



Recent and Future Efforts Growing Green Roofs in Copenhagen

Text and photography by Dorthe Romø
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Imagine that you can go for a run in a green park on the sixth floor overlooking the entire city—already an option in Toronto. Or that you are sitting in a hotel, waiting for dinner to be served with fresh herbs and vegetables from the hotel's own vegetable garden on the third floor—a reality today on The Fairmont Hotel in Vancouver. Or imagine a meadow with red-listed orchids, bees, spiders, and beetles—you will find green roofs that provide such excellent habitats on green roofs in Switzerland. Green roofs worldwide give inspiration for the process, progress, and future of our cities in Scandinavia.

Green roofs are the liveable alternative to traditional roofs that provides multitudes of benefits. Green roofs in urban areas are an alternative adapted to the living climate. Approved local plans in Copenhagen will provide approximately 200,000 square feet of green roofs in the coming years, with more expected over the later years. The green highline near The Inner Harbor of Copenhagen is a cutting-edge project.

Focus on Green Roofs since 2008

In Copenhagen, we started to focus on green roofs in 2008, the same year we worked out our Wastewater Plan 2008.¹ The plan describes the framework for working with the local drainage of rainwater and recovery of clean rainwater for recreational purposes, development, and testing of new alternative cleaning methods. Composed of a wide range of objectives and initiatives to address changes in precipitation, for example as a result of climate change, the plan will use over the next 12 years 2,165 million Danish crowns for new- and re-sewerage, renewal of sewers, and improvement of the aquatic environment. Since 2008, green roofs in Copenhagen have evolved in step with the increased knowledge about the potential of green roofs.

Participation in the World Green Roof Congress in London 2008 was the start of building up a large international network, which over the years has brought great knowledge and experience to Denmark from

North America, Germany, Switzerland, and Singapore. A strong international network has been one of the cornerstones in the development of green roofs in Copenhagen and Denmark.

Green roofs act like meadows: they absorb, evaporate, and infiltrate rainwater. In this sense, green roofs act as a sustainable solution, by using rainwater as a life-giving resource instead of letting it flow directly into the sewers, which would take up capacity and ultimately create flooding in the streets. Therefore, green roofs have increasingly been integrated into many cities' stormwater management policies.

At the same time, by transforming black surfaces to green vegetated roof systems, green roofs can have a major effect on temperatures—not only in buildings but also in the city; traditional black roofs absorb heat and create a dome of higher temperatures within cities. This function also makes green roofs a part of many cities' strategy to reduce the Urban Heat Island effect.

At the building level, green roofs provide better insulation. During summer, they keep the heat out of the building, so the buildings are not so hot inside and the need for air conditioning is reduced. In the winter, green roofs keep the cold out of the building, thereby reducing the need for heating.

Green roofs can also provide valuable habitats for plants and animals. For many years, researchers in Switzerland have studied green roofs in relation to biodiversity and documented that green roofs can serve as habitats for red-listed species such as orchids and insects.² The results of a particular study have led to legislation in Basel for all buildings over 500 square metres to be covered with green roofs, and in a way that supports biodiversity. Recommended and regulated guidelines include: the growing medium should use native regional soils, with advice from a horticulturalist if necessary, and be at least 10 centimetres deep; mounds 30 centimetres high and



3 metres wide should be provided as habitat for invertebrates; vegetation should be a mix of Basel's native plant species; and green roofs on flat roofs over 1,000 square metres must involve consultation with the city's green roof expert during design and construction.³

Based on this knowledge about and the international experience with green roofs that prove a multitude of ecosystem services, green roofs became a part of Copenhagen's climate plan in 2009⁴, and since then also a part of its strategy for biodiversity plan⁵, guideline for sustainable urban drainage⁶, and climate change adaptation plan⁷. Copenhagen's green roof policy from 2010 mandated that green roofs become a part of the Municipal Plan 2011, a framework for setting requirements for green roofs in new local plans.⁸ The city also developed a guideline for the environment in construction for the buildings owned by the Municipality. In that guideline green roofs were mandated for the Municipality's own constructions.⁹

Since 2010, the city has mandated green roofs in most new local plans, to provide approximately 200,000 square metres of green roofs in the coming years, a figure based on approved local plans in 2010 and 2011, including those for Kalvebod Brygge, Carlsberg, Århusgadekvarteret, and Grønttorvsområdet, so even more will be expected over the years!

