Denmark's Global Climate Impact

2024

Global Report

Danish Energy Agency

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Summary

Denmark's Global Climate Impact – Global Report 2024 (GR24) is an analysis of how Danish consumers, businesses and authorities affect emissions of greenhouse gases outside Denmark in different ways. Climate change is a global challenge, and this report contributes an important examination of Denmark's role in global climate action. The findings in this report can support Denmark's future climate action.

GR24 has four parts on four different sub-topics: 1) *Denmark's climate footprint*, 2) *Focus on energy and transport*, 3) *Climate action by businesses*, and 4) *Global action by authorities*.

Denmark's climate footprint

GR24 estimates emissions associated with the goods and services imported, consumed and exported by Denmark. Furthermore, Denmark's climate footprint from consumption is projected to 2035 on the basis of different scenarios. This is supplemented by a series of key indicators for consumption areas with a significant climate footprint. Finally, there is an estimate of the climate footprint of Danish public procurement.

The climate footprint of consumption is an estimate of the greenhouse gas emissions that occur inside as well as outside Denmark's territorial borders and that are associated with Danish consumption. Denmark's consumption-based climate footprint **has been estimated at 64 million tonnes CO_2e for the year 2022**. This corresponds to around **11 tonnes CO_2e per capita**.

The estimate shows that more than half of emissions associated with Danish consumption occurred in countries outside Denmark. The climate footprint of Danish consumption **is largest in Europe and Asia.** The climate footprint is just under 13 million tonnes CO_2e in the EU27 and 7.4 million tonnes CO_2e in China.

The majority of the consumption-based climate footprint is related to **household consumption** (59%), which covers goods and services bought by private households. According to the estimate, emissions from household consumption relate in particular to food and beverages, and transport. Household consumption of household goods, clothes and electronics in particular has a higher footprint outside rather than inside Danish borders.

Projection of the climate footprint of consumption presents the results of the projection of Denmark's consumption-based climate footprint to 2035. The projection is associated with considerable uncertainties. The projection is based on a frozen-policy scenario for the development of Danish emissions, as well as on a series of scenarios for the development of emissions in the wider world. Depending on developments in the wider world, the projection predicts that Denmark's consumption-based climate footprint will **drop to somewhere between 30-49 million tonnes CO_2e by 2035**. In a current-policy scenario for the wider world, which assumes no additional climate policy measures by countries in the wider world than those implemented up to and including

2020, the consumption-based climate footprint is projected to be at **around 49 million tonnes CO_2e in 2035**. In an NDC scenario (Nationally Determined Contributions), which assumes countries in the wider world achieve the targets set out in their climate action plans submitted under the Paris Agreement, Denmark's consumption-based climate footprint is projected to be at **around 45 million tonnes CO_2e in 2035**. In scenarios in which the global temperature rise is limited to 2°C or 1.5°C by 2100, the consumption-based climate footprint is projected to be at **around 35 or around 30 million tonnes CO_2e, respectively, in 2035**. Across the scenarios, Danish consumption is projected to account for **a growing share of the climate footprint in developing economies.**

Key indicators of consumption describes a number of specific activities in regard to Danish consumption of transport, food products, electronics and energy. The key indicators for **passenger transport** by car and aircraft show **increased consumption** over time, including for the most recent year. At the same time, sales of electric vehicles have increased. With respect to food products, Danish **meat consumption fell slightly** in 2021, the most recent statistical year, but the indicator generally fluctuated up and down during the period 2010-2021. **Sales of electronics** have increased since 2012. Sales peaked in 2021 and then, in 2022, dropped to around the same level as in 2019. Overall, sales of electronics have **increased by around 40%** since 2012. Total **electricity and heating consumption** by households was **30 GJ** per capita in 2022, with a **renewables share** of **72%**. Household electricity and heating consumption is lower today than in 1990 and **the renewables share has increased significantly**.

The climate footprint of Danish imports has been estimated to be **108 million tonnes CO_2e in 2022**. The estimate includes the entire value chain for imported goods and services up to the point where they transfer from foreign to Danish hands. Emissions from total Danish imports include emissions related to goods and services consumed in Denmark, as well as emissions from goods and services exported onwards from Denmark.

According to the estimate, emissions linked to Danish exports increased by **6.5 million tonnes CO_2e from 2021 to 2022**. **The level in 2022** is thus higher than in the years leading up to the Covid-19 pandemic. At the same time, according to the estimate, in the past ten years, Danish imports have become less climate-impacting per DKK imported.

The majority of Danish imports emissions occurred in **Europe (41.5 million tonnes CO_2e)** and in **Asia (36.5 million tonnes CO_2e)**. The estimate shows that the highest climate footprint from Danish imports at country level was in China and Germany.

The climate footprint of Danish exports has been estimated at just shy of **130 million tonnes CO_2e in 2022**. Slightly more than **half of these emissions have been estimated to occur in countries outside Denmark** in connection with the production of goods that are imported to Denmark and then either directly exported onward by Denmark or included in products that Denmark exports. The other **half has been**

estimated to be Danish emissions. The estimate shows that about half of total emissions from Danish exports are associated with **the transport sector**, and most of these emissions are associated with freight of goods by Danish shipping companies. Denmark's climate impact per DKK exported has decreased since 2016 according to the estimate. A little more than half of emissions from Danish exports went **to Europe**. The largest recipients of Danish exports outside Europe are **Asia and the USA**.

The climate footprint of Danish public procurement in 2022 has been estimated at **14.3 million tonnes CO_2e.** Public procurement by central government accounted for 32%, regional government 23% and local government 45% of emissions. Building and construction accounted for around 25% of total public procurement emissions. The climate footprint of public procurement has increased by 2% since 2019, while it fell by 9% compared with 2021. The total climate footprint of public procurement has been projected at **15.6 million tonnes CO_2e in 2030**.

Focus on energy and transport

Energy and transport have a significant climate impact both inside and outside Denmark. GR24 describes the greenhouse gas emissions embedded in Denmark's imports and exports of fuels and in electricity trade between Denmark and other countries. This part of GR24 includes an estimate of the net emissions related to Danish consumption of solid biofuels, as well as the cradle-to-grave emissions related to Danish biofuel consumption. There is also an estimate of the greenhouse gas emissions associated with activities in international shipping and aviation, where these are linked to Denmark or Danish businesses.

The energy balance provides an outline of energy flows into and out of Denmark. The outline is based on a calculation of Danish imports and exports of fuels and electricity.

In the most recent decade, 2010-2020, Denmark imported the greatest share of fuels from Norway, Russia and Sweden, while the greatest share of fuels exported *from* Denmark went to **Sweden, the Netherlands and Germany**. In all years in the period 2015 to 2022, total greenhouse gas emissions linked to imports of fuels have been estimated as higher than emissions linked to exports of fuels. However, this is expected to change up to 2030, with emissions from imports becoming smaller than emissions from exports. If anticipated future PtX products produced in Denmark replace fossil fuels abroad, Denmark will contribute to reducing emissions abroad. The largest reduction abroad is likely to be through the direct replacement of natural-gas based hydrogen with PtX products.

The estimate shows that, in 2022, Danish electricity *imports* were associated with **0.6 million tonnes CO_2e** emissions outside Denmark, while Danish electricity *exports* in 2022 were associated with **0.6 million tonnes CO_2e** emissions in Denmark *and* with emissions reductions *outside* Denmark of **1.0 million tonnes CO_2e**. The estimate also shows that, although the electricity production of countries outside Denmark is becoming greener by the day, Danish electricity exports will also **reduce emissions in countries outside Denmark** in 2035, because Danish electricity exports will have a lower emissions factor than the electricity produced in countries outside Denmark.

Solid biofuels have replaced a large part of Danish fossil fuel consumption. Under the UN IPCC guidelines, harvesting of wood and other biomass is estimated as emissions in the country where the wood is harvested. If the biomass is subsequently burned in power plants, for example, this counts as zero emissions in the utilities sector, because the emissions have already been included in the estimate in connection with harvesting the biomass, see the UN IPCC guidelines. This is to prevent double counting of emissions from biomass. GR24 takes a different perspective on emissions from solid biofuels, in that it presents an overall estimate of all Danish and global emissions associated with the use of biomass in the Danish utilities sector.

According to this estimate, Danish consumption of wood pellets, wood chips and firewood for electricity and district heating, as well as directly for household heating, in 2022 led to emissions of **12.4 million tonnes CO_2** in the year of consumption. Of this, the time-dependent, temporary biogenic emissions from biomass burning, etc. accounted for **11.6 million tonnes CO_2**. **Net emissions** from consumption of wood fuels in 2022 have been estimated to **fall exponentially over time**. After ten years, the amount of CO_2 in the atmosphere linked to the specific consumption in 2022 will have **fallen by 47%**, after 20 years, it will have fallen by **67%**, and, after 30 years by **78%**.

In Denmark, **biofuels** are used as an alternative to fossil fuels, and they therefore contribute to reducing greenhouse gas emissions from the transport sector. GR24 estimates emissions associated with bioliquids used in Denmark, including emissions associated with the production (growing and processing), transport and use of biofuels. The cradle-to-grave emissions of CO_2e from biofuels in 2022 have been estimated at around **0.25 million tonnes**. As a weighted average, cradle-to-grave emissions fell from 34.7 g/MJ in 2018 to 24.0 g/MJ in 2022. If indirect emissions from land-use change are included in the estimate, the amount of emissions from biofuels more than doubles.

International transport accounts for emissions from international shipping and aviation related to Denmark. These two sectors account for a major part of international transport of passengers as well as of freight. Aviation activities primarily comprise passenger transport, which means that passenger aircraft are the primary source of the sector's emissions of greenhouse gases. Emissions linked to flights by Danish and foreign air carriers to and from Denmark in 2022 have been estimated at around **4.2 million tonnes CO_2e**.

Shipping industry activities pertain mainly to the transport of goods between countries and parts of the world on large container ships cargo ships. Emissions linked to Danish-operated ships on international voyages have been estimated at around **37.5 million tonnes CO_2e** in 2021.

The Covid-19 pandemic led to significant reductions in air transport activity and, thus, in CO_2e emissions from air transport. The shipping industry was less affected by the restrictions during the pandemic. The most recent data available in GR24 shows that, in both sectors, activities and emissions have subsequently risen again globally and are heading towards pre-pandemic levels.

Climate action by businesses

Businesses greatly influence global greenhouse gas emissions as there are emissions associated with everything from production, operation and transport to final consumption of the products sold. The climate footprint of activities by Danish businesses is included in the estimates of emissions embedded in Danish consumption, imports and exports. GR24 also presents an estimate of the monetary and climate-related value of Danish exports of green energy and environmental technologies. Furthermore, there is an analysis of the degree to which the largest businesses are ready to comply with new EU requirements for climate reporting.

Danish green exports is an estimate of revenues from exports of green energy technologies and environmental technologies and the related potential for CO_2 emissions reductions in the use phase of the technologies. In 2023, Denmark exported **green energy technology worth around DKK 64 billion** and **green environmental technology worth around DKK 23 billion**. Over the entire lifetime of the individual product, it is estimated that Danish exports of energy technologies in 2023 have potential to **reduce emissions by between 120 and 212 million tonnes CO_2**. This corresponds to 4-8 million tonnes CO_2 in any given year of the individual technology's lifetime. Technologies within wind and hydro/wave dominate Danish green exports. In 2023, Germany was the largest buyer of Danish green energy technologies, as Germany bought technology worth a total of DKK 10 billion.

Climate action by large Danish businesses analyses the degree to which the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses are currently reporting their climate footprint and climate targets. **The majority of all these businesses report their emissions for the 2022 financial year to some extent or other**. A total of 25% of the 110 businesses report emissions under both Scopes 1 and 2 and estimate all Scope 3 categories, which represents a considerable increase compared with 2021 when only 14% of businesses did so.

Most of the businesses base their work on the accounting standards outlined in the Greenhouse Gas Protocol (GHG Protocol). Many of the businesses also have third parties to audit their climate accounts. As many as **71% of non-financial as well as 70% of financial businesses** have also set reduction targets in their most recent annual reports.

Global action by authorities

In a number of areas, Denmark is active in promoting global sustainability and green transitions. This is through the exchange of experience and climate diplomacy initiatives, via bilateral and multilateral cooperation and via the EU. GR24 includes a review of a number of selected initiatives for 2023 that contribute to reducing greenhouse gas emissions globally and that support climate change adaptation efforts in countries outside Denmark.

Global climate ambitions describes how Denmark works to encourage other countries and players to raise their climate ambitions. Prior to COP28, Denmark hosted the Copenhagen Climate Ministerial (CCM), which included facilitation of consultations on **the first-ever Global Stocktake** of the long-term targets of the Paris Agreement. COP28 proper saw the launch of the Danish-initiated Group of Negative Emitters (GONE) alliance. The alliance is working to encourage **more countries to set negative emissions targets before COP30** and to develop the policy frameworks and technical solutions needed to achieve negative emissions. September 2023 saw the announcement of an African initiative: Accelerated Partnership for Renewables in Africa. Denmark and Germany are the primary donor countries behind this initiative, the objective of which is **to establish an African-led coalition of countries with ambitious targets for a green energy transition.**

Denmark supports **global reductions** by providing climate assistance for a range of multilateral and bilateral initiatives. Denmark is working to ensure that the largest emitting countries reduce their emissions, and that developing countries follow sustainable development paths. In 2023, Denmark contributed to projects for **redevelopment and renewable energy transition in Ukraine** and to support work by the International Maritime Organisation to explore and develop shipping routes for low-emissions ships in developing countries. Through bilateral cooperation, **in 2023, Denmark again shared its knowledge and experience in the areas of energy, the environment and food** with a view to developing the capacity of its partnership countries in these areas.

Support for **global climate change adaptation action** is through bilateral and multilateral channels as part of Danish climate assistance in 2023. In 2023, through assistance, Denmark contributed to **increasing resilience** to climate change among the most vulnerable people and groups, and to promoting climate change adaptation action with a holistic approach to the environment, climate and biodiversity. Current projects focus on early-warning systems, access to clean drinking water and climate-resilient agriculture, for example.

Climate assistance and finance looks at Danish climate assistance and mobilised climate finance. In 2022, Danish climate assistance was around **DKK 1.9 billion,** of which around 60% went to climate change adaptation initiatives and around 40% to emissions reduction initiatives. Denmark contributes to increasing private investment in the climate by providing public funding for projects, because this reduces the risk for private investors. In 2022, **IFU (Investment Fund for Developing Countries)**, which is owned by the Ministry of Foreign Affairs of Denmark, **mobilised around DKK 1.9 billion in financing** for climate projects. Denmark also contributes to mobilising public as well as private finance **through the multilateral development banks**.

Climate footprint of public and private investments abroad describes the climate footprint of Danish public investment and financing in other countries through the state-owned Export and Investment Fund of Denmark (EIFO) and Investment Fund for Developing Countries (IFU), as well as the climate footprint of the shares and corporate

bonds held by Danish insurance and pension companies, investment associations and banks and mortgage-credit institutions in non-Danish listed companies[1].

EIFO has estimated its total climate footprint from financing projects internationally at **2.97 million tonnes CO_2e** for 2023. IFU has estimated the climate footprint of its portfolio at **around 0.77 million tonnes CO_2e** for 2022. Together, Danish private investment funds financed Scope 1 and Scope 2 emissions totalling **around 3.5 million tonnes CO_2e in 2023** through their investments in shares and corporate bonds in non-Danish listed companies, while insurance and pension companies financed Scope 1 and Scope 2 emissions totalling **around 5.8 million tonnes CO_2e** and banks and mortgage-credit institutions **0.2 million tonnes CO_2e**.

Cooperation with businesses on green solutions describes initiatives to facilitate opportunities for businesses to contribute to Denmark's global climate action. The Action Plan for Economic Diplomacy 2022-2023 includes focus on **improving the framework conditions**, multilaterally as well as bilaterally, for **Danish businesses and Danish exports of green solutions**. Furthermore, 2023 saw focus on implementing action plans for increased green exports and on boosting green exports by the Danish food cluster and the Danish water sector in particular. Besides this, a partnership for biodiversity was established to encourage initiatives for biodiversity in the value chains of businesses.

