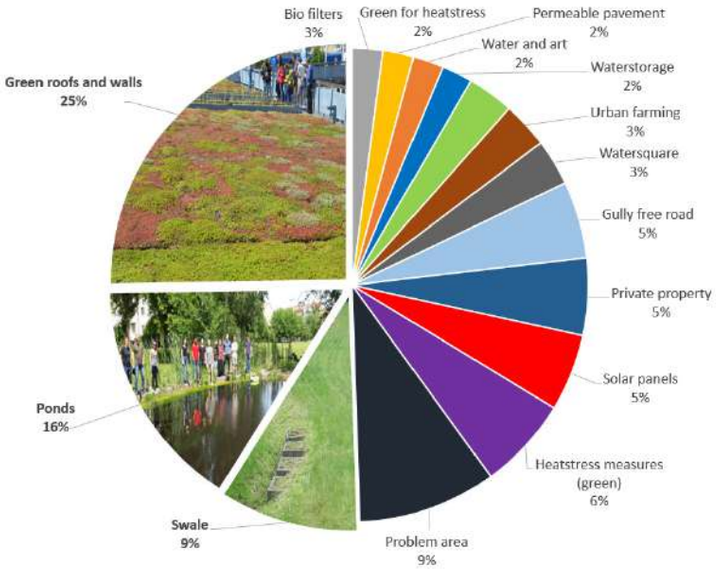


Figure 6 shows the results of the NBS mapping in Augustenborg (87) with high percentages on green roofs and walls (25%), ponds (16%) and swales (9%) covering half of the mapped NBS.

The mapped climate adaptation solutions in Malmo (175) were distributed in 19 categories, with the majority within the green roofs and walls category (26%). The following categories were bio filters (14%), rain gardens (12%), and ponds (9%).

Soil quality of NBS

Method: Quick scan mapping of pollutants with the use of portable XRF

NBS are constructed to receive, store, and infiltrate surface water to restore the groundwater balance and to remove pollutants. After 20 years of operation, build-up of pollutants is expected (Jones and Davis 2013). Therefore, the mapping of potential toxic elements in several NBS at Augustenborg is vital knowledge for stormwater managers that can be incorporated into management and maintenance.

The portable XRF (X-ray fluorescence) was used to map PTE (Figure 6). pXRF is an instrument that analyses the content of elements from magnesium (Mg, 12) to uranium (U, 92) in the periodic table. As stormwater is the transporting media of the pollutants the profiles of measurements must cover the inlet(s), the deepest part, and, if possible, the outlet(s) of the swale to map the distribution. For a systematic mapping of the dispersion of PTE in swales, measurements at a predetermined interval along profiles were conducted. Since the profiles were relatively short (max. 2 meters), the measuring intervals were from 0.2 to 0.5 meters. Each point was measured for 60 seconds, and the values displayed on the screen as well as stored for a later download from the instrument (Venvik and Boogaard 2020).

Figure 7. Quick scan mapping with portable XRF (X-ray fluorescence).

Results

The mapping of the PTE lead (Pb), zinc (Zn), and copper (Cu) in the large swale behind Augustenborg school by pXRF shows that the highest concentration of PTE was at the inlets and the deepest part of the swale. This is as expected since these are the areas in the swale most exposed to surface water in frequency and duration. All measurements were well below the Swedish thresholds for lead (80 ppm (mg/kg)), zinc (350 ppm), and copper (100 ppm) (Naturvårdsverket. 1997) and are thereby not polluted. After 20 years in operation, the NBS at Augustenborg shows a little build-up of PTE. This is most likely due to the absence of polluting source(s), such as no or little traffic, separate drainage system from the surrounding areas, thereby no drainage from major roads, industrial areas, or brownfields. This has not been the case in other residential areas after 20 years of operation, where PTE in the topsoil exceeded quality guidelines (Venvik and Boogaard 2020).

Water quality

Method: Measuring water quality using Remote Open Vehicles (ROV)

There are multiple ponds located within the district of Augustenborg, which collect and store rainwater. Literature often argues that the implemented measures reduce water quality degradation and that they have inclusively contributed to the improvement of the surface water quality (Boogaard *et al*. 2014). However, little is known about the water quality conditions of these small water bodies, as only a few studies have addressed water quality directly, and they mostly focus on the discussion of runoff water quality from green roofs in the area (Naeem 2010).

In order to map the spatial distribution of water quality parameters in the ponds, multiple sensors were attached to an aquatic drone (de Lima *et al* 2020) (Figure 7), which was then piloted across the ponds. A global positioning system (GPS) logger was also installed on the drone to record the coordinates of each measurement. The measurements took place on June 11th, 2019, after scattered rain events.

Results

Some ponds were clearly less turbid than others, as confirmed in the data collected. In most ponds, dissolved oxygen concentrations were above the minimum values required to sustain aquatic life

Figure 8. Demonstration of the water quality measurement campaign by Rui de Lima (Portugal) and Allard Roest (The Netherlands) with an aquatic drone in a pond.

(5mg/l). In three ponds dissolved oxygen reached values under this threshold (figure 8). The lowest value recorded corresponded to a location where a wastewater outlet was present (discharged water from washing machines, after passing by a small water treatment unit) and was measured in a small channel before it gets diluted in a pond. Chlorophyll-a and phycocyanin (cyanobacteria/blue-green algae) reached very high concentrations in a few ponds, which could become a threat to local populations. Results of turbidity measurements are in accordance with the other parameters measurement: when water is more turbid, algae concentrations and electrical conductivity are also higher.

Hydraulic efficiency of swales

Method: Measuring the hydraulic efficiency of swales using waterheight loggers

Bioretention swales are one type of NBS that has been used for decades globally to provide stormwater conveyance and water quality treatment (Woods Ballard *et al* 2015). Swales are a landscape surface-drainage system planted with vegetation that collect rainwater and allow surface runoff to be detained, filtered, and then infiltrate into the ground. The aim is to reduce peak flow, collect and retain water pollution, and improve groundwater recharge. However, one common issue is that swales can be subject to clogging (Boogaard 2015).

After mapping multiple swales in Augustenborg data were collected on the hydraulic conductivity and infiltration capacity using wireless, self-logging, pressure transducer loggers as the primary method of measuring and recording the reduction in water levels over time. Two loggers were installed at the lowest points of the swale. The transducers continuously monitored the static water pressure at those locations, logging the data in internal memory. To calibrate and verify the transducer readings also hand measurements, underwater cameras and time-lapse photography was applied (Figure 9).

Results

The test on the hydraulic performance of swales was performed after 20 years of operation. The results showed that all three swales are able to empty their water storage volume within 48 hours. The saturated infiltration capacity is thereby in the order of 0.15 m/d and 0.2 m/d (Table 3 and Figure 9).

These values are comparable to values found on the infiltration capacity of Dutch and German swales monitored after 10 to 20 years (Le

Figure 9. Discussion during swale monitoring with Floris Boogaard (The Netherlands) in Augustenborg.

	Logger	Slope	R2	k (cm/min)	k (m/d)
Swale 1	Logger 1	−21.804	0.9594	0.0174	0.23
Swale 1	Logger 2	−24.571	0.9702	0.0155	0.20
Swale 2	Logger 1	−15.824	0.9865	0.0112	0.15

Table 3. Hydraulic performance of two swales after 20 years.

Coustumer *et al*. 2012, Ingvertsen *et al*. 2011). The results show that these swales are considered sustainable after 20 years, with sufficient infiltration rate to infiltrate the stormwater in Augustenborg without any other maintenance than mowing the grass.

Conclusions

The results of the different workshops show that valuable multidisciplinary data can be gathered in a short period of time, which can be used by local stakeholders to improve, maintain, or evaluate the effectiveness of nature-based solutions in their local context.

