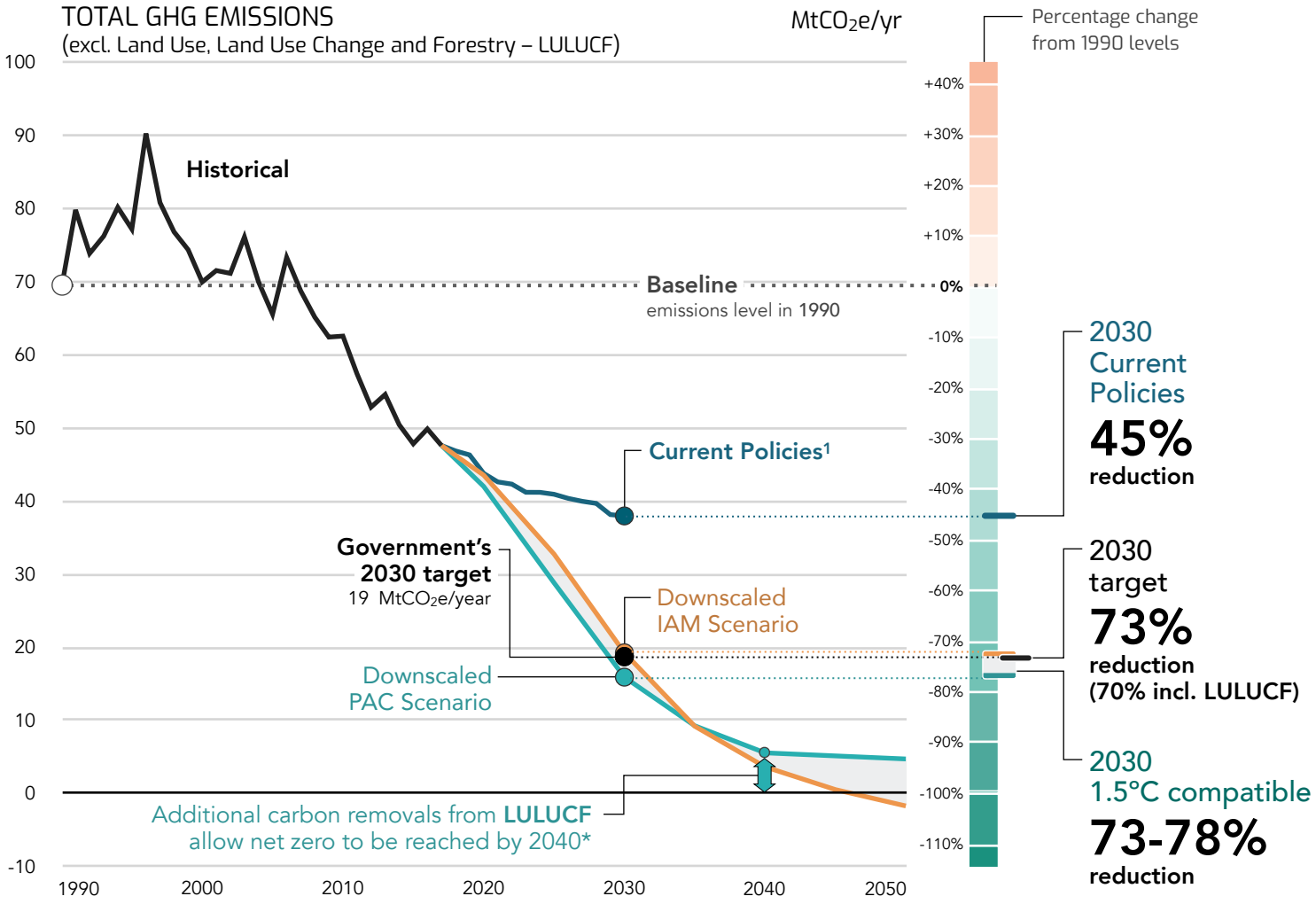
DENMARK

Country Factsheet: 1.5°C Pathways for Europe

EU DE DK ES FR IT PL PT RO SE

Denmark's current 2030 emissions target is 1.5°C compatible



*To achieve the net zero emission target, emissions from LULUCF need to be reduced while increasing the capacity of forests, wetlands, grasslands and farmlands to remove carbon. These carbon removals are not equal to emissions in other sectors and the two cannot simply be considered fungible.

