



# Climate change adaptation of major infrastructure projects

Country report for Denmark

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# Contents

1. INTRODUCTION .....	6
2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK .....	7
3. RESOURCES .....	9
3.1. Data Availability .....	10
3.2. Methodologies .....	11
3.3. Tools .....	12
3.4. Guidance .....	13
3.5. Design Standards .....	13
3.6. System .....	14
3.7. Institutional Capacity .....	15
4. SECTOR OVERVIEW .....	17
4.1. Transport .....	18
4.2. Broadband .....	19
4.3. Urban Development .....	20
4.4. Energy .....	20
4.5. Water .....	21
4.6. Waste .....	22
5. CASE STUDIES .....	23
5.1. Case studies of climate adaptation projects .....	23

**Note for the readers of the printed version:** the present country report links to a large number of resources via hyperlinks, which by nature are only active in the electronic version. In order to find the identified resources, an online search will usually deliver the right result; but otherwise it is also possible to make use of Annex II of the main report where all the identified resources and their hyperlinks are presented.

**Disclaimer:** The identified resources are non-exhaustive and present a snapshot of the readily available and accessible material during 2017. This information was collected through finite web-based desk research, and through questionnaires and interviews aimed at the relevant national competent authorities (ESIF managing authorities, research institutes, ministry officials, etc.). Further resources might be available but not accessible due to privacy restrictions, or a lack of mandate to share related material. Following the publication of the present report, more resources will continue to reach the public domain, including through Climate-ADAPT and the identified national websites.

## 1. INTRODUCTION

The [EU Strategy on Adaptation to Climate Change](#) of 2013 includes actions to enhance the resilience of infrastructure and mainstream climate adaptation into the European regional and cohesion policy. The [Common Provisions Regulation](#) (CPR) of 2013 states under article 8 that climate change mitigation and adaptation, and risk prevention shall be taken into consideration for investments made with the support of the European Structural and Investment Funds (ESI Funds). The regulation integrates climate change adaptation considerations into the preparation and approval of major projects<sup>1</sup> or other projects funded by the ESI Funds through the requirement to conduct climate change vulnerability and risk assessments. In coordination with the ESI Funds, and complimentary to them, the LIFE fund in addition assists in the realisation of the climate change adaptation objectives. Climate change analyses (such as vulnerability and risk assessments) are also sporadically found to be undertaken for infrastructure projects that are financed outside the framework of EU funds.

This report for Denmark focuses on the adaptation to climate change of infrastructure projects supporting the requirement to undertake climate change vulnerability and risk assessments by presenting:

- **Legal, policy and institutional framework:** A schematic outline of national and regional policy and legal framework, and organisational structure to deal with adaptation;
- **Resources:** Offering the most important resources supporting the realisation of climate change vulnerability and risk assessments for infrastructure projects. The available resources for data, methodologies, tools, guidance, design standards, system framework and institutional capacity are contextualised and listed in this section;
- **Sector overview:** Identifying the approach, main strengths and weaknesses for each of these sectors: Transport, Broadband, Urban development, Energy, Water and Waste;
- **Case studies:** Current practice in adaptation and resilience of infrastructure projects.

### ***Country Overview***

The inaugural [Danish Strategy for Adaptation to a Changing Climate](#) was published in 2008, followed by an [Action Plan for a Climate-Proof Denmark](#) in December 2012. The Ministry for Energy, Utilities and Climate carries out legislative work in cooperation with other government agencies – in particular the [Danish Energy Agency](#), and consults with other ministerial institutions when in need of expert advice. All [Danish municipalities have finalized their climate adaptation action plans](#). Local Government Denmark (LGDK) has a specific department focusing on technology and the environment, which assists the municipalities with consultancy services within areas such as water, nature, planning, urban and road traffic.

The Danish portal “Klimatilpasning” provides open access to the latest knowledge of climate change adaptation, and is continually being developed so it can be used by authorities, businesses, sector specialists and the general public. Meteorological data are available throughout Denmark, via the [Danish Meteorological Institute \(DMI\)](#) offering data, planning tools and information on climate adaptation. There are also sector-specific

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<sup>1</sup> major project: an operation comprising a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds EUR 50 000 000 and in the case of operations contributing to the thematic objective under point (7) of the first paragraph of Article 9 of Regulation 1303/2013 where the total eligible cost exceeds EUR 75 000 000

websites, such as [kyst.dk](http://kyst.dk) with further work currently being carried out to coordinate between each key stakeholder at municipality level, before disseminating this information nationally to businesses, local government and all citizens. Climate change adaptation methodologies adopted across Denmark vary between municipality and on a case-to-case basis. The Danish web portal [Klimatilpasning](http://Klimatilpasning.dk) has published a [guide](#), introducing a general methodological framework and model to estimate climate change risks and climate change adaptation possibilities. [Klimatilpasning.dk](http://Klimatilpasning.dk) provides a set of interactive tools to help users, including a climate change map and a report featuring models to do with erosion and perceived risk. EIONET provides both [Flood Maps](#) and [Flood Risk Management Plans](#). Institutes at [Aarhus University](#) and the [University of Copenhagen](#) work closely with relevant agencies such as the [DMI](#) and [DEA](#), who collect and share knowledge regarding climate change adaptation throughout Denmark. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