Roof Gardens on the Kalvebod Brygge Green Corridor
Kalvebod Brygge's green botanical corridor is a project that is interesting in many aspects. In one of the most traffic-heavy streets of Copenhagen near The Inner Harbor, an area with one of the lowest green area per capita rates, the Copenhagen Municipality chose to establish a new, green highline, lifted seven metres, which when

finished will connect two urban areas. Completed in 2010, the city worked with architects Lundgaard & Tranberg Architects A/S and SLA and Holscher Architects to develop the master plan for the area. Composed of at least four connected green roofs on four separate buildings, this green botanical corridor is accessible to the public to walk and cycle through in green surroundings away from the heavy traffic from one area in the city to another.

Today, you can go straight up to the first green roof from the street; inspired by the Scandinavian landscape, a sculptural staircase covered with trees rises seven metres. Called The City Dune, the first green roof covers a parking lot between SEB bank's two buildings and is quite popular by skaters, such that a new liveable area has been successfully created. From this roof, one can move over to the green roof garden on the new National Archive that has been planned with a primary path and axis running across the total length of the project, along which several spaces are defined. They include elevated strawberry beds with integrated benches and espaliers that will over time become overgrown with intertwining, flowering plants, thereby creating well-defined spaces, which are created for the public to sit and have a lunch, read a book or relax, listen to the busy bees, and enjoy the scent from the Thyme.

The green roof garden on the new National Archive merges into the green roof of Tivoli Congress Centre, with colourful tulip beds in the spring and with beautiful trees and shrubs. A fine green view has been created not only for the guests at the Tivoli Congress Centre but also its neighbours Tivoli Hotel and Wakeup hotel, both of which also have a thin green roof solution consisting of sedum plants.



1. Grown on a rooftop garden, fresh fruits are available to the children of a school in the middle of Copenhagen.

2. Completed in 2010, the Kalvebod Brygge green corridor is composed of at least four connected green roofs on four separate buildings (Photo: Ursula Bach).

3. The green roof on the parking lot between the SEB Bank's two towers is called The City Dune.

4. Spring on the roof garden on the New National Archive.

5, 6. Flowers in bloom on Tivoli Congress Centre roof.

7. A playground for children atop the Tivoli Congress Centre green roof.

8-10. The National Archive green roof corridor has become a public resource of aesthetic, ecological, and recreational value.

11. The new test centre of Agro Tech A/S carries out research on green roofs.

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The green corridor project is in many ways unique in its form and expression, with green roofs on various buildings connected to each other, available for the public and connecting two urban areas. The green roofs further have a park-like function with recreational possibilities, including for skaters to express themselves and anyone to walk or cycle in peace and quiet, away from the traffic from one end of town to the other. The urban development in Kalvebod Brygge can work as a model for future urban sustainable design and development, by showing how the city may maximise its use of the many thousands of square metres of unused potential and create multifunctionalities of buildings for the benefit of the city and the society as a whole.

Steps Ahead

The city's early and rapid success with green roofs has demanded strong, clear, and inspiring communication about the subject. A wide range of workshops, seminars and meetings has been held, creating awareness within the Municipality to bring the green roofs into the planning process.

Copenhagen is also involved in several external networks that focus on climate change adaptation and green environments. For example, *Water in Cities* is a "Triple Helix" project between the private, public, and scientific institutions in Denmark.¹⁰ With *Water in Cities*, a working group was established, with more than 20 participants from consulting firms, universities, waste water supplies, and municipalities, that gathers and shares knowledge about green roofs with a special focus on stormwater management. In the wake of the attention the Kalvebod Brygge project has created about green roofs, approved technological service institute Agro Tech A/S has further established a test centre for green roofs and is still working to provide further knowledge in the field. In the last three years, green roofs have proved to be a very popular topic for students to deal with.

