

# DANMARKS NATIONALBANK

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## Flood risk can potentially affect a large share of credit institutions' exposures

- Credit institutions have exposures collateralised by real estate at risk of flooding. These exposures account for kr. 41 billion today and could increase to kr. 198 billion by the end of this century.
- Some credit institutions have a high share of exposures at risk of flooding. These exposures are also concentrated in the same geographical area.
- Credit institutions should incorporate climate-related risks and geographical concentrations in their risk management for real estate lending.



### Flooding

is increasingly becoming  
a risk in Denmark

[Read more](#)

### The risk is concentrated

along the coastline  
in certain areas

[Read more](#)

### Exposures at risk

of flooding can increase  
over the next 50-80 years

[Read more](#)

# Climate change

Climate change is impacting society already today and will have further consequences in the future. A successful green transition will require unprecedented efforts, both in Denmark and abroad.

As a case in point, climate change and the transition to a greener economy will impact corporate earnings and economic activity. This may compromise price and financial stability in Denmark, which it is Danmarks Nationalbank's objective to ensure. It is therefore essential that Danmarks Nationalbank increases its knowledge of how, and by how much, the climate challenges will impact various parts of the economy.

Against this backdrop, Danmarks Nationalbank will focus on climate challenges in a series of publications.

## ABOUT THIS ANALYSIS

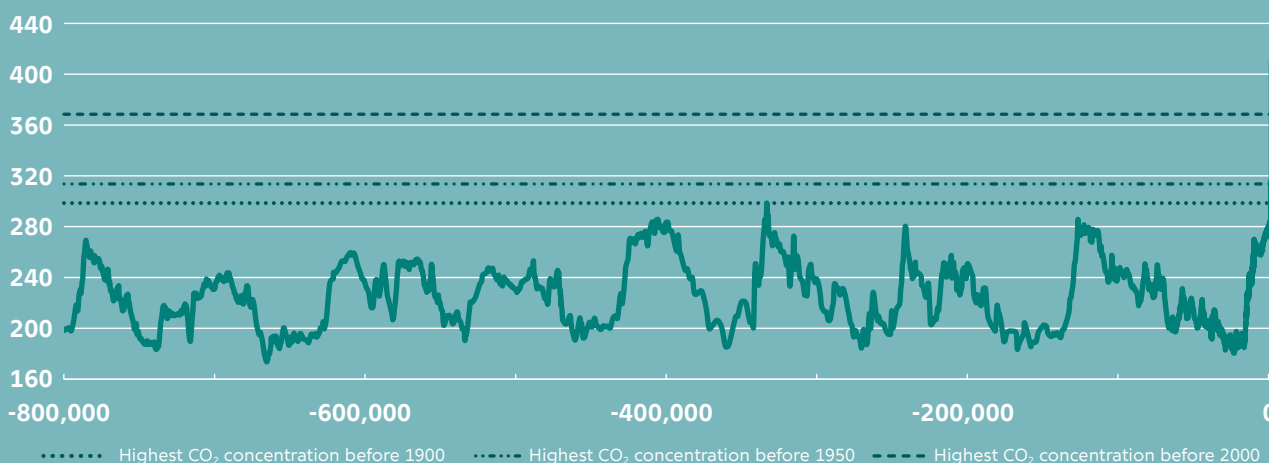
This analysis is a result of cooperation with DTU, Technical University of Denmark, Climate Economics and Risk Management. DTU provided climate and flooding data at a detailed geographical level, which made it possible to draw a more accurate picture of the financial risks associated with flooding.

## CO<sub>2</sub> concentration in the atmosphere

800,000 BCE to 2019 ACE

The chart shows the number of carbon dioxide molecules per million molecules of dry air.

CO<sub>2</sub> (parts per million)



## Danish credit institutions have exposures at risk of flooding that could amount to kr. 198 billion

Danish credit institutions have real estate exposures<sup>1</sup> of kr. 2.8 trillion. These exposures include loans and guarantees granted against collateral in the underlying properties. Exposures of kr. 41 billion are currently located in areas already at risk of flooding, see chart 1. This amount will increase to kr. 198 billion over the next 50-80 years in the most extreme climate scenario, equivalent to 7 per cent of the existing exposures. This implies that the risk could constitute a risk for individual credit institutions as well as the financial system.