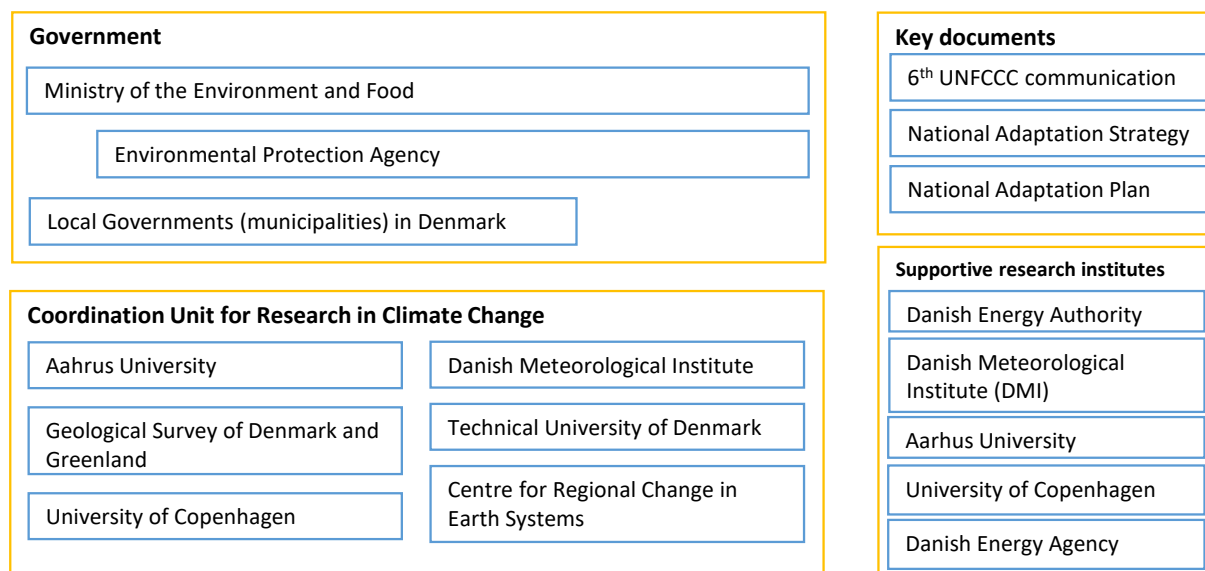
The [Danish Road Directorate](#) ("[Vejdirektoratet](#)") is committed to protecting the Danish state-owned road network through climate change adaptation by producing a strategy. With a new [climate change adaptation plan](#) and [a contingency plan for torrential rain](#), Copenhagen Airport is now in the process of adapting to future climate conditions. Local authorities have carried out a number of smaller projects to ensure stable connection across the country. An example is the Solrød municipality, which has internally-connected their local institutions with fibre connections. [Flydende og fast](#) is a Danish handbook with methods and tools to develop climate change adaptation solutions, particularly within urban cities; whereas [Kysterne](#) contains interactive maps that depend on inputs and show different scenarios regarding especially floods and erosion. [Klimatilpasning.dk](http://Klimatilpasning.dk) provides up-to-date news and information regarding various strategies and projects, including in the [Energy distribution page](#). The [National Environmental Research Institute](#) is also involved in energy and climate adaptation projects, such as NORD-STAR. There is a national focus on water-related measures in urban areas, particularly since the [Copenhagen floods in 2011](#). In Copenhagen, there have been calculations regarding the risk of damage from rising seawater levels. This is further described in the Copenhagen Climate Change Strategy ("[Københavns Klimatilpasningsplan](#)"). Various organisations in Denmark are establishing strategies to ensure the waste management sector is adapting to climate change. One organisation, "[Multikant](#)", develops strategies and solutions for state-of-the-art waste handling and for both the public and the private sector.

The case studies found in the accompanying country report for Denmark, feature Copenhagen's 2012 [Cloudburst Management Plan](#), a socio-economic study analysing the combined sewer solution in the city; and a [local adaptation planning project across 15 Danish municipalities](#).

## **2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK**

The responsibility for climate change adaptation is shared between the national and the municipality levels. The overall responsibility of climate change adaptation is with the Danish Environmental Protection Agency, within the Ministry of the Environment and Food.

A cross-ministerial committee of government officials has been responsible for mapping the impacts of climate change in Denmark and the Action plan for a climate-proof Denmark. To ensure a coordinated effort among public authorities, an organisational framework worked from 2008 to 2011, including a horizontal coordination forum on adaptation (KoK).



The Government's [strategy for adaptation to climate change](#) focuses on adaptation at a national level. The strategy describes the vulnerability of each “focus sector” where climate change is expected to have significant consequences. The focus of this strategy will be on supporting “autonomous” adaptation measures already underway, whereby authorities, businesses and private citizens react to the consequences of climate change on their own initiative in a timely manner within the given legislative, economic and technological framework.

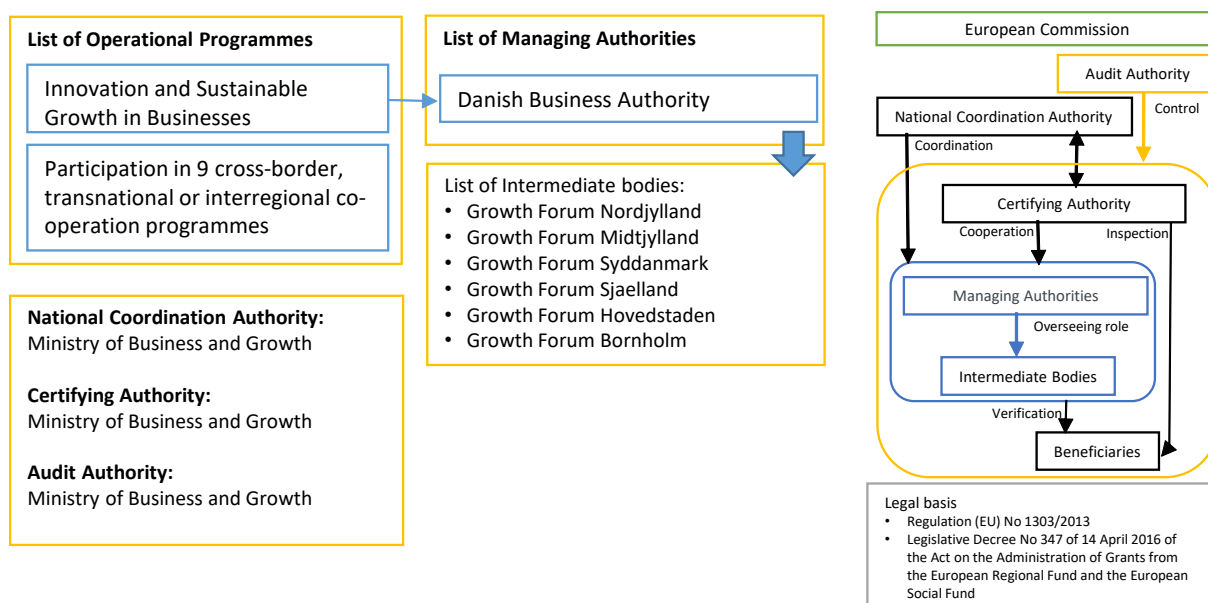
The Coordination Research Unit at [Aarhus University](#) aims to collate and transfer knowledge within all Danish (and international) research areas that work on the issue of climate change adaptation, and to help coordinate information access at the science-policy interface. They work alongside various other institutions, such as the [Danish Meteorological Institute \(DMI\)](#), the [University of Copenhagen](#) and the [Danish Energy Authority \(DEA\)](#).

The [Ministry for Energy, Utilities and Climate](#) carries out legislative work in cooperation with other government agencies – in particular the [DEA](#). They are primarily responsible for coordination and development of domestic climate and energy policy, inter-ministerial coordination, and negotiation and implementation of international agreements and EU regulations. The Ministry consults with other ministerial institutions when in need of expert advice.

[Local Government Denmark \(LGDK\)](#) is the network and interest group for all 98 Danish municipalities. The mission of [LGDK](#) is to safeguard the common interests of the municipalities, assist individual municipalities with consultancy services and ensure that the local authorities are provided with up-to-date and relevant information. [LGDK](#) has a specific department focusing on technology and the environment, which assists the municipalities with consultancy services within areas such as water, nature, planning, urban and road traffic. The NAP requires all municipalities to develop an action plan for climate change by the end of 2013. To support municipalities and local level decision makers in their work, the Danish Nature Agency issued a Guidance document in 2013. All 98 Danish municipalities have finalized their action plans. Each plan includes a flood risk mapping and sets the priorities for the local climate change adaptation measures.

For the 2014-2020 programming period, ERDF is mainly absorbed through the Operational Programme “Innovation and Sustainable Growth in Businesses” managed by the Danish Business Authority.





