

A sunset scene over a body of water. In the foreground, the water is dark with shimmering reflections of the sun. A bridge with a railing spans across the middle ground, with several silhouetted figures walking on it. To the left, a dark, cylindrical structure resembling a lighthouse or observation tower stands prominently. In the background, tall, thin poles with spherical lights are visible against the bright, hazy sky. The overall mood is serene and contemplative.

CLIMATE- ADAPTED CITIES

SOLUTIONS FROM COPENHAGEN

”In Copenhagen we always try to find solutions that do not just solve the problem, but also create a better quality of life for the citizens in Copenhagen. We incorporate climate change adaptation at all levels of city planning and prepare comprehensive solutions for the entire city.”

*Mayor for Technical and Environmental Affairs
Morten Kabell
Municipality of Copenhagen*

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DANISH STRONGHOLDS IN CLIMATE ADAPTATION

Climate change is one of the most serious global challenges facing our society. The changing climate impacts society and large ecosystems. Climate change can increase or decrease rainfall causing drought, can affect human health in urban areas, and cause stronger storms and extreme weather incidents which have large impact on local infrastructure in terms of energy, water and food supply.

Climate-related impacts occur across regions and across many sectors of our economy. Many state and local governments are already preparing for the impacts of climate change through "adaptation", which is planning of the expected changes.

"Adaptation" has become synonym for large national and regional investments within the fields of coastal protection and flood management, climate resilient buildings, and emergency preparedness measures, as well as new technology to ensure future resilient urban areas.

In this sense climate adaptation has become a driver for green growth, creating new employment, innovative solutions and increasing exports.

Denmark and the capital Copenhagen is a global leader within the field of "adaptation". We have a number of

leading edge competencies within planning and implementation of climate adaptation solutions that we want to share with the world.

Synergies from integrated approach

Danish experiences showcase how Denmark and Copenhagen having a holistic approach, and by "walking the talk" has included adaptation and transformation to rethink urban development towards more resilient and livable cities.

Combining holistic planning with "State of the Art" adaptation technology secures urban living and works as green growth catalysator for job creation locally.

The best examples of climate adaptation are those who succeed in solving more than one problem at the same time. For example, using rainwater in the solutions for the city that at the same time minimize water consumption and contribute to the recreational value of city.

On the following pages you will find a short overview and a few cases of Danish strongholds in climate adaptation.

CLIMATE RESILIENT BUILDINGS

Preparing buildings to become more resilient to extreme weather events like storms, heavy precipitation and extreme temperatures is essential to avoid costly damages to homes, office buildings and production facilities as well as to save lives.

Robust materials and proper design parameters

Weatherproofing a building should include a combination of robust building materials and proper design parameters – for example concerning the maximum level of snow load and wind speed the building should be able to withstand as well as measures to secure proper thermal insulation and rainwater drainage.

Long tradition of building sustainably

Denmark holds a strong tradition of architecture and design that takes the surrounding environment into account. Legislatively, lessons learned from previous extreme weather events have been used to upgrade the national building code to promote measures that will ensure more climate resilient buildings.

CASE 1: Climate resilient office buildings – SEB Building

During the planning of this new office building in Copenhagen, the future's climate was taken in to account and the building was made climate resilient in various ways. White concrete to avoid unnecessary heating of the surface, green areas and local use of rainwater to secure proper rainwater drainage, are all approaches that made this building climate resilient. Additionally dispersing of rainwater helps prevent urban heat effect on warm days as well as ensuring good growing conditions for trees and plants.



Picture: SEB

CASE 2: Climate resilient apartments in the middle of Copenhagen

Søpassagen is a block of residential buildings in Copenhagen which are made resilient to extreme weather conditions. The main focus has been to prepare the buildings and the area to cope with heavy rainwater and at the same time to make the building more sustainable and energy efficient. Solar panels have been installed at the rooftop and all the rain from the rooftop is being harvested and led down to the basement where it is used in the common washing machines or to water the plants at the street. The remaining water is led to two dry wells. The result is that rainwater from these buildings does not reach the sewer systems but is treated locally.

MORE INFORMATION:

- ① SLA.dk
 - ① Itarkitekter.dk
 - ① kk.dk
- searchfield: soepassagen



Picture: Municipality of Copenhagen

INTEGRATED PLANNING FOR CLIMATE ADAPTATION

In addition to having to deal with the effects of urbanization and increasing population density, cities around the world need to develop solutions that enable them to withstand the threats of extreme weather events and rising sea levels.

An integrated approach ensures cost-efficiency

Climate adaptation also presents an opportunity to gain greater value from urban development investments. For instance, rather than expanding the sewage system underground, stormwater drainage capacity can be increased by integrating canals, lakes etc. which can also serve as recreational areas, help cool the city and increase biodiversity.