Evaluation results show that the selected green infrastructure have a satisfactory infiltration capacity and low values of potential toxic element pollutants after 20 years in operation. In contrast, the study has shown that the blue infrastructure in Augustenborg requires further research and monitoring, as in some ponds the algae (blue-green algae) and dissolved oxygen concentrations revealed undesired values, which could have negative implications for inhabitants and animals in contact with the water.

The results of this study regarding quick scan mapping of pollutants and hydraulic test of nature-based solutions could help (storm) water managers with planning, modelling, testing, and scheduling of maintenance requirements for swales, raingardens and ponds with more confidence so that they will continue to perform satisfactorily over their intended design lifespan.

Long term lessons learnt from Augustenborg will help stormwater managers within planning of NBS. Lessons learned from this ClimateCafés will improve capacity building on climate change adaptation in the future. Furthermore, this chapter offers a method and results to prove the German philosopher Friedrich Hegel wrong when he opined that "The only thing we learn from history is that we learn nothing from history." Let's learn from Augustenborg.

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Augustenborg – the answer to a global challenge?

Jennifer Lenhart

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Cities are a collection of stories. They are also a collection of neighborhoods. Malmö's Augustenborg neighborhood is a tale of struggle and success. It is a part of Malmö larger story of transition; a story that speaks to the city's bold and optimistic character – one built on the city's past, with an innovative hope of its future. In doing so, Augustenborg, while committed to its own character, offers lessons for Malmö's other districts, as well as other cities seeking to transition to more sustainable models of urban development. The story of Malmö's Eco-city Augustenborg is one of learning to perceive challenges as entry points for improvement.

Augustenborg is several things simultaneously. It is the redevelopment of an existing city district: a district built in the 1950s, now home to circa 4000 residents. A district that in the early 1990s suffered from high unemployment, urban flooding and social conflict in a predominantly immigrant neighborhood. And a district that sought to use its crisis as on opportunity to break from "business as usual" planning, testing new ways of working within its Eco-city approach, while finding strength in what others might have encountered as challenges. This approach sought to address the area as an integrated whole – to transform it into an ecologically, socially and economically sustainable city district. Equally, it set a high priority on engaging residents, as well as a range of stakeholders in the public and private sectors.

Augustenborg is also a piece in Malmö's overall transition puzzle: one with large-scale developments featuring the latest technical innovations, such as Europe's first 100% renewable energy district in Malmö's Western Harbour; and one that recognizes the need to retrofit existing city districts, such as Augustenborg. Malmö (population app 350 000) is Sweden's third largest city and the growth centre of Southern Sweden. Malmö is also home to several world-leading projects in sustainable urban development, bringing ongoing attention to this medium-sized coastal city in northern Europe.

Malmö's growth (economically, environmentally or population-wise) were not always assumed. Malmö was a very different city in the late 1980s and early 1990s, troubled by a collapsing industrial sector, coupled with economic losses and social conflict. To shift from this negative trajectory required bold political vision and concrete planning in the built environment; the latter focused on physical changes "on the ground" that the city and citizens could witness. Fortunately, Malmö was rich in both political vision and concrete planning. Some 30 years later, Malmö is a different city. Consequently, Malmö and Augustenborg offer lessons that extend beyond the borders of this medium-sized city – ever more pertinent in a rapidly urbanizing world. Before zooming in on Malmö and Augustenborg, their stories need to be placed in a global context.

Rapid urbanization and global challenges

For the first time in human history, we live in an urban era: more than 50% of global population lives in cities and urban areas. This statistic is expected to reach 60% by 2030. As citizens flock to cities for the relative opportunities they provide – jobs, educational advancement, experiences – resource consumption together with resulting waste streams have also multiplied. Cities and urban areas are also responsible for circa 70% of global CO2 emissions from land and energy consumption in buildings and transport, waste and water services, industrial processes, as well as food and other citizen consumption choices. Urbanization and climate change are thus two of the most pertinent global phenomena and they are inherently interlinked. Equally, cities are vulnerable. They contain wide expanses of non-porous surfaces, exacerbating urban heat island and flood risk from either sea level rise or extreme weather events. In short, cities contribute to climate change and cities are vulnerable to its consequences.

Simultaneously, cities also act on climate change, mitigating their existing impacts and adapting to coming challenges. Cities are the origin or testbed for transformative climate innovations that can have a positive environmental impact, while improving urban quality of life.

Examples of climate action in the Eco-city Augustenborg which form a part of daily life in the district: solar cells and green structures which both contribute to wellbeing and function as climate adaptation actions. Image by Sanna Dolck

Cities make climate actions tangible – in the form of solar panels, bike lanes green roofs and open storm water management systems. All are found in Augustenborg, and in wider Malmö.

Cities like Malmö are improving energy systems (e.g. energy efficiency, local renewables or district energy systems) and transport systems (e.g. cycling and walking infrastructure, improved public transport or electric vehicles). They invest in better waste management systems, (e.g. using wastes as a resource, such as biogas from food waste). When doing so, they often address several sectoral strategies holistically, adopting integrative planning and policy methods for more resilient cities. Notably, such actions to address climate change and sustainability can have many positive co-benefits, including improvements to urban quality of life or the development of new or niche economic opportunities. The tangibility of positive changes made by early forerunner cities – like Malmö – in their quest to improve urban sustainability and quality of life have been noticed and replicated in cities across the globe. Thus, despite the multiple and complex challenges we face today at the global or national scale, cities matter – they make climate action both tangible and attractive.

Augustenborg is of course not the only story of urban transformation, but it is recognized in multiple fora (e.g. 2010 World Habitat Award, 2009 UN-Habitat Scroll of Honour, 2014 European Climate Adaptation Platform) for concrete and tangible actions, as well as planning and policy that focused on inclusion. Equally important, Malmö is keen to share this story and its methods.

As the case of Malmö and Augustenborg demonstrate, cities act individually to address climate change, as well as collectively via city networks. For example, the Global Covenant of Mayors brings 7500 mayors together committed to strong climate action; Malmö is a signatory in the Covenant. To unleash their potential however, cities need the legal mandate to act as well as the finances and capacity to implement their plans. The importance of city-to-city learning and sharing, as well as lobbying for stronger urban climate action, are central justifications as to how and why cities increasingly work together – and how successful stories can have an ever-greater impact.

Cities are central to meet global sustainability objectives

As humanity flocks to cities and their role to address complex global challenges becomes increasingly evident, cities are increasingly seen as central arenas within global policy. Cities and human settlements were prioritized at the 2012 Conference on Sustainable Development in Rio de Janeiro (Rio+20) in the outcome document, The Future We Want, as a physical place and political space to address sustainable development. In 2015, the UN Sustainable Development Goals (SDGs) the Paris Agreement on climate change, the Sendai Framework for Disaster Risk Reduction were signed, chartering a pathway for a sustainable, just future for all – with cities as a central theme. For example, SDG 11 on Sustainable Cities and Human Settlements calls to: make cities inclusive, safe, resilient and sustainable. In 2016, the Habitat III conference in Quito adopted the New Urban Agenda, establishing a political mandate for nation states to support urban action. Cities are thus fundamental to deliver on the above, recognized for their negative impacts and their potential to develop and implement solutions. While such governance deliberations are global, they become meaningful through the stories and transformative lessons of cities, such as in Eco-city Augustenborg.

The 2017 World Economic Forum Global Risk Report identifies extreme weather events, water crises and failure to mitigate or adapt to climate change as high societal risks. Conversely, Eco-city Augustenborg demonstrates how preventive planning can be more cost-effective than retroactive responses. While the policies and planning measures originally adopted in Augustenborg were done to address urgent localized challenges (e.g. to reduce basement flooding and improve social cohesion) they were later interpreted and shared as effective climate adaptation measures – and for good reason too. Integrative and cross-sectoral planning can enable urban areas to stand robustly in the face of climate risks, while enhancing social cohesion and economic wellbeing.