[1] The figures are not directly comparable because of methodological differences (for example, the sector figures from Danmarks Nationalbank (the Central Bank of Denmark) do not include Scope 3, whereas Scope 3 is included in calculations for EKF and IFU). Furthermore, note that with regard to private investments, Danmarks Nationalbank does not include a number of investments, such as other types of bonds, unlisted shares, etc. This means the calculations do not reflect the total climate footprint of the portfolio.

About Denmark's Global Climate Impact

Focus on Denmark's Global Climate Impact

Denmark's Global Climate Impact - Global Report 2024 (GR24) has its legal basis in the Danish Climate Act. The report provides a picture of how, in various ways, Danish consumers, businesses and authorities are contributing to climate impacts as well as to climate action outside Danish borders.

The purpose of drawing up annual global impact reports is to illustrate Denmark's global impact on the climate, see box 1 and Annex 1.

Box 1: The purpose of global impact reporting (Klimaloven, 2020)

The purpose of global impact reporting is to illustrate Denmark's global impact on the climate. The reports include negative impacts, for example from Danish consumption, but also positive impacts, for example from Denmark's bilateral cooperation with other countries to help these countries convert their energy sector, among other things.

The global impact reports are published as a supplement to Denmark's climate status and outlook reports, which only look at Danish territorial greenhouse gas emissions, see box 2.

Box 2: Denmark's Climate Status and Outlook

Denmark's climate status and outlook reports provide an annual status report on and projections of CO_2e emissions from Danish territory based on policies already adopted. The reports are prepared on the basis of the UN IPCC methodological principles, which are applied across countries, the EU and the rest of the world to assess progress with regard to internationally agreed targets. Similarly, the reports compare Denmark's 70% emission reduction target by 2030 to greenhouse gas emissions from Danish territory in accordance with the UN IPCC methodological principles[1].

[1] The international methodologies for estimating greenhouse gas emissions are based on guidelines from the UN Intergovernmental Panel on Climate Change (IPCC, Guidelines for National Greenhouse Gas Inventories, 2006). All parties to the UN Framework Convention on Climate Change (UNFCCC) must estimate and report their greenhouse gas emissions according to the IPCC guidelines to ensure comparability across countries. National emissions inventories include territorial emissions, i.e. all emissions taking place within national territory. This also applies to land use, which means that felling trees must be accounted for as CO_2e emissions in the country of origin, even though the resulting biomass may be exported and used for energy in another country.

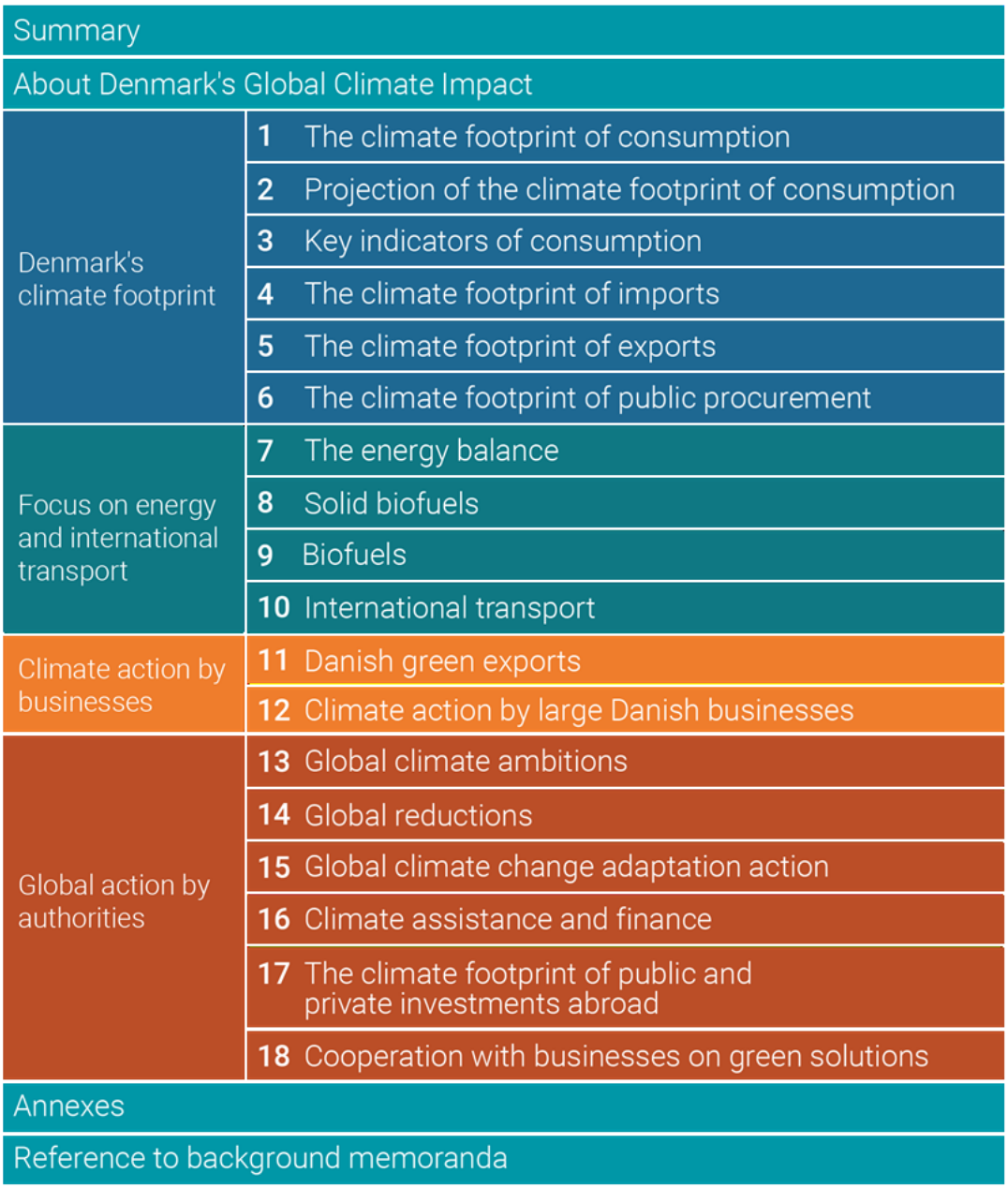
The publication each year in April of Denmark's global impact report and climate status and outlook report is part of the annual cycle described in the Danish Climate Act. The purpose of the annual cycle is to ensure annual follow-up on whether Danish climate action is supporting fulfilment of the targets in the Climate Act.

Structure of Denmark's Global Climate Impact 2024

GR24 consists of a main report, incl. annexes, as well as 20 background memoranda further elaborating on the topics described in the report. The focus of the main report is on presenting key results. For descriptions of supplementary results, methodology approaches, data bases, etc., consult the background memoranda.

The main report has four parts: 1) Denmark's climate footprint, 2) Focus on energy and transport, 3) Climate action by businesses, and 4) Global action by authorities, see Figure 1.

Figure 1: Structure of GR24



Part 1 considers the fact that a product will often have left climate footprints in several countries before it reaches the consumption stage. Part 1 sheds light on Denmark's climate footprint from Danish imports, consumption and exports of goods and services. Furthermore, a number of specific areas of consumption are dealt with in more detail. **Part 2** focusses on emissions related to Denmark's consumption of energy in the form of electricity and fuels, as well as on emissions related to international transport. **Part 3** focusses on climate action by large Danish businesses, as well as on reductions that can be linked to Danish exports of green energy technologies and environmental technologies. Finally, **Part 4** contains a review of the climate action of Danish authorities to reduce global emissions.

There is still no standard international methodology for estimating the global climate impact of a country. Estimates are therefore associated with uncertainty, and not all aspects of Denmark's global climate impacts are covered. Furthermore, methods and data bases for estimates are continuously developed and improved.

How we estimated Denmark's global climate impact

The results in GR24 have been arrived at using a number of different data sources and methodologies. Read more about these in the background memoranda.

Denmark's emissions linked to consumption, imports and exports have been calculated using an input-output model. The basic model is the same as was used by the Danish Energy Agency in last year's Global Report (GR23). The method is based on a Simplified SNAC approach (Tukker, et al., 2018) and combines data from Statistics Denmark with data from the global EXIOBASE database. The model calculates greenhouse gas emissions embedded in goods and services that Denmark consumes, imports and exports. Denmark's consumption-based climate footprint has been estimated in cooperation with Statistics Denmark.

Projection of Danish consumption has been calculated in collaboration with the DREAM group (Danish Research Institute of Economic Analysis and Modelling) and is generally based on the same methodological approach as the estimate of Denmark's historical consumption-based climate footprint. The DREAM group makes forecasts of the Danish economy using the GrønREFORM model, an environmental and climate-economic model in which Danish emissions are calibrated against last year's Climate Status and Outlook report. This is combined with four scenarios for global development implemented in EXIOBASE.

The climate footprint of Danish public procurement is based on invoice data and energy consumption data collected by the Agency for Public Finance and Management from the central government (including self-governing institutions), from regional governments, and from local governments through SKI (the procurement service of central and local governments). Procurement categories were matched with data on emissions, and then the climate footprint was calculated.

Key indicators of Danish consumption is based on data from Statistics Denmark, the Danish Road Directorate, the Danish Civil Aviation and Railway Authority, Danish Producer Responsibility (DPA), FAOSTAT and the Danish Energy Agency.

The energy balance describes Denmark's *fuel balance* and *electricity trade*. The fuel balance describes Danish imports and exports of fuels. The estimates include fossil fuels and fuels from renewable energy sources, and also consider energy quantities, emissions from combustion, and the countries to and from which Denmark exports and imports fuels, respectively. Historical data is primarily from the Danish Energy Agency's energy statistics (quantities), Statistics Denmark (breakdown by countries), and, for projection years, from Denmark's Climate Status and Outlook 2024 (CSO24). With regard to PtX fuels, the approach has been to look at what the exported fuel replaces in the country of destination and not at the emissions from burning the PtX fuel.

Electricity trade describes Danish imports and exports of electricity and looks at emissions for every hour based on the average electricity production mix for exports (electricity production in Denmark) and imports (electricity production abroad). Data for

historical years is based on data from Energinet (their energy declaration data) and data for projection years is based on detailed model results from Denmark's Climate Status and Outlook 2024 (CSO24).

Emissions related to Danish consumption of *solid biofuels* are based on reported data on consumption of solid biofuels in Denmark, as well as on calculations by the Department of Geosciences and Natural Resource Management, University of Copenhagen (IGN, 2022) and (Nielsen, 2024).

Emissions associated with Danish consumption of *biofuels* are based on reported data on consumption of biofuels in Denmark.

International transport is based on official statistics from the Danish Energy Agency, Statistics Denmark, the Danish Civil Aviation and Railway Authority and the International Maritime Organization (IMO).

Global climate action by large Danish businesses is based on data collected by the Danish Energy Agency from the annual reports and sustainability reports of the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses.

Danish green exports builds on analyses of exports of energy technology published by the Danish Energy Agency in cooperation with the Confederation of Danish Industry, Green Power Denmark and the Danish District Heating Association. Furthermore, it builds on an analysis by the Danish Environmental Protection Agency of exports of water technology and on the agency’s data on exports of waste and clean-air technologies. The estimate of potential greenhouse gas reductions linked to Danish green exports is based on data from the Danish Energy Agency's Technology Catalogues.

Global action by authorities is reported through direct input from the players responsible for Danish climate assistance (the Ministry of Foreign Affairs of Denmark) and bilateral energy, food and environment cooperation (the Danish Energy Agency, the Danish Veterinary and Food Administration and the Ministry of the Environment). With regard to green investments, this part is based on input from the Ministry of Industry, Business and Financial Affairs, EKF Denmark’s Export Credit Agency, and IFU (Investment Fund for Developing Countries).

Thus, contributions to this year's report have been obtained from a number of different ministries and stakeholders. Furthermore, according to the Climate Act, global impact reports must be submitted for external consultation, see Annex 1. The full GR24 report underwent external consultation in April/May 2024.

Denmark's climate footprint

The value chain of a product often goes across borders and can therefore leave climate footprints in several countries during the product's lifetime.

This part of GR24 presents an estimate of emissions associated with goods and services imported, consumed and exported by Denmark. Furthermore, Denmark's climate footprint from consumption is projected to 2035 on the basis of different scenarios. Further to this, there is an estimate of the climate footprint of Danish public procurement, including a projection to 2030.

To give a more detailed understanding of Danish consumption, there is an analysis of a number of key indicators for consumption areas with a significant climate footprint.

Chapter 1 *The climate footprint of Danish consumption* presents an estimate of the greenhouse gas emissions embedded in Danish consumption, regardless of where these emissions occur. The estimate therefore includes all emissions related to the production chain for products and services consumed by the Danish population.

Chapter 2 *Projection of Danish consumption* describes four different scenarios for developments in foreign greenhouse gas emissions linked to Danish consumption up to 2035 and one scenario for developments in emissions that take place inside Danish borders (in the following referred to as Danish emissions).

Chapter 3 *Key indicators for consumption areas* presents a series of key indicators for consumption areas with a significant climate footprint. These consumption areas are transport, food products, electronics and energy.

Chapter 4 *The climate footprint of Danish imports* presents an estimate of greenhouse gas emissions linked to Danish imports. This includes foreign production and carriage of goods and services to the point where they are transferred to Danish hands. Goods and services imported to Denmark can either be consumed in Denmark or they can be exported onward to other countries. The calculation includes the entire value chain of

imports and therefore covers more than the foreign emissions included in the calculation of the consumption-based climate footprint as imports.

Chapter 5 *The climate footprint of Danish exports* presents an estimate of greenhouse gas emissions embedded in Danish exports. The chapter describes greenhouse gas emissions from extraction of raw materials, processing, production and carriage of goods and services to the point where they are transferred from Danish to foreign hands in the form of exports.

Chapter 6 *The climate footprint of public procurement* describes the climate footprint of all Danish public procurement, including a projection to 2030. Methodologically, this estimate differs from the consumption-based climate footprint.

Descriptions of the methodologies applied, more detailed results, as well as a description of the uncertainties associated with the results of the analyses are provided in the respective background memoranda on consumption, projection, key indicators of consumption, imports, exports, and the climate footprint of public procurement.

1 The climate footprint of consumption

This chapter looks at the greenhouse gas emissions linked to Danish consumption. This estimate therefore covers emissions related to the consumption in Denmark of products imported to or produced in Denmark from a value chain approach. For example, if a mobile phone is manufactured in China, transported to Denmark and sold in a Danish shop, then the emissions from production and transport of the phone to the Danish border are considered *foreign emissions* from Danish imports, and the emissions from such things as lighting and heating the shop in Denmark are considered *Danish emissions.* Greenhouse gas emissions from *Danish exports* are not included because exported products and services are by definition consumed outside Denmark. Estimating Denmark's consumption-based climate footprint is a fairly new exercise, and the development of methodologies in this area is still at an early stage.