Synergies from holistic planning and prioritization

Danish cities have increasingly adopted an integrated approach for solving the challenges of climate change and urbanization. Through public-private cooperation and long term holistic planning, they have managed to achieve cost-efficiencies, greater public support and ultimately healthier and more livable cities.

CASE 1: Sankt Jørgens Lake – a future water reservoir

The lake in the middle of Copenhagen will play an important role to prevent floods when Copenhagen in the future will face more cloudbursts. The plan is to lower the water table so the lake can work as a huge reservoir to spare the sewers. The lower water table will be established together with a new green area around the lake, which works as a recreational area and a reservoir.



Picture: City of Copenhagen


CASE 2:

St. Annæ Square: An open green and blue cloudburst solution

During its renovation, St. Annæ Square will be strengthened with regard to everyday rain as well as cloudbursts. The challenge is that the area is situated in a densely populated part of the city and cannot deal with rain from a cloudburst with its present design. One of the solutions to the cloudburst problem is to increase the area's drainage capacity by integrating the small park in the middle of the square. The park will be designed with a concave shape able to hold large amounts of water, which would then be channeled to the harbor. This solution ensures that the area will work as a peaceful retreat and a beautiful connection to the rest of the city.

Also attempts are being made to solve the cloudburst problem as well as achieving other urban goals at the same time by establishing a public-private cooperation covering both financing and implementation

MORE INFORMATION:

 stateofgreen.dk



Picture: City of Copenhagen/Ursula Bach

THE HARBOUR TURNS BLUE

The idea of swimming in Copenhagen's harbour would have been out of the question back in the 90's because the water was badly polluted. Many problems had to be solved before the citizens of Copenhagen could start swimming in the clean harbors. Among others was discharge of wastewater from sewers and industrial companies having a major impact on the water quality. Storm water run-off entered the sewage system and 93 overflow channels fed the wastewater into the harbour.

However, the problem was addressed by investigating in a complete modernisation of the sewage system. The water quality improved so much, the municipality of Copenhagen was able to open the first public harbour bath in 2002 and more have been established since then offering the people in Copenhagen an unique recreational area.