### 3. RESOURCES

This country report has reviewed the currently available resources in Denmark for adapting to the impacts of climate change across six key infrastructure sectors. Adaptation to climate change is integrated in the legal basis<sup>2</sup> for ESIF-funded projects, through the processes of vulnerability and risk assessments which are, broadly:

1. Vulnerability – evaluating the sensitivity and exposure of infrastructure to climate change
2. Risk – estimating the likelihood and impact of relevant climate hazards
3. Adaptation - consideration of adaptation options and integration into the project planning

The legal requirements for major projects also foresee climate change mitigation. This study however is focused on climate change adaptation and does not cover mitigation aspects.

Information on the requirements for climate change adaptation is available in the 2016 publication [Climate Change and Major Projects](#), and details on the methodology of climate resilience analysis is provided in the 2017 JASPERS publication [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#). Further resources are being identified in the present publication and its references. Effective vulnerability and risk assessments for the adaptation of major projects to climate change require the resources explained in the following table:

Resources	Explanation
<b>Data Availability</b>	The availability, accessibility and applicability of data on climate projections and impacts, on past and historic events, on geophysical parameters, on long-term scenarios, on economic, environmental and social impacts, etc.

<sup>2</sup> Regulation (EU) No 1303/2013, Commission Delegated Regulation (EU) No 480/2014, Commission Implementing Regulation (EU) No 1011/2014, No 215/2014, 2015/207; and the Directives 2001/42/EC, 2011/92/EU and 2014/52/EU

<b>Methodologies</b>	The existence of quantitative or qualitative methodologies (a system of processes, a set of principles and rules) for integrating climate change adaptation in the development of infrastructure projects.
<b>Tools</b>	The availability of tools for planning, evaluation, impact estimation (i.e. software, maps, computer simulations, long term climate forecasts etc.) to assist with the adaptation of infrastructure to climate impacts
<b>Guidance</b>	The provision of guidance on how to use methodologies (i.e. for conducting climate change vulnerability and risk assessments) or develop the required infrastructure project documentation relating to climate adaptation.
<b>Design Standards</b>	The availability of published engineering design standards (i.e. by BSI, DIN, ISO) for infrastructure projects that include sections or appropriate provisions to ensure resilience to climate change impacts
<b>System</b>	The institutional and legal framework that the formal authorities work with to deliver their primary responsibilities for climate adaptation, infrastructure, and management of European Structural and Investment Funds
<b>Institutional Capacity</b>	The human and technical capacity of institutions to carry out their functions. It depends on being adequately resourced, on having the appropriate expertise, and on collaborating effectively and enforcing laws and regulations

### **3.1. Data Availability**

Quantitative data are essential to understand the relevant risks and the requirements for any corresponding climate change adaptation in key sectors.

[Klimatilpasning.dk](http://Klimatilpasning.dk) is a Danish web portal that was established in connection with the new climate change adaptation strategy. The purpose is to gather all information, tools and news regarding climate change. Although this portal contains information about climate change adaptation within a number of sectors, the primary focus is to provide a database with examples of climate change adaptation cases and reports in Denmark. [Klimatilpasning](http://Klimatilpasning) provides open access to the latest knowledge of climate change adaptation, and is continually being developed so it can be used by authorities, businesses, sector specialists and the general public. The web portal also includes a wide range of examples of adaptation action in various sectors linked to the NAS/NAP, and a few sectors, such as transportation and coastal protection, have dedicated adaptation plans embedded in sector strategies.

More specialised resources are also available with a greater sectoral focus:

- [kyst.dk](http://kyst.dk) is the website for the Danish Coastal Authority, where more coastal specific news, publications, strategies and other relevant information are available;
- [kystatlas.dk](http://kystatlas.dk) is a tool for analysing coastal data, such as sea level rise, erosion and more. The user is able to click input on/off e.g. the "risk of erosion" or "risk of flooding" and it will show the affected coastal line on the map. These are primarily used by coastal land owners and by urban developers.

In 2016 a [National Coastal Report](#) was also prepared. This included an analysis of which coastal assets were at risk due to climate change.

The Danish Meteorological Institute (DMI) is the official [Danish meteorological](#) institute, administrated by the [Ministry of Energy, Utilities and Climate](#). The institute makes weather forecasts and observations for Denmark, Greenland, and the Faroe Islands. The DMI hosts climate projections for Denmark and has participated in a number of international projects directed towards a variety of climate-related research, including contribution to the [Intergovernmental Panel on Climate Change's \(IPCC\) Fifth Assessment Report](#).

[Statistics Denmark](#) is the national statistics authority and maintains a database of statistics relating to the economy, society and environment. The exact content of this database was not examined in the context of the present study.

There are a number of research institutions in Denmark that make available information and data relating to climate adaptation, including the [Center for Ice and Climate](#), the [Interdisciplinary Centre for Climate Change](#), and the [Niels Bohr Institute](#).

Denmark's [Sixth National Communication](#) to the United Nations Framework Convention on Climate Change (UNFCCC) also provides long-term climate change assessments across a range of sectors, with scenarios on risk and vulnerability assessments by sector.

A major part of land coverage and socio-economic data is freely available for all public institutions (including universities) through the [KMS governmental data agreement](#). Thematic impact maps are publically available; however further detailed analysis of some of these may be accessed by contacting the institutions responsible for conducting the analysis and producing the maps. Additionally some institutions provide web-based Geographic Information Systems (GIS) solutions, including dynamic interfaces where thematic impacts maps can be explored.

Updates for a wide range of national adaptation actions, can be found in the [National adaptation actions deliveries database on EIONET](#), and on the [Climate-ADAPT](#) website.

### **3.2. Methodologies**

Methodologies for integrating climate change adaptation into the development of infrastructure projects rely on the basic rules of risk assessment.

Climate change adaptation methodologies adopted across Denmark vary between municipality and on a case-to-case basis. The decision to delegate responsibility for climate change adaptation methodology to individual municipalities, rather than national government (see System/Institutional Framework), is intended to give municipalities greater flexibility in assessing climate change adaptation requirements.

A mutual agreement between the national government and [LGDK](#) in 2012 led to each municipality being required to prepare a local climate change adaptation plan "[Kommuneplan](#)" (see System and Legal Framework). The Government and relevant agencies assist the municipalities with data, though both planning and execution of the climate change adaptation project is solely the responsibility of the municipality. An estimation of the risk entailed within each local plan is also required.

The Danish web portal [Klimatilpasning](#) has published a [guide](#), introducing a general methodological framework and model to estimate climate change risks and climate change adaptation possibilities. The methodology report includes definitions of major concepts, an outline of an analytical structure, a presentation of models and their applicability, and the results of case studies. This framework can be used to assess climate change impacts, vulnerabilities, and adaptation options in Denmark. Another report, "[Mapping Climate Change](#)", details existing barriers and potential opportunities for Denmark in the wake of action through adaptation.

### **3.3. Tools**

Tools are highly valuable for facilitating climate adaptation studies and planning for infrastructure. They can be public or private, numerical or descriptive, and be provided in many mediums, such as software, text documents, maps, and so on. Some tools are generic (such as in risk assessments) whilst others are specific to a certain set of circumstances.