Denmark's 2030 target is aligned with the Paris Agreement long-term goal

A reduction of 73-78% below 1990 levels (excl. LULUCF) is a 1.5°C compatible range for a 2030 domestic emissions target according to the two downscaled emissions pathways,† implying that Denmark's target is aligned with the Paris Agreement long-term temperature goal.

Denmark's current suite of climate policies will, however, fail to achieve this target, reflecting the need for greater urgency across all sectors of the economy.[1]

To ensure Denmark is contributing its fair share to global climate mitigation efforts, additional emission reduction activities should also be supported in developing countries.[2]

† **Scope and limitations of downscaled emissions and energy mix pathways:**

- Pathways were downscaled using the SIAMESE model developed by Climate Analytics. See full 1.5°C Pathways for Europe Report[3] for details
- Land use, land use change and forestry (LULUCF), and international aviation and shipping emissions are not covered by this assessment
- Detailed macro-economic modelling was not conducted as part of this assessment
- Historical and future energy imports and exports were not considered

CURRENT SITUATION
Snapshot of Denmark's emissions and energy system

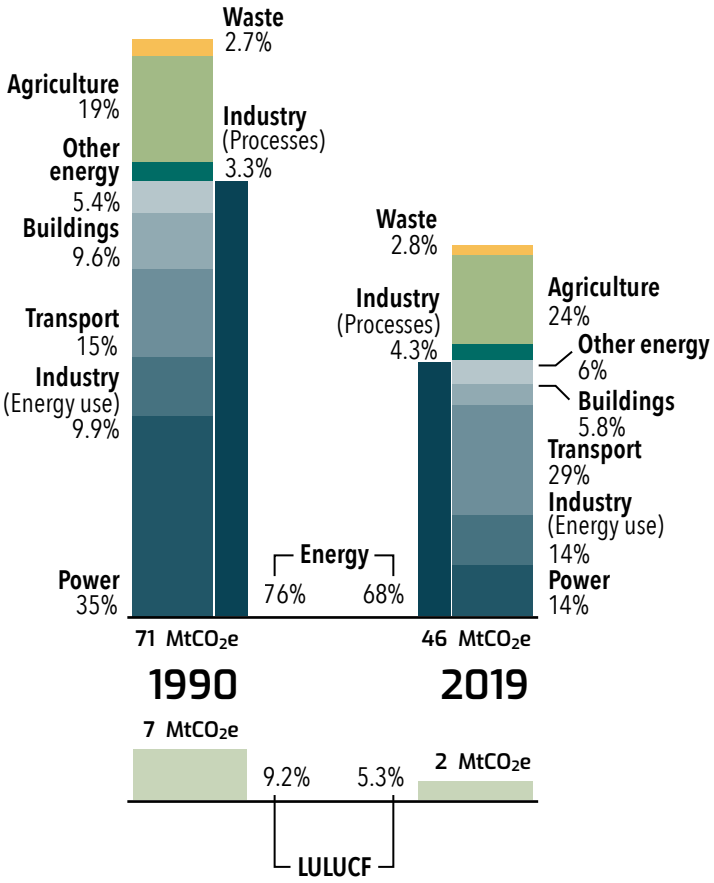
Emissions profile

Danish emissions were 36% below 1990 levels in 2019, led primarily by steep reductions over time in the power sector.[4] The transport sector overtook the power sector in 2015 to become the largest source of emissions, and has seen a 22% increase since 1990. It is the only sector in which emissions did not fall over this period, highlighting the strong need for policies targeting transport.

The more than fourfold increase in the combustion of biomass and biogenic waste in Denmark between 1990 and 2019 includes a large increase in the overall proportion of imported biomass. While emissions from domestically sourced biomass is captured under the LULUCF sector, this is not the case for imported biomass. These emissions are instead generated in third party countries which creates the impression of lower overall emissions within Denmark despite the actual emissions from combustion being generated in Denmark.

Under current policies, as communicated in Denmark's National Energy and Climate Plan (NECP) in 2020, Denmark's emissions (excl. LULUCF) would reach 45% below 1990 levels by 2030, far from achieving its 73% target.[1]

DENMARK
EMISSIONS BY SECTOR[6]



Energy overview and main policy gaps

Total energy demand in Denmark has not fallen as much as in other European countries, reaching just 14% below 1990 levels in 2019.[5] However, coal demand has fallen by 85% over this time, replaced primarily with increased combustion of natural gas and, in particular, biomass, which rose by 330%. Oil and petroleum products constitute the largest share of Danish primary energy demand at 44% in 2019, while making up 63% of energy-related emissions.