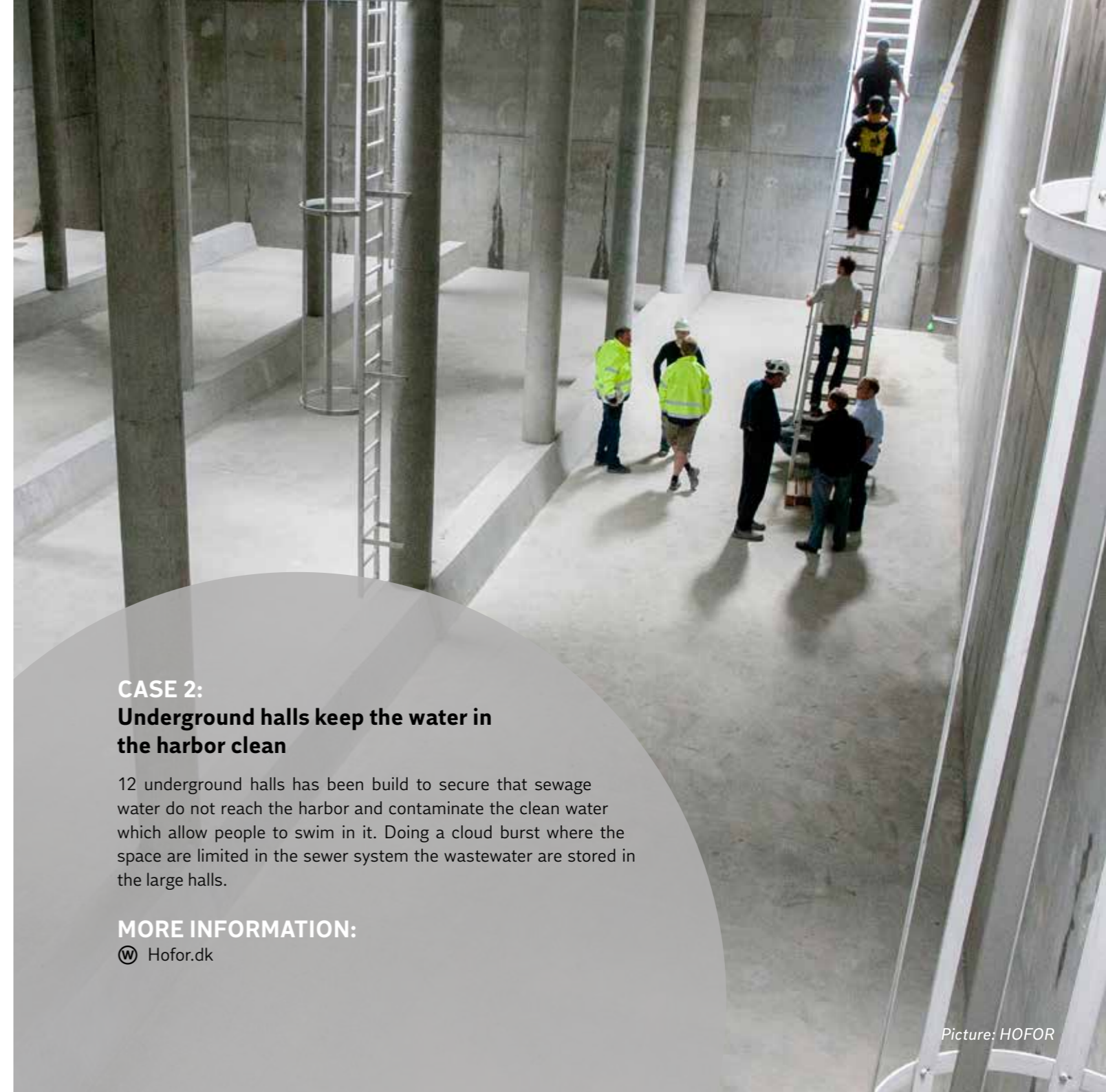


Picture: City of Copenhagen/Ursula Bach

CASE 1:

Sea water cools buildings in Copenhagen

Cooling of buildings with district cooling can save the climate for large amounts of greenhouse gases by utilizing seawater throughout the year. In Copenhagen two cooling centrals have already been established but the demand is huge and more centers are about to be built. District cooling is the distribution of cold water through pipes from a central to a customer where the water cools the air in the customer's air conditioner.



CASE 2:

Underground halls keep the water in the harbor clean

12 underground halls has been build to secure that sewage water do not reach the harbor and contaminate the clean water which allow people to swim in it. Doing a cloud burst where the space are limited in the sewer system the wastewater are stored in the large halls.

MORE INFORMATION:

🌐 Hofor.dk

Picture: HOFOR

RAINWATER MANAGEMENT

Increasing and more heavy precipitation caused by climate change is putting greater pressure on the sewer systems. Rather than replacing existing pipes with larger ones, it is often better to focus on managing the rainwater more intelligently by detaining it in existing structures or distributing it to areas, where it creates the least damage.

Retention, drainage and treatment of rainwater

Solutions to managing increasing volumes of rain span from hydraulic models in the planning phase over solutions for local retention of rainwater, such as subsurface infiltration beds, green roofs and permeable paving to drainage solutions such as separate sewers for rainwater and sewage water and finally local rainwater treatment via roadside infiltration beds and sand traps etc.

Local drainage water solutions

More and more Danish cities and water utilities are looking into handling the rainwater as close to the source as possible and diverting it away from the sewer systems and wastewater treatment plants, thereby bringing down the chance of combined sewer overflows.

CASE 1:

Ny Kongensgade

The water is collected in grated channels at the side of the road and is channeled in storm drains and flows out into the harbour. In this case, the subterranean solution with an outlet to the port is the most appropriate. An open and green solution would have been difficult to design in Ny Kongensgade because of space problems and the traffic conditions.



Picture: City of Copenhagen/Ursula Bach



CASE 2:

A public roof garden at the new National Archives

At the new National Archives a roof garden has been constructed in a way that leads all precipitation water through the growth media and the reservoir plates, before the excess water reaches the drainage system. This optimizes the reservoir effect and holds back up to 70 per cent of the water on an annual basis.

However the green roof is more than just a smart way of managing rainwater. The project also brings landscape and publicly accessible space into an area characterized by large building volumes with an industrial character. The roof terrace of the new National Archives is a part of the future elevated pedestrian passage, accessible to the public, which will connect two areas in the Centre of Copenhagen and create a quiet garden for people to relax in. In the coming years, the planned elevated passage will be completed, stretching approximately 900 metres in total.

MORE INFORMATION:

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searchfield: solutions

Green roofs Copenhagen

Picture: City of Copenhagen/Dorthe Rømo

COASTAL PROTECTION

Rising sea levels and more frequent storms and storm surges increase the threat of erosion and flooding of coastlines. The UN climate panel (IPCC) predicts a global water level increase of 0.3–1.0 metres by 2100. As the sea-level rise and weather patterns change, so does the need for shoreline, and coastal management and protection.

Protective solutions

Denmark has developed expertise in modelling forecasting and environmental engineering, providing a strong basis for protecting its coastal areas in the future. This include both solutions against erosion, such as shore nourishment, breakwaters, cliff and slope defences, groynes and sand dunes, and solutions against rising sea levels, such as dikes, mobile and permanent quay walls.

