

Copenhagen Prepares

PHOTO BY URSULA BACH

Denmark's capital has already begun to implement a comprehensive response to the threats of climate change.

By Don Hinrichsen

The central Copenhagen cityscape shows rows of near-shore wind farms in the harbor area.

Text and photographs by





PHOTO: DAVID BUCHMANN

Details of the "green scaping" of Tasinge Plads in the Østerbro section of Copenhagen.

THOUGH COPENHAGEN IS NOT THE ONLY URBAN AREA developing an active strategy to combat climate change, the city—home to roughly 1.9 million people out of a total Danish population of 5.6 million (2014)—is unique in its integrated, neighborhood-based approach. The City Council developed a comprehensive Climate Plan for Copenhagen in 2009, followed by a Climate Adaptation Plan adopted in 2011.

The original Climate Plan aimed to reduce carbon dioxide emissions by 20 percent by 2015 and to make the Danish capital the first city in the world to be "carbon neutral" by 2025. In fact, the city managed to reduce carbon emissions by 21 percent by 2011, ahead of schedule, and is well on its way to becoming "carbon neutral" within 10 years.

The term "carbon neutral" does not mean zero carbon dioxide emissions. Rather, carbon neutrality is measured by both a reduction in carbon emissions at their source and an increase in green areas to absorb and offset remaining emissions. In the case of Copenhagen, the goal calls for the city to reduce carbon dioxide emissions by 70,000 tons. This is being accomplished through a combination of three broad approaches:

- The largest reductions, about three quarters, will come from the energy sector. The city is constructing more land-based and offshore wind farms, bringing on stream a new biomass-fired combined district-heating and electricity-generating plant, building another waste-to-energy plant and phasing out fossil fuels for peak load

Close to half of all Copenhagen residents feared damage from future storms.

(electricity) generation. In addition, a geothermal plant may also be constructed.

- The transport sector will account for a reduction in carbon emissions of roughly 15 percent. This will be achieved by encouraging more cycling (more than half the population already cycles regularly), introducing biogas and hybrid buses and promoting the use of electrical and hydrogen-powered private vehicles.
- The third pillar in the plan calls for energy savings, so-called "megawatts", by reducing energy consumption by around 7 percent. This will be accomplished through the design of new low-energy buildings, retrofitting existing structures (better insulation and double-glazed windows) and the use of solar cells for off-peak electricity production, particularly in the summer months.

These longer-term goals were supplemented in 2011 by a more immediate, second phase strategy, aimed at mitigating some of the worst impacts of climate change. The Climate Adaptation Plan was prompted by two major downpours (called cloudbursts)—one in August 2010 and the second in July 2011. The later dumped six inches of rainfall on the city in less than three hours, flooding cellars and completely inundating streets and main roads. Some low-lying areas were overwhelmed by 20 inches of sewage-contaminated water. This event alone caused 6 billion Danish kroner in damages (over \$1 billion).

Subsequent surveys found that close to half of all Copenhagen residents feared damage from future storms, while 61 percent of apartment dwellers in vulnerable areas had experienced water damage from recent flooding.

"These events put us in the front line of climate change mitigation," points out Lykke Leonardsen, head of the city's Climate Unit. "We had to develop both short-term and long-term responses to climate change in order to avoid more severe flooding as a result of an increase in storms."

Leonardsen heads up a ten-person team within the city administration devoted entirely to coping with the worst effects of climate change. "We had already experienced within the last five years a storm that should occur only once every 100 years, followed by one that should only occur once every 200 years," she observes. "Redesigning the entire storm-water drainage system, which is part of the city's sewage system, was simply not feasible; we would have to tear up the entire city at enormous costs and inconvenience to residents."

City planners, hydrologists and climate experts worked with the city government to design what Esben Alslund-Lanthén, an analyst at the Copenhagen-based think tank Sustainia, refers to as the "green-blue"

Climate change is here now

According to recent research by the Intergovernmental Panel on Climate Change (IPCC), the world has already warmed by nearly one degree Centigrade since the end of the Industrial Revolution. Furthermore, sea levels have risen by 20 cm since 1880, but projections indicate that by the end of this century sea levels could well be one meter (three feet) higher!

Higher sea levels are triggered by the fact that sea water expands when heated; the oceans are absorbing nearly all the heat added to the climate system. Temperatures have increased sharply in the Arctic. As a result, summer Arctic sea ice has declined by more than 40 percent over the past four decades. At the same time land-based glaciers are melting at record levels.

This dire situation—more and more severe storms, melting glaciers and rising sea levels—has not gone unnoticed by the insurance industry. According to Mark Carney, Governor of the Bank of England, there is growing evidence of humanity's role in climate change. "Since the 1980s," he says, "the number of registered weather-related loss events has tripled. Losses for the insurance industry have increased five-fold to \$50 billion per year!"