The build-up of exposures at risk of flooding reflects the increasing risk of flooding in Denmark, see box 1. The existing exposures at risk of credit institutions will increase to kr. 87 billion for the baseline scenario and to kr. 108 billion in the worst-case scenario over the next 20-50 years. Over the period until 2100, the credit institutions' exposure at risk are estimated to increase to kr. 134 billion in the baseline scenario and further to kr. 198 billion in the worst-case scenario.

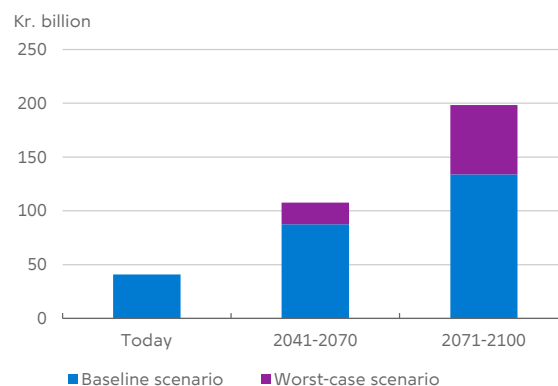
### Losses caused by flooding can affect households, private companies and credit institutions

Depreciation of properties caused by damage from flooding will initially affect the property owner. However, the loss can ultimately affect credit institutions.

The value of properties can be adversely affected by e.g. a storm surge event or increased probability of flooding. Value depreciation has a direct effect on homeowners and can be transmitted to credit institutions if the real estate has been pledged as collateral for the loan. In case of actual losses, these will have to be borne by the owner of the property, creditors or insurance companies. In Denmark, the Danish Storm Council may cover losses.<sup>2</sup>

**Exposures at risk of flooding in the four scenarios**

Chart 1



Note: The chart shows the build-up of exposures at risk in two flooding scenarios over two periods of time, see box 2 for scenarios. Financial data is from end-2020. The sample of credit institutions included in the analysis is shown in annex 1.

Source: The credit register, DTU's flood scenarios, DMI's Klima-atlas and own calculations.

This analysis does not account for potential compensation from private insurance policies or the Storm Council. This is due to the fact that compensation is assessed on a case-by-case basis. Potential losses incurred by credit institutions will be smaller if private insurance companies or the Storm Council provides compensation.

### Differences between credit institutions' exposure at risk of flooding can, to some extent, be explained by geography

There are substantial differences between the individual credit institutions' exposures at risk of flooding,

<sup>1</sup> The exposures include loans and off-balance sheet items, e.g. guarantees. Other exposures collateralised against real estate are included unless otherwise specified. Some exposures are excluded due to data issues. All numbers are end-2020 unless otherwise stated.

<sup>2</sup> The Danish Storm Council is a public council that may cover losses on properties from damage related to flooding. The council is financed by the insurance sector, see also regulation on the Storm Council ([link](#) – in Danish only).

## Flooding is an increasing risk in Denmark

Box 1

Denmark is increasingly at risk of flooding. In the period 1991-2017, there were more than 40 flooding events caused by storm surges. At the same time, there has been an increasing trend in the number of events, see chart A.

Climate change is leading to increased recurrence and severity of flooding from storm surges, and the effect from storm surges is further exacerbated by sea level rises.<sup>1</sup>

In Denmark, a coastline of more than 8,000 km increases the vulnerability and potential damage for homeowners and private companies. Residential real estate accounts for the largest share of real estate along the coastal line; however, a substantial number of commercial real estate properties as well as factories and public properties are also exposed to flooding.

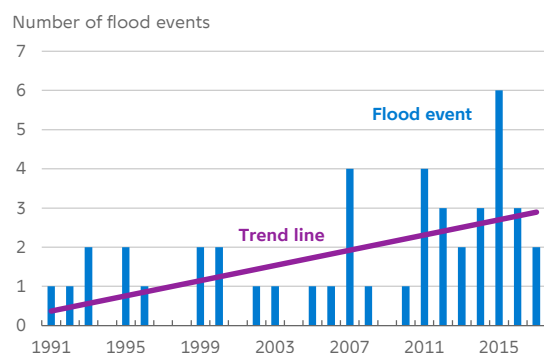
### Future effects of climate change are associated with uncertainty