Geography made Denmark a specialist

Being a flat country, almost completely surrounded by the sea, Denmark has a strong tradition for public-private collaboration on the management and protection of its 7,300 km of coastline. Danish expertise includes risk assessment of sea and inlet flooding due to expected water level rises caused by climate change.

CASE 1: Coastal protection creates a more livable harbor

In the Danish city, Lemvig, a wish for making the harbour more attractive for people was combined with a new coastal protection. A curved concrete wall has been built to cope with storm surges. The special design functions as a big furniture and divide the large area into smaller spaces which makes the harbour a more interesting place for people to reside.



Picture: Mads Krabbe

CASE 2: A new dike and a coastal path

One of the largest climate adaptation projects in Denmark takes place south of Copenhagen where a new dike has been built behind the old dike. This has increased the dike by approximately 2 metres. The dike protects city areas, urban infrastructure and nature. The project is an example of an initiative that will become necessary in order to climate-proof large community values.

The project has also created a great opportunity to open a coastal path on the old dike. It is now possible to ride a bike, skate or walk this scenic stretch.

The new dike is a good example of how climate protection and coastal protection can be integrated with other green and recreational purposes.

MORE INFORMATION:

🌐 hogk.dk

🌐 klimatilpasning.dk
searchfield: Vestamager



Picture: Danish Nature Agency/Martin Nielsen

FLOOD MANAGEMENT

Rising water levels and extreme weather conditions make flooding an inevitable consequence of climate change. The question of how to cope with these events and minimize the inherent environmental and social damages is on the agenda across the world.

Means for mitigation

Although it may be impossible to avoid floods entirely, Danish companies have developed highly effective solutions for preparing for and mitigating the effects of flooding. Danish expertise comprises systems for modelling, risk mapping, monitoring and early warning, as well as for retention, drainage, pumping and even cleaning of flood water.

Intelligent drainage

In Denmark there is a strong focus on developing intelligent links between early warning systems and management of flood water. This include combining flow measurements with automated drainage systems, pump stations and lock systems to prevent flooding in vulnerable areas, e.g. by leading urban flood water into ponds and reservoirs, rather than directly to the sewers.

CASE 1: NoFloods Mobile Barrier

This solution is an easy way of protecting vulnerable areas to mitigate the effects of flooding.

It is a mobile solution that can easily be set up for temporary large scale flood protection. The solution is far more easy to work with than sandbags because it demands less man-hours and time.



Picture: Environment Solutions



CASE 2: Musicon – a skate park as flood mitigation

Storm water solutions with multiple purposes are implemented in a new developed area near Copenhagen. The idea is to handle all storm water on the surface and utilize the facilities for other purposes during dry weather. At the same time the storm water system should make the whole area climate change resilient to avoid damages from heavy rain storm and cloudbursts.

One of the results is a new storm water system and storage facilities. Most of the streets, canals and storage facilities serve a double purpose as recreational facility for skating and ball gaming. A big skater bowl has been build, which under normal weather conditions works as a normal skater bowl but during cloudburst s serves as a reservoir for rainwater which is led from the surrounding area to the skate bowl.

MORE INFORMATION:

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searchfield: solutions/NoFloods Mobile Barrier

searchfield: solutions/Musicon

Picture: Municipality of Roskilde

WANT TO KNOW MORE?

Stateofgreen.com is your on-line entry point for all relevant information on Denmark's green solutions and stakeholders. Here you can explore state-of-the-art climate adaptation solutions and take advantage of the lessons learned from leading Danish companies and institutions through a tailored State of Green Tour in Denmark. You can also find news and facts on climate adaptation and connect directly with the companies and cities behind the cases in this brochure.

 [stateofgreen.com/
climate-adaptation](http://stateofgreen.com/climate-adaptation)

Danish Cleantech Hub (DCH) is a public-private partnership aiming to increase Danish export of cleantech solutions to New York. DCH was established to support the visibility and commercialization of Danish cleantech by jointly promoting Danish solutions through local network and partnerships. DCH provides the strong, local platform necessary to bring your solutions into play in New York.

Contact us at
danishcleantechhub@di.dk

 di.dk/dch

A web portal on **Climate Change Adaptation**, managed by the Danish Nature Agency under the Ministry of the Environment, presents a wide range of resources pertaining to climate change and climate change adaptation within a number of areas. The site is a collaborative effort with Danish ministries and agencies, targeted at citizens, companies and local authorities.

The portal provides up-to-date information and news on developments regarding climate change adaptation in Denmark and abroad.

 en.klimatilpasning.dk