Five praiseworthy areas of Eco-city Augustenborg

While there are many relevant aspects of Augustenborg's Eco-city transition, five areas stand out with lessons for other cities.

Firstly, Augustenborg prioritizes participatory planning. Different stakeholder groups were involved early in the process, and in different ways (see page 43). This included resident groups and school children, as well as collaboration with national/ European authorities – the former groups to ensure local ownership, the latter to provide financial and technical capacity, as well as visibility and outreach. Citizen participation, which focused on engaging different resident groups, encouraged project ownership, clarified expectations of the local authority and residents, and facilitated project legitimacy. This was done via information sessions, workshops, festivals and cultural events. Throughout the process, circa 20% of residents became involved in various planning activities, some quite extensively; the Local Agenda 21 office, for example, trained circa 40 residents in sustainable business practices to assist their job search. Moreover, many projects are resident-initiatives, such as portions of the open storm-water management (OSWM) system, a community car-sharing system (long before this was a popular phenomenon in cities) as well as the Rabbit Hotel, where school children come together to play and share responsibility to take care of some 15 pet rabbits (see page 120). Even in newer parts of Augustenborg, such as the 14-story "Malmö Greenhouse" apartment house, finished in 2016 by Malmö's Public Housing Company (MKB), a focus on active resident engagement is prioritized to enhance social cohesion and reduce environmental impacts (learn more about Greenhouse on page 84).The Malmö Greenhouse carries the Eco-city Augustenborg approach forward: this complex includes both individual and community spaces for gardening, and residents are regularly consulted on how environmental impacts can be reduced, as well as social cohesion improved, by working together.

Image by Frida Persson Boonkaew/MKB

The annual Eco-city Day gathers residents and a many organisations in the area.

Secondly, Augustenborg's participatory planning process was enhanced by improvements to the physical environment, highlighting the delicate balance of innovative policy processes with tangible physical changes. Initially, planners tackled the area's most tenacious issue: flooding of basements and courtyards during heavy rain. This was addressed via an intricate system of green roofs (which intercept some of the average rainwater) with an integrated OSWM system and collection ponds. In 2001, the rooftop of a former industrial area was transformed into a world-leading green roof institute, covering 9000 square meters (see page 149). Still, while green roofs may contribute to reducing flooding, they were less visible. Courtyards and public spaces between housing blocks were redesigned to provide allotments for residents, playgrounds for children, as well as collection ponds to manage rainfall as well as providing spaces for aquatic biodiversity or children's curiosity.

Thirdly, local politicians and civil servants were risk-averse. They encouraged experimentation and new ideas, knowing that sometimes adopting new policies or technologies can be difficult, resulting in failure. But in doing so, new methods (such as different types of green walls, or a local car-sharing system) can be freely tested, and where not successful – at least initially – a dual focus on learning and evaluation ensures continual development. This is part of a larger trend in Malmö, adopted during the economic crisis of the 1990s. This reality forced Malmö to learn to work across departments, sectors and hierarchies to solve the city's complex and pressing challenges. In this process, this way of working generated technical know-how and collaboration methods. Building on both

Image by Sanna Dolck

A multifunctional pond - an important cog in Augustenborg's famous stormwater system, but also a place which captures the imaginations of children.

success and failure, Malmö was not afraid to experiment with new policy or technical approaches. There are no mistakes, only learning processes.

Fourthly, in Augustenborg adopting the Eco-city approach has not about making sacrifices, but about improving quality of life. It has made Augustenborg a more attractive, safe and comfortable place to live. Energy efficiency improvements in the 1950s-era apartment blocks enhanced building comfort. Green roofs and OSWM reduced district flooding, while increasing urban biodiversity and aesthetic pleasure. Residents were also engaged in the process, with several local businesses later emerging; such as resident Morten Ovesen, who with Curt Hallberg, developed part of the OSMW system and founded Watreco AB to promote this technology elsewhere. During the annual Eco-city day, the community could celebrate together. And throughout the year, visitors from across the globe come to study the Augustenborg model.

Finally, in the process of Augustenborg's transition – and in part because of active citizen engagement – residents feel a growing sense of pride and identity to their city district. Residents became used to have new environmental technologies tested first in their neighborhood, such as the means for collection of food waste in their apartments. Most of all, many ideas come not only from the local authority or MKB, but from the residents.

As a local politician in Malmö once reflected, "The transition towards sustainable urban development is not a destination, but a journey." Augustenborg proves just this: it is a long-term and inclusive change of an evolving Eco-city district.

Text: Monika Månsson

Prizes and awards for the Eco-city Augustenborg

Over the years, the Eco-city Augustenborg and Greenhouse have received a whole range of awards and prizes. This is a selection.

1998: The Green Roof Institute received the 1998 award for Europe's most successful LIFE project

2001: Augustenborg's electric trackless train Gröna Linjen (Green Line) was given the Bremen Partnership Award

2002: The City of Malmö gives the Urban Development Award to the Eco-city Augustenborg

2009: The City of Malmö is presented with the UN Habitat "Scroll of Honour 2009" for its innovative and holistic efforts to become a modern, sustainable city. The award encompassed all of Malmö's environment and sustainability work, but the application was mainly based on the Eco-city Augustenborg and the Western Harbour. UN Habitat is the United Nations programme for sustainable development and good housing conditions in cities around the world.

2010: Malmö is handed the prestigious "World Habitat Award" for its efforts to make Augustenborg a more environmentally, economically and socially sustainable residential area. The prize was awarded during the Shanghai World Expo on October 4, 2010.
The justification read: *The Eco-city Augustenborg sets an extraordinary example for cities that want to remedy their problems using urban renewal and environmental questions. The City of Malmö and MKB Fastighets AB have shown how a residential area's physical environment and social and economic problems can be tackled in collaboration with the residents by creating an Eco-city.*

2013: The Eco-city Augustenborg receives a special mention in the awarding of the City to City Barcelona FAD Award. The mention speaks of its urban development efforts such as green roofs and rainwater management.

2014: Greenhouse is among the winners in the 'new buildings' category and is displayed at the World Sustainable Building Conference 2014 (SB14) in Barcelona. The research council Formas, the Sweden Green Building Council and the National Board of Housing, Building and Planning tasked a jury of researchers and industry experts with choosing the winners from around 50 nominations.

2017: Malmö's environmental building award Gröna Lansen is given to Greenhouse, with the motivation: *"With its roots in urban farming, Greenhouse explores ways of reaching a climate-smart lifestyle. Visualised energy and waste management and shared facilities help solve everyday concerns while making it easy to do the right thing. Greenhouse takes the Eco-city Augustenborg to new heights and sows the beneficial seeds of new thinking and environmental thinking in housing development."*

When the United Nations gave its prestigious World Habitat Award to the Eco-city Augustenborg, an entrepreneur who lives in the area simply made a scaled-up copy of the award. It was natural that an award for the Eco-city should have pride of place in the neighbourhood. Image by Marc Malmqvist/City of Malmö

Urban neighborhoods - the locus of change. What can we learn from the transition story of Augustenborg?

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Cities, and more importantly urban neighborhoods, are key sites of infrastructure provision with direct links to social and environmental concerns. They are increasingly seen as sites of strategic action in transitions toward sustainability and resilience, and offer big opportunities for fundamental societal change (Acuto, Parnell, & Seto, 2018; Sanchez Rodriguez, Ürge-Vorsatz, & Barau, 2018). The framing of neighborhood-level problems and their solutions, governance processes for managing problems and implementing solutions, and learning processes for evolving new ways of thinking and doing are of special interest for urban socio-techno-ecological transitions. In this context, the over 70-year story of Augustenborg offers invaluable lessons in urban sustainability transitions. These come from a continuous search for well-being and enhanced living environments supported by global agendas and local visions, materializing in sustainable solutions which have brought together a multitude of actors experimenting with new ways of thinking and organizing themselves.