[Klimatilpasning.dk](https://www.klimatilpasning.dk) provides a set of interactive tools to help users. These tools are designed to help both municipalities and individuals. For example, an interactive climate change map where the user is able to zoom in on a geographical area of Denmark and see the predicted future climate for this area.

A new tool, PLASK, that calculates the socioeconomic benefits from climate change adaptation, has been developed and can be found on the web portal. The tool is now being tested in municipalities.

The Ministry of Environment and Food provides detailed [Flood Maps](#). This is publically available and provides detailed insight into a location's flooding probability. As part of the European Floods Directive, flood risk [management plans](#) were also formulated, which signal areas with the highest risk of floods in Denmark. Denmark also offer advanced tools to measure the risk of floods in specific areas, for example a height model (højdemodel) "[Højdemodellen](#)", which is a national topographical tool displaying the risk of an area flooding based on sea level rise.

Denmark will experience an increase in the frequency and duration of heat waves. A report on future climate in Denmark is available and an analysis of the 5th Assessment Report from IPCC, with special focus on Denmark is available.

[VisAdapt](#) is a tool that guides citizens on how to prepare for weather and climate related events that may affect private houses. VisAdapt is a science based tool developed by researchers from Linköping University (Sweden), the Norwegian University for Science and Technology (NTNU) (Norway) and Aarhus University (Denmark), together with experts from the insurance industry, in the context of the NORD-STAR project.

[Klimatilpasning](#) features a report ("[Erosionatlas](#)") by the [Danish Hydraulic Institute \(DHI\)](#) assessing the risk of erosion across Denmark, mapping which coastlines have the highest risk of erosion and presenting possible methods to calculate the perceived risk. Further to this, the erosion model follows the same methodology as the height model above, showing the risk of a coast line eroding dependent on the inputs used. Municipalities also have access to other advanced tools e.g. consulting engineers if they choose to use them in specific cases.

EIONET provides [Flood Maps](#) which are publically available, mapping areas of potential significant flood risk. EIONET also contains Flood Risk Management Plans.

For a continual update of available tools, the reader is referred to the European Climate Adaptation Platform [Climate-ADAPT](#), which has a dedicated tools section.

### **3.4. Guidance**

Guidance is an essential requirement to ensure consistency in applying methodologies and tools.

The NAP requires all municipalities to develop an action plan for climate change by the end of 2013. To support municipalities and local level decision makers in their work, the Danish Nature Agency issued a Guidance document in 2013. All 98 Danish municipalities have finalized their action plans. Each plan includes a flood risk mapping and sets the priorities for the local climate change adaptation measures. [Klimatilpasning.dk](http://Klimatilpasning.dk) also provides guidance to municipalities in setting municipal action plans.

The following guidance is available at municipality level:

- West Jutland case: There exists a [common agreement between the municipalities of West Jutland and the government](#) on how to protect the coastline from flooding and erosion. This agreement usually runs for five years and works as a financial framework agreement, where both municipality and government undertake a specific financial commitment;
- Aarhus case: Combining climate change adaptation with urban development. In Aarhus [this agreement](#) has raised the level of a road to adapt to flood risks; and
- Copenhagen case: Calculating the risk of damage from rising seawater and rainwater levels. It is expected that the risk of damage will rise above an acceptable level by 2040. Copenhagen is now actively trying to implement changes to prevent this, described in the Copenhagen Climate Change Strategy ("[Københavns Klimatilpasningsplan](#)").

Regarding coastlines, there are specific guidelines to how municipalities/land owners can evaluate the risk of floods in coastal regions ("[Guidelines for klimatilpasning i kystområder](#)"). The Government has developed a "plan line" (planlinje) and "action line" (aktionslinje), which are geographical lines delineating a coastal area at risk of floods and/or erosion:

- Plan line: The purpose of the plan line is to inform local land owners and urban developers intending to build new structures in that zone, that they should take into consideration the potential risk of flooding and erosion. Plan lines have a long-term perspective and indicate areas that are threatened by erosion, floods or sea level rise in the life time of an asset;
- Action line: The purpose of the action line is to inform land owners/municipalities that if there are houses/structures in the zone, they need to take action regarding flood risk. Action lines therefore indicate when one needs to consider taking measures to handle the threat of a climate hazard, e.g. erosion. The use is more immediate and the line continuously changes depending on new climate data.

There is effort to implement these guidelines across Denmark, but currently only [one municipality](#) has adopted both "plan lines" and "action lines". The municipality has also developed a local strategy for climate change adaptation. The [Ministry of Transport in Denmark](#) published their strategy framework to frame the future work with climate change adaptation regarding the coast lines and infrastructure assets. The Danish Coastal Authority ("[Kystdirektoratet](#)") has spread good practice by considering the risk of floods and erosion during the planning of all infrastructure projects.

### **3.5. Design Standards**

Design standards are critically important for all infrastructure projects to ensure stability and optimal functioning under the strain of natural phenomena. For civil works (including bridges, buildings, masts and towers for the mobile access networks), EN standards are available to address natural forces such as wind and snowfall, e.g. EN1991-1-4 (Eurocode 1) and EN1993 (Eurocode 3) for structures in steel. However, these standards might be outdated and not account for the impacts of climate change.

[Dansk Standard](#) (DS), the national standards authority, is collaborating with the [European Standardisation Organisations](#) in the context of the EU Regulation No 1025/2012 on European standardisation. The European Committee for Standardisation (CEN) and Electrotechnical Standardisation (CENELEC) established the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) to coordinate standardisation work in the field of adaptation to climate change in support of the implementation of the EU Strategy on Adaptation to Climate Change. More information is available in the section on *Available resources at the EU level* in the Final Report of the present study (European Commission, 2018).

### **3.6. System**

The institutional system for adapting to climate change requires a legal framework (laws and implementing regulations) and strategies and policies (with implementing action plans). The system is usually conflated with disaster management (and its various components, preparedness, reduction etc.) and more generally with resilience.

#### ***Institutional and legal framework***

The Government has formulated a [National Adaptation Strategy](#) that describes where climate change is expected to have a significant consequence in the future.

In December 2012, the government launched an [Action Plan for Climate Protection of Denmark](#). The action plan describes a number of initiatives that, from the state side, will help to create a sustainable green climate adaptation effort in Denmark. The action plan is supported by the [Background Report on Mapping Climate Change Opportunities and Barriers to Action](#).

All [Danish municipalities have finalized their climate adaptation action plans](#). Each plan includes a flood risk mapping and sets the priorities for the local climate change adaptation measures. The EU Water Framework Directive and the EU Floods are transposed in Danish legislation and are implemented at municipal level as Water Treatment Plans and Risk Management Plans. These municipal plans combine with the Action Plan For Climate Change Adaptation to influence the Sector Plans, over which the municipalities have authority.

The Danish transposition of the revised EIA directive (Law number 448/2017) includes adaptation considerations.

The National Risk Assessment is undertaken in line with thematic ex-ante conditionality 5.1, according to which, national or regional risk assessments for disaster management need to be taking into account climate change adaptation.