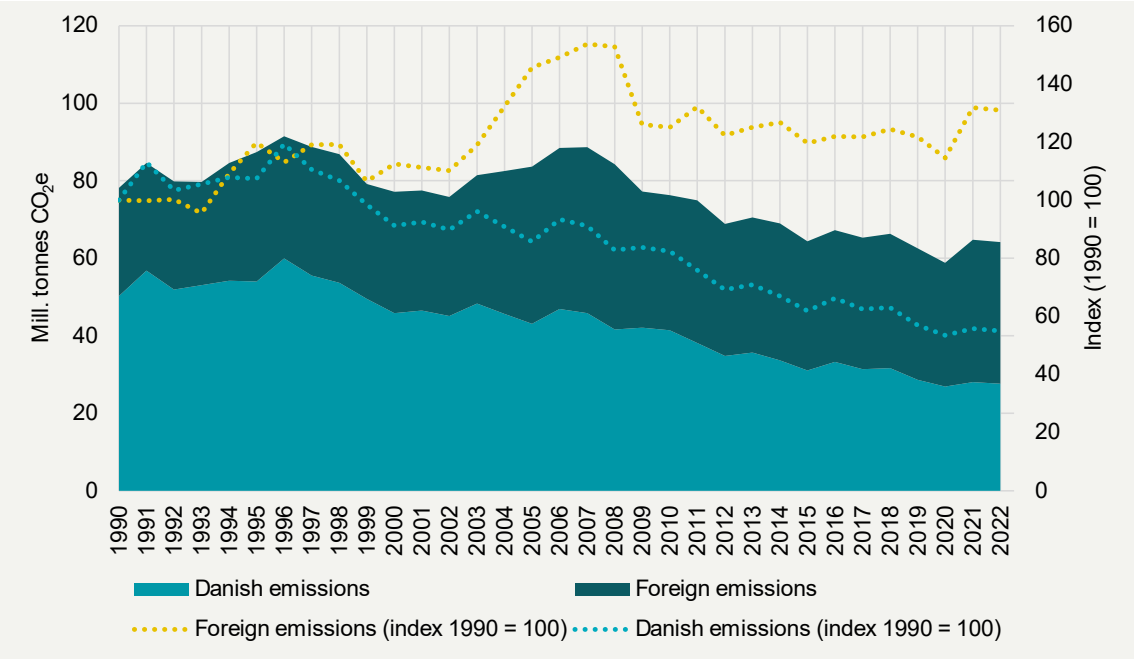
1.1 Main results

1.1.1 Denmark's consumption-based climate footprint was around 64 million tonnes CO_2e in 2022

Denmark's consumption-based climate footprint was around 64 million tonnes CO_2e in 2022. This corresponds to around 11 tonnes CO_2e per capita. The consumption-based climate footprint fell by 0.6 million tonnes CO_2e, which is a fall of 1% from 2021[2]. Figure 2 shows that 43% of Denmark's total consumption-based climate footprint for 2022 was from Danish emissions and 57% was from foreign emissions. The size of Denmark's climate footprint abroad is affected by what and how much Denmark imports for consumption, but also by how many emissions are linked to the production of the goods imported to and consumed in Denmark.

[2] Denmark's consumption-based climate footprint for 2021 was estimated at 63 million tonnes CO_2e in GR23 whereas it has been estimated at just under 65 million tonnes CO_2e in GR24. The difference is due to improved methodology and improved data in GR24. Differences between GR23 and GR24 are described in more detail in the background memorandum on the climate footprint of Danish consumption.

Figure 2: Denmark's consumption-based climate footprint broken down by Danish and foreign emissions



Source: The Danish Energy Agency. **Note:** Emissions related to Danish imports and Danish production are included, whereas exports have been deducted.

1.1.2 Emissions in Denmark linked to Danish consumption fell from 1990 to 2022

The estimate shows that Danish emissions linked to Danish consumption almost halved during the period from 1990 to 2022. Foreign emissions linked to Danish consumption, on the other hand, increased by around 30% during the same period. The fall in Danish emissions is because the Danish energy sector has become significantly less climate-impacting, underpinned by an increasing share of renewable energy.

Box 3: Danish territorial emissions and Denmark's consumption-based climate footprint

Denmark's consumption-based climate footprint is around 50% higher than Denmark's territorial greenhouse gas emissions. In 2022, Danish territorial emissions were estimated at around 42 million tonnes CO_2e, corresponding to around 7 tonnes of CO_2e per capita (Klima-, Energi- og Forsyningsministeriet, 2024). This means that Denmark's climate impact is higher if we use a consumption-based approach and include the greenhouse gas emissions abroad that are embedded in Danish consumption and deduct the greenhouse gas emissions that are embedded in Danish goods and services exported for consumption abroad.

1.1.3 Foreign emissions dropped slightly from 2021 to 2022, but are still higher than in the years before the Covid-19 pandemic

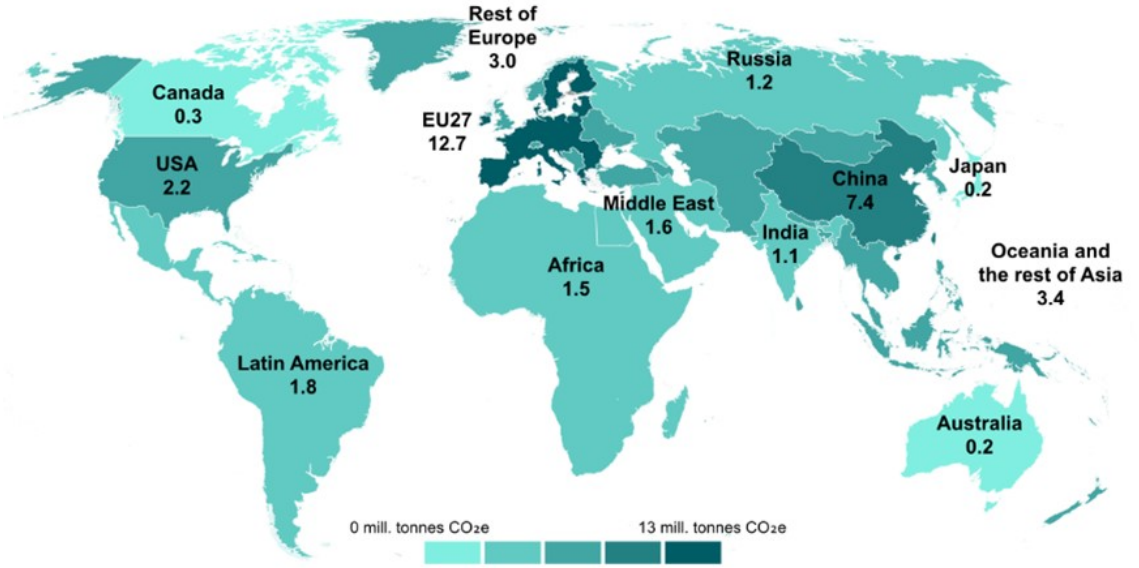
Emissions abroad linked to Danish consumption fell slightly during the period from 2021 to 2022. Levels in 2021 and 2022 are higher than in the years leading up to the Covid-19 pandemic. The effect of the pandemic on activity in society caused a drop in foreign emissions in 2020. The increase in 2021 and 2022 is assumed to be related to

increased imports for consumption in Denmark. However, it could also be due to other aspects, including a change in the mix of goods imported.

1.1.4 Danish consumption has the highest climate footprint in Europe and China

More than half of emissions related to Danish consumption occur outside Denmark. Figure 3 shows a breakdown of foreign emissions by regions and countries. According to the estimate, around 43% of foreign emissions in 2022 occurred in Europe[3]. This corresponds to almost 16 million tonnes CO_2e. Of these, 13 million tonnes CO_2e are emitted in the EU27. Danish consumption also has a high climate footprint in China (7.4 million tonnes CO_2e), while the remaining foreign emissions break down more evenly across the remaining regions and countries of the world.

Figure 3: Foreign emissions from Danish consumption in 2022 by regions (million tonnes CO_2e)



Source: The Danish Energy Agency. **Note:** The breakdown of the world into 12 regions is based on the regional breakdown in EXIOBASE.

1.1.5 Household emissions are most prominent and are linked primarily to food and beverages, and transport

In 2022, 59% of consumption-based emissions were related to household consumption of goods and services. A total of 29% of consumption-based emissions were related to investments[4] (primarily by public bodies and by businesses), whereas 12% were linked to consumption by public bodies (excluding public investments). The methodology for estimating emissions from 'consumption by public bodies' differs from the methodology for estimating 'the climate footprint of public procurement' presented in chapter 6. The two figures can therefore not be compared. The difference in methodology is described in the box below.

[3] Here, Europe means the sum of the EU27 and the Rest of Europe region.
[4] Investments include investments with a lifetime of more than one year by public bodies and businesses. For example, investments in fixed assets, transport vehicles and fixtures and equipment/furnishings. Household purchases that are used for more than one year are generally not categorised as investments in Danish national accounts and these purchases have therefore not been included in the investment category but instead under household consumption. Household purchases of newly built residential homes and of major repair work have, however, been included as investments.

Box 4: Different methodologies for estimating Denmark's consumption-based climate footprint and the climate footprint of Danish public procurement

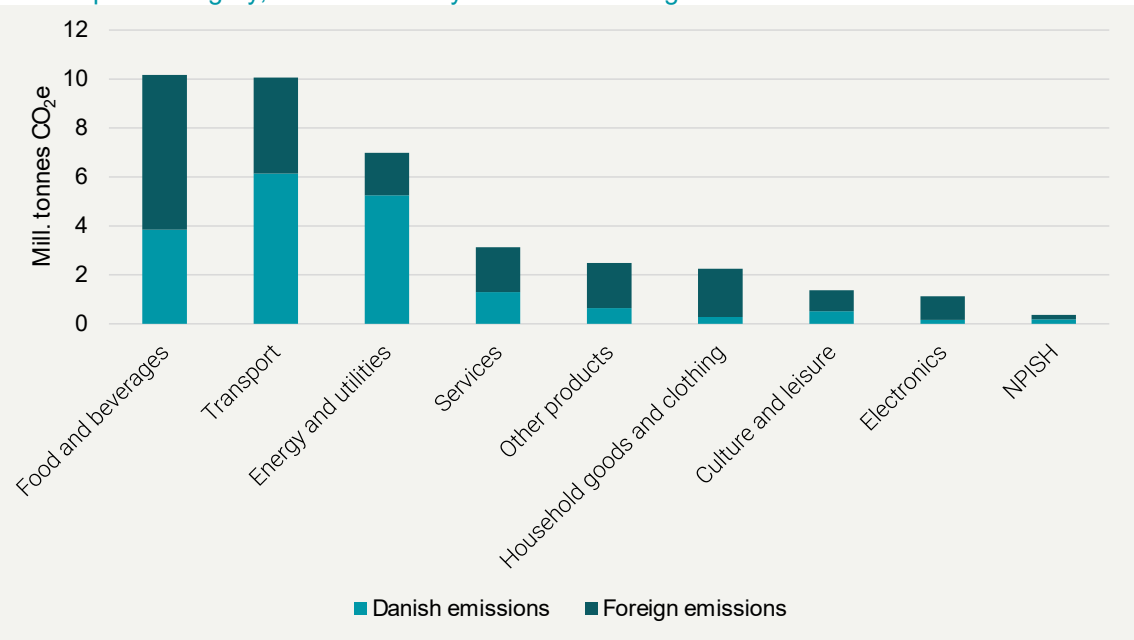
The Danish Energy Agency each year prepares an estimate of the climate footprint of Danish public procurement. This estimate is presented in chapter 6. The estimate of the climate footprint of public procurement cannot be compared with the estimate of the climate footprint of consumption by public bodies as estimated for Denmark's consumption-based climate footprint. One reason for this is that a large share of consumption by public bodies is categorised as 'investments' in the Danish national accounts (investments in development projects or equipment, for example). The climate footprint from these is therefore included under 'investments' in the estimate of Denmark's consumption-based climate footprint rather than under 'consumption by public bodies'. There are also differences in emissions factors and in the data basis. See the background memorandum on Denmark's consumption-based climate footprint for more about this.

Figure 4 shows that the majority of household emissions in 2022 stemmed from consumption for transport and for food and beverages. These two categories account for around 10 million tonnes CO_2e each. Petrol for vehicles and transport services (air and train travel, for example) comprise the two largest items for transport.

1.1.6 Half of household emissions occur abroad

Around half of emissions embedded in consumption by households in 2022 occurred abroad, according to the estimate. See Figure 4. Foreign emissions make up by far the majority of emissions embedded in household goods and clothing, electronics and 'other products', because a major part of the production of these goods takes place outside Denmark. Conversely, there are more Danish emissions than foreign emissions embedded in the consumption categories 'transport' and 'energy and utilities'. This is because the combustion of petrol and diesel fuel for transport and the production of electricity and heating primarily occur in Denmark and therefore fall under Danish emissions.

Figure 4: Greenhouse gas emissions arising from consumption by households in 2022 by consumption category, broken down by Danish and foreign emissions

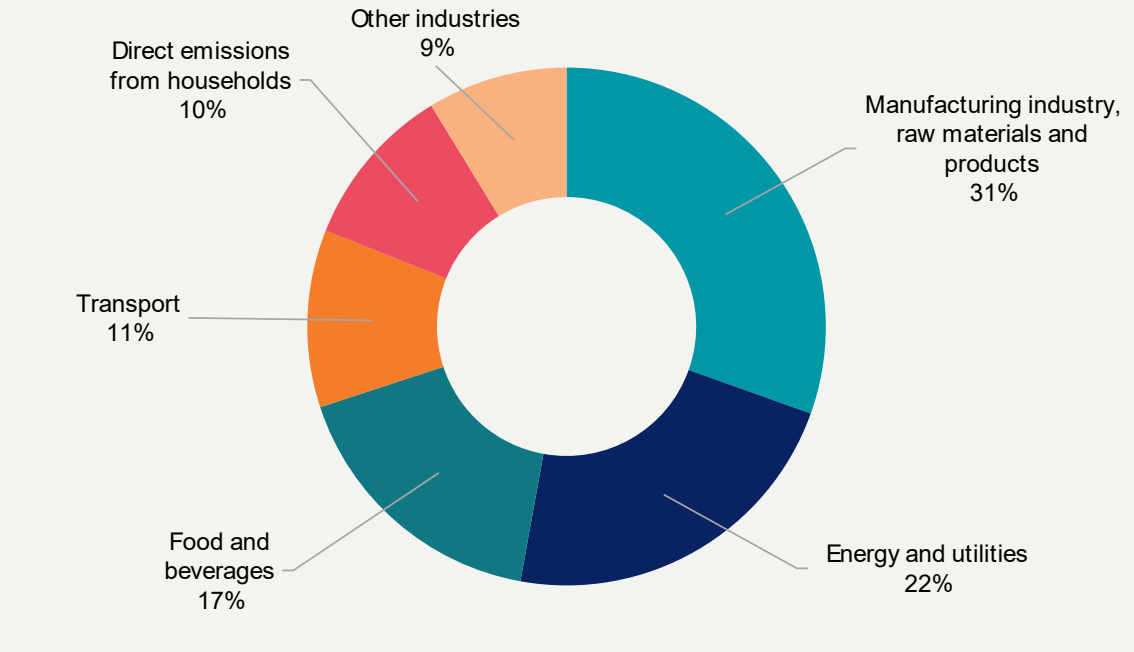


Source: The Danish Energy Agency. **Note:** NPISH stands for Non-Profit Institutions Serving Households and includes sports associations, private relief organisations, independent schools and trade unions, for example.

1.1.7 Most emissions from industries producing raw materials and products, energy and utilities, and food and beverages

Denmark's consumption-based climate footprint can also be estimated by industry group, see Figure 5. The majority of emissions from Danish consumption stem from relatively few industry groups. Almost one-third of emissions stem from industries producing raw materials and products. Of this one-third, the largest share stems from industries within oil and gas extraction, concrete and the manufacture of metal. About one-fifth of emissions stem from the energy and utilities industry, which produce energy and heating for several other industries. This is followed by the food and beverages industries (17%) and the transport sector (11%). Emissions in the food and beverages industries stem almost exclusively from agriculture, while shipping is responsible for more than half of transport sector emissions.

Figure 5: Greenhouse-gas emissions by industry groups, for emissions in 2022



Source: The Danish Energy Agency. **Note:** The industry groups include industries in Denmark and abroad. 'Other industries' cover building and construction, as well as trade and service sectors.

2 Projection of the climate footprint of consumption

This chapter presents the results of the projection of Denmark's consumption-based climate footprint. The results are associated with significant uncertainties, and the methodology will be developed further in years to come. This year's results cannot be directly compared with the results from last year due to new scenarios, updated data and improvements to the underlying models, see the background memorandum on projection of Denmark's consumption-based climate footprint.

The projection comprises two main parts: 1) an economic forecast for Denmark using the *GrønREFORM* model, and 2) a projection of developments in the wider world based on a number of scenarios.