Through this story, we reveal underlying processes of change by analyzing three key aspects of urban transitions: framing, governing and learning. By framing we understand narratives, discourses and storylines through which problems arise and their solutions emerge (Berkhout, 2006; van Lente, 2012; Frantzeskaki *et al.*, 2018). Governing entails the creation and management of solutions, including policies, financial resources, institutional structures, networks, practices, and collaboration and power dynamics among involved actors (Loorbach, 2010). Governance processes also entail cognitive capacities (such as leadership, commitment, experimentation and reflexivity) to handle uncertainty in a continuously changing urban reality (Kemp & Loorbach, 2006, van den Bosch, 2010). In this context, learning – including both cognitive and social learning - is understood as multi-level processes to realize social, economic and environmental sustainability (van de Kerkhof & Wieczorek, 2005; Reed *et al.*, 2010). Using innovation-system theories, we analyze framing, governing and learning through key conditions enabling sustainability transitions, from contextual to cognitive levels (van der Jagt *et al*, 2019). Through analysis of various conditions' convergence, we identify critical processes and conditions which facilitated Augustenborg's sustainable transition, including the local geographical context, local visions, strong agency, timely mobilization of resources, and open-mindedness toward re-thinking institutional structures and working practices. Ultimately, we aim to better understand the sustainable transition pathway of Augustenborg to encourage urban neighborhoods worldwide to take agency for their own urban futures.

Each year, come rain or shine, the Eco-city Augustenborg attracts a large number of field trips from experts from around the world. They come to see the green solutions in the area, but what exactly are the lessons from Augustenborg? Image by Bernadett Kiss

From crisis to connectivity

Framing, as a means to construct certain visions, has shaped the dynamics of urban sustainability transitions, especially to facilitate identifying problems and their solutions, making particular interventions in physical structures more legitimate and favorable than others (Berkhout, 2006; van Lente, 2012; Frantzeskaki *et al.*, 2018; Stripple & Bulkeley, 2019). The transition story of Augustenborg has been guided by a variety of frames over the past 70 years. In this section, we unfold this story by discussing how problems and their solutions have been framed and the physical structures they helped create during three distinct periods: Augustenborg's foundation (1940s), its ecological regeneration (1990s), and sustainable lifestyle-focused seed actions (2010s).

Neighborhood units in welfare spirit (1940s)

The story of Augustenborg began in the post-war period. Human needs were centered to provide a safe, comfortable, functional, and green living environment with enhanced social integration. Driven by values of the welfare state, Augustenborg was one of the first neighborhoods built under Sweden's social housing policy in the 1940s, with the aim to improve the quantity and quality of housing. Malmö's city plan envisioned integrated neighborhood units, where all residents had convenient and equal access to recreation, consumption, healthcare and education. The Chicago School's service-oriented functionalism was taken one step further, and socio-physical factors, such as attitudes and actions of different social groups, were included in planning practices, with the ultimate goal to create an 'our-neighborhood feeling'.

> *"… we must create an environment in our society that promotes co-operation between people and helps them become involved and active citizens" (Uno Åhren, Final report of the Social Housing Policy Commission, SOU 1945:63)*

Clear physical borders provided unique geographical conditions for integrative neighborhood development with physical measures designed to serve the needs of the working class in a welfare society. From 1948-1951, in a spatially distinct area of 32 hectares, 1,800 apartments were built in 34 houses in connected parkland to accommodate 5,600 citizens (Tägil, 2020; Aunér, 2009). The apartments had 'modern' features, such as bathrooms, stainless kitchen sinks, electric stoves and refrigerators. Indoor waste chutes allowed residents to bypass unhygienic outdoor waste collection areas and several basements were built as after-school activity centers. The neighborhood had its own school, theater, public laundry, coal-fired power plant, fire station, business centers and small shops around a central square (Aunér, 2009). Not foreseen the rapid growth of car traffic, most transport infrastructure ended at the area's borders, while the space between buildings was enriched by parks and playgrounds providing a green, safe, and walkable integrated living environment.

Eco-city Augustenborg (1990s)

Due to a combination of climatic and construction conditions, a socially weak tenant structure, and little effort to overcome these problems, Augustenborg became increasingly vulnerable during Malmö's economic downturn. By the 1990s the neighborhood had high unemployment, rapid turnover of residents, and an immigrant-dominated population. In addition, the old combined sewage and stormwater drainage system could not cope with the mixture of rainwater runoff, household wastewater and pressure from elsewhere in the city, causing annual flooding and long-lasting damage to the underground facilities.

The Eco-city Augustenborg project (1998-2002), framed by long-term ecological sustainability principles, was a direct and tangible response to the neighborhood's economic, social and environmental challenges (Graham, 2009). It was

Augustenborg has become a green city district, which is welcomed by the residents and strengthens biodiversity. This is one of the district's 13 recycling houses. Image by Sanna Dolck

also a flagship project of a local political visionary process searching for a new identity, aiming to demonstrate that sustainable development was not only about new production, but also about the regeneration of existing post-industrial residential areas[1].

> *"We shall be able to pass on to the next generation a society in which the major environmental problems have been resolved" (Göran Persson, Prime Minister, 1996)*

[1] The European housing fair (2001) 'Bo01' was hosted by the city of Malmö in the brown-field development of Western Harbor area, literally becoming a demonstration site for projects of sustainable urban development.

This process converged with higher-level political agendas inspired by the 1992 Rio de Janeiro Earth Summit's notion of sustainable development, the Swedish Government's environmental policy objectives (Government Bill, 1997/98), Malmö City's Local Agenda 21 work (1995-1997) and Environmental Program (1998-2002). Building on eco-cycle principles, concrete environmental objectives related to climate change, resource efficiency and biodiversity were set in action plans which operationalized a vision of a sustainable neighborhood in the Eco-city project. The project's ecological focus was later extended to social sustainability – aiming for participatory social integration.

The blue-green infrastructure, façade renovations and green-roofed recycling centers integrated new ecological and aesthetic features to the townscape. The water channels, retention ponds, wetlands, trenches, natural ditches, sunk parks and 10,000 sqm of green roofs enhanced the size, number and quality of green spaces, increasing biodiversity and well-being while creating a sense of place (Kruuse, 2020). The thirteen neighborhood recycling centers quickly became meeting points for the 100-200 households they were serving.

Seed actions for sustainable lifestyles (2010s)

Little by little, Augustenborg has grown into an urban living lab[2], a physical and political space for continuous action to respond to challenges of the time by experimenting with sustainable alternatives while re-configuring their norms and working practices. The newest physical structure, the Greenhouse, was designed to integrate many aspects of the Eco-city project and advance state-of-the-art environmental and social sustainability agendas. These include circular economy principles, sustainable waste management, local energy and food production, sharing economy, sustainable transportation, enhanced biodiversity, climate change adaptation, social integration, and improved health and well-being in the search for sustainable lifestyles (WEF, 2017; Dauvergne & Alger, 2018).

> *"Awareness is raised and sustainability impacts are communicated through tailored infographics. The unique approach in bringing the natural environment close in an urban setting also provides an opportunity for a more balanced life with lower stress." (UN, One Planet Network, Greenhouse-Augustenborg, 2017)*

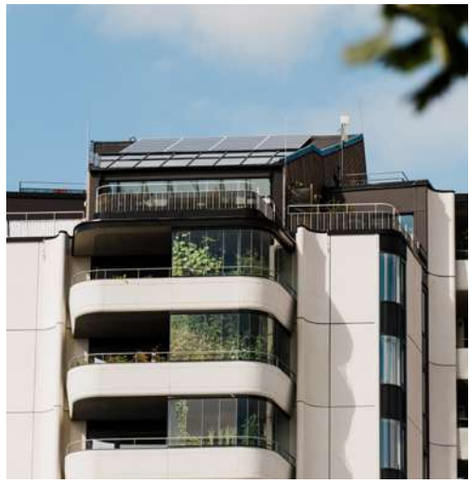


Image by Sanna Dolck

Greenhouse was created to promote sustainable living. One well-known part of this is the large garden balconies. The building is in the middle of the old settlements, and how this might influence the area's character is interesting.