#### ***Responsible authorities***

The [Danish Coastal Authority](#) and the [Ministry of Environment and Food of Denmark](#) has the overall responsibility for the NAS, and can aid the municipalities if required. The [Ministry for Energy, Utilities and Climate](#) carries out legislative work in cooperation with other government agencies, such as the [Danish Energy Agency](#) (DEA). Their area of responsibility is primarily coordination and development of domestic climate and energy policy, inter-ministerial coordination, and negotiation and implementation of international agreements and EU regulations.

The climate information website [Klimatilpasning.dk](#) is anchored in The [Ministry of Environment and Food of Denmark](#), and delivered in collaboration with a number of ministries, government agencies and stakeholders, including Danish regions and [LGDK](#).



Institutes at [Aarhus University](#) and the [University of Copenhagen](#) work closely with relevant institutes and agencies such as the [DMI](#) and [DEA](#), who collect and share knowledge regarding climate change adaptation throughout Denmark. [Local Government Denmark \(LGDK\)](#) is the network and interest group for all 98 Danish municipalities. The mission of [LGDK](#) is to assist and ensure that local authorities are provided with up-to-date and relevant information.

In general, a large level of responsibility regarding planning of climate change adaptation is “outsourced” to the local municipalities. They are the innovative authorities who develop a majority of the projects. The [Kommunalteknisk chefforening](#) is an industry organisation representing all the Danish municipal authorities, with a focus on legislation and developing knowledge. Presented below is an example of each stakeholders’ assigned responsibility within coastal adaptation planning:

Long-term planning	Government	Municipality	Private
Cloudburst	-	+++	+
Floods from the ocean	+++	+++	+
Floods from streams	-	+++	+++
Coastal erosion	+++	+++	+++

“+” marks level of responsibility. Source: LGDK

### **Management of the ESI Funds**

Denmark has an operational Programme for Innovation and Sustainable Growth in Businesses, which is the National Programme for the European Regional Fund – 2014-2020. Its Managing Authority is the Danish Business Authority. Additionally, Denmark is participating in nine cross-border, transnational or interregional co-operation programmes. The intermediary bodies identified are the Growth Forums of Nordjylland, Midtjylland, Syddanmark, Sjælland, Hovedstaden, and Bornholm. In the control system of the ESI Funds, the National Coordination Authority, the Certifying Authority, and the Audit Authority are all part of the Ministry of Business and Growth.

### **3.7. Institutional Capacity**

The institutional challenge for climate change adaptation is that climate policy is a cross-cutting issue, and requires co-operation across a large number of institutions. To be effective in delivering climate change adaptation a minimum level of capacity is needed on leadership, technical and human resources, effective collaboration, and financial support.

#### **Technical and human resources**

The technical and human capacity of Denmark to meet the challenge of climate adaptation is well developed and supported by a multitude of research institutes.

The Coordination Research Unit at [Aarhus University](#) aims to collate and transfer knowledge within all Danish (and international) research areas that work on the issue of climate change adaptation, and to help coordinate information access at the science-policy interface. They work alongside various other institutions, such as the [Danish Meteorological Institute \(DMI\)](#), the [University of Copenhagen](#) and the [Danish Energy Authority \(DEA\)](#).

The Danish Centre for Environment and Energy ([DCE](#)) is a web portal hosted by [Aarhus University](#), for authorities, businesses and the public to provide knowledge on the environment and energy based research including climate change adaptation.

NORD-STAR, the Nordic Centre of Excellence for Strategic Adaptation Research offers state-of-the-art climate visualisation techniques and policy analysis tools to help bridge the gaps between adaptation science, practice and policy, and an explicit link between climate adaptation and mitigation. The NORD-STAR consortium consists of nine core partners from the five Nordic countries: Aalto University, Aarhus University, Chalmers University of Technology, the Institute for Research in Economics and Business Administration, Linköping University, the Norwegian University of Science and Technology, ProjectZero, the Stockholm Environment Institute, the University of Iceland, and Umeå University.

Interviews conducted in the context of this study with national authorities, identified that economic analyses on climate adaptation could be improved. An occasional issue is the lack of clear allocation of responsibilities , i.e. between the municipalities and the Danish Coastal Authority.

### ***Effective collaboration***

It has been identified that there is a lack of coordination between authorities, and a governance/coordination issue over whose responsibility it is to produce such analysis e.g. does this rest with the municipalities, or other national authorities.

Local Government Denmark (LGDK) is the umbrella and interest group for Danish municipalities. All 98 municipalities are members. LGDK has a climate network, which comprises some of the municipalities. As part of the coastal analysis "[Kystanalyse](#)" undertaken during 2016, all 78 coastal [municipalities](#) were invited, with 56 participating. LGDK were also involved. Key conclusions from the stakeholder involvement included:

- Several municipalities showed interest in collaborating with other municipalities during planning coastal protection. However, there are examples of each municipality prioritizing coastal protection differently making collaboration difficult (29 of 46 municipalities have never collaborated with another municipality regarding coastal protection);
- Municipalities' internal processes regarding coastal protection projects are viewed as inefficient. There is a demand for a clarification of roles and governance regarding coordination between actors; and
- One barrier is that the individual land owner is required to pay for the coastal protection. This results in short-term solutions without a combined strategy for the entire municipality.

There was a strong consensus among municipalities that national government should plan and finance future Danish coastal protection projects.

At a local level, municipalities have stressed they are not always informed of wider national guidelines/standards in a timely manner, and therefore national guidelines/requirements could be a solution, without hampering the flexibility of the municipalities. The national government communicating with the municipalities to understand any issues and needs.

### ***Financial resources***

The [ESI Funds are enabling the development of major projects](#) in the 2014 – 2020 programming period. Concerning major projects, by early 2018, there have been no funds allocated for major projects in Denmark for the 2016 -2020 programming period



according to the datasets of the European Commission. The [data set is updated regularly](#) to reflect changes in the programme lists and major project notifications.

According to the [ESIF-viewer](#), Denmark is planning investments of 552 Million EUR. Projects under the Thematic Objective 7 on Network Infrastructures in Transport and Energy are benefiting from 18 Million EUR; and additionally, 23 Million EUR have been approved under the thematic Objective 6 on Environment Protection & Resource Efficiency.

During the period 2014-2020, under the EU Regional Fund, 72 million DKK have been allocated to sustainable green city development in Denmark. For example, in January 2018, the municipality of Odense received commitments from the EU Regional Fund of 12 million DKK for [sustainable green city development in Odense](#).

The [Danish Local and Regional Fund](#) supports projects that have activity and movement on technical facilities in focus while contributing to climate protection. The [Water Development and Demonstration Program](#) (VUDP), set up by water companies, provides grants for technology and demonstration projects. The projects improve efficiency, quality, environment and export potential in the water sector. In 2017, DANVA's Board of Directors has allocated a total of 7.6 million DKK for new projects, including climate adaptation. VUDP application round 2018 was launched on January 8, 2018. The [Industriens Fond](#) supports some climate adaptation actions within its mandate to develop and support innovative, inspiring and economically sustainable projects and initiatives that strengthen the competitiveness of Danish industry and industry. [Nordeafonden](#) supports some activities relating to climate adaptation. In 2014, the Nordea Fund focused on the good city life through the development of green spaces, with a total of up to NOK 100 million. The Fund supports both projects with national relevance and local projects. The local projects fund is worth NOK 25 million each year.