Flooding events are driven by the increased likelihood and intensity of extreme storm events. Combined projections of

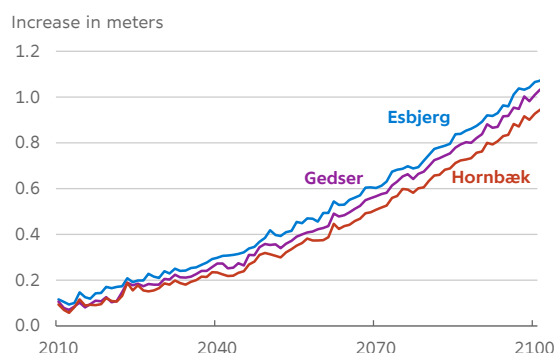
these make it possible to estimate the risk of flooding. The future path of average temperature increases – and thus also sea level increases – is nonetheless associated with uncertainty, which translates into the need for a number of different climate scenarios. There are considerable regional differences of risk of flooding across the country due to e.g. differences in the distance to the sea and differences in altitude.

Chart B shows the change in sea level in an extreme scenario in three different locations in Denmark. The rise in sea level is estimated in the short term (until 2040), in the medium term (2041-2070) and long term (2071-2100).

**Chart A**  
**Storm surges in Denmark**



**Chart B**  
**Rise in sea level**



Note: Chart A shows the annual number of flooding events caused by storm surges in Denmark. Chart B shows the rise in sea level for three different locations in Denmark towards the end of this century.

Source: Danish Storm Council statistics ([link – in Danish only](#)), DMI's Klimaatlas.

<sup>1</sup> Danmarks Nationalbank has previously mapped the risk of flooding in Denmark in an extreme scenario, showing a significant amount of collateral at risk of flooding, see Danmarks Nationalbank: Climate change can have a spillover effect on financial stability, *Danmarks Nationalbank Analysis*. No. 26, December 2019 ([link](#)).

Scenarios in the analysis

Box 2

This analysis is based on two different scenarios from the UN Intergovernmental Panel on Climate Change that state representative concentration pathways (RCP): RCP 4.5 (baseline) and RCP 8.5 (worst-case). The scenarios indicate pathways, not emissions, for greenhouse gas concentrations, thus describing how climate change will develop globally; however, countries are affected differently. The analysis is applying scenarios that have been estimated for Denmark comprising two 30-year periods from 2040 onwards. Future adaptation measures, e.g. dykes, are not taken into account.

The build-up of aggregated exposures at risk of flooding for the credit institutions included is presented for four scenarios, see table below. In the remainder of the analysis, however, focus will be on the long-term worst-case scenario, see the lower right-hand corner in the table.

The baseline scenario assumes a reduction in the global emission of greenhouse gases, leading to a moderate rise in the sea level in 2070 and in 2100. The worst-case scenario is based on assumptions that the current high level of emissions continues throughout this century.<sup>1</sup>

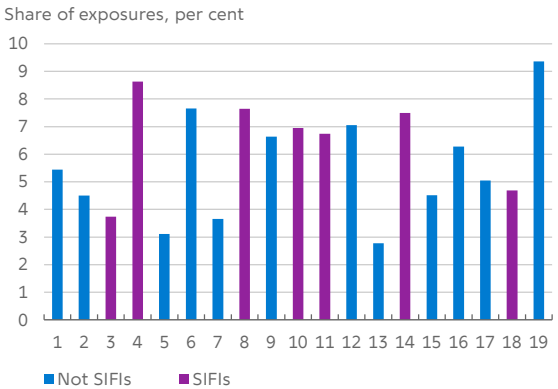
Scenarios applied in the analysis

2041-2070 (MEDIUM TERM)	2071-2100 (LONG TERM)
<b>Baseline scenario</b> Reductions in greenhouse gas emissions	<b>Baseline scenario</b> Reductions in greenhouse gas emissions
<b>Worst-case scenario</b> Current high level of emissions continues	<b>Worst-case scenario</b> Current high level of emissions continues

Note: The table shows the four scenarios on which the analysis is based.  
Source: Based on the IPCC scenarios, DTU flooding scenarios and DMI Klimaatlas.  
<sup>1</sup> The ambitious scenario, RCP 2.6, indicates what it takes to limit global warming to two degrees Celsius and assumes use of technologies that can absorb greenhouse gases and accordingly a reduction of emissions from 2020. This scenario has been excluded.