Biomass is the next largest at 29%, more than all remaining energy sources combined. Transport energy demand has risen by almost 30% between 1990 and 2019, accompanied by a 23% rise in emissions, demonstrating the need for strong policies in this sector to bring emissions down rapidly over coming years. Several options have been recently proposed to address emissions from the LULUCF sector, which turned from a sink to an emissions source in 2012, with emissions rising since then.

Civil Society & Global Integrated Assessment Models
1.5°C energy and climate scenarios for Europe

The aim of the 1.5°C Pathways for Europe Project is to derive Paris Agreement compatible emissions and energy mix pathways for key European countries. The project seeks to highlight existing scenarios that demonstrate that a **very high level of ambition on climate and energy policy *is possible* for the European Union.** To reflect the varied methodologies employed to construct such scenarios, we assess the Paris Agreement Compatible (PAC) energy scenario, and a scenario from the global REMIND integrated assessment model (IAM), both embodying high levels of 2030 climate ambition in the European Union region. We use the SIAMESE model developed by Climate Analytics to create country level pathways, using the PAC/REMIND scenario results for the European Union as input and downscaling them based on demographic, economic, energy system, and policy heterogeneity between countries.[3,7] We outline key differences between the two scenarios used as input for the SIAMESE downscaling process below.

PAC [8]
Paris Agreement Compatible Energy Scenario

The PAC scenario for the EU28 was developed through a bottom-up collective research exercise involving energy and climate experts and incorporating findings from relevant scientific literature.

Around 150 stakeholders from member organisations of the European Environmental Bureau (EEB) and Climate Action Network (CAN) Europe, and from science and industry were involved in the scenario building process.

The PAC scenario is an attempt to construct a European-wide energy scenario which is aligned with the Paris Agreement's objective to limit global warming to 1.5°C and which embodies the demands of civil society.

In doing this it suggests a trajectory with:

- **100%** renewable energy supply by 2040
- **At least 65% GHG** emissions reduction below 1990 levels by 2030
- Net zero emissions by **2040**

Carbon Capture and Storage (CCS):

A key assumption underpinning the PAC scenario is that carbon capture and storage **will not be required** to achieve net zero emissions for the European Union.

Global IAM[9,10]
An integrated scenario reaching 1.5°C

We assess the global REMIND 1.7 CEMICS-1.5-CDR8 scenario as an additional line of evidence for pathways for the European Union to achieve the 1.5°C long-term temperature goal of the Paris Agreement. REMIND is a global energy-economy-climate model that maximises inter-temporal welfare. It contains macro-economic, energy system, and climate modules that are integrated to attain exogenously prescribed climate targets.[11]

Population and GDP growth are key drivers of future energy demand and, thus, GHG emissions in IAMs. In our SIAMESE-based downscaling approach, we therefore take growth rates from the shared socio-economic pathway (SSP) scenarios, specifically SSP2, a middle of the road scenario, in order to assess what the EU-region results of this scenario imply for country-specific energy system transformation.

Key outputs for the EU region from this scenario are:

- **90%** renewable energy supply by 2040
- **62% GHG** emissions reduction below 1990 levels by 2030 (excl. LULUCF)
- Net zero emissions between **2045-2050**

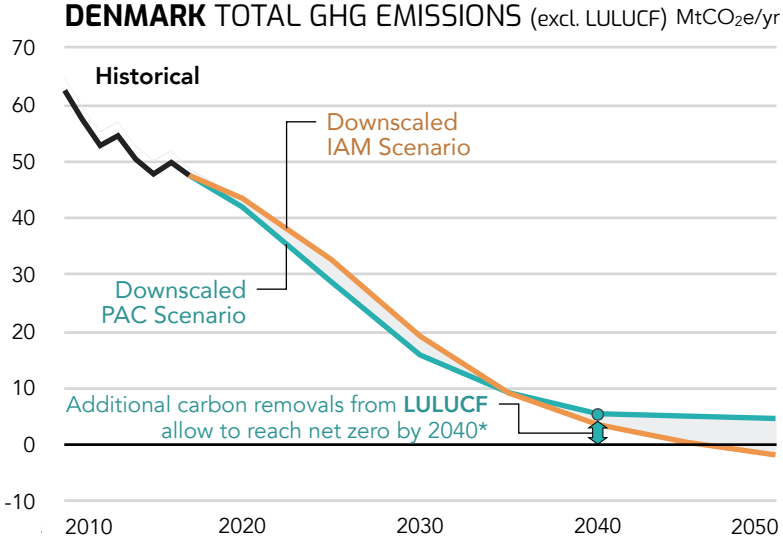
Carbon Capture and Storage (CCS):