The Greenhouse – an environmentally benign multi-story residential building – illustrates the mutual shaping and interaction between physical structures and people. The building integrates a multitude of sustainability features, including resource and energy efficiency improvements, solar energy, green roofs, urban roof gardens and balconies, automated and monitored recycling facilities requiring more sustainable daily household

[2] In this context, an urban living lab "is a local place for innovative solutions that aims to solve urban challenges and contribute to long-term sustainability by actively and openly co-constructing solutions with citizens and other stakeholders." (Chronéer, D., Ståhlbröst, A. & Habibipour, A. 2019, p.60) See more on urban living labs in sustainability transitions in Bulkeley *et al.* (2016) and Voytenko *et al.* (2016).

waste management practices, and a rental bike pool promoting non-car-oriented transportation modes. Greenhouse residents have grown recognition of Augustenborg's eco-profile both inside and outside the neighborhood. Whether these new structures will lead to 'eco-gentrification' or other changes is an interesting subject for future research (Grander, 2020).

Key conditions and processes in neighborhood transitions

Augustenborg's transition story has illuminated the frames of the neighborhood's physical structure emergence. These frames also shaped the *governance dynamics* of the neighborhood's transitions by assembling actors to create local visions and mobilize cognitive (agency) and structural (institutional and financial) capacities. These processes have generated knowledge and different types of *learning* has taken place, through which frames and changes in physical structures have reinforced and been reinforced by institutional structures, cultures, norms and practices. Some examples include breaking silos, altering policy, embracing complexity and becoming more prone to co-creation. In this section, we highlight four key conditions that facilitated processes of change in Augustenborg's transition.

Creating local visions

Local visions have always been central to Augustenborg's transition. They have been shaped by the convergence of global agendas, internationally-agreed principles, national environmental objectives, and local policies and interests. Reflexive processes of rethinking urban problems and their solutions have reformulated these visions and changed the type of actors involved in visioning (Feindt & Weiland, 2018). Augustenborg has always been a socio-political project to forestall social segregation, while representing the 'modern', offering alternative ways of urban life. In the 1940s, this meant creating a 'we-feeling' in a comfortable welfare-neighborhood unit under municipal governance - without the involvement of private actors. The Eco-city project (1998-2002) further advanced toward a sustainable neighborhood with ecological qualities, initiated and run by a diversity of public and private actors. At a later stage, along with Malmö's Local Agenda 21 work, local residents got involved in the neighborhood's regeneration.

> *"Malmö's residents will be given an opportunity to participate in the creation of the city's eco-cycle" (Environmental Program of Malmö City, 1998)*

Today, Augustenborg is a leader in nurturing sustainable lifestyles – a concept envisioned as a system-oriented approach balancing social and ecological values and co-creating services with responsibilities gradually devolved to the beneficiaries.

Recognizing cognitive capacities and agency

Cognitive and social capacities and agency have always played a key role in building Augustenborg's local visions, mobilizing structural capacities and building human resources. The strong political will to establish a welfare state, along with social reforms to realize visions required engaged local actors, including city planners, landscape architects and representatives of Malmö Fastighets AB (MKB)[3]. These actors helped operationalize political visions in evolving city plans, and reconfigured institutional practices for social reform, such as MKB's facility and activity management.

The role of agency is particularly apparent in the Eco-city project. Funding for urban transformation came from the government's sustainable development co-financing scheme, Local Investment Programmes (1998-2003)[4], but individuals committed to operational solutions behind a well-negotiated common vision were required to tap on these resources[5]. Despite authorities' citizen engagement goals, participation in the neighborhood's development has not grown (Aunér, 2009). However, a few individuals have been inspired to contribute to neighborhood development. Some of these seed actions have grown into more institutionalized structures: local water experts developing the open storm water system established a consulting company (Watreco), and after-school activities initiated by a local resident have grown into institutions like Gnistan and the Rabbit Hotel[6]. The Greenhouse grew from the organizational effort of a handful of creative and committed MKB employees who, inspired by sustainability and resource efficiency principles, found planners and developers to implement their ideas (Persson, 2020).

Collaborating and bridging disciplinary divides

The Eco-city Augustenborg project's unique governance processes have been referred to as inter-, multi- or transdisciplinary (Fitzgerald & Lenhart 2016; Kiss, 2017), integrative and interactive (Stahre & Geldof, 2003; Stahre, 2008), experimental (Karvonen, 2020) and collaborative and reflexive (Kiss, McCormick & Wamsler, 2019). Indeed, local actors began a new era in the neighborhood's transition by realizing that multidisciplinary expertise and collaboration - among municipal departments and a variety of stakeholders - was needed to address the challenges faced by the neighborhood. Searching for sustainable solutions through strong agency, new types of governance starting to crack vertical municipal structures and disassemble the wall between public bodies and locally engaged private actors. Today, in the Greenhouse project, clear intentions toward collaborative governance continue, with distinctive co-creation features. Residents and the municipally-owned real estate company collaborate to co-create sustainable lifestyle practices (Grander, 2020; Wester & Carlsson-Kanyama, 2020).

Creating conditions for continuous learning

The notion of learning has percolated through Augustenborg's transition pathway, from physical interventions to governance processes and from cognitive to institutional levels (Karvonen, 2020). Critically for the neighborhood's development, it has created conditions for learning, illustrated in the following examples.

During the post-war housing boom, architects borrowed and further developed functionalism and the garden city concept. Erik Bülow Hübe's plan for Augustenborg, for instance, was finalized and implemented by Gunnar Lindman. Many of the values they had advocated, such as public green spaces to promote social activities, became cornerstones of the Eco-city re-generation project. Their work and vision of Malmö as a green 'city which grows without suburbs', remains important in the city's planning (Aunér, 2009, p27).

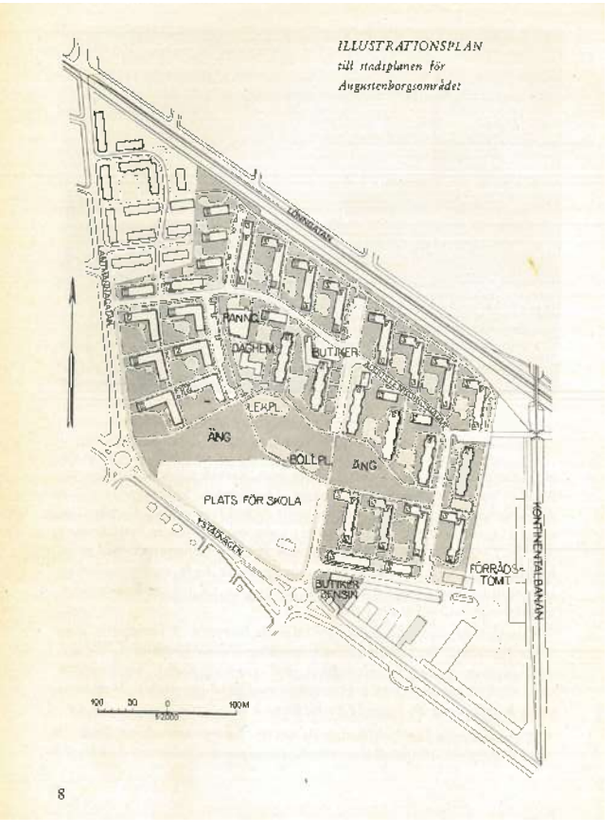
While the experimental atmosphere of the Eco-city project incubated new physical and governance structures, existing institutional frames were also challenged and reformulated in the

[3] MKB 1946) was one of the municipally-owned public housing companies which were established in the 1940s-50s, along with access to favorable state loans, as a direct outcome of the national Social Housing Investigation (1933-1947). See more about role of actors in Aunér (2009).