Credit institutions exposures at risk of flooding

Chart 2



Note: The chart shows the credit institutions' exposures at risk of flooding as a percentage of the total exposure collateralised by real estate. The calculations are based on the worst-case scenario in the period 2071-2100. Financial data is from end-2020.  
Source: The credit register, DTU's flood scenarios, DMI's Klimaatlas and own calculations.

see chart 2. The share of exposures at risk varies from 3 per cent for the least exposed institution to 9 per cent for the most exposed institution. Nine credit institutions have a higher share of exposures at risk of flooding than the sector average of 7 per cent.

The geographical concentration of the exposures at risk also varies across the credit institutions, see chart 3. Seven of the nine most exposed credit institutions have between 50 per cent and 80 per cent of their exposures at risk of flooding concentrated in just three municipalities. Additionally, six of these nine institutions have more than 50 per cent and up to 74 per cent of their exposures located within the same geographical area in Greater Copenhagen, i.e. the municipalities are located in the proximity of the same coastal line or territory (see box 3 for concentration of exposures). This geographical concentration implies that just one flooding event can have a severely adverse effect on these credit institutions. A flooding event that hits several credit institutions simultaneously can pose a systemic risk.

The geographic concentration should be seen in view of the fact that some credit institutions have a prominent regional focus. Credit institutions should generally take geographical concentrations into account in their risk management of real estate lending.

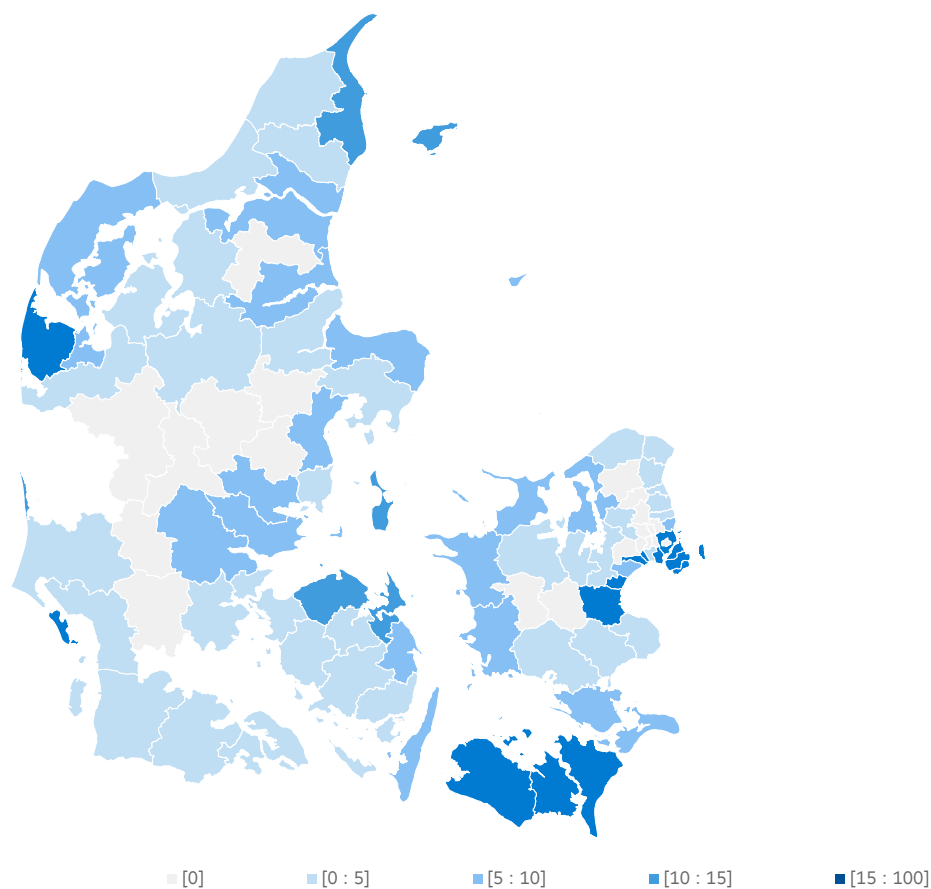
### Concentration of exposures

Box 3

Some coastal areas have a large share of exposures at risk of flooding. The chart shows, for each municipality, the share of exposures at risk of flooding as a proportion of the total amount of exposures. The lighter the shaded area, the lower the share of exposures at risk of flooding within the municipality. With the grey areas having no exposures at risk and the dark blue municipalities having more than 15 per cent.