This IAM scenario envisages some **natural gas and biomass** combustion with carbon capture and storage.

Economy-Wide 1.5°C Pathways

According to the analysis undertaken in this project, achieving a 1.5°C compatible economy for Denmark requires a 73-78% reduction in total GHG emissions by 2030 (excluding LULUCF), and reaching net zero emissions between 2040 and 2050.

There are numerous different pathways to reaching net zero emissions in this timeframe. In the scenarios downscaled, a LULUCF sink of up to 5 $MtCO_2e$ would achieve net zero by 2050, while under the downscaled PAC scenario, a LULUCF sink of 6 $MtCO_2e$ would achieve net zero emissions in 2040.



*To achieve the net zero emission target, emissions from LULUCF need to be reduced while increasing the capacity of forests, wetlands, grasslands and farmlands to remove carbon. These carbon removals are not equal to emissions in other sectors and the two cannot simply be considered fungible.

1.5°C Compatible 2030 primary energy mix*

	2017[5]	2030
Renewables incl. biomass	35%	**68–75%** IAM PAC
Fossil Fuels	65%	**25–32%** PAC IAM
Nuclear	0%	**0%**

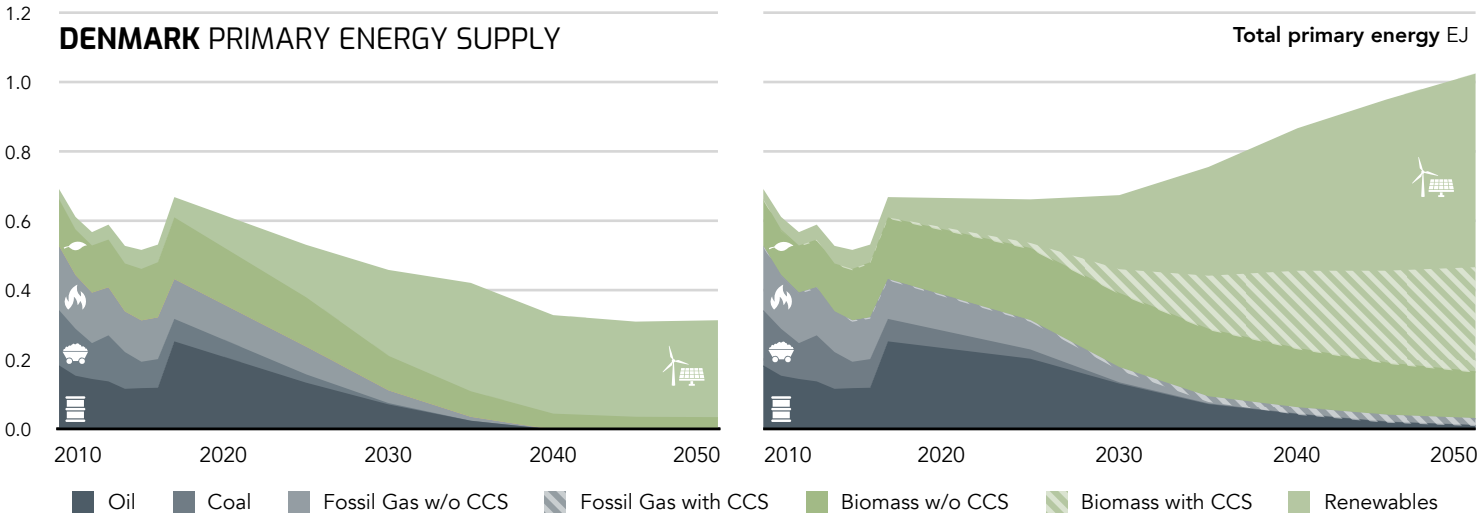
In the downscaled PAC and IAM pathways, the share of unabated fossil fuels in primary energy demand should be reduced to between 25-32% by 2030, whereas the renewable energy share should reach between 68-75% by the same date.