[4] To support the transformation of municipalities towards sustainable development, the Swedish Government allocated SEK 7.2 billion (1998-2003) for Local Investment Programs (LIP). In 1998, the City of Malmö was allocated SEK 147 million in grants for seven projects, among which the largest was Eco-city Augustenborg (SEK 24 million). The total sum invested in physical structures in Augustenborg however was much higher (SEK 86 million); this is partly thanks to MKB's strategic investment with the objective to reverse the area's downward trend and the coordinated resource management of different local authorities, including the Waterworks, Streets and Parks Department, Internal Services Department and some national and international research funds available at that time (e.g. Formas, the Swedish Research Council for Sustainable Development, Swedish Water Development Fund and EU LIFE Fond).

[5] Middle-level managers from the Waterworks (Peter Stahre), Service Management Department (Peter Lindhqvist), Streets and Park Department (Gunnar Ericson), the city district (Jürgen Lindemann), the municipally-owned housing company (Christer Sandgren), and the Augustenborg School (Bertil Nilsson) as agents of change successfully attracted financial resources to the project while connecting municipal silos to implement various measures under the shared vision of sustainable urban redevelopment. See more about the individual actions and commitments on page 16 in this book.

[6] See more on Gnistan and Rabbit Hotel on page 120.



This is how the original plan for Augustenborg looked. From Bertil Pfannenstills Sociologisk undersökning av Augustenborgsområdet i Malmö, MKB, 1953

process of social and cognitive learning. The development of the open storm water management system and the emergence of green roofs are good examples of how collaborative, transdisciplinary and reflexive experiments overcame institutional barriers and bridged disciplinary knowledge gaps, resulting in evidence-based policy making (see Box 1) and an international knowledge hub (Scandinavian Green Roof Institute)[7].

Recent learning processes include MKB's gradual internalization of some features of the Eco-city's governance practices, and current advocacy for continuous techno-socio-ecological innovations. It also exemplifies integrating community development into MKB's real estate management practices while supporting residents' daily activities with an emphasis on sustainable lifestyles (Grander, 2020; Wester & Carlsson-Kanyama, 2020). Continuous governance learning has not only reconfigured working practices but has successively changed socio-cultural frames and behaviors. Many sustainability initiatives, such as car-pooling, solar energy, CO2 emission reduction, and urban gardening grew out of this supportive experimental climate in Augustenborg.

Text: Bernadett Kiss

From cognitive to social and policy learning – the case of the open storm water management system

Peter Stahre, professor and protagonist of sustainable drainage systems, together with representatives from the Waterworks and the Streets the Parks Department of Malmö City had already started to experiment on sustainable urban drainage systems (SUDS) in the late 1980s. These experiments were not only critical to better understand the conflicts between hydrological engineers and city planners and to slowly eliminate barriers for collaboration between municipal departments, but also to enable learning in real-life contexts by gradually improve technical skills and experience at the Waterworks as well as by creating a knowledge-base on water systems at the Streets and Park Department. Through these experiments, more evidence of successful SUDS was generated, which in turn could be applied in Augustenborg. The integrative and interactive governance processes of the Eco-city project, through which a multitude of actors have been engaged in a range of socio-technical sites, were built on values of trust and openness (Quiao, 2019) and as such allowed for further learning. These include the re-naturalization of the initially concrete ponds of Arla (Folkesson *et al*, 2020) and the intake of local residents' scientific knowledge.

All these experiences were fed into the upcoming Stormwater Policy (2000), which actively promotes transdisciplinarity, emphasizing that stormwater must be taken into account early on in the planning process and representatives of different disciplines in the city administration are to be actively involved in creating additional values to parks, recreation areas and other free spaces in urban environments (Stahre, 2008). As a result, urban drainage problems became better recognized by different municipal departments, which was clearly reflected in the forthcoming Stormwater Strategy (Malmö City, 2008). It was adopted with the intention to serve as a "communication platform" for all actors involved in the planning and design of open drainage systems, clearly describing the responsibilities of different municipal departments in SUDS development.

[7] See more about the Scandinavian Green Roof Institute emergence in page 149 of this book and in Emilsson & Sörensen, 2020.

Concluding remarks

The prominence of urban neighborhoods in responding to cities' sustainability challenges has become particularly salient in recent years. Global agendas, such as the Paris Climate Agreement (2015) and the United Nations Sustainable Development Goals (SDGs), increasingly highlight the importance of cities as physical and political spaces for local action. Local governments are also progressively leading responses to critical sustainability issues ranging from climate change, ecosystem degradation, health and well-being, social justice, and sustainable consumption and production. This was demonstrated recently when, despite no agreement being reached on the full implementation of the Paris Agreement in COP25 (2019), cities and regions worldwide committed to keep delivering climate action ahead of COP26.

Augustenborg's transition story carries a multitude of learning for sustainable urban development. This study sheds light of the importance of urban transition narratives, through which problems are identified and solutions determined – in physical structures, ways of governance and learning processes. This study concludes that in the case of Augustenborg, there have been four critical conditions facilitating its transition process. These include strong local visions providing a sense of direction about changes needed to reach a sustainable future while fostering local initiatives and innovations. This environment has also strengthened agency and empowered local actors from different backgrounds experiment and explore (new) roles, often shifting their views on working practices. This entails for instance ways of collaboration among actors which grew from silo-structured municipal engagement to horizontal multidisciplinary collaboration with the involvement of private actors. Recent governance developments increasingly include residents through processes of co-creation. Shifts in views also involved municipal employees playing into the city's existing dynamics instead of formulating policy 'from behind their desk'. Learning from and about own mistakes and other initiatives helped to develop context-specific solutions.

Collaborative learning-based multilevel governance has also required self-conscious and self-critical reflexivity. This reflexivity has consciously worked with individuals' knowledge and skills, available resources and coordinated actions toward negotiated visions. It has also tapped into individuals' enthusiasm and the strength of existing professional networks, including the multiple values and interests they entail – technical, economic, historical, cultural, biological, ecological, environmental, pedagogical, aesthetic, and recreational – and used them in the planning process. Consider the technologies applied in the Eco-city project: PVs, green roofs and walls, open drainage systems, urban gardens. None of these had been radically new innovations at the time. However,

Solar cells, a green structure and an open blue-green infrastructure. These are perhaps not the most advanced innovations, but the combination and their successful integration in the area mean the solutions still pique people's interests. Image by Frida Persson Boonkaew/MKB

getting them funded in the same place and time allowed a reconfiguration of the existing urban fabric (Karvonen, 2020). As demonstrated above, reflexive governance is often a challenging process, however much needed in our rapidly changing urbanized world.

Despite the enthralling transition story of Augustenborg, noticeably the neighborhood's sustainability practices have not been widely adopted either on a national or international scale. The question 'why' naturally arises. This study analyses the conditions which enable context-specific sustainability solutions, while the overall question of why there are not more Augustenborgs cannot be answered by studying Augustenborg, but by understanding obstacles and barriers for everywhere that is not Augustenborg.

Acknowledgement

We would like to thank all informants who contributed to this research. We also gratefully appreciate the valuable editorial and reviewer feedback on drafts of this article. This work was funded by the NATURVATION project under the European Union's Horizon 2020 research and innovation programme (under grant agreement No. 730243) and the Japan Society for the Promotion of Science under the International Research Fellowship Programme.

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Augustenborg – a role model for climate-positive welfare?