The [Environmental Technology Development and Demonstration Program](#) (MUDP) is a program in the Ministry of Environment and Food, which supports development, testing and demonstration of environmentally efficient technology. It's about 80 million DKK 2018 for total environmental technology efforts. In 2018 there are a total of approx. 64.5 million. DKK Available for Demonstration of Full-scale Environmental Technology Solutions (Lighthouse Projects) and Development, Test and Demonstration Projects and Approx. 19.5 million. DKK to Green Innovation Pool.

## 4. SECTOR OVERVIEW

Since 2014, the requirements for major projects to obtain ESIF funding<sup>3</sup> demand that project applications integrate climate change considerations<sup>4</sup>, such as a vulnerability and risk analysis and adaptation option appraisal. At EU-level, material is available to assist in fulfilling these requirements. Key websites and documents are:

- The [Climate-ADAPT](#) website containing many links to data and a [map viewer](#)
- EUROPEAN COMMISSION Directorate-General for Regional and Urban policy: The [Guide to Cost-benefit analysis of Investment projects](#) (also referred to as the 'CBA guide')

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<sup>3</sup> [http://ec.europa.eu/regional\\_policy/archive/projects/major\\_projects/index\\_en.cfm](http://ec.europa.eu/regional_policy/archive/projects/major_projects/index_en.cfm)

<sup>4</sup> For a compilation of the climate change requirements for major projects in 2014-2020, see: <http://www.jaspersnetwork.org/plugins/servlet/documentRepository/displayDocumentDetails?documentId=401>

- EUROPEAN COMMISSION DIRECTORATE-GENERAL CLIMATE ACTION: [Non-paper of Guidelines for Project Managers: Making vulnerable investments climate resilient](#)
- JASPERS Guidance note: [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#)
- JASPERS Guidance note: [An overview of the most important sources for integrating climate change in \(major\) projects](#)

Additional relevant material can be found in the Final Report of the present study (European Commission, 2018) in the section *Available resources at the EU level* and in *Annex I*.<sup>5</sup>

#### **4.1. Transport**

Investments in the transport sector are very diverse, covering roads (including bridges and tunnels), inland waterways, rail, ports / airports, and public transport infrastructure. Any disruption caused in this sector can affect many other sectors (economic and societal) directly. Potential threats are sea-level rise and extreme weather events, such as extended heatwaves, flooding, heavy rainfall or storm, and landslides amongst others. Extreme weather events are a potential threat to both infrastructure and operation of the transport system.

##### **Road infrastructure**

The Danish Road Directorate ("[Vejdirektoratet](#)"), an agency under the [Ministry of Transport, Building, and Housing](#), is committed to protecting the Danish state-owned road network through climate change adaptation. A [strategy](#) for adapting to climate change was produced in October 2013, where the agency describes how they manage flooding, improve the resiliency of roads, and prevent climate-related events, wherever it is possible. A background report to the strategy provides detailed analysis of the climate change related challenges with a prioritised list of means to handle each challenge and includes estimated cost. The road-user information centre at the Danish Road Directorate provides information about flooding on their traffic information services, such as [vejdirektoratet.dk](#), mobile telephone apps and GPS. The Road Directorate also cooperates closely with [Denmark's Radio](#) with regard to traffic updates. When a road has to be closed due to flooding, the [Danish Road Directorate](#), in cooperation with the police, call-out services and authorities, will manage the situation to optimise goals for road users, with regard to the condition of the road and informing road users about the flood.

The [Blue Spot model](#), mentioned in the [Danish Road Directorate](#) strategy, describes a screening method to assess flood risk on vulnerable sections of the road network. It is based on Scenario A1B, a model developed at the [DMI](#) and upon the UN climate panel's scenarios, which is used to support research in road flooding. Road improvements are undertaken by the [Danish Road Directorate](#) if the analysis suggests a financially viable solution, which can minimise the risk of subsequent similar events occurring. [Mapping Climate Change](#) provides relevant information on the barriers and opportunities with regards to taking action against climate change consequences. The [National Environmental Research Institute](#) at the University of Aarhus also published "*Danish emission inventories for road transport and other mobile sources. Inventories until the year 2010*" in a scientific report.

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<sup>5</sup> European Commission (2018) Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Final report.

See section 4.1. for more information on other documents that can help in taking climate considerations into account.

### ***Railway infrastructure***

Expected impact of climate change on railway infrastructure includes enhanced risk of flooding and landslides, and breakdowns of overhead wires and fallen trees due to more powerful storms. Although there is no specific strategy to make railway infrastructure more climate resilient, the strategy for road infrastructure as described in the section above, is also relevant for railway infrastructure.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

### ***Airport infrastructure***

With a new [climate change adaptation plan](#) and [a contingency plan for torrential rain](#), Copenhagen Airport is now in the process of adapting to future climate conditions. Copenhagen Airport examined the climate impacts that could hit the airport, such as temperature increases and changes in precipitation or wind conditions. Due to interdependencies with the surrounding areas, the airport needs to cooperate with its neighbouring municipalities to make sure that all their climate adaptation plans are coherent. The airport's [contingency plan](#) identifies the key areas of the airport that must be adequately protected, so that operations are not disrupted for a long time. [The contingency plan](#) also designates the stands and taxiways that will quickly be able to be operational in extreme weather events.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

## **4.2. Broadband**

The International Telecommunication Union has issued the recommendation L.1502 "[Adapting information and communication technology infrastructure to the effects of climate change](#)" for the purpose of identifying climate threats and their impact. L.1502 supports Resilience by design in identified risky areas, and proposes changes to equipment installation standards to ensure protection from more frequent extreme weather phenomena and their impacts. The European broadband sector standardisation bodies have not prepared vulnerability assessment and risk management framework for dealing with climate change in broadband projects.

Local authorities have carried out a number of smaller projects to ensure stable connection across the country. An example is the Solrød municipality, which has internally-connected their local institutions with fibre connections. There is no European funding for the broadband sector in Denmark.

It is a general best practice for operators to use flood mapping information from environmental agencies to safeguard new planned data centres from flooding. For civil works (e.g. masts and towers for the mobile access networks), EN standards are available to address wind and snowfall, e.g. EN1991-1-4 (Eurocode 1) and EN1993 (Eurocode 3) for structures in steel. But these standards don't take climate change into account. CEN-CENELEC is currently working on adapting a number of EN standards to climate change. See Final Report of the present study (European Commission, 2018) for [more information in the section on Available resources at the EU level](#).<sup>6</sup>

<sup>6</sup> European Commission (2018) Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Final report.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

### **4.3. Urban Development**

Investments in the urban development sector include site developments (industrial and other), urban planning, local infrastructure, building projects (such as hospitals, schools), and much more diverse projects. Cities have a unique position to analyse and respond to local impacts and vulnerabilities, such as heat island effects, which depend on the specific layout of a city, its green spaces, and numerous other factors. Cities can actively support the uptake of climate change adaptation in infrastructure projects through, for instance pilot projects, and can initiate dedicated infrastructure projects to improve their resilience to climate change.