Artist rendering of Skt. Kjelds Plads, the next area of the city to be redesigned according to the "green-blue" approach.

approach. "Copenhagen developed this concept as a cost-effective way for neighborhoods to deal with the consequences of increased rainstorms by introducing a two-pronged approach—increasing the city's green areas by lining main streets with mini-parks containing more trees, shrubs and grasses in order to absorb more rain; and second by turning some streets

into literal cloudburst avenues as a way of channeling excess runoff into our extensive harbor area."

The first neighborhood to be re-designed following the "green-blue" approach was the Østerbro area, in the north-central part of the city. The Danish architecture firm, Tredje Natur, was chosen to redesign the neighborhood as a model for the rest of the city.

"Instead of doing pinpoint projects, we decided to develop a rainwater master plan," points out René Sommer Lindsay, the city official in the mayor's office in charge of Østerbro's transformation. "Given the fact that our storm-water system is over 100 years old, we had to look at practical

ILLUSTRATION: SILAS VISUALIZATIONS



ILLUSTRATION: SLA

Skt. Kjeld Plads from another perspective in the architect's rendering.

solutions from a hydraulic and environmental point of view. After all, rainwater is only a problem if it goes where you don't want it to go."

Working with Tredje Natur, which designed the master plan, along with a number of other architectural and engineering firms, officials decided to tear up a number of the neighborhood's sterile asphalt streets and squares and replace them with green areas consisting mostly of grass, trees and small shrubs. The main streets are being turned into tree-lined boulevards with elevated sidewalks and bike paths on both sides. When the next downpour occurs, more of the water will be absorbed by the green areas and pocket parks, while the main streets will become canals, directing the water away from the squares and people's cellars and into the harbor. As the cloudburst avenues approach the last 100 meters or so before reaching the harbor, the water will be directed into newly installed underground storm-water drains. "This way, millions of gallons of water will be effectively channeled back into the harbor with minimal, or no, damage to the built environment," observes Lindsay.

In December 2014, Østerbro's Climate Quarter, the city's first, was inaugurated in the climate resilient square known as Tåsinge Plads. In the summer of 2016, the neighborhood's first green courtyard will be finished, while by the end of 2017, the streets-turned-cloudburst boulevards will be ready for the next major rainstorm. A group of residents have also planted a rooftop garden which already supplies fresh produce to the neighborhood. The redesign of Østerbro's Climate Quarter should be finished by sometime in 2020.

"We are not only doing disaster preparedness, but beautifying the city and making it more liveable at the same time," insists Lindsay. "The other

New York City officials like the idea of having an experimental model neighborhood.

benefit of more green space is that the vegetation will act as a natural air conditioner during the hotter summer months, reducing Copenhagen's "heat island" effect."

If all goes according to plan, Copenhagen's climate change adaptation plan will be fully implemented throughout the city by around 2033. By the middle of this century, Copenhagen will have smaller streets surrounded by plenty of trees and shrubs designed to absorb runoff and regulate water flow, while channeling excess water from storms into cloudburst boulevards. At the same time, the city is expected to be fully carbon neutral within 10-15 years, perhaps the first urban area in the world to achieve this goal.