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Augustenborg was built around 1950 to be a full-scale model of the new vision for a beneficial and modern Folkhem (People's Housing) welfare state that would lead the way to a better society after the Second World War. 50 years on the Eco-city Augustenborg once again became a model, this time to showcase social, environmental and financially sustainable change following a time of major social challenges. The area won the United Nations' World Habitat Award with the motivation *"The Eco-city Augustenborg sets an extraordinary example for cities that want to remedy their urban renewal and environmental problems. The City of Malmö and MKB Fastighets AB have shown how a residential area's physical environment and social and economic problems can be tackled in collaboration with the residents by creating an Eco-city"*. Positive development has since continued through the creation of Greenhouse, among other things. But some things are developing in the wrong direction, amid increases in socio-economic problems, crime, overcrowding and poorer school results. At the time of writing, in 2020, there are both major challenges and great opportunities, and there is a need to continue to develop Augustenborg into a pioneer for local and global sustainable urban development.

Since its inception, Augustenborg has been characterised by forward-looking planning, at the forefront of social development. When Augustenborg was built in the late 1940s and early 1950s, it was Malmö's first neighbourhood unit, a community development idea with strong social characteristics. The planning and implementation of the Eco-city project in the late 1990s and early 2000s was a revolution in how to environmentally adapt a residential area while weaving in strong social goals and ambitions. It was the cutting edge of societal development. Municipal housing company MKB's project Greenhouse was a major environmental investment in the mid-2010s, which was both a cutting-edge example for other construction projects and a social investment to increase Augustenborg's diversity and attractiveness.

Augustenborg has set an example and taken steps ahead of its time, but the focus has been different and tackled different, contemporary, problems. Now, in 2020, Augustenborg is continuing to manage and develop what it built and renewed. Over the decades strong individuals have pushed through major projects, by finding the resources to establish and then develop Augustenborg.

The players who pushed for ideas, drive and resources during Augustenborg's three major leaps have looked a little different. The City of Malmö was a key driver of the first two projects as it kicked off construction in Augustenborg, leaving the area's development to the newly formed housing company MKB. MKB worked with various departments from the City of Malmö that had responsibility for Augustenborg, to create the conditions needed to push through the Eco-city project. Greenhouse was mainly created by MKB.

MKB and the City of Malmö are still the two main players that will be able to initiate and implement continued development in Augustenborg to meet the challenges of today. MKB owns and manages the majority of Augustenborg's properties. There is a long list of others who need to be involved to continue development, but MKB and the City of Malmö take the initiative.

Today's starting point and driving forces

It is important from a global perspective to set a concrete example and build models of genuine social, economical and ecological sustainable development. Malmö was the first city in Sweden to adopt the UN's Agenda 2030 global sustainability goals. The City of Malmö has also adopted far-reaching climate and environmental targets and commitments to meet the international Paris climate agreement to limit global warming to 1.5 degrees. Furthermore, Malmö is the only Swedish municipality to have supported *The Shift*[1], a UN initiative on universal housing rights. Role models and examples are needed to meet these goals and commitments. Augustenborg is particularly well placed to lead the way.

From a neighbourhood perspective, there are several opportunities, in the reasonably short term, to make Augustenborg an even better local, national and international role model for sustainable development. Since much has already been done in Augustenborg and since the City of Malmö, through MKB and its own departments, has a strong influence, then this could be done relatively quickly and with limited resources. Significant development and innovation support from the EU and the national government will likely also be available for some measures.

Governments in both Sweden and the EU are heavily focused on the transition to what could be termed a "climate-positive welfare society", in part through the EU's new European Green Deal[2]. Augustenborg could lead the way within a few years. Augustenborg's success in creating major change without sharpzly increasing housing costs and segregation is an important part of this. Augustenborg could also be an important part of the proposed national efforts to promote innovative urban development, known as the *plus energy city*.

Some of the actual conditions that create opportunities for this in Augustenborg are: planned densification in conjunction with the new railway station in Persborg/Augustenborg; plans to relocate parts of the Service Department's operations from workshops, warehouses and offices; planned and partially started renewal of green areas; planned new development of loft apartments; new opportunities for the development of climate-smart energy and mobility investments; and continued involvement of the residents in collaboration with MKB and relevant municipal departments.

[1] See https://www.make-the-shift.org/ for more information.
[2] See https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en for more information.

Image by Studio Sofie Stenberg AB

Can Augustenborg become a plus energy city? The cover image for Plusstad, en nationell kraftsamling för export av innovativ stadsutveckling (Plus energy city, a national effort to export innovative urban development), a proposal from Samordning för bostadsbyggande (Coordination for house building) and Fossil Free Sweden, describes an urban landscape with integrated food production and enhanced ecosystem services.

In addition to general social problems such as high levels of crime, lack of safety, high proportion of newly arrived refugees and social exclusion, there are three more general challenges that today's housing construction is focused on meeting:

- climate change adaptation,
- long-term sustainability and quality
- affordable housing

In the discussion on how to make rents affordable, already existing housing is often forgotten. Newly built homes do not provide rental levels that the resource-poor and those in need of housing can afford. It is impossible to push down rents in newly produced homes to the levels in buildings that are several decades old. This also applies to day-to-day needs and the costs of meeting them.

Augustenborg a plus energy city

Sweden will hold a world fair in 2030 with four other smaller expositions every other year from 2020. The initiative aims to ensure that districts that are planned, built and rebuilt in Sweden over the next ten years are given a better chance to reach sustainability targets and create values that benefit the entire city and its inhabitants. The starting point is the concept plus energy city where plus also stands for solutions that give more than they take. Augustenborg has taken major strides towards plus energy through the Eco-city investments and the continuing development such as the Greenhouse project. It now has opportunities to go further on the road to becoming a plus energy district. Few other places in Sweden and Europe have followed a similar path to Augustenborg, using simple means

Image by Mandaworks. Background: Google maps

Illustration of a proposed new development next to the Persborg station. New apartments run along a new street facing the railway, with bushes planted in front of the tracks. Further noise protection is provided by a taller barrier. A new tunnel under the railway line, extends the cycle path towards Västra Kattarpsvägen. A new preschool will be established next to Södervärnstråket.

to redevelop an existing neighbourhood, and designing it in such a sustainable way. Current plans would put Augustenborg even further ahead of other similar residential areas.

Augustenborg – good homes of the future

It is time for Augustenborg to take the next step to lead the way for Malmö, Sweden and the world in establishing how good homes of the future can be developed through managing and complementing the existing housing. Augustenborg's urban development will be both good and wise. Alongside the residential area, there is a school, train station and a range of amenities that provide the building blocks for a healthy daily life. When the Internal Services Department gradually stops parts of its operations in the workshop and warehouses, this will leave space for higher density development. Even within the existing residential area there are opportunities to provide more homes in a positive way, directly linked to the train station.

Tomorrow's good living is being developed in Augustenborg with long-term perspectives and reasonable rents, by retaining a responsible customer-focused strategy to manage and develop the older housing stock allowing current residents to stay and supplies homes to new tenants at affordable prices. Another way of expressing this is that it *takes responsibility for the responsibility of the future*. This is in line with the City of Malmö's commitment to develop housing, symbolised by the city signing the *The Shift*, among other things.

Image by Sanna Dolck

At the Blue Green City Lab, Augustenborg's experimental test site for blue-green solutions, combined solutions are being developed to meet urban climate challenges.

Augustenborg – research and development of blue-green urban solutions

Augustenborg is a strong, established research and development area and testbed for measures to increase biodiversity and environmental stormwater management together - so-called blue-green solutions. The botanical roof garden was unique in the late 1990s when it was installed, and the site has been vital in driving green roofs nationally and internationally. The City of Malmö's Internal Services Department made a huge contribution by allowing green roofs to be installed on its workshop and warehouses in the area. Using project financing from Vinnova and Formas, among others, the project has continued for years.