The transport and industry sectors constitute a combined 42% of total GHG emissions in Denmark, illustrating the need for strong policies to reduce the oil and natural gas demand that produce these sectoral emissions.[6]

*Primary energy supply includes losses that occur during the conversion of nuclear and fossil fuels to electricity, resulting in a higher proportion of both nuclear and fossil fuels than in total final energy demand

Downscaled PAC Scenario

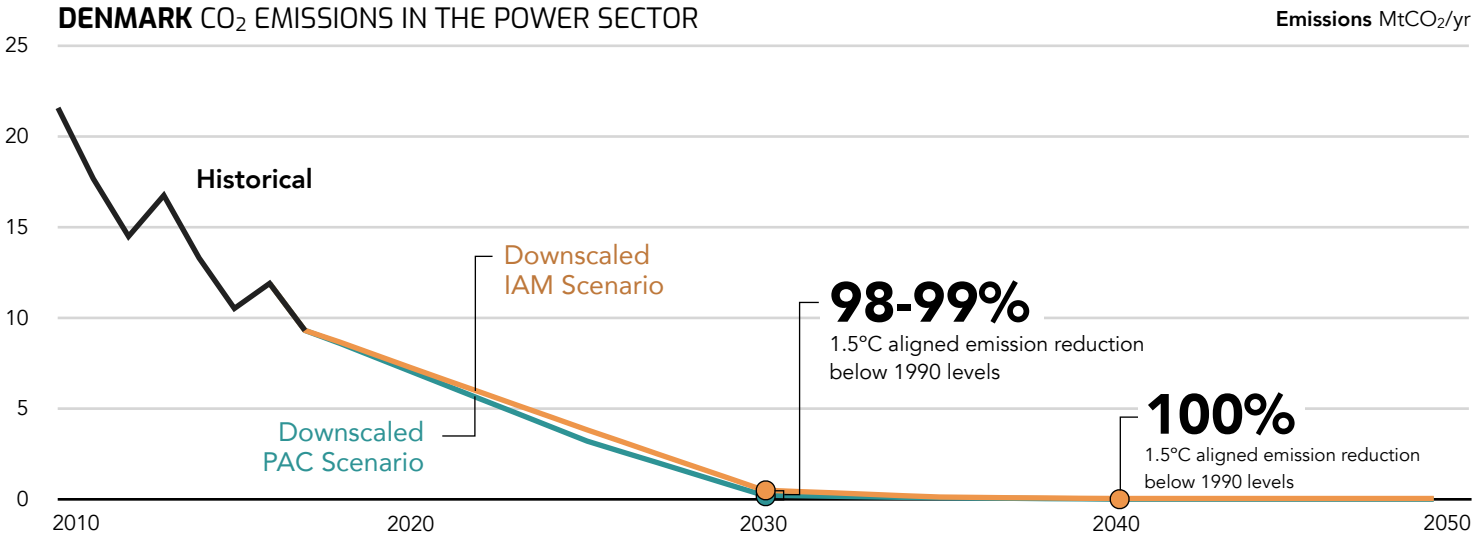
Downscaled IAM Scenario



The PAC scenario depicts a future where total energy use rapidly declines through efficiency gains, largely from switching fossil fuel consumption to renewables, increased rates of material reuse and recycling, and consumer demand reduction.

The IAM scenario also achieves efficiency gains, but assumes energy demand continues to rise over time in line with historical growth trends. The large increase in national total primary energy supply reflects the overall increase in the modelled Europe-wide scenario results.