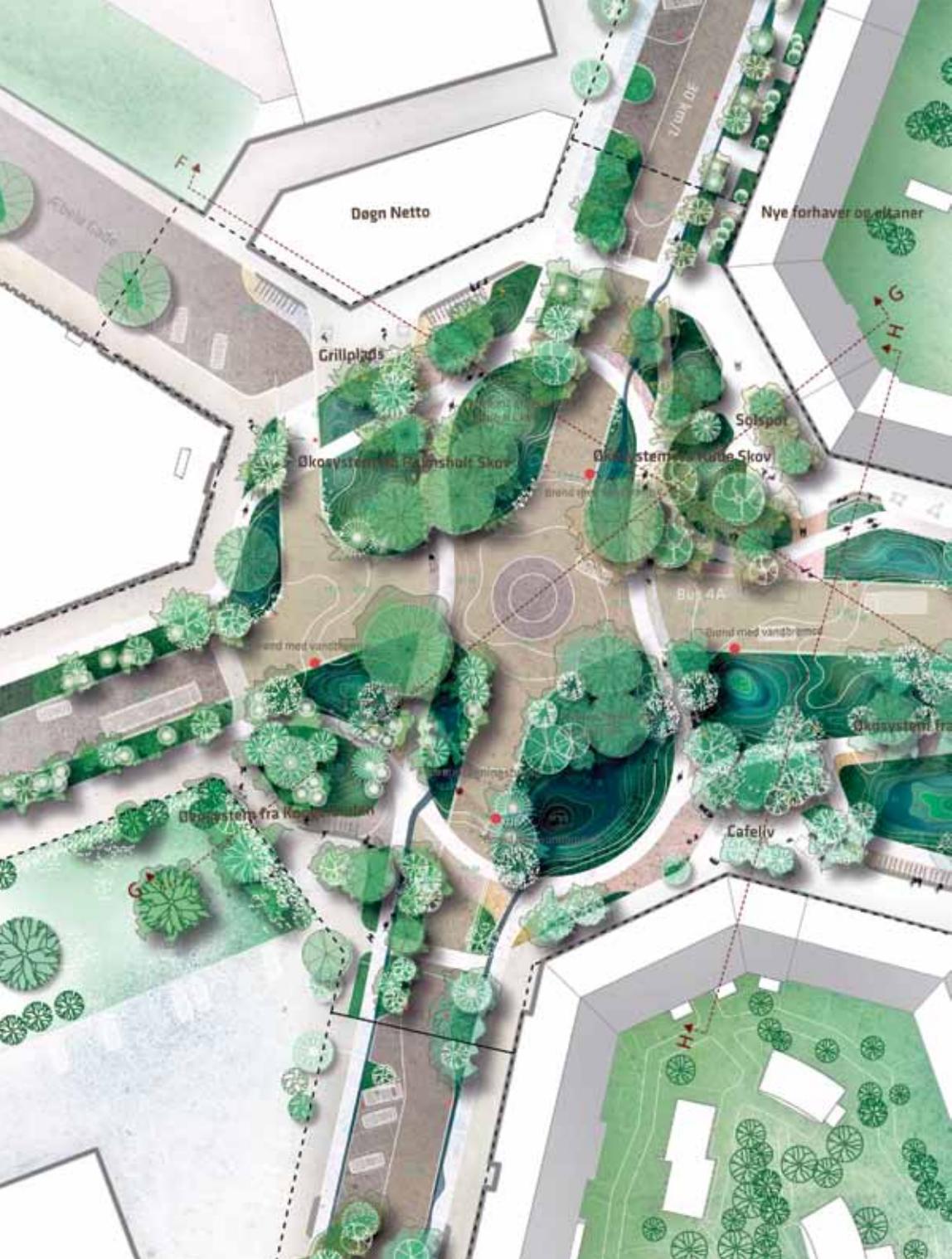
"So far," points out Leonardsen, "no other city is taking such a sustainable, integrated approach to mitigating climate change." The other benefit of this "green-blue" approach is that it is much cheaper than building sea walls or expanding the storm-water sewer system. "We have calculated that the total cost of redesigning Copenhagen will be on the order of \$1.5 billion," affirms Leonardsen. "Re-doing the storm-water sewer system alone would have cost at least twice as much."

ACCORDING TO MORTEN KABELL, COPENHAGEN'S DEPUTY Mayor in charge of environment and technology, this approach "is unique because it's the first system in the world to cover an entire city, as an inter-connected system. It is also unique because there is a strong focus on using adaptation as a way to create better urban space—more green and blue—creating a more liveable city. In this way," he continues, "we can turn rain into a resource, a natural part of the city."

Kabell was in New York City at the invitation of the mayor's office in September 2015. New York has come up with a \$19.5 billion climate change adaptation plan of its own, consisting of some 250 separate projects. But the plan relies too heavily on expensive "gray" solutions, including building very expensive sea walls.

"New York is interested in two aspects of our plan," explains Kabell. "First is the integrated, connected system for cloudburst management; planning for a 100-year storm instead of the usual 10-year storms. And second, they are interested in the climate neighborhood approach as exhibited in Østerbro."

New York City officials like the idea of having an experimental model neighborhood, "one where they can also work with integrated solutions where storm-water management, greening the city, urban space improvement and creation of public areas where residents can meet and interact all come together," says Kabell.



The architects overall design of Skt. Kjelds Plads.



Another rendering of Skt. Kjelds Plads.

New York is already looking at the possibility of setting up a model project in the southeast area of Queens, in Jamaica, which could then be used as an experimental neighborhood.

“In adapting to climate change, cities can choose either grey or green infrastructure,” points out Professor Stuart Gaffin, a research scientist at the Center for Climate Systems Research at Columbia University. Professor Gaffin, who also advises the New York City municipal government on how to adapt to climate change, says “gray infrastructure means building walls and barriers. In the case of New York, we might lose Long Island if we went for the gray option. The green option, which has growing support, includes green roofs, green streets that will capture more storm-water and pavements that allow water to percolate through.”

Other coastal cities are also climbing on board, introducing plans to deal with rising sea levels and increased rainfall, among other perturbations. The Dutch delta city of Rotterdam, for instance, is even designing a plan for floating neighborhoods.

Kabell is upbeat about Copenhagen’s approach. “There is no reason why Copenhagen could not be a model for other cities,” he says. “But context is a big issue when talking about adaptation and urban development. However, handling floods with surface solutions instead of using storm-sewers and making cities greener is definitely exportable.”

Don Hinrichsen, an internationally recognized environment writer, has undertaken numerous assignments for United Nations agencies. He is the author of *The Atlas of Coasts and Oceans: Threatened Resources and Marine Conservation*, published by the University of Chicago Press.