Now it is time to take Augustenborg's Blue Green City Lab, where blue-green solutions are tested, to the next level. The Swedish University of Agricultural Sciences, SLU, has long been a user and stakeholder in the botanical roof garden and the testbed for organic urban cultivation technology that is in part funded by Vinnova. Participants include Sustainable Business Hub, which commercialises and spreads the blue-green innovations. SLU is now part of a project to turn Augustenborg into an urban experimental site for plant production, to research and develop plant systems and cultivation models for urban greenery. This unique research and exhibition site can help develop the multifunctional blue-green environments of the future. These can provide locals with a good, educational and recreational outdoor environment while providing blue-green solutions to help meet the challenges of climate change.

The stormwater facility as an educational development opportunity

Augustenborg is a unique area for VA Syd, which is responsible for Malmö's stormwater and sewage network. It is an example of how to create enough capacity to manage sewage and major rainfall by greening an existing combined sewage infrastructure, rather than using more expensive technical solutions. The Eco-city's solution is still a unique example of how to environmentally adapt stormwater management in an existing residential area. This is also done without particularly favourable topography as the area only slopes slightly.

VA Syd wants to create so-called Water-wise Cities and Augustenborg is the leading example of how to do it around existing buildings. The use and management of the system will be especially in focus during the development of water solutions and stormwater management in Augustenborg in the coming decade.

Augustenborg in the future

What will Augustenborg look like in five years? The area is already a radical example of environmental regeneration and a role model that should be imitated in more existing residential areas than has been the case. The question why there are not more Augustenborgs has been raised in some parts of this anthology. There is no clear answer, but there are potential explanations, including: fortunate circumstances, urgent development needs, influential individuals who drove the changes, and access to external grants that covered some costs but primarily motivated further investment from MKB and the City of Malmö.

Like other residential areas that require radical refurbishment, Augustenborg needs both the driving force of individuals and organisations and mobilised resources to take its next development step. There are pressing development needs because the stable positive social development of the Eco-city years has stagnated recently, but also because more people need affordable homes. The driving forces are in MKB and the City of Malmö and resources can be found in external grants that unlock internal investment. But urban development does not happen overnight. Changes to let Augustenborg set an even more interesting example in 2025 need to be initiated now. There are signs of growing interest in developing Augustenborg's next stage, but these need to be united into an overall ambition to build on the Augustenborg of today.

Ten ideas to make Augustenborg a role model for Agenda 2030 in Malmö and the world

1. Keep adding to the buildings in Augustenborg, to offer climate-adapted, high quality and sustainable housing at reasonable costs. There are already plans to install several smaller attic apartments, and there is a possibility to start a new housing development next to Persborg station
2. Adapt Augustenborg's Blue Green City Lab (BGCL) to be an international hub for knowledge and development of urban blue-green solutions. BGCL is based on increased collaboration between the City of Malmö, VA Syd, the Swedish University of Agricultural Sciences (SLU), IVL Swedish Environmental Research Institute, Sustainable Business Hub and the Scandinavian Green Roof Institute. This can be an important step to bring research and development to a part of Malmö where it is missing.
3. Expand local investment in new blue-green solutions in Augustenborg and its surrounding area. New flood prevention measures are needed in nearby residential areas, and additional green infrastructure is needed in Augustenborg and its surrounding areas. MKB has started a major investment to install better planting beds and more trees in Augustenborg.
4. Transform Augustenborg into a local smart energy community to boost resilience and provide an example of climate-smart energy supply. Here local solutions such as solar energy, energy storage, energy efficiency and smart control combine with opportunities and incentives for residents and businesses to join the transition to a climate-friendly society.
5. Invest in biochar for plant beds, on roofs and as a component in building materials. This can both create better conditions for plants and water management and a long-term method to bind carbon and reduce climate change.
6. Invest in education around sustainable development in Augustenborg. This should build on and develop initiatives and activities that are already happening in the school, at Gnistan, on the water walks, through guided tours and Augustenborg's botanical roof garden. Utilise the entire neighbourhood as a living classroom.
7. Support the development of culture and leisure activities in Augustenborg. Ensure Gnistan and its rabbit hotel become permanent features that can be further developed.
8. Stimulate and strengthen retail and businesses in Augustenborg that contribute to sustainable development and build on Augustenborg's profile as a forerunner in sustainable development.
9. Create a digital twin for Augustenborg to store information and spread knowledge about sustainable development. The digital twin can further internal development and planning and disseminate knowledge of sustainable development in Augustenborg.
10. Sign Augustenborg up to the proposed new national efforts to export innovative urban development 2022-2030, which is based on demonstrations of plus energy districts.

Image (right) by Sanna Dolck

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1 Augustenborg's square

The typical 1950s square functions as a hub for the Eco-city. Here, residents themselves have helped design the furniture in order to create more meeting places and greenery. The square is most lively on the Eco-city's Day and the market days which are arranged together with the many actors on the square with a green and sustainable profile.

2 Community garden

An allotment area with private and shared allotments. Created by residents in Augustenborg together with MKB. One of many community gardens in the district.

3 Plant wall

A green canvas with mixed plants which provide year-round greenery. Developed with MKB, Movium, the Swedish University of Agricultural Sciences och BARA Mineraler.

4 World Habitat Award

In 2011 the Eco-city Augustenborg was given an award from the United Nations' World Habitat Award. A small business in the area has created a larger replica of the prize.

5 Teater Augusten

Augustenborg's theatre which has for many years been run by local enthusiasts. The theatre's future will include a living meeting place for culture and the performing arts.

6 Gnistan and the rabbit hotel

Augustenborg's organisation for children and young people and rabbit hotel is run by Safija Imsirovic, a local enthusiast.

7 Augustenborgsskolan, the eco building

The Augustenborgsskolan school's eco building is a flexible, demountable, building made from sustainable materials. The building also contains several environmental technical innovations.

8 Service Department's direct works unit, a sustainable industrial site

The industrial area is home to solar cells, solar thermal systems and green roofs, among other things.

9 Augustenborg's Botanical Roof Garden

Demonstration and research area for green roofs. Also hosts many field trips and shows off both the roof garden and the whole of Augustenborg

10 & 11 Laundrette of the Future

A new concept for laundrettes intended to promote sustainable laundry habits and creating new meeting spaces.

12 Greenhouse

A residential building which makes it easy to make sustainable choices. Greenhouse is a passive house and innovates around energy, environmental technology, gardening, lifestyles and social cohesion.

13 Solar cells

In the Särla block there are 200 square metres of fully integrated solar cells.

14 Residential gardens

With added focus on biodiversity and collaboration with the residents. In the anthology you can also read about how the gardens in the Arla block have changed over the years.

Each year, the Eco-city Augustenborg attracts visitors who want to see sustainable transition in action. They walk along stormwater canals, gaze up towards the green roofs, maybe visit the rabbit hotel or the eco-high-flying Greenhouse. They witness how climate adaptation can be both functional and attractive.

But how was success possible here, when environmental regeneration of an existing area is still relatively rare, especially with such high levels of socio-economic ambition? And how successful is Augustenborg really? This anthology tracks the area's development from 1948 to the present day. It contains the story of the Eco-city and insights into the experiences and lessons that can be learnt from the project. Alongside the main texts, which are written by well-informed people who were not themselves part of the implementation, there are eight scientific chapters by researchers from different disciplines that explore the issues in greater depth. This sits alongside more personal observations, fact boxes and interviews.

The antholgy has been supported by

Sten K Johnsons Stiftelse · Sustainable Business Hub · VINNOVA Sveriges innovationsmyndighet · FORMAS · Mistra Urban Futures · SLU · MKB · Malmö stad

ISBN 978-91-519-7868-0

Arkus skrift 79

ISBN: 978-91-519-7868-0

arkus