Sectoral decarbonisation: Power

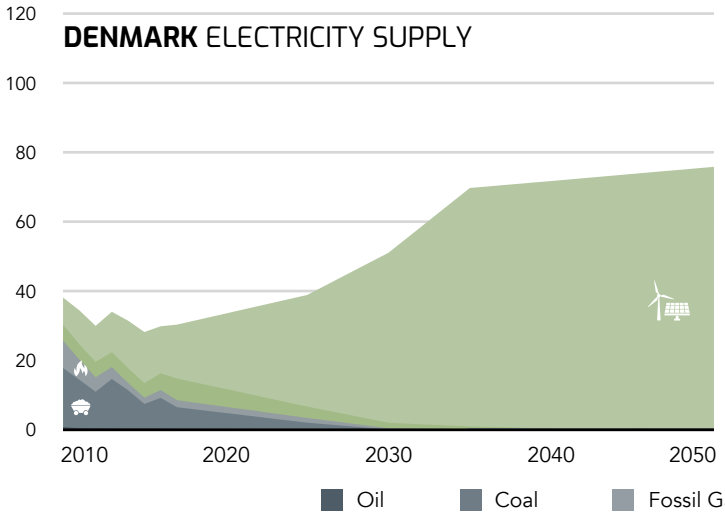


1.5°C Compatible 2030 power sector fuel mix*

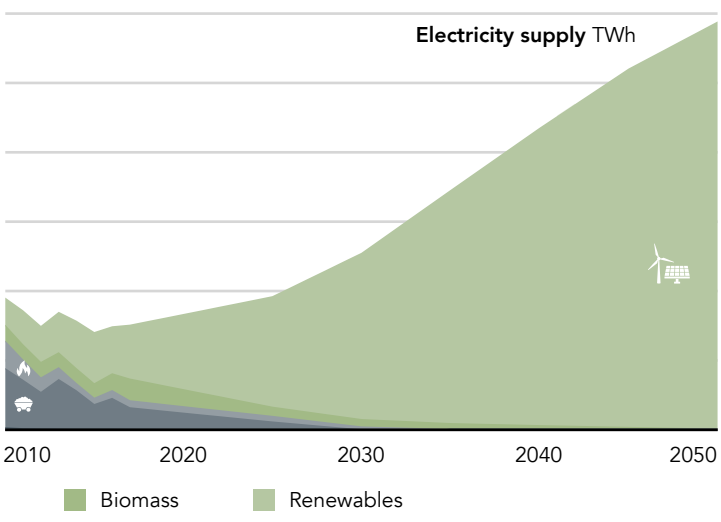
	Renewables incl. biomass	Coal	Fossil gas	Nuclear
2017 [5]	72%	20%	7%	0%
2030	98–99% IAM PAC	0%	1–2% PAC IAM	0%

*No detailed wholesale electricity market modelling was undertaken for this assessment

Downscaled PAC Scenario



Downscaled IAM Scenario

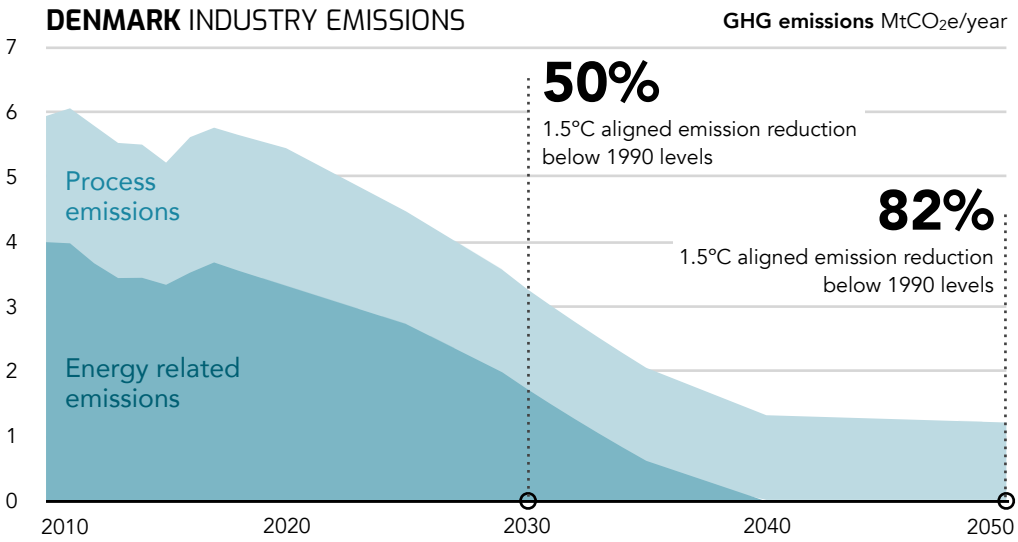


Oil Coal Fossil Gas Biomass Renewables

Towards a fully decarbonised power sector

Denmark's power sector has undergone a transformation over the last decade, marked by rapidly declining coal and gas use and rising generation from renewables and biomass. The government's 2030 coal phase out is 1.5°C compatible, and should now be accompanied by a commitment to phase out gas use by around the same date.