Main results

2.1 Depending on developments in the wider world, Denmark's consumption-based climate footprint is projected to fall to somewhere between 30 and 49 million tonnes CO_2e in 2035

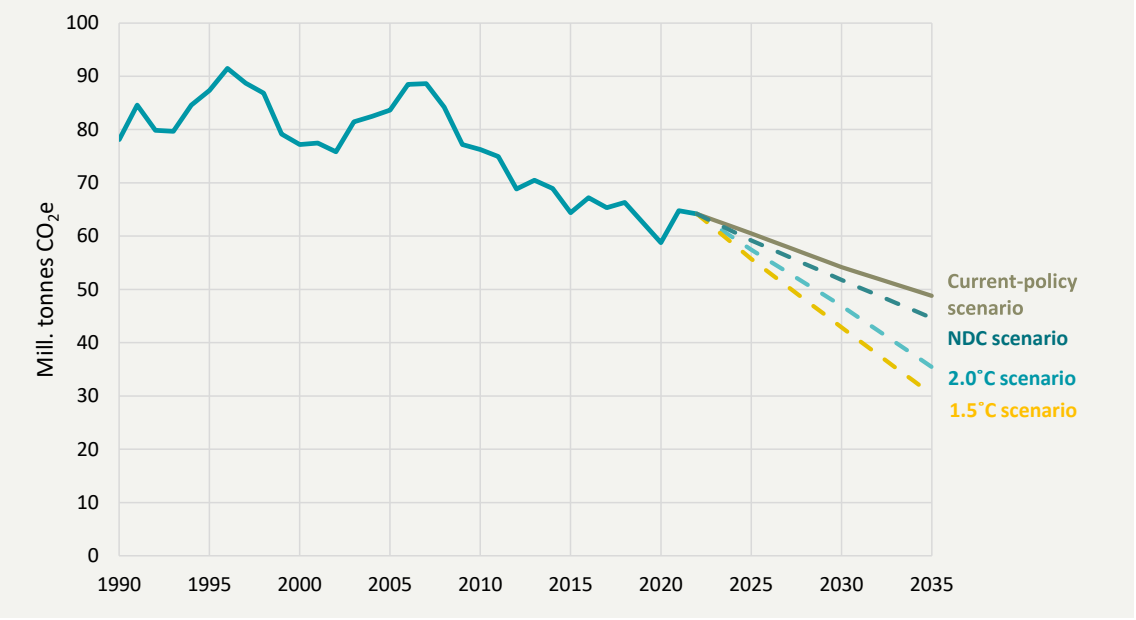
The future climate footprint of Danish consumption depends on developments in both Denmark and the wider world. The consumption-based climate footprint has been projected on the basis of one scenario for developments in Denmark and four scenarios for developments in the wider world. The scenarios for developments in the wider world are all based on the same underlying SSP scenario (Shared Socio-Economic Pathway) for socio-economic developments[5], but they vary with regard to the level of ambition for the green transition in the wider world. The first scenario for the wider world is a current-policy scenario, in which it is assumed that the countries in the wider world implement *no additional climate policy measures* than those already introduced up to and including 2020 and, therefore, do not necessarily succeed in meeting their climate targets for the future. The second scenario, the NDC scenario (Nationally Determined Contributions), is more ambitious and assumes that the countries in the wider world achieve the targets set out in their climate action plans submitted under the Paris Agreement[6]. Finally, the remaining two scenarios assume a green transition in the wider world limiting the global temperature rise to 2°C or 1.5°C, respectively, by 2100.

[5] This is the so-called 'SSP2: Middle of the Road' scenario, representing a middle-of-the-road development (relative to the other Shared Socio-Economic Pathways).
[6] The NDC scenario is based on the NDCs submitted to the UNFCCC between 2015 and 2017.

The projection of Danish emissions is based on a frozen-policy scenario[7] calibrated against Denmark's Climate Status and Outlook 2023. Danish emissions are therefore constant across the four scenarios for developments in the wider world.

In all scenarios, Denmark's consumption-based climate footprint is projected to fall up to 2035, thus continuing the trend since the mid-2000s. If Danish consumption follows the projected path, and the wider world develops according to a current-policy scenario, Denmark's consumption-based climate footprint will be around 49 million tonnes CO_2e in 2035, see Figure 6. If, however, the wider world develops according to the NDC scenario, Denmark's consumption-based climate footprint is estimated at around 45 million tonnes CO_2e in 2035. In scenarios in which the global temperature rise is limited to 2°C or 1.5°C by 2100, Denmark's consumption-based climate footprint is estimated at around 35 or around 30 million tonnes CO_2e, respectively, in 2035.

Figure 6: Projection of Denmark's consumption-based climate footprint to 2035



Source: The Danish Energy Agency.

Box 5: Economic forecast for Denmark

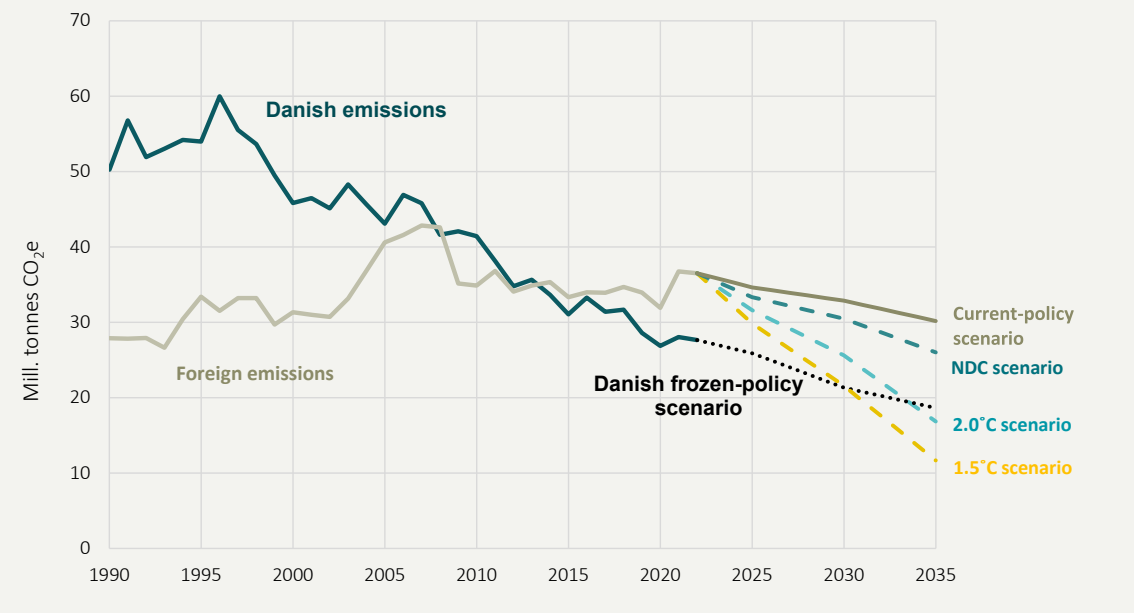
The projection of Danish consumption has been based on the GrønREFORM model. The economic forecast for Denmark projects that Danish consumption will increase by around 21% (constant 2020 prices) from the economic forecast's baseline year (2019) to 2035. The increase is greatest for household consumption, less so for consumption by public bodies and least for investments. Developments in Danish consumption and in import volumes are the same in all the scenarios for developments in the wider world.

[7] A frozen-policy scenario calibrated against CSO23 means that the projection takes account of policies adopted up to 1 January 2023.

2.2 Both Danish and foreign emissions are projected to fall up to 2035

Denmark's consumption-based climate footprint can be broken down by Danish and foreign emissions. Figure 7 shows that Danish emissions are projected to fall continually up to 2035. In all the scenarios for wider world developments, foreign emissions embedded in Danish consumption are lower in 2035 than in 2022. The fall in foreign emissions is smallest in the current-policy scenario.

Figure 7: Projection of Denmark's consumption-based climate footprint, broken down by Danish and foreign emissions

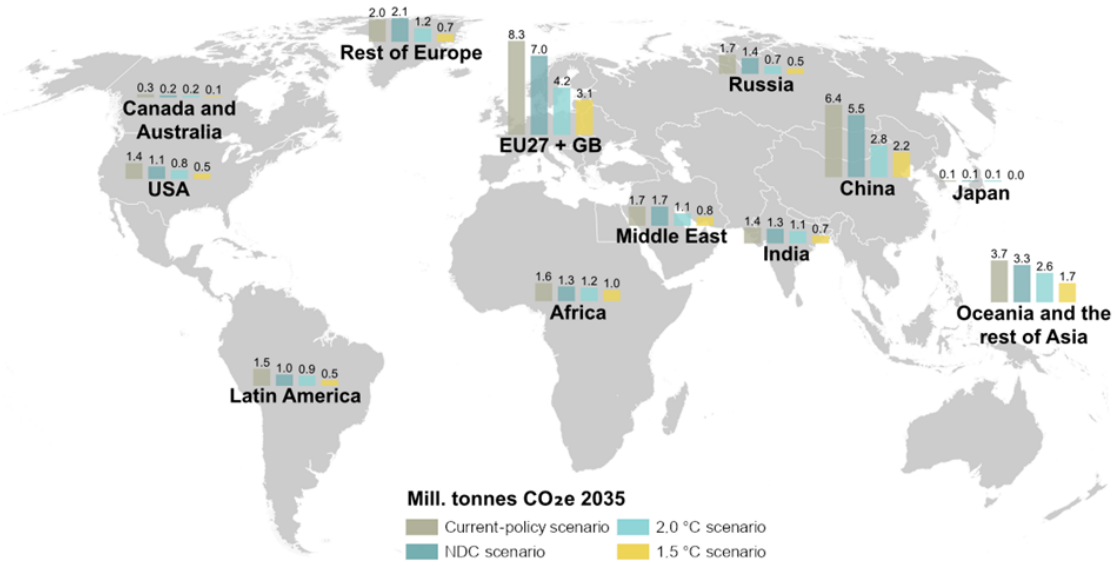


Source: The Danish Energy Agency.

2.3 A relatively large share of projected emissions from Danish consumption occur in developing economies

The projection of developments in the wider world is broken down by 12 regions and is therefore less detailed than the estimate of Denmark's historical consumption-based climate footprint. Across the scenarios, Danish consumption is projected to account for a growing share of the climate footprint in developing economies. In 2035, the climate footprint of Danish consumption will be highest in the EU27, the UK and China across all three scenarios, see Figure 8.

Figure 8: Foreign emissions in 2035, by scenarios (4) and regions (12)



Source: The Danish Energy Agency. **Note:** The breakdown by region is based on EXIOBASE.

3 Key indicators of consumption

To give a more detailed understanding of Denmark's consumption, this chapter describes a number of key indicators for consumption areas with a significant climate footprint. These consumption areas include transport, food products, electronics and energy. The key indicators are activity-based and quantify specific activities such as average number of kilometres flown per capita, tonnes electronics sold or per capita meat consumption. A more detailed analysis of the individual key indicators and their development can be found in background memorandum no. 3 to this report.

Main results

3.1 Diverse developments in key indicators

The key indicators for passenger transport by car and aircraft show increased consumption over time, including for the most recent year. At the same time, sales of electric vehicles have increased. With respect to food products, Danish meat consumption fell slightly in 2021, the most recent statistical year, but the indicator generally fluctuated up and down during the period 2010-2021. Sales of electronics have increased since 2012. Sales peaked in 2021 and then, in 2022, dropped to around the same level as in 2019. Overall, sales of electronics have increased by around 40% since 2012. Total electricity and heating consumption by households was 30 GJ per capita in 2022, with a renewables share of 72%. Household electricity and heating consumption is lower today than in 1990 and the renewables share increased significantly.

Figure 9: Key indicators for 2021 to 2023 and developments in each key indicator

		Key indicators 2021* 2022** or 2023***	Growth 2021-2022	Average annual growth 2010-2022
Transport	Annual new registrations of passenger cars: total	173,400 pcs***	+16%	+0.2%
	Annual new registrations of passenger cars: petrol and diesel	93,577 pcs***	+1.7%	-4.8%
	Annual new registrations of passenger cars: electric	62,601 pcs***	+103%	+51%
	Annual new registrations of passenger cars: plug-in hybrids	17,222 pcs***	-35%	+56%
	Annual passenger car-kilometres per capita	6963.1 km**	+1.7%	+1.2%
	Average occupancy rate (passengers per vehicle) per trip in passenger cars	1.43 pers.**	+0.7%	-0.3%
	Annual bus-kilometres per capita	306.2 km**	+23%	-2.8%
	Annual train-kilometres per capita	944.2 km**	+39%	-1.3%
	Annual bicycle-kilometres per capita	476.5 km**	+16%	+0.4%
	Annual aircraft-kilometres per capita: domestic	45.96 km**	+43%	-5%
	Annual aircraft-kilometres per capita: international	7104.2 km**	+164%	+0.7%
	Annual number of flights per capita	0.64 pcs**	+98%	-9.3%
Food	Annual per capita meat consumption	70.5 kg*	-2.2%	-0.8%
Electronics	Annual domestic sales of electronics	198,960 tonnes**	-8.1%	+3.5%
	Annual per capita sales of electronics	26.8 kg**	-8.1%	+2.6%
Energy	Annual average consumption of energy for electricity and heating per capita	29.58 GJ**	-7.3%	-1.3%
	Annual RE share of household energy consumption	71.93%**	+5%	+5.1%

Sources: The Danish Energy Agency, Statistics Denmark, the Danish Road Directorate, the Danish Civil Aviation and Railway Authority, Danish Producer Responsibility (DPA) and FAOSTAT.

3.1.1 Passenger transport by car and aircraft is increasing and sales of electric vehicles are up

The annual per capita number of kilometres travelled by air on international flights increased by around 3,750 km from 2004 to 2019. 2020 and 2021 saw a significant decline in air transport, but in 2022 travel restrictions related to the Covid-19 pandemic were eased and this may explain why the annual number of kilometres travelled by air per capita was around 4,400 km more than in 2021. The per capita number of kilometres travelled by air on domestic flights peaked in 2010 at around 85 km and has since dropped to around 45 km per capita.

The annual number of kilometres travelled by passenger car per capita increased by around 1,100 km from 2000 to 2022. The 2022 figure is slightly lower than before the Covid-19 pandemic. However, the climate footprint of this mode of travel depends on the type of car. In this context, the key indicators for new registrations of passenger cars show a significant increase in the number of new registrations of electric vehicles since 2019, as well as a slight increase for plug-in hybrid vehicles, whereas new registrations of petrol and diesel cars have declined, although, in 2022, petrol and diesel cars were still being sold in far larger numbers than plug-in hybrid vehicles and electric vehicles. There was an overall fall of 25,000 in the number of new registrations of vehicles in the period 2020-2023.

In 2022, the average per capita number of kilometres travelled by train was around 944 km, which was about the same as in 1990. During the Covid-19 pandemic, passenger transport by bus dropped drastically by around 140 km but increased again in 2022 to just over 300 km per capita. This corresponds to a decrease of around 20% compared to before the Covid-19 pandemic.

3.1.2 A slight drop in meat consumption

The key indicator for food products shows that, in 2021, Danish meat consumption was slightly lower than in 2010. This decrease is most prominent for consumption of beef and poultry meat, whereas consumption of pig meat has gone up. However, per capita meat consumption has generally fluctuated throughout the period 2010-2021.

Sales of electronics have gone up for both households and businesses

Key indicators for electronics show an increase in sales of electronics since 2012. Sales peaked in 2021 and then, in 2022, dropped to around the same level as in 2019. Overall, sales of electronics have increased by around 40% since 2012. The increase is most prominent for product categories such as washing machines, dryers, dishwashers, shavers and household tools. This applies primarily to households.

The development from 2019 to 2022 may be attributable to the extensive demand for electronics during the Covid-19 lockdowns (Danmarks Nationalbank, 2022). The largest increase in electronics procurement by the business sector is seen for electronics such as refrigerators and production equipment. Furthermore, sales of solar PV to business and industry (included as electronics products) have seen a large increase, with sales in 2022 having increased thirtyfold since 2019.

An increase in the renewables share and a fall in consumption of electricity and district heating

Danish energy statistics show that overall electricity and heating consumption per capita in households is lower today than in 1990, and that the renewables share has increased considerably. Energy consumption in households peaked in 1993 at 37 GJ per capita. The subsequent period up to 2010 saw minor fluctuations in demand. The period 2010-2022 saw a clearer overall fall, with consumption falling to 30 GJ per capita in 2022. The share of renewable energy in household energy consumption increased consistently between 1990 and 2022. Overall, the share increased from 9% in 1990 to 72% in 2022. The large renewables share in household energy consumption in 2022 comprised solid biofuels and biodegradable waste (around 55%) and other renewable energy sources such as wind, solar and hydro, as well as other bioenergy (around 45%).