[Flydende og fast](#) is a Danish handbook with methods and tools to develop climate change adaptation solutions, particularly within urban cities; whereas [Kysterne](#) contains interactive maps that depend on inputs and show different scenarios regarding especially floods and erosion. It also includes a map of Denmark showing which areas are more susceptible to flooding in the case of extreme rain.

The guidelines and recommendations within the [Climate Adaptation Plan](#) is incorporated into the Municipal Plan as part of Copenhagen's regional strategy. Copenhagen has established three levels of adaptation:

- **First level:** Choose those initiatives which prevent the damage. For example, the building of dykes, building higher above sea level, the expansion of the sewers' capacity and local management of rainwater.
- **Second level:** If it is impossible to prevent the damage, choose those initiatives which minimise the extent of the damage. For example, warning systems for rain, establishing waterproof cellars and adapting areas where rainwater can be stored.
- **Third level:** Measures which reduce the city's vulnerability, for example equipping cellars so they can cope with flooding and being prepared with pumps.

The city of Aarhus has also combined climate change adaptation with urban development. [Interventions at the Aarhus Docklands](#) have raised the level of a road to adapt to flood risks.

The Danish Centre for Environment and Energy has funded two interesting urban development projects on climate adaptation. [ØKOKLIM](#) (*Ecosystem based approaches to climate adaptation – possibilities and conflicts in urban Areas*) investigates the prospects and conflicts of systematically applying an ecosystem based approach to climate adaptation in the municipality of Copenhagen; and [ØkoFORS](#) (*Ecosystem services, climate adaptation and nature quality in suburban landscapes*) uncovers the potential of suburban private landscapes to host a richer nature and ecosystem services.

In January 2017, a six-year climate adaptation project supported by the LIFE programme was launched, namely the [C2C CC](#) (Coast to Coast Climate Challenge) project. It consists of 24 subprojects, including urban development projects, capacity building and innovation actions.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

#### **4.4. Energy**

Project investments in the energy sector are related to power generation infrastructure, energy distribution networks and energy storage (e.g. through hydropower). Potential impacts of climate change on energy infrastructure include damage to power generation plants or problems with energy provision, leading to black-outs or other disruptions. Disruptions in the energy sector can have large impacts on different sectors due to the increasing dependency on (electric) power provision for all kind of operational systems such as water supply (pumping installations, ...), the food system (transport, cooling, ...), transport (electrified vehicles, dynamic traffic information, ...), etc.

[Denmark's 6<sup>th</sup> submission to the UNFCCC](#) observed that changed precipitation patterns in Sweden and Norway will mean production of more hydropower. Higher temperatures in Norway and Sweden will also reduce electricity consumption for heating in these countries. Both these factors should increase electricity supply to Denmark. In recent years, flooding from cloudburst and heavy rain have affected the local power supply causing severe outages. Distribution companies have subsequently carried out screening to identify the exposed areas, raising the cable boxes and transformer stations to prevent future flooding having a similar impact. Historically, the distribution network has been vulnerable to storms from fallen utility poles and overhead wires. In order to rectify this through climate change adaptation, in 2003-2014 power supply lines to households and larger transmission lines across Denmark went through the process of being replaced with underground cables. This increased the resilience of the energy network to the effects of climate change.

[Klimatilpasning.dk](#) provides up-to-date news and information regarding various strategies and projects, including in the [Energy distribution page](#). The [National Environmental Research Institute](#) is also involved in energy and climate adaptation projects, such as NORD-STAR.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

#### **4.5. Water**

Investments in the water sector are linked to efficient water supply (including reduction of leakage), waste-water treatment and water reuse as well as the implementation of [River Basin Management Plans \(RBMP\)](#) to ensure integrated water management at the river basin scale. Important threats are linked to water quantity (droughts and floods) as well as quality (water pollution). Climate change can have an impact on both water quantity and quality. Following the EU Floods Directive 2007/60/EC, Member States are obligated to perform flood risk assessment and to elaborate flood hazard and risk maps and [flood risk management plans](#). [Flood risk maps](#) include the history of floods and climate scenario's. Member States also need to take climate change into consideration when developing RBMP. A [Guidance document on adaptation to climate change in water management](#) is available to ensure that the RBMP are climate-proofed. [Evaluations of the RBMP and FRMP](#) are also available on the EC website.

There is a national focus on water-related measures in urban areas, particularly since the [Copenhagen floods in 2011](#), where related insurance claims amounted to c. 6.2bn DKK. During the summer of 2012 LGDK and the National Government entered into a mutual agreement, whereby 2.5bn DKK was to be invested in climate adaptation projects related to wastewater.

The innovative network "[Water in Urban Areas](#)" develops documents and presents climate adaptation technologies and associated planning tools for transformation of existing urban areas in Denmark. An example of a project from Water in Urban Areas is [Water Sensitive Urban Design](#) (WSUD) in Denmark. WSUD aims to collect and present all available information about local rainwater and harvesting in Denmark, which Municipalities and other actors can then use when planning climate adaptation in urban areas.

In Copenhagen, there has been calculations regarding the risk of damage from rising seawater and rainwater levels. It is expected that the risk of damage will rise above an acceptable level by 2040. Copenhagen is now actively trying to implement changes to prevent this, described in the Copenhagen Climate Change Strategy ("[Københavns Klimatilpasningsplan](#)"). Subsequently, there exists a [common agreement](#) between the municipalities of West Jutland and the government on how to protect the coastline from flooding and erosion. This agreement usually runs for five years and works as a financial framework agreement, where both municipality and government undertake a specific financial commitment.

The Government has developed a "plan line" (planlinje) and "action line" (aktionslinje), which are geographical lines delineating a coastal area at risk of floods and/or erosion ("[Guidelines for klimatilpasning i kystområder](#)").

Based on future projections of climate change included in [Denmark's 6<sup>th</sup> submission to the UNFCCC](#), key consequences for Danish coasts and ports will include: increased erosion, which will be most pronounced for the west coast of Jutland and less pronounced for other Danish coasts; more frequent flooding of low-lying coastal areas and powerful storm surges making activity at ports more difficult.

The [Danish Water and Wastewater Association](#) (DANVA) provide analyses and reports regarding design standards for climate change adaptation e.g. [drainage systems](#) during extreme rainfall. Waste water companies have an important role in [\(co-\)financing climate adaptation measures](#). They can for instance co-finance climate adaptation projects of the municipality.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

#### **4.6. Waste**

Project investments in the waste sector are related to separate collection infrastructure, re-use and recycling infrastructure, energy recovery facilities and closure of landfills. Potential impacts of climate change on waste infrastructure may include increased rates of waste decomposition, odour and dust due to increased temperatures, flooding of landfills and waste treatment facilities, and reduced water availability for wet processes in waste treatment facilities. Also the impact on transport infrastructure should be considered, as transport is a critical component of waste management (collection, transport to and from waste treatment facilities). The impact on transportation is discussed in the section on transport above.