Sectoral decarbonisation: Industry



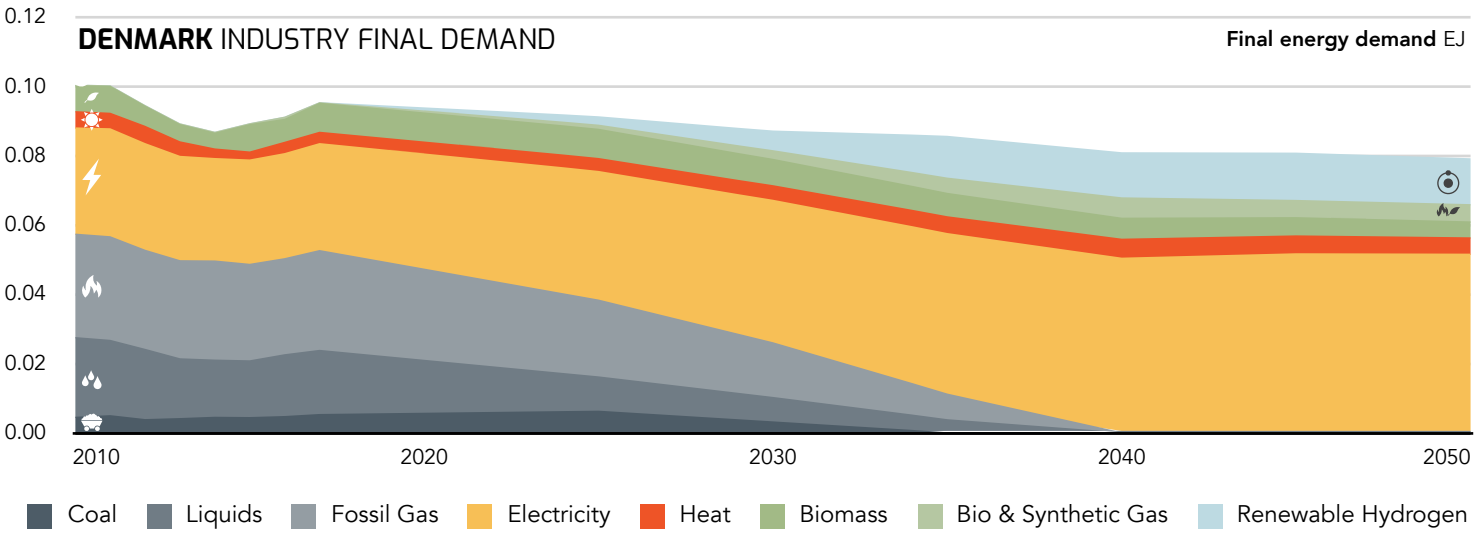
Emissions from industry decline significantly until 2040 in the pathway downscaled from the PAC scenario, whereby energy-related emissions reach zero, and further reductions occur more gradually. This is due to the nature of these residual (process) emissions that are harder to mitigate than those from fuel combustion.

It was not possible to downscale the chosen IAM scenario due to a misalignment of scenario and historical energy data.

1.5°C Compatible 2030 industry sector final energy mix

	Electricity	Coal	Fossil gas	Renewable Hydrogen
2017 [5]	32%	6%	30%	0%
2030	**47%**	**4%**	**21%**	**6%**

Downscaled PAC Scenario



Towards a fully decarbonised industry sector

Emissions from Denmark's industry sector have fallen at more than double the rate (-31%) at which energy demand has declined (-15%) over the period 1990-2019.[5,6] This is primarily due to fuel switching from coal and oil, which have seen demand decline by 71% and 41% respectively, to natural gas and biomass, which are 15% and 133% higher in 2019 than in 1990. The remaining coal use in industry should be phased out by 2035 at the latest, while oil and gas demand should be eliminated between 2035 and 2040.