The interaction between many parties has also been an important part of the project, helping to create a dynamic to clarify the needs of the project for progress. There is no doubt that many urban planners, consulting firms, and architects to some degree are familiar with the concept of the green roofs today.

However, there is still a long way to go before we will see the city embrace green roofs on more levels to maximise their full potential as a sustainable solution: where green roofs are a natural integrated part of urban planning; where main developers know what they can expect of green roofs; and where consultants have the confidence and qualified know-how to advise and design the green roof solutions. But the city is well on its way and has great projects to lead the way, such as Kalvebod Brygge.

The initiative in Copenhagen has been an inspiration. Now green roofs have captured interest, not only in Copenhagen, but also in Denmark, Sweden, and more recently Norway. The city pays attention to them as a solution for and a contribution to a sustainable climate-adapted urban development. The 2012 World Green Roof Congress in Copenhagen saw Arup San Francisco present key findings from its first cost-benefit analysis, which revealed various positive values for net present values, return of investment, and cost savings for the installation of a green roof, and more are coming. Analyses that quantify the refund of the additional investment that a green roof costs is another important aspect that it will look closer to in the coming years.

The work that lies ahead of us is to create guidelines that can work as inspiration for urban planners as well as consultants and clients. As an important part of ensuring the quality of green roof solutions depends on proper consideration about their purpose, these guidelines should help to identify and clarify the goals of each project at the beginning. If they are designed to support biodiversity, then it is important to consider the potential of the construction to take the load of different build-ups thickness of substrate (also in retrofitting a project).

In many aspects, green roofs in Copenhagen are in the middle of an exciting phase, where their considerations are integrated in the planning stages and where they are visible as an alternative to conventional roofing. Now we have to bring together all the threads, formulate standards, ensuring quality, and qualify demand through inspirational guidelines. 



¹ City of Copenhagen. "Wastewater Plan 2008." Accessed April 12, 2013. www.hofor.dk/wp-content/uploads/2012/06/spildevandsplanKE.pdf

² Urban Habitats. "Green Roofs and Biodiversity." Accessed April 12, 2013. <http://urbanhabitats.org/v04n01/introduction.html>

³ Kazmierczak, Aleksandra, and Jeremy Carter (for the Interreg IVC Green and blue space adaptation for urban areas and eco towns (GRaBS) project). 2010. "Basel, Switzerland: Building Regulations for Green Roofs." In *Adaptation to climate change using green and blue infrastructure. A database of case studies*, 105-109. Accessed April 12, 2013. http://www.grabs-eu.org/membersArea/files/Database_Final_no_hyperlinks.pdf

⁴ City of Copenhagen. 2009. "Climate Policies." Accessed April 12, 2013. www.kk.dk/da/om-kommunen/indsatsomraader-og-politikker/natur-miljoe-og-affald/klima

⁵ City of Copenhagen. 2009. "Biodiversity Policies." Accessed April 12, 2013. www.kk.dk/da/om-kommunen/indsatsomraader-og-politikker/natur-miljoe-og-affald/groenne-omraader/biologisk-mangfoldighed

⁶ City of Copenhagen. 2009. "Method Catalogue for local rainwater drainage (SUDS)." Accessed April 12, 2013. www.kk.dk/da/erhverv/tilladelse/byggeri/vand/lokal-afledning-af-regnvand/metoder-til-lar/metodekatalog

⁷ Task Force for Climate Change Adaptation, Ministry of Environment / Nature Agency. 2011. "Climate adaptation plan in Copenhagen." <http://www.klimatilpasning.dk/aktuelt/nyheder/2011/februar2011/klimatilpasningsplanikoebenhavnskommune.aspx>

⁸ City of Copenhagen. 2011. "Municipal Plan - Green Growth and Quality of Life." https://subsite.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/Growth_and_partnerships/Strategy/-/media/E9CC623FEEA6485582EEA7BDEEFE066B.ashx

⁹ City of Copenhagen. 2010. "Environment in Construction and Building 2010." kk.sites.itera.dk/apps/kk_pub2/pdf/684_u93mX48Rkx.pdf

¹⁰ Vand I Byer. Last modified April 21, 2010. "Water in Urban Areas." <http://www.vandibyer.dk/english/>