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Adapting the Danish Building Stock and Urban Environment to Climate Change

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SUMMARY

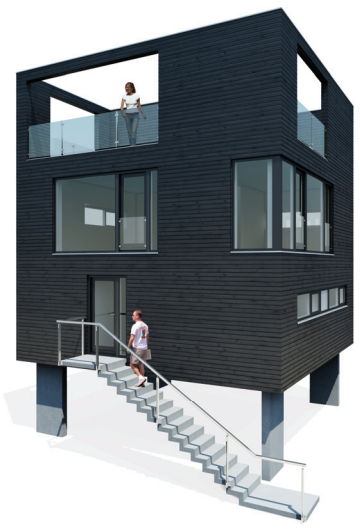
This poster presents important climate parameters relevant for Denmark including the change in mean year values, as well as the extent of maximum and minimum extremes.
Below four cases show how building stock and the urban environment in Denmark have been adapted to climate change.

Case – heat wave

The AA single-family house from "House Project"

The building is a low-energy category 1 building constructed with highly insulating prefabricated loadbearing elements made and joined to be airtight. A soundless ventilation system with heat recovery ensures aeration with outdoor air. Solar water heaters produce domestic hot water and outdoor air is preheated under the roof cladding. Solar cells on the roof produce electricity for the building; the surplus production is sold via the electric grid. A wood-burning stove is connected to the building's ventilation chimney. Mechanically openable skylights contribute to passive solar gain in the winter and are intended to prevent overheating of the building in the summer.
http://klimabyggeri.dk/pdf/aa-huse.pdf

Case - flood



A single-family house of three storeys turned upside down

The building is constructed with the lower storey raised 2.5 m above ground level. It is designed for low-lying locations and areas close to the sea with high risk of flooding due to rising sea levels. The size of the building is 8 x 8 x 8 m and it rests on four pillars with car parking beneath the building. Bedrooms are located on the 1st floor, living rooms and a kitchen on the 2nd floor and a roof terrace or roof garden on the top floor. This placement of the different rooms and garden is to ensure the occupants' view and privacy. Other versions of buildings turned upside down are designed for placement in dunes or close to the sea.
http://klimabyggeri.dk/pdf/sortsol-roemoe.pdf

Challenges

Buildings play a vital economic and social role in society. They are vulnerable to climate change and it is therefore an important issue to reduce CO_2 emissions from the building stock; another important issue is to adapt the building stock to the challenges of the future climate. It is important to preserve the value of the building stock by adjusting it to future performance-based building requirements, as buildings have been for centuries. However, in the future adaptation is expected to be dictated by climate change in contrast to the past when it was dictated by the need for protection. The adaptation needed is strongly related to the expected climate change. Available emission scenarios from SRES [1] include A2 and B2 [2], and EU2C scenario [3] are used for describing the expected climate change in Denmark leading up to year 2100, see table 1 and 2. The consequences of climate change on the existing built environment are not known, nor has the vulnerability of the existing building stock been investigated.

Table 1. *Expected climate change*

Scenario		A2			B2			EU2C	
Years	2006-2035	2036-2065	2071-2100	2006-2035	2036-2065	2071-2100	2006-2035	2036-2065	2071-2100
On land: change in:									
Annual average temperature	+0.6°C	+1.4°C	+3.1°C	+0.7°C	+1.4°C	+2.2°C	+0.7°C	+1.2°C	+1.4°C
Winter average temperature	+0.6°C	+1.4°C	+3.1°C	+0.7°C	+1.3°C	+2.1°C	+1.0°C	+1.7°C	+2.0°C
Summer average temperature	+0.5°C	+1.3°C	+2.8°C	+0.6°C	+1.3°C	+2.0°C	+0.7°C	+1.1°C	+1.3°C
Annual rainfall	+2%	+4%	+9%	+2%	+5%	+8%	0%	0%	0%
Winter rainfall	+8%	+19%	+43%	+6%	+11%	+18%	0%	0%	+1%
Summer rainfall	-3%	-7%	-15%	-2%	-4%	-7%	-2%	-3%	-3%
Maximum daily rainfall	+4%	+10%	+21%	+5%	+12%	+20%	+11%	+18%	+22%
At sea: change in:									
Average windspeed	+1%	+2%	+4%	+1%	+1%	+2%	+1%	+1%	+1%
Maximum windspeed	+2%	+5%	+10%	0%	+1%	+1%	+1%	+1%	+1%
Maximum sea level (West Jutland)			+0.45-1.05m						

Table 2. *Expected change in extreme climate events ± present events*

Indicator	A2	B2	EU2C	Current value
Number of days with frost (days/year with T_{min} under 0°C)	-44	-31	-26	73
Growth season's length (days in a row over 5°C)	55	39	22	224
Annual longest heat wave (days in a row, T_{max} more than 5°C over normal)	9	4	4	5
Hot summer nights (% days T_{min} over normal 90 percentile)	20	13	10	10
Number of days with >= 10mm rainfall (days/year)	3	3	-1	13
Annual largest 5 days total of rainfall (mm/5 days)	4	4	1	47
Average intensity of rainfall for days with more than 1mm rainfall (mm/day)	0.3	0.3	0	4.7
Extreme rainfall (% rainfall over 95 percentile)	5	6	0	32

Case – low energy

B&O headquarter in Struer

Climate change implies that new buildings will have an increasing demand for cooling and a falling demand for space heating. This means that new buildings need to manage future climate change and growing comfort problems indoors due to overheating. For office buildings and other large types of buildings, it gives less meaning to use large south-facing glazed areas. Instead, the lowest total of CO_2-emissions can be achieved with a larger north-facing glazed area and a smaller south-facing area. Daylight-optimised design can be used to create office buildings with low CO_2-emissions, minimal overheating problems and a design adapted to future climate change.
http://klimabyggeri.dk/pdf/lavenergi-bygningsdesign.pdf

Case – urban planning

Rainwater reservoir with recreational value in Odense

An extension of the existing sewer system, in order to handle the heavier rainfall expected in the future, is costly and technically a challenge. As an alternative solution, the local authority in Odense plans to establish different types of delay basins to prevent Odense Å from overflowing and the resulting flooding of basements. In one case the delay basin consists of a 2.2 km long new pipe network. In another area of Odense, a subsurface delay basin is constructed. By means of valves, segments of the basin can be sealed off in order to hold back the excess water until the river can contain and handle it. In a new community a planned artificial lake is intended to serve as a delay basin.
http://klimabyggeri.dk/pdf/kloak-odense.pdf

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[1] Nakićenović, N. et al. (2000): IPCC Special Report on Emissions Scenarios, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 599 pp.

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[3] Danish Government (2008) Danish Strategy for adaptation to a changing climate. Copenhagen: Danish Energy Agency.