Closing the Ambition Gap

Key characteristics of Denmark's 1.5°C compatible pathways

	Historical	1.5°C compatible benchmarks		Country targets	
	2017	**2030**	**2050**	**2030***	**2050** incl. LULUCF**
Total GHG excl. LULUCF	48 $MtCO_2e/yr$	16–19 $MtCO_2e/yr$	-2–5 $MtCO_2e/yr$	19 $MtCO_2e/yr$	0 $MtCO_2e/yr$
	31 % below 1990	73–78 % below 1990	93–103 % below 1990	73 % below 1990	100 % below 1990
Emissions intensity of power generation* **	307 gCO_2/kWh	4-10 gCO_2/kWh	0 gCO_2/kWh		
Share of renewable power	72 %	98–99 %	100 %	100 %	
Share of unabated fossil fuel in power	28 %	1–2 %	0 %	0 %	
Share of nuclear power	0 %	0 %	0 %		
Industry electrification rate	32 %	47 %	65 %		

* 2030 target excluding LULUCF calculated using the government's 'with existing measures' emissions projections from the NECP 2020[1]
** 2050 target is shown including LULUCF emissions due to the absence of government projections for these emissions to 2050
*** Does not include upstream emissions

Raising Ambition

Denmark has set ambitious domestic emissions and renewable energy targets that are aligned with 1.5°C compatible pathways derived in this analysis, but so far lacks the policies to achieve them.[1] In particular, policies are lacking to encourage the necessary rapid decarbonisation of the transport, industry, and buildings sectors. After falling from their record high in 2018, transport emissions need to continue to decline. Investments to achieve modal shift from cars to public transport and walking or cycling are crucial moving forward, as are incentives to encourage house owners to install low carbon heating options.

Other modelling results

Inforse Europe: Energy Vision 2030 for Denmark[12]

- 100% renewable energy by 2030

View the full report covering the EU27 and the 9 member states below or view the other factsheets in this series

Denmark | France | Germany | Italy | Poland | Portugal | Romania | Spain | Sweden

About the author

Supporting science-based policy to prevent dangerous climate change, enabling sustainable development.

Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Our mission is to synthesise and advance scientific knowledge in the area of climate change.

climateanalytics.org

Acknowledgments

We would like to acknowledge the Swedish Postcode Foundation for providing funding for this project.

Climate Action Network (CAN) Europe and AirClim provided ongoing and invaluable coordination support but do not necessarily endorse all findings from this project.

References and Data Sources

1. Integrated National Energy and Climate Plan 2021-2030
   Source: Government of Denmark (2020).
   Link: https://ec.europa.eu/energy/sites/ener/files/documents/es_final_necp_main_en.pdf
2. Comparability of Effort
   Source: Climate Action Tracker (2021).
   Link: https://climateactiontracker.org/methodology/comparability-of-effort/
3. 1.5°C Pathways for Europe: Achieving the highest plausible climate ambition
   Source: Climate Analytics (2021)
   Link:
4. National Inventory Report - Denmark
   Source: Government of Denmark (2021)
   Link: https://unfccc.int/documents/273129
5. World Energy Balances 2020
   Source: International Energy Agency (IEA) (2020).
   Link: https://www.iea.org/data-and-statistics/data-product/world-energy-balances
6. Denmark. 2021 Common Reporting Format (CRF) Table
   Source: Government of Denmark (2021).
   Link: https://unfccc.int/documents/273486
7. Paris Agreement Compatible Scenarios for Energy Infrastructure
   Source: PAC Consortium (2020).
   Link: https://www.pac-scenarios.eu/
8. Towards Optimal 1.5° and 2 °C Emission Pathways for Individual Countries: A Finland Case Study
   Source: Sferra, F. et al, *Energy Policy,* (2018).
   Link: https://doi.org/10.1016/j.enpol.2019.04.020
9. Paris Agreement Compatible Scenarios for Energy Infrastructure
   Source: PAC Consortium (2020).
   Link: https://www.pac-scenarios.eu/
10. REMIND
    Source: Potsdam Institute for Climate Impact Research (2020).
    Link: https://www.pik-potsdam.de/en/institute/departments/transformation-pathways/models/remind
11. Description of the REMIND model (Version 1.6)
    Source: Potsdam Institute for Climate Impact Research (PIK) (2015).
    Link: https://www.pik-potsdam.de/en/institute/departments/transformation-pathways/models/remind/remind16_description_2015_11_30_final
12. Energy Vision for Denmark 2030
    Source: Inforse-Europe (2010).
    Link: https://www.inforse.org/europe/pdfs/EnergyVision2030-UK.pdf