4 The climate footprint of imports

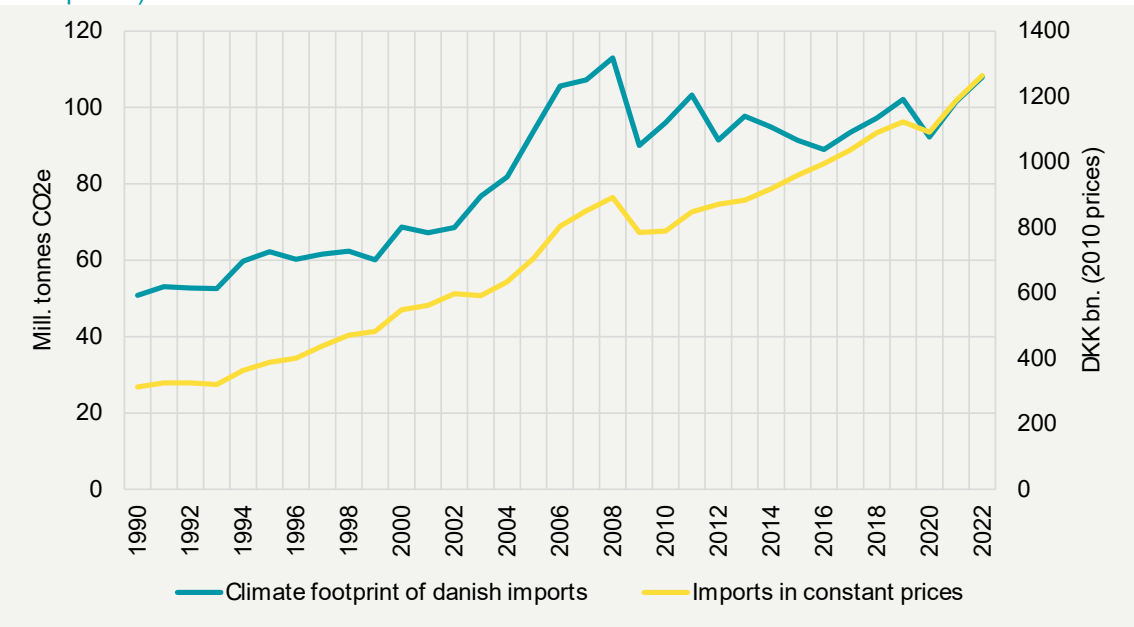
This chapter describes greenhouse gas emissions embedded in Danish imports in the period 1990 to 2022. The estimate includes the entire value chain for imported goods and services up to the point where they transfer from foreign to Danish hands. A German car bought in Denmark will be associated with embedded emissions related to production and transport of the car. For example, emissions from the production of electronics in Taiwan or emissions from the manufacture of tyres in India. The use and the disposal phases are not included in the estimate of emissions from imports described in this chapter, because these emissions occur after the car has been imported to Denmark.

Main results

4.1 Emissions from Danish imports in 2022 were 108 million tonnes CO_2e

Emissions embedded in goods and services that Denmark imports have been estimated at 108 million tonnes CO_2e in 2022. This corresponds to around 1.7 times Denmark's consumption-based climate footprint. The estimate shows that two-thirds of emissions linked to Danish imports were linked goods and services exported onward from Denmark, while the remaining emissions were linked to consumption of the goods and services in Denmark. The estimate also shows that emissions from imports have more than doubled since 1990, and this is due primarily to a significant increase in emissions embedded in the goods and services that are exported onwards from Denmark. Figure 10 shows that emissions from Danish imports increased up to the financial crisis in 2007/2008 and then dipped abruptly. From 2021 to 2022, emissions increased by 6.5 million tonnes CO_2e. There were increases in both 2021 and 2022 after the onset of the Covid-19 pandemic in 2020, and the levels are higher than in the years leading up to the pandemic.

Figure 10: Developments in emissions from Danish imports and the value of imports (constant 2010 prices)



Source: The Danish Energy Agency. **Note:** Imports are stated in chain-linked values, 2010 prices.

4.2 Danish imports have become less climate-impacting per DKK imported

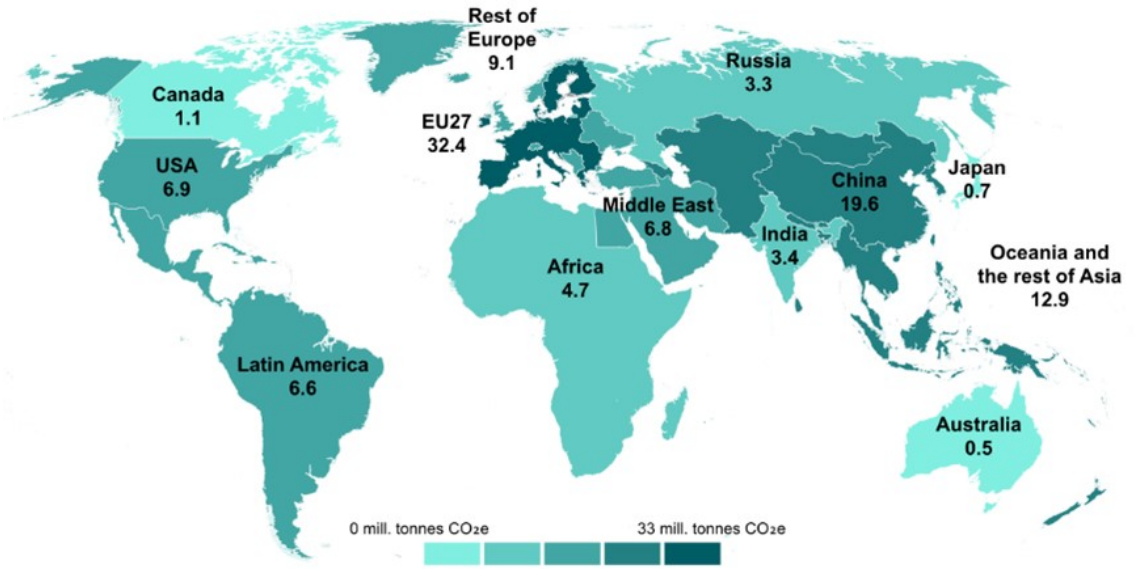
The value of Danish imports puts the emissions from imports into perspective. Figure 10 shows that the value of Danish imports rebounded after the financial crisis, whereas emissions remained relatively stable during the same period and, in 2022, were at around the same level as when emissions peaked during the financial crisis. Over the last decade or so, Danish imports have therefore become less climate-impacting per DKK imported.

4.3 The majority of Danish imports emissions occurred in the EU27

Denmark imported goods and services from large parts of the world in 2022. Figure 11 shows that 40% of emissions from Danish imports occurred in Europe[8] with 41.5 million tonnes CO_2e, of which 32.4 million tonnes CO_2e were in the EU27. One-third of emissions were in Asia[9] with 36.5 million tonnes CO_2e, of which the majority in China (19.6 million tonnes CO_2e).

[8] Here, Europe means the sum of the EU27 and the Rest of Europe region.
[9] In this context, Asia refers to China, Japan, India, and Oceania and the rest of Asia.

Figure 11: Emissions from Danish imports by regions/countries in 2022 (million tonnes CO_2e)



Source: The Danish Energy Agency. **Note:** The breakdown of the world into countries and regions is based on the breakdown in EXIOBASE.

At country level, the largest climate footprint from Danish imports was in China. This is not surprising, as China has a large production of the goods consumed in Denmark and other Western countries. The largest share of emissions related to imports from China was in the Chinese electricity supply sector, which is dominated by coal-fired power plants that produce electricity to manufacture the products exported to Denmark. This is followed by metal manufacturing, which relies directly on fossil energy such as coal and gas for a number of processes with very high emissions. According to the estimate, the largest footprint from Danish imports in Europe in 2022 was in Germany, where emissions related to Danish imports came to 10 million tonnes CO_2e. The majority of these emissions were from the German agriculture and horticulture sector, which produce food. Next was the German electricity supply sector and industrial sectors, which manufacture machinery and metal.

5 The climate footprint of exports

This chapter looks at the greenhouse gas emissions associated with Danish exports. The estimate includes the entire value chain for the exported goods and services up to the point where they transfer from Danish to foreign hands. For example, in the case of exports of Danish wind turbines, the estimate includes all emissions related to producing and transporting the wind turbine to the point where it is transferred to foreign hands. This includes both Danish and foreign emissions.

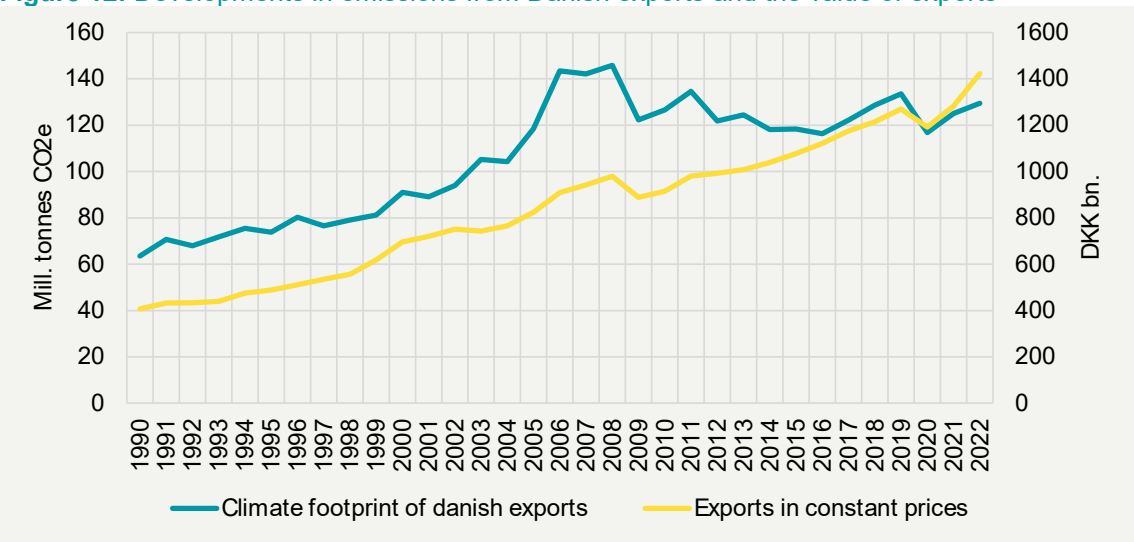
Main results

5.1 Emissions from Danish exports in 2022 were almost 130 million tonnes CO_2e

Emissions from Danish exports in 2022 were almost 130 million tonnes CO_2e. This corresponds to two-times Denmark's consumption-based climate footprint. Therefore, more emissions are linked to Danish exports than Danish consumption, and this is because Denmark is an open economy with extensive trade with the outside world. Just over half of these emissions are estimated to occur in countries outside Denmark in the form of imported goods that are either directly exported onward by Denmark or are included in products that Denmark exports. The remaining half of the emissions occur in Denmark[10]. A large part of emissions from Danish exports is associated with freight of goods by Danish shipping companies using Danish-operated ships.

Figure 12 shows that emissions embedded in Danish exports have doubled since 1990, and this is linked to increased exports measured in monetary terms. The climate footprint from Danish exports rose by 4.4 million tonnes CO_2e from 2021 to 2022.

Figure 12: Developments in emissions from Danish exports and the value of exports



Source: The Danish Energy Agency. **Note:** The export value is stated in chain-linked values, 2010 prices.

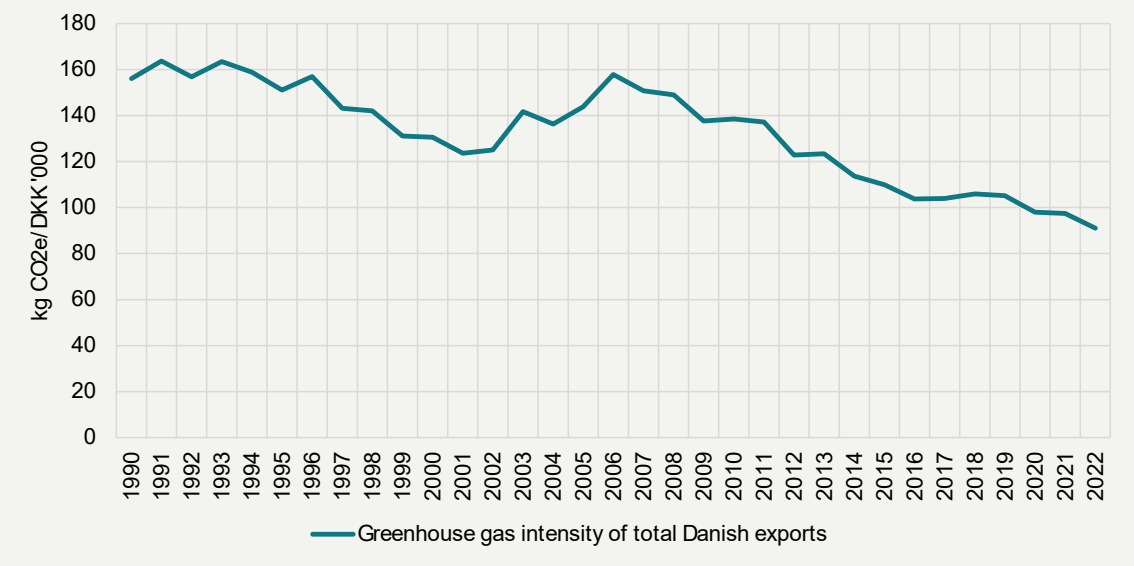
[10] Danish territorial emissions also include emissions abroad by Danish businesses registered in Denmark. The emissions of Danish shipping companies have therefore been included as Danish emissions, even though these emissions often occur outside Danish territorial waters.

Even though the climate footprint of exports increased in both 2021 and 2022, the 2022 level was still not as high as it was in 2019 before the challenges to global trade following the Covid-19 pandemic.

5.2 Danish exports have become less climate-impacting per DKK exported

Figure 12 shows that the climate impact per DKK exported has been falling since 2006. See Figure 13. According to the estimate, greenhouse gas intensity for total Danish exports fell by 41% from 1990 to 2022. This trend is also apparent in Figure 12 where emissions and export values followed each other in a rising curve until the financial crisis. After this point, emissions from exports remained relatively stable, while the value of exports continued to rise.

Figure 13: Greenhouse gas intensity of Danish exports in the period 1990 to 2022



Source: The Danish Energy Agency.

5.3 The shipping sector accounts for just under half of emissions from Danish exports

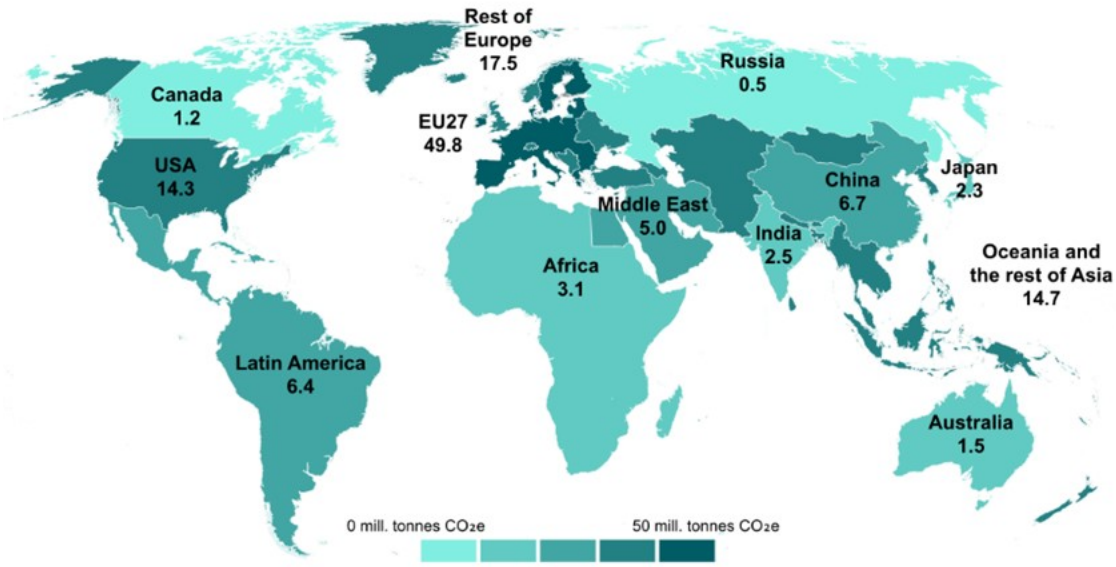
In 2022, export activities by the Danish transport sector accounted for around half of emissions from Danish exports, according to the estimate. Danish-operated ships are estimated to account for 88% of these transport emissions, corresponding to 44% of total emissions from exports. The reason that shipping accounts for a large share of Danish exports is partly that Denmark has a relatively large transport fleet, and partly that the freight and freight procurement of Danish shipping companies around the world are categorised as Danish exports when the freighted goods are not consumed in Denmark. As mentioned in the previous chapter, the transport sector also accounts for a considerable share of imports emissions, of which the major part is related to exports as Danish shipping companies freight goods for consumption outside Denmark. Next after the transport sector comes the export of raw materials and products, of which pharmaceutical products, products from oil refineries, as well as wind turbines and engines are estimated to account for a significant share.