[Directive 1999/31/EC on the landfill of waste](#) requires that landfills are situated and designed in such a way that pollution of the soil, groundwater or surface water is prevented. This requirement is translated into [national design standards](#) for the construction of landfills, that include the consideration of temperature, precipitation extremes and flooding where relevant.

Large waste treatment plant are subject to [Directive 2010/75/EU on industrial emissions](#) (IED), which requires as a general principle that necessary measures should be taken to




prevent accidents which may have environmental consequences, and to limit those consequences. This requires that a structured management plan should be available that includes and mitigates hazards such as extreme weather conditions (e.g. flooding, very high winds). In the [BAT reference document \(BREF\) on Waste Treatments Industries](#), some information is provided on the impact of certain climatic conditions (e.g. the impact of higher temperature on biofilter performance, aerobic decomposition, etc.). Although climate change is not specifically addressed.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

## 5. CASE STUDIES

### 5.1. Case studies of climate adaptation projects

#### The economics of managing heavy rains and stormwater in Copenhagen – The Cloudburst Management Plan (2016)

Project description	To combat the impacts of cloudbursts, the City of Copenhagen developed a Cloudburst Management Plan in 2012, which is an offshoot of the Copenhagen Climate Adaptation Plan. The Plan outlines the priorities and measures recommended for climate adaptation including extreme rainfall. The City carried out an overall assessment of the costs of different measures (traditional vs different options including adaptation measures), the cost of the damages despite the measures and resulting financial impact.
Photograph	
Budget	Not available
Climate Change Vulnerability and Risks	According to the Copenhagen Climate Adaptation Plan, a primary challenge for Copenhagen in light of climate change is more and heavier downpours in the future. Precipitation is expected to increase, while at the same time rain events will decrease, resulting in more intense rain events and subsequent flooding. Using the IPCC projections, the Danish Meteorological Institute projects that there will be 25-55% more precipitation in the winter months in 2100, with decreasing events in the summer by 0-40%. At the same time, the intensity of heavy rainfall could rise by 20-50%. An economic

	<p>assessment of the costs of damage to Copenhagen if nothing is done to adapt the current runoff and sewage system is estimated around DKK 16bn over 100 years. Up to DKK 9 billion of this sum has already been “used up” in the recent major rainfall events.</p> <p>The City of Copenhagen has neither the capacity nor the economy resources to implement all measures at once. The Cloudburst Management Plan operates with a minimum time frame of 20 years, requiring a prioritisation of individual projects in line with the Copenhagen Climate Adaptation Plan.</p>
Climate change adaptation measures	<p>Pluvial flood risk will be addressed through adaptive measures to store or drain excess water at ground level, such as re-opening streams, constructing new canals or establishing lakes and more green spaces, and using roads with high kerbstones to direct the pluvial flood water into these. In addition, in the most densely built-up area of central Copenhagen, the water can be diverted to the harbour through large pipes. In particular, the Cloudburst Management Plan consists of four surface solutions as well as pipe-based solutions, including:</p> <ul style="list-style-type: none"> <li>• Stormwater roads and pipes that transport water towards lakes and the harbour;</li> <li>• Detention roads for storing water;</li> <li>• Detention areas to store very large volume of water, e.g. parks that could turn into lakes during flood events;</li> <li>• Green roads to detain water in smaller side streets.</li> </ul>
Good practice	<p>The assessment shows that under present-day circumstances an overall benefit of DKK 5bn could be expected from the combined solution in Copenhagen in comparison to a situation in which the City does nothing. The socio-economic benefit by choosing the combined solution compared to the traditional sewer solution is around DKK 9bn.</p>
Further information	<p><a href="#">Cloudburst Management Plan 2012</a></p>

#### Addressing governance challenges that 'cross' administrative boundaries: Supporting 15 municipalities in the Central Denmark Region in adaptation planning

Project description	<p>The cost of inaction on climate change is significant for Denmark and the wider EU. As a result, the Danish government made it mandatory in 2013 for municipalities to draw up climate change adaptation plans. It also encourages the integration of the climate change adaptation action plans into the municipal spatial planning covering all spatial areas including cities and countryside. In this way, it is facilitating compliance with the EU Water Framework Directive and the Floods Directive. The climate change adaptation plans have now been adopted, but their implementation has not been initiated. The C2C CC project will provide a comprehensive base for implementation, evaluating the results and the process, as well as</p>
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	<p>providing local authorities with the tools for better integrated planning, taking into account the uncertainties of future climate change.</p> <p>The Central Denmark Region (CDR) is the second largest regional administrative body in Denmark covering 19 municipalities, of which 15 are associated beneficiaries in the C2C CC project. CDR coordinates regional development within the context of nature, environment, business and tourism.</p>
Photograph	n/a
Budget	<p>Total Budget 11,683,058.00 €</p> <p>EU CONTRIBUTION 7,009,893.00 €</p>
Climate Change Vulnerability and Risks	<p>The project supports the implementation of 21 municipal climate change adaptation plans and four risk management plans under the Flood Directive in the CDR. It provides decision-makers with a framework for sustainable and integrative climate change adaptation planning, mainstreams climate change adaptation into local planning and integrates other policy areas. A total of 24 specific actions cover capacity building within all themes in the hydrological cycle and improve multi-level management structures. The climate change adaptation plans address cities as well as the countryside and coastlines.</p>
Climate change adaptation measures	<p>The objectives of the hydrological cycle related to the challenges documented in the climate change adaptation plans are to:</p> <ul style="list-style-type: none"> <li>• Increase coastal resilience taking into consideration the environmental state and marine biodiversity and to enhance urban resilience;</li> <li>• Increase the resilience of land alongside riverbanks taking into consideration the environmental state and biodiversity;</li> <li>• Increase resilience and optimising use of rising near-surface groundwater;</li> <li>• Increase urban resilience taking into consideration the synergies with green infrastructure and urban liveability;</li> <li>• Increase resilience through capacity building, strengthened network governance and cross-border coordinated planning;</li> <li>• Increase resilience through enhanced decision-making processes; and</li> <li>• Increase resilience by generating jobs and green investments.</li> </ul>
Good practice	<p>Expected results:</p> <ul style="list-style-type: none"> <li>• A 3D model of flooding that combines flood events owing to rainwater, rivers and the sea;</li> <li>• A hydrological model combining rising groundwater with surface water;</li> </ul>

	<ul style="list-style-type: none"> <li>• New business models that consider climate change adaptation activities;</li> <li>• New methods for city planning that can help prevent flooding (e.g. permeable surfaces);</li> <li>• Warning systems for flooding;</li> <li>• Network governance and integrative planning of large catchment areas.</li> <li>• A range of capacity building events.</li> </ul>
Further information	<a href="http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&amp;n_proj_id=6139">http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&amp;n_proj_id=6139</a>

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