Municipalities with large shares of exposures at risk of flooding are located in the Greater Copenhagen area, on Lolland-Falster, certain parts of northern Funen as well as on the west and northern coasts of Jutland. Municipalities along the coasts of Zealand, part of western Jutland and large areas of the eastern coasts in Jutland have minor shares of exposures at risk of flooding.

### Concentration of exposures by municipality



**Note:** The map shows the share of exposures collateralised by real estate at risk of flooding in proportion to the total number of exposures collateralised by real estate. The exposures are by the end of 2020. The shares are by municipality. Based on the worst-case scenario in 2071-2100.

**Source:** Credit register, DTU's flood scenarios, DMI Klimaatlas and own calculations.

### Loans at risk of flooding have a lower loan-to-value ratio

Credit institutions' lending risks depend, among other things, on the level of collateralisation. In the event that a borrower defaults, the loss borne by the credit institution will depend on the extent of the collateral devaluation as a consequence of the flooding event.

Chart 4 shows that there are significant differences in the loan-to-value (LTV)<sup>3</sup> ratio between the exposures<sup>4</sup> at risk of flooding and those not at risk of flooding. The former exposures have a lower average LTV, 46 per cent, than the latter, 52 per cent. Other things equal, the lower LTV values for the exposures at risk reduce the risks for the credit institutions.

### There are large differences across credit institutions

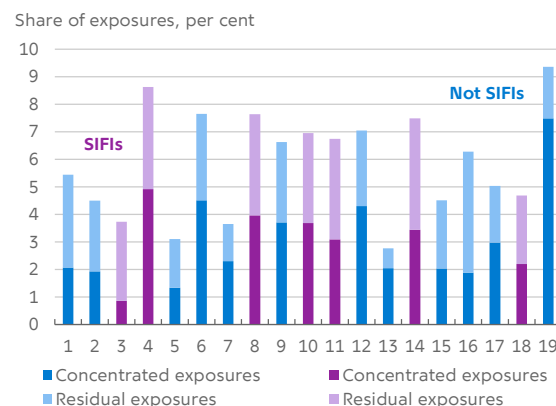
There are differences in LTV values across credit institutions. The median LTV value for exposures at risk of flooding varies between 48 per cent for the credit institution with the lowest median LTV to just over 77 per cent for the credit institution with the highest median LTV, see chart 5. Five of the nine credit institutions with the largest share of exposures at risk of flooding, see chart 2, have a higher median LTV than the sector's median of 56 per cent. This implies that these five credit institutions have higher exposures at risk of flooding and less collateral against losses than the sector average.

Chart 6 shows the concentration of exposures with a high LTV. A high LTV is defined as an LTV above 80 per cent. A large share of exposures at risk with a high LTV increases the risk of losses for the credit institution.

Three of the nine credit institutions with high shares of exposures at risk of flooding, see chart 2, have the largest proportions of exposures with an LTV value

### Concentration of credit institutions' exposures at risk of flooding

Chart 3

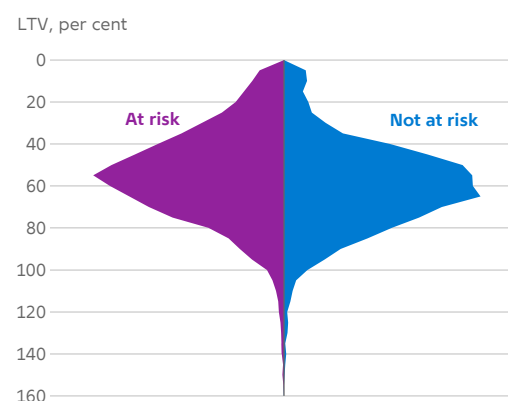


Note: The chart shows the credit institutions' exposures at risk of flooding as a percentage of the total exposures collateralised by real estate. For each credit institution, the concentrations are computed as the sum of the exposures at risk of flooding over the three municipalities with the largest share of exposures at risk. The residuals consist of the sum of the remaining exposures at risk of flooding. The calculations are based on the worst-case scenario in the period 2071-2100. Financial data is from end-2020.