5.4 More than half of emissions from Danish exports went to the EU27 countries

In 2022, Denmark exported goods and services to several different countries. Figure 14 shows the associated emissions broken down by 12 regions in the first export link. The first export link refers to the country that receives Danish exports, regardless of whether goods are subsequently exported onward. According to the estimate, slightly more than half of emissions (54%) were linked to Danish exports to Europe[11], by far most of which were exported to EU27 Member States and accounted for 49.8 million tonnes CO_2e. After this, the largest buyers were the USA, as well as Oceania and the rest of Asia.

[11] Here, Europe means the sum of the EU27 and the Rest of Europe region.

Figure 14: Emissions from Danish exports in 2022 broken down by 12 regions of the world (million tonnes CO_2e)



Source: The Danish Energy Agency. **Note:** The breakdown of the world into countries and regions is based on the breakdown in EXIOBASE.

6 The climate footprint of public procurement

This chapter describes the climate footprint of public procurement, including a projection to 2030. The Danish Energy Agency and the Agency for Public Finance and Management have calculated the climate footprint over a four-year period (2019-2022) to provide a basis for monitoring developments. The projection is an estimate of expected emissions from public procurement in 2030.

The estimate of the climate footprint of Danish public procurement differs methodologically from the estimate of the climate footprint of consumption by public bodies, which is included in Denmark's consumption-based climate footprint described in chapter 1. The results can therefore not be directly compared.

Main results

6.1 The climate footprint of public procurement fell in 2022, but is expected to rise going forward

Figure 15 shows the climate footprint of public procurement from 2019 to 2022 and projected to 2030. The climate footprint of Danish public procurement for 2022 has been estimated at 14.3 million tonnes CO_2e. According to the estimate, the climate footprint has increased by 2% since 2019, but has fallen by 9% compared with 2021, see Figure 15. Reduced procurement during the Covid-19 pandemic is assessed to be the primary explanation for the fall from 2021 to 2022.

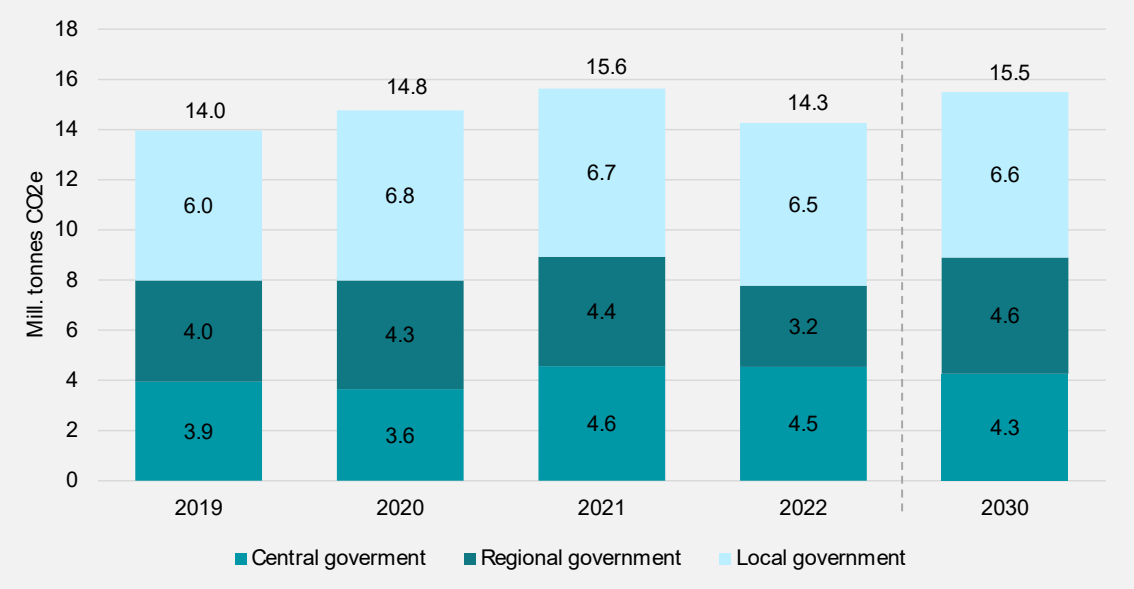
Public procurement by central government accounted for 32% of the climate footprint of Danish public procurement in 2022, while regional and local governments accounted for 23% and 45%, respectively, see Figure 15. Local governments have an overall larger procurement volume than central and regional governments because of the nature of their tasks.

Furthermore, the projection shows that the total climate footprint of public procurement is likely to be 15.6 million tonnes CO_2e in 2030, which is 1.3 million tonnes higher than in 2022, and 1.6 million tonnes lower than in the baseline year, 2019. A correction has been made in the projection relative to last year's estimate. Read more about this in the method memorandum on the climate footprint of public procurement.

Seen in isolation, the expected higher share of renewable energy in 2030 will lead to a drop in the climate footprint of around 0.8 million tonnes CO_2e from 2019 to 2030, of which around 0.3 million tonnes CO_2e have already been realised in the estimate for 2022. However, this effect will be offset by additional emissions of 2.3 million tonnes CO_2e because of an expected increase in public procurement in the same period, particularly within building and construction. The expected increase in public procurement, and, with it, the expected climate footprint of procurement, are therefore a reflection of the political prioritisation of increased public spending and investment in

the welfare area, for example. Public procurement at central, regional and local government levels is expected to increase to DKK 243 billion in 2030, relative to DKK 217 billion in 2019 and DKK 224 billion in 2022 (all in constant 2022 prices).

Figure 15: The climate footprint of public procurement by central, regional and local government in 2019-2022, as well as projected to 2030



Source: The Danish Energy Agency.

The projection assumes a higher percentage of renewable energy in Denmark and other countries but does not take account of possible technological advancements in the production of goods and services. Nor does it take account of possible implementation of new green-procurement initiatives up to 2030. The results of the projection of the climate footprint of Danish public procurement are therefore associated with considerable uncertainty.

6.2 Building and construction is a large emitter

Figure 16 shows the climate footprint of Danish public procurement from 2019 to 2022, divided into different procurement areas. The largest procurement area is building and construction, which accounted for 25% of total emissions of CO_2e in 2022. This is attributable to the considerable financial scope of the area, as well as to the relatively high level of emissions per DKK spent on procurement in the construction sector.

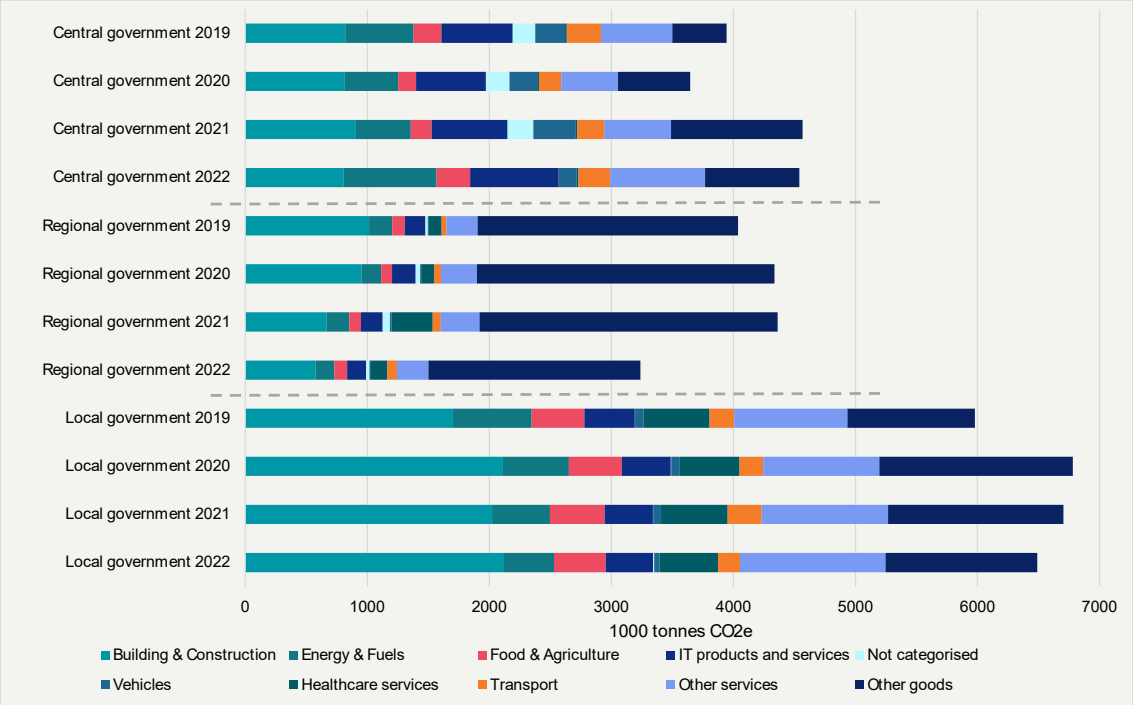
The most significant changes in the climate footprint of government procurement from 2021 to 2022 include a fall of 0.4 million tonnes CO_2e from Covid-19-related procurement. The remainder of the changes are primarily due to fluctuations in procurement of fuel and equipment by Danish Defence as well as general increases across state procurement areas.

The climate footprint of procurement by regional government fell from 4.4 to 3.2 million tonnes CO_2e from 2021 to 2022, primarily due to a reduction in Covid-19-related procurement such as pharmaceuticals (around 0.4 million tonnes CO_2e) and personal protective equipment (around 0.2 million tonnes CO_2e). The climate footprint of regional

government was also lower in 2022 than in 2019, primarily because of falling emissions from building and construction due to reduced emissions per DKK spent on procurement as well as to lower total procurement.

The climate footprint of procurement by local government fell by about 0.2 million tonnes CO_2e, which can also be attributed to lower Covid-19-related procurement compared with 2021. The results are described in more detail in method memorandum no. 6 on the climate footprint of public procurement available on the Danish Energy Agency website.

Figure 16: The climate footprint of public procurement by procurement area



Source: The Danish Energy Agency.

The model used for the estimate has some limitations: For example, it is not possible to distinguish between products with various lower climate footprints, just as the more expensive procurement option will always result in a higher climate footprint solely because it is more expensive. Read more in method memorandum no. 6 on the Danish Energy Agency website.

Despite the need for further development, calculations of the climate footprint of public procurement provide a basis for assessing the overall picture and proportions of CO_2e emissions from procurement across the public sector.

Focus on energy and international transport

This part of GR24 highlights Denmark's global climate impact within energy and transport. Energy and transport have a significant climate impact both inside and outside Denmark. With regard to energy, the chapter looks at Denmark's energy balance, as well as Denmark's consumption of biofuels and solid biofuels. With regard to transport, the chapter looks at international transport within shipping and aviation related to Denmark.

Chapter 7 *The energy balance* describes Denmark's imports and exports of fuels and the electricity trade between Denmark and other countries.

Chapter 8 *Solid biofuels* describes greenhouse gas emissions related to Danish consumption of solid biofuels (biomass) for electricity and district heating production. The estimate of Denmark's consumption-based climate footprint only includes emissions from transport and processing of the biofuels, whereas the estimate in this chapter also includes biogenic emissions from biomass burning as well as indirect impacts.

Chapter 9 *Biofuels* describes greenhouse gas emissions related to production of biofuels used in Denmark. The outset is Denmark's EU reporting on emissions from biofuels.

Chapter 10 *International transport* describes the greenhouse gas emissions related to international shipping and aviation. Emissions from aviation include emissions related to international flights into and out of Denmark as well as bunkering abroad by Danish-operated aircraft. Emissions from shipping include emissions related to bunkering in Denmark by foreign operated ships as well as bunkering abroad by Danish-operated ships.

Descriptions of the methodologies applied, more detailed results, as well as a description of the uncertainties associated with the results of the analyses are available in the relevant background memoranda on fuel balance, electricity trade, solid biofuels, fuels for transport including biofuels, and international transport.

7 The energy balance

This chapter presents estimates of Denmark's fuel balance and electricity trade in Denmark's global climate impact. The aim is to provide an outline of energy flows into and out of Denmark.

The fuel balance provides an outline of Danish imports and exports of coal, oil, natural gas, solid biomass, bioliquids and other fuels. Expected exports of PtX products up to 2030 are also described through simple case-calculations of the potential CO_2 displacement abroad of PtX products produced in Denmark.

Electricity trade describes Danish imports and exports of electricity as well as global emissions associated with these. Electricity requires hourly balancing of demand and capacity because of the limited storage possibilities. The electricity trade estimate shows emissions embedded in Danish imports and exports of electricity on an hour-by-hour basis and also describes the possible increased global emissions from Danish electricity trade. The emissions related to electricity trade have been estimated for historical years and projected up to 2030. The projected emissions are based on electricity production and consumption in Denmark's Climate Status and Outlook 2024 (CSO24).[12]

Main results - fuel balance

7.1 Exports to Sweden and imports from Norway dominate

Table 1 shows total imports and exports by country and time period. The table shows the top-three countries with which Denmark has had most fuel imports/exports, measured in energy quantities for a given period. Note that quantities are falling, and that, historically, Sweden has accounted for a large proportion of both imports and exports of fuels to/from Denmark. In terms of fuel imports alone, Norway has been the dominant trading partner for the past 30 years. In the last ten years, Denmark has imported most fuels from Norway and Russia, and has exported most fuels to Sweden and the Netherlands, measured in terms of energy quantities (PJ).

[12] Thus, projection years are based on a frozen-policy scenario, which assumes that no new policy measures are introduced in the climate and energy area other than those decided by the Danish Parliament before 1 January 2024, or arising out of binding agreements. The estimate therefore does not reflect the likely real developments, including the effect on foreign emissions. Furthermore, foreign development trends are based on data from 2022. CSO24 therefore includes scoping (limitations) that are significant for the estimated future impacts.