Source: The credit register, DTU's flood scenarios, DMI's Klimaatlas and own calculations.

### Distribution of exposures by loan-to-value ratio

Chart 4



Note: The chart shows the distribution of LTV (the y-axis) in intervals of five per cent. The purple area shows the exposures at risk, while the blue area indicates exposures not at risk of flooding. The calculations are based on the worst-case scenario in the period 2071-2100. Financial data is from end-2020.

Source: The credit register, DTU's flood scenarios, DMI's Klimaatlas and own calculations.

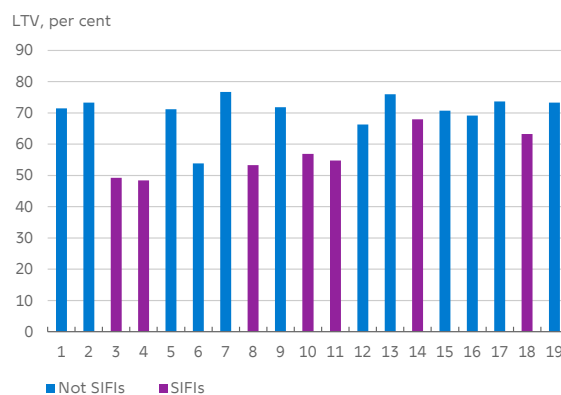
<sup>3</sup> LTV indicates the value of a loan as a proportion of a property. Regulations allow for lending of up to 95 per cent of the value of the property. As the loan is repaid, the LTV will decrease, while a decline in the property price will increase the LTV.

<sup>4</sup> In the context of LTV, exposures only include loans.

above 80 per cent. The combination of high exposures at risk of flooding with a larger proportion of these exposures having lower collateralisation makes these institutions particularly vulnerable to flood risk.

**Median LTV per credit institution**

Chart 5

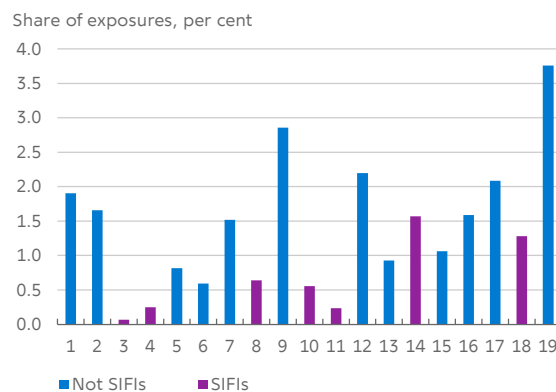


**Note:** The chart shows the median LTV of exposures at risk of flooding for the credit institutions. The calculations are based on the worst-case scenario in the period 2071-2100. Financial data is from end-2020.

**Source:** The credit register, DTU's flood scenarios, DMI's Klimaatlas and own calculations.

**Share of exposures at risk with high LTV value**

Chart 6



**Note:** The chart shows the share of exposures at risk of flooding with a high LTV value (defined as an LTV above 80 per cent). The calculations are based on the worst-case scenario in the period 2071-2100. Financial data is from end-2020.

**Source:** The credit register, DTU's flood scenarios, DMI's Klimaatlas and own calculations.

## Annex 1

### Sample of credit institutions

#### Systemic credit institutions

DLR Kredit

Danske Bank

Jyske Bank

Nykredit Realkredit

Nordea Kredit

Spar Nord Bank

Sydbank

#### Non-systemic credit institutions

Arbejdernes Landsbank

Alm. Brand Bank

Den Jyske Sparekasse

Handelsbanken

Jutlander Bank

Lån og Spar Bank

Ringkjøbing Landbobank

Salling Bank

Sparekassen Kronjylland

Sparekassen Sjælland-Fyn

Sparekassen Vendsyssel

Vestjysk Bank

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The analysis consists of a Danish and an English version. In case of doubt regarding the correctness of the translation the Danish version is considered to be binding.

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FINANCIAL STABILITY

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