Table 1: Ranking of countries by total imports or exports in PJs divided into time periods

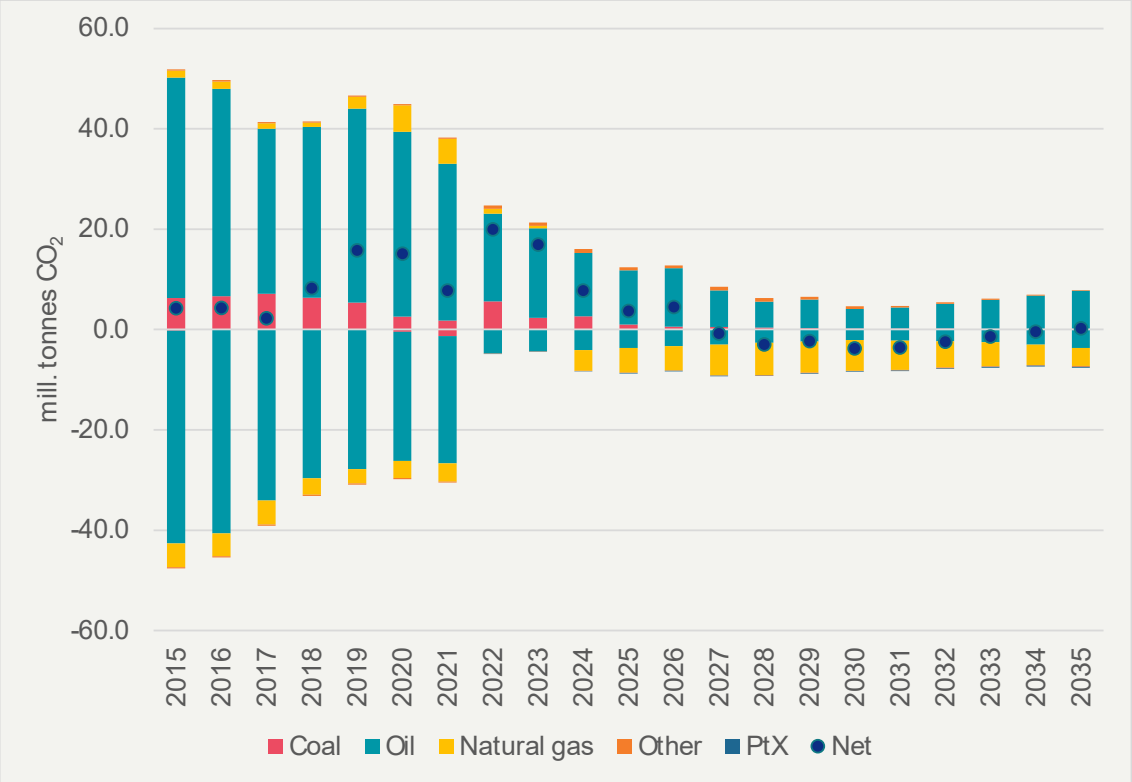
Exports			Imports and consumption		
1990-2000	Sweden	6,907	**1990-2000**	Norway	5,689
	The Netherlands	3,021		Russia	2,546
	Germany	2,643		Sweden	1,964
2000-2010	Sweden	3,310	**2000-2010**	Norway	1,810
	The Netherlands	1,579		Sweden	799
	Germany	1,366		Russia	759
2010-2020	Sweden	2,386	**2010-2020**	Norway	2,061
	The Netherlands	1,115		Russia	1,459
	United Kingdom	744		Sweden	482

Source: The Danish Energy Agency.

7.2 More emissions embedded in Danish imports than in Danish exports of fuels

Greenhouse gas emissions embedded in Danish imports of fuels have been estimated to be higher than those embedded in Danish exports of fuels for all the years from 2015 to 2022. However, this is expected to change up to 2030, with emissions from imports becoming smaller than emissions from exports. Emissions are based on burning the fuels. For example, emissions from importing 1 PJ of natural gas have been estimated as what is emitted when burning 1 PJ of natural gas. Figure 17 shows developments in emissions.

Figure 17: Emissions linked to imports and exports of fuels from 2015 to 2035

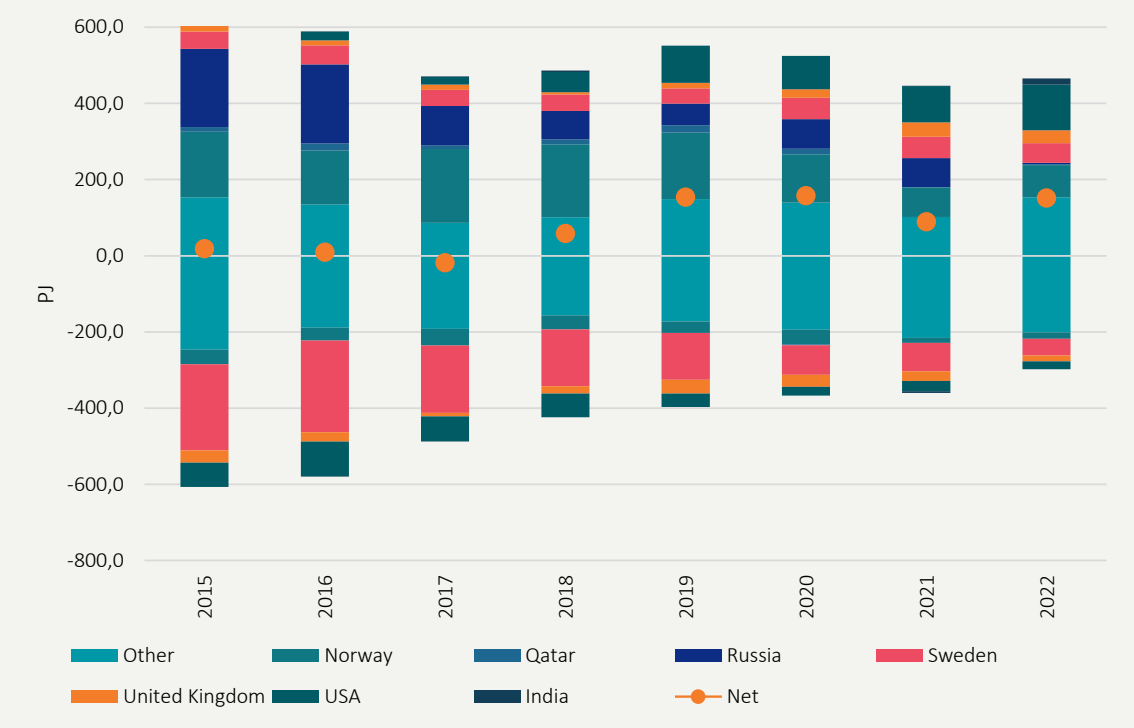


Source: The Danish Energy Agency. **Note:** Positive figures are imports and negative figures are exports. The net value is imports minus exports. Solid biomass is addressed in Chapter 8 on solid biofuels.

7.3 Denmark continues to reduce its direct imports of Russian fuels

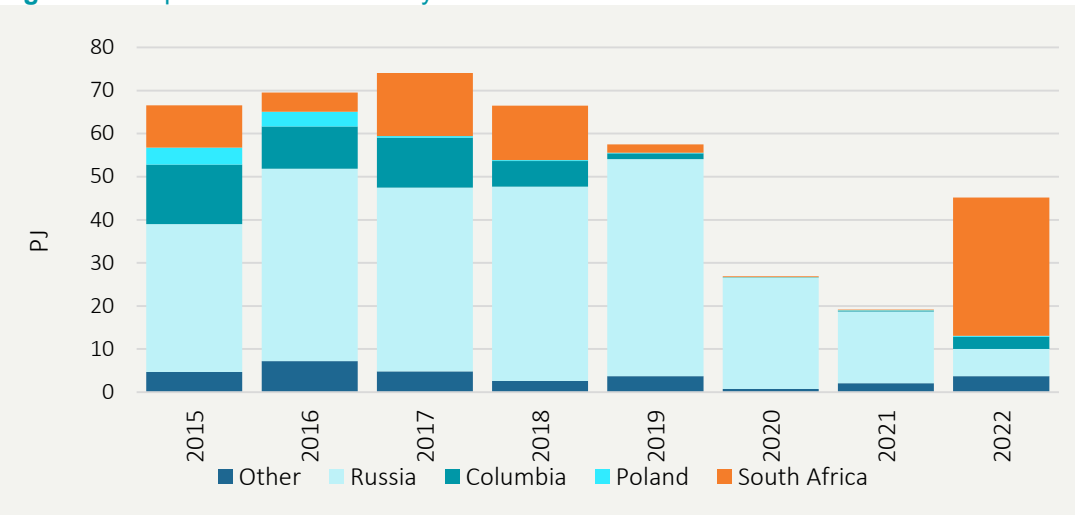
Direct fuel imports from Russia fell from 76.3 PJ in 2021 to 4 PJ in 2022, the most recent statistical year. This is a significant change, as Russia has previously been a large exporter of fuels to Denmark. The change has made room for other players, and there has been a significant increase in coal imports from South Africa (see Figure 19) as well as in oil imports from countries such as the USA and India (see Figure 18), for example. The increase in coal imports is attributable to the high electricity prices in 2022, which meant that Danish CHP plants still running on coal imported larger amounts of coal to run their plants.

Figure 18: Imports and exports of crude oil and petroleum products calculated at country level



Source: The Danish Energy Agency. **Note:** Positive figures are imports and negative figures are exports.

Figure 19: Imports of coal at country level



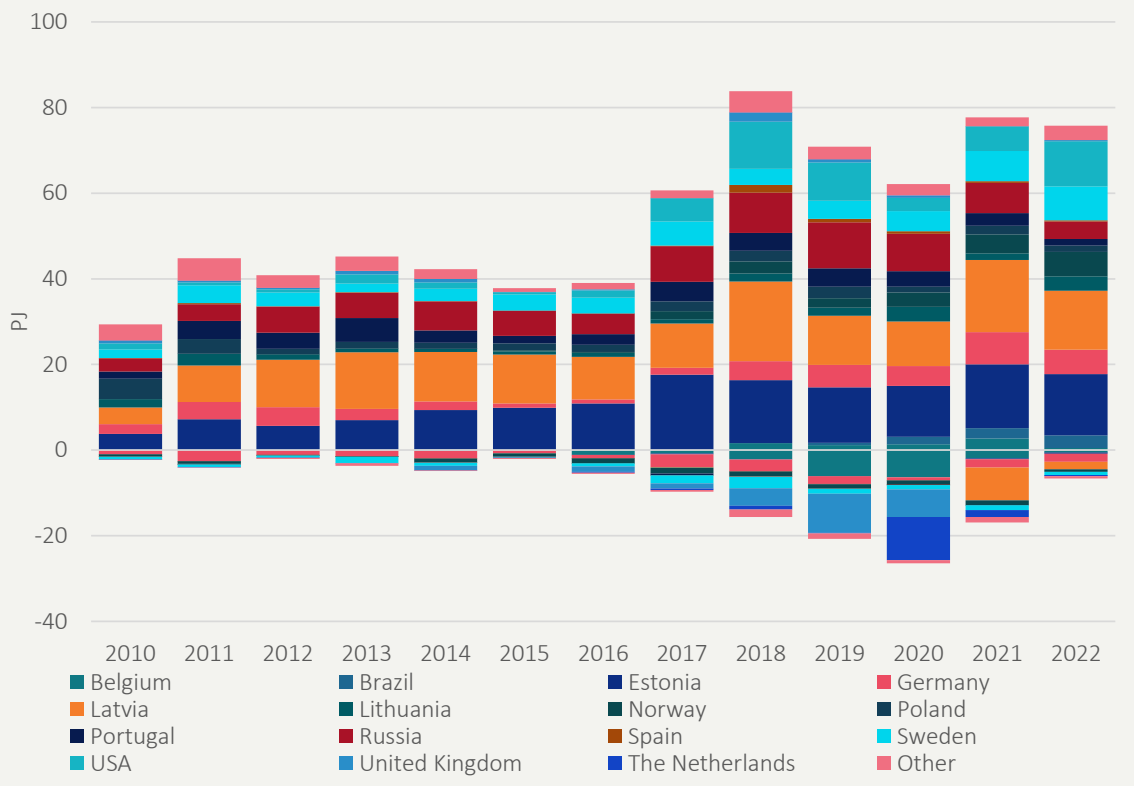
Source: The Danish Energy Agency. **Note:** Positive figures are imports and negative figures are exports.

7.4 Denmark is predominantly a net importer of biomass

Denmark depends on imports to cover its biomass consumption. Figure 20 shows imports and exports of biomass from 2015 to 2022. The figure shows more countries than the figure on coal imports, for example, (see Figure 19). This indicates that trade in biomass is divided between far more countries, with many possible suppliers to Denmark.

However, Denmark still imports significantly more from some countries than from others. In 2022, Denmark primarily imported from Estonia, Latvia and the USA. In 2022, Denmark also imported biomass from Russia, although imports have fallen since their peak in 2019.

Figure 20: Imports and exports of solid biofuels from 2010 to 2022



Source: The Danish Energy Agency. **Note:** Imports are positive, and exports are negative.

7.5 PtX products can displace foreign emissions by replacing fuels

The estimate shows that if anticipated future Danish PtX products replace fossil fuels abroad, Denmark will contribute to reducing CO_2 emissions abroad. According to Denmark's Climate Status and Outlook 2023, Denmark will be a net exporter of PtX products from 2024.

Whether exported PtX products reduce carbon emissions abroad depends on what types of fuel they replace and any losses in the conversion of hydrogen to the final product. Simplified case calculations indicate a general potential for Danish exports of PtX products to reduce carbon emissions abroad. The case calculations basically compare the use of PtX products with a hypothetical reference scenario in which another fuel is used. For example, according to the calculations, it is expected that direct replacement of natural-gas-based hydrogen with green hydrogen will provide the largest reduction.

Main results - electricity trade

7.5.1 Danish electricity trade has historically increased global emissions but in 2022 the trade reduced global emissions

Cross-border electricity trade helps to ensure security of supply, the sale and marketing of green and cheap electricity, and a reduced need to establish of electricity production capacity. Denmark has historically imported more electricity from abroad than it has

exported. The electricity Denmark imports and exports is associated with emissions.[13] Electricity imports are associated with emissions abroad and electricity exports are associated with emissions in Denmark. The estimate shows that, in 2022, Danish electricity imports were associated with emissions of 0.6 million tonnes CO_2e outside Denmark, see Table 2.

The estimate also shows that, in 2022, Danish electricity exports were associated with 0.6 million tonnes CO_2e emissions in Denmark but at the same time reduced CO_2e emissions abroad by 1.0 million tonnes CO_2e. In 2020 and 2021, Denmark is estimated to have increased emissions abroad by 0.7 and 0.2 million tonnes CO_2e, respectively, while Denmark reduced emissions by 0.4 million tonnes CO_2e in 2022. This is a continuation of the relatively low net imports of electricity in 2022, which mean that more CO_2e were saved abroad by Danish exports than were increased by Danish imports of electricity, see Table 2.

Table 2: Danish electricity imports and exports, as well as the estimated impact on emissions abroad: historical

Key indicators	Type	2020	2021	2022
Net imports TWh	Imports of electricity	8.4	6.8	5.0
	Exports of electricity	1.9	2.0	3.6
	Net imports	**7.2**	**4.7**	**1.4**
Average emissions factor g CO_2e/kWh	Abroad from Danish imports	101	99	122
	Abroad from Danish exports	178	272	267
	In Denmark from Danish exports	71	84	179
Estimate of emissions mill. tonnes CO_2e	From Danish electricity imports, emissions abroad	0.9	0.7	0.6
	From Danish electricity exports, emissions in Denmark	0.1	0.2	0.6
Renewables share (incl. biomass) when Denmark exports, %		88	86	71
Reduced emissions abroad from Danish electricity exports, mill. tonnes CO_2e.		0.2	0.5	1.0
Impact on emissions abroad, million tonnes CO_2e.		0.7	0.2	-0.4

Source: The Danish Energy Agency. **Note:** The key indicator for impacts on emissions abroad is arrived at as follows: imports (or exports) times the emissions factor when Denmark imports (or exports) = impact on emissions. The key indicator of the impact on emissions abroad is calculated as: Emissions abroad from Danish imports – reduced emissions abroad from Danish exports = impact on emissions abroad.

7.5.2 Higher emissions factor for Danish electricity exports than for Danish electricity imports

The estimate shows that the electricity imported to Denmark in 2022 has a lower emissions factor, and, thus, lower CO_2e emissions, than the electricity that is produced in, and then exported from, Denmark. This constitutes a major change from 2020 and 2021 and is due to the high electricity prices in 2022, which meant that CHP plants in Denmark based on gas and coal produced more than in the previous years. The estimate also shows that emissions factors differ depending on from which country

[13] Emissions linked to electricity production only include emissions from electricity production and not upstream and downstream emissions. Furthermore, biomass is considered CO_2 neutral.

Denmark imports electricity. Thus, the majority of emissions linked to Danish electricity imports occur in Germany and the Netherlands, even although Denmark imports more electricity from Norway and Sweden. This is because the emissions factor for German electricity production is higher than for Swedish and Norwegian electricity production.

According to the estimate, up to 2035, Germany and the United Kingdom will account for the largest share of emissions embedded in Danish electricity imports. This is due to increasing imports of electricity from Germany and the United Kingdom, and because energy mixes in Germany and the United Kingdom are expected to continue to comprise a large share of fossil fuels.

7.5.3 Continued large share of renewable energy in Danish electricity exports

Danish electricity exports include a large share of renewable energy[14]. In the period 2020 to 2022, the renewables share was between 88% and 71%. The drop in the renewables share in 2022 is attributable to the higher electricity prices that year, which made it more attractive for CHP plants to produce for more hours than in the previous years.

The estimate shows that the renewables share in electricity exports is expected to rise in years to come, and in the long term al electricity exports are expected to be renewables-based. This is due to expected deployment of renewable energy capacity in Denmark, and because hours with high electricity production from wind and solar are likely to lead to Danish exports of electricity. In CSO24, wind and solar are projected to account for 63% and 36% of electricity exports, respectively, in 2035.

7.5.4 Projection of impact abroad

Danish cross-border electricity trade is projected to continue to reduce emissions abroad, but the reduction will gradually become smaller. This is because, although Denmark is expected to export more electricity due to a massive expansion of renewable energy capacity up to 2035, and although this electricity will have a lower emissions factor than electricity produced abroad, electricity production abroad will also gradually become more and more renewables-based.

Specifically, the estimate shows that, in 2035, Danish electricity exports are expected to have an emissions factor of 6.5 g CO_2e/kWh, while electricity produced abroad during hours when Denmark exports electricity is estimated to have an emissions factor of around 17.9 g CO_2e/kWh in 2035.

[14] Based on the average electricity mix during hours when Denmark exports.

8 Solid biofuels

Since 1990, Denmark has replaced a significant part of its fossil fuel consumption in electricity and heating production with solid biofuels (previously called biomass[15]) (Energistyrelsen, 2020).

Under the UN IPCC guidelines (IPCC, 2006), harvesting of wood and other biomass is estimated as emissions in the country where the wood is harvested. If the biomass is subsequently burned in power plants, for example, this counts as zero emissions in the utilities sector, because the emissions have already been included in the estimate in connection with harvesting the biomass, see the UN IPCC guidelines (IPCC, 2006). Emissions from Danish-produced biomass must therefore be included in Denmark's official climate accounts, whether the biomass is consumed domestically or exported. Similarly, emissions from imported biomass must be included in other countries' national greenhouse gas inventories for the LULUCF sector (forests and soils), see the UN IPCC guidelines.

Solid biofuels made of woody biomass used for energy production in Denmark must comply with a number of EU sustainability criteria, as well as strict Danish requirements.

GR24 takes a different perspective on emissions from solid biofuels, in that it presents an overall estimate of all emissions associated with the use of these fuels in the Danish utilities sector. The estimate covers wood pellets and wood chips, which are used in production of electricity and district heating in the collective supply system, as well as wood pellets and firewood used for direct heating in households. These wood fuels account for the majority of solid biofuels in the Danish energy sector. Two-thirds of these wood fuels are imported[16].

Emissions from burning biofuels can be calculated in two ways. The results of the calculations depend on the underlying data basis, the methodology applied, market conditions and assumptions, and they are associated with various uncertainties. Assumptions about what would have happened with the woody biomass had it not been used to produce energy are particularly important. The specific impact on the atmospheric content of CO_2 also depends on the time perspective chosen to measure the content after the year of consumption.[17]
A description of the climate impact of Danish consumption of solid biofuels in 2022 is provided through an estimate of the impact on the atmosphere (net emissions) over time.
Because different methods of calculation have been used, the results for the climate impact of the consumption of solid biofuels presented in this chapter cannot be directly added to the climate footprint of consumption presented in Chapter 1.

[15] Biomass is all the biological material that may be either included in the energy sector or as part of food, animal feed, etc. Solid biofuels, such as wood pellets or straw, are thus composed of biomass.
[16] Imports account for 66% of total Danish consumption of wood pellets, wood chips, and firewood in energy production (Energistyrelsen, 2022) (Nielsen, 2024). See Figure 2 in the relevant background memorandum.
[17] Consumption of wood for energy production also affects forest biodiversity. This has not been accounted for in GR24, but see, for example, (JRC, 2021).

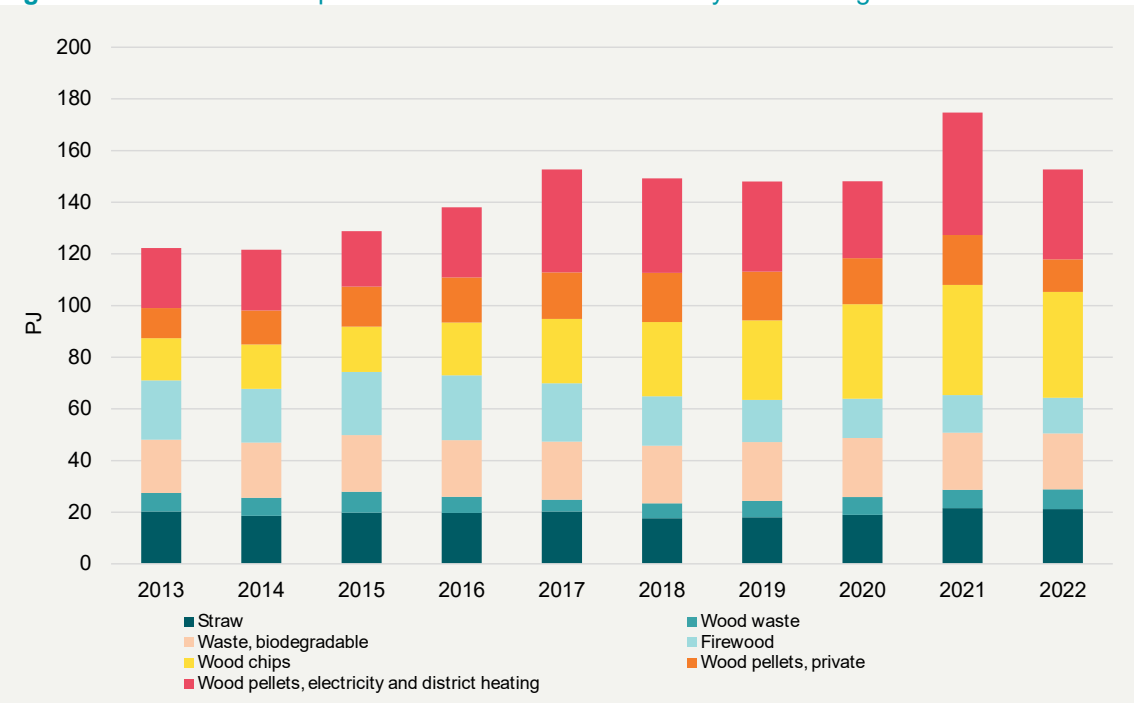
Main results

8.1.1 Wood pellets and wood chips dominate consumption of solid biofuels

Figure 21 shows total Danish consumption of solid biofuels to produce electricity and heating. In the period 2013-2022 consumption rose from 122 PJ to 153 PJ. Consumption fell by 22 PJ from 2021 to 2022, after rising the year before. The increase in 2021 was primarily due to high electricity and natural gas prices during the second half of the year, which increased the financial incentive for biomass-based production of electricity in particular. In 2022, wood fuel prices rose because of strong demand as an alternative to gas and because of reduced supply caused in part by restrictions on imports of wood from Russia, although overall this had a limited effect on consumption.

Wood pellets and wood chips used in electricity production and district heating together accounted for the largest share of total consumption of solid biofuels in 2022 at 78 PJ, see Figure 21. Consumption of wood pellets and firewood in households together amounted to 24 PJ in 2022. The following describes the emissions related to the total consumption of wood fuels of 102 PJ wood pellets and wood chips for electricity and district heating, and for direct heating in households.

Figure 21: Danish consumption of solid biofuels for electricity and heating 2013-2022



Source: The Danish Energy Agency. **Note:** In the figure, wood chips have not been divided into collective consumption (electricity and district heating) and individual/private consumption (households and manufacturing industries). Consumption for electricity and district heating makes up 96% of the total consumption of wood chips.

8.1.2 Net emissions from a single year's consumption of wood fuels for electricity and heating fall over time

In the production of energy from woody biomass, trees are removed from the forest and burned in a heating plant, for example, and the content of CO_2 in the wood is thereby released to the atmosphere. Without the demand for woody biomass for

energy production, the woody biomass would have been left in the forest to rot, burned in situ without energy recovery, used in other wood products, or not harvested at all. This is called the alternative fate of woody biomass. With this outset, in most cases burning the wood fuels for energy production will mean the biogenic CO_2 emissions occur at an earlier stage than would otherwise have been the case. The biogenic net emissions from a single year's consumption of wood fuels for electricity and heating fall to zero almost exponentially over time if the woody biomass originates from production forests managed according to a long-term management plan, according to which the forest is reestablished after felling, and if the alternative fate of the woody biomass would be for use in harvested wood products so that the resulting unmet demand for energy purposes could lead to indirect impacts in other places, see box 6. As global warming is continuous, the temporary displacement of the carbon pool from forests to the atmosphere has an impact on the climate, however.

Box 6: CO_2 impacts from consumption of woody biomass

The results for CO_2 impacts (net emissions) from Danish consumption of wood fuels for electricity and heating production are based on an analysis from the Department of Geosciences and Natural Resource Management at the University of Copenhagen, as well as on recalculation and extension of the main results of this analysis on the basis of consumption data from 2022.[18] The net emissions are the increased content of CO_2 in the atmosphere caused by consumption of the biofuels. The calculation includes observed emissions from energy production, process emissions and emissions from indirect impacts. The trends in total net emissions over time take account of the alternative fate of the trees, in that the alternative emissions that would have occurred over time as the trees rot are deducted from the observed gross emissions. Observed gross emissions include the following three elements:

- *Biogenic emissions from energy production*: The carbon, in the form of CO_2, released to the atmosphere from chimneys when wood is burned instead of being bound up in the forest's carbon pool of dead and live wood, etc.
- *Process emissions:* Emissions from production and transport of wood fuels. Can be both fossil and biogenic.
- *Emissions from indirect impacts:* Emissions embedded in land-use change or in the use of wood as a result of consumption of wood fuels in energy production[19].

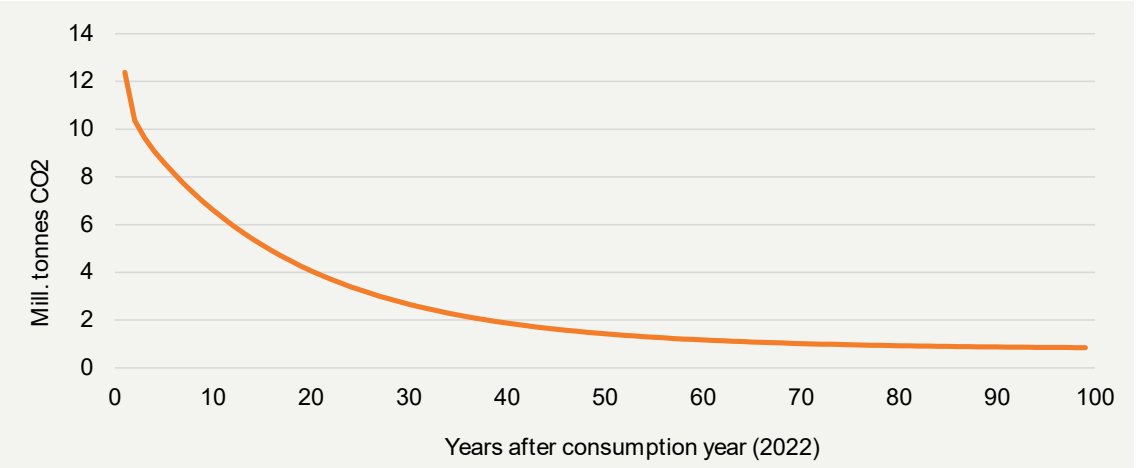
Net emissions from consumption of wood fuels for electricity and heating have been calculated separately from other parts of the energy system. So, emissions from possible alternative energy sources have not been deducted.

[18] *"CO_2 emissions from biomass use in district heating and combined heat and power plants in Denmark*". Department of Geosciences and Natural Resource Management, University of Copenhagen 2022 and "*Recalculation of CO_2 emissions from biomass use in district heating and combined heat and power plants in Denmark with 2022 input data*". Anders Tærø Nielsen, 2024 (Nielsen, 2024).

[19] See box 1 in the background memorandum on solid biofuels for a description of emissions from indirect impacts.

Danish consumption of wood pellets, wood chips and firewood for electricity and heating in 2022 led to emissions of 12.4 million tonnes CO_2 in the year of consumption, of which fossil emissions from production and transport, etc. as well as permanent biogenic emissions as a consequence of indirect market impacts were 6%.[20] The time-dependent temporary biogenic emissions, which account for 94%, correspond to the carbon content in the wood burned for energy production as well as, for a small part of these emissions, to dry wood pellets. Figure 22 illustrates the drop in overall net emissions over 100 years following 2022, the year of consumption. The reason for the drop is that the emissions that would otherwise have occurred over this period due to the trees rotting, for example, do not materialise because the trees have already been felled and burned, and these emissions have therefore been deducted from the emissions estimated for the consumption year. After ten years, the amount of CO_2 in the atmosphere associated with specific consumption in 2022 will be 6.6 million tonnes (a drop of 47%), after 20 years to 4.1 million tonnes (a drop of 67%), and 30 years after consumption year 2022, net emissions will have dropped to 2.7 million tonnes (a drop of 78%).

Figure 22: Total CO_2 impacts (net emissions) over time from consumption of 102 PJ wood pellets, wood chips and firewood for electricity and heating production in 2022



Source: (Nielsen, 2024) **Note:** The figure illustrates the net emissions from the specific quantities and consumption mix of wood pellets, wood chips and firewood used to produce electricity and heating in the collective supply system, as well as in households, in the year of consumption (2022).

Emissions in the year of consumption have been estimated to have increased by 1.8 million tonnes CO_2 from 2021 to 2022. This increase is due solely to the fact that consumption of wood pellets and firewood for direct heating in households has now been included in the estimate. The total consumption of wood fuels included in the estimate in 2022 is 102 PJ, compared with 88 PJ in 2021, and the whole curve is therefore at a higher level than in GR23. However, consumption of wood chips and wood pellets for electricity and district heating fell by 10 PJ from 2021 to 2022, and emissions exclusively from electricity and district heating in the year of consumption therefore fell from DKK 10.6 million tonnes CO_2 in 2021 to 9.5 million tonnes CO_2 in

[20] Permanent biogenic emissions are changes in forest management practices that lead to a permanently smaller carbon stock in the forest. Indirect market impacts consist of iLUC (indirect Land Use Change) and iWUC (indirect Wood Use Change). See the background memorandum.

2022. Besides the level of consumption, the amount of additional CO_2 in the atmosphere is also affected by the type of biomass input, see section 8.1.3.

The results are based on data on biomass consumption and assumptions about forest management practices, the wood market, etc., (IGN, 2023) (Nielsen, 2024).

The part of the tree that is felled for other purposes than energy production and that cannot be sold for other products on the current market is categorised as residues, and these have been estimated to account for around 92% of total consumption in 2022[21].

The remaining 8% of consumption has been distributed on the basis of the assumption that 10% of certain biomass types (totalling 6.5% of consumption) could have been used for harvested wood products in the current market situation, which results in indirect emissions from changes in land use material use following from price effects. Furthermore, 10% of certain biomass types (totalling 1.5% of consumption) is felled because of the demand for biomass for energy production, i.e. additional felling, which also results in additional emissions.

Trees are generally felled because the most valuable part of the tree can be sold for building materials, paper and other harvested wood products. The part of the tree that is used for woody biomass primarily comprises branches, tops and poor-quality parts of the trunk, as well as residues from the timber industry.

Another important assumption in the calculation is that the biomass comes from forests that are re-established after felling, so that new trees grow. Re-establishment of forests after felling is a requirement in the voluntary sector agreement of 2016 (Dansk Energi, 2016) and since 30 June 2021 it has also been a statutory requirement in the Danish sustainability criteria for woody biomass for electricity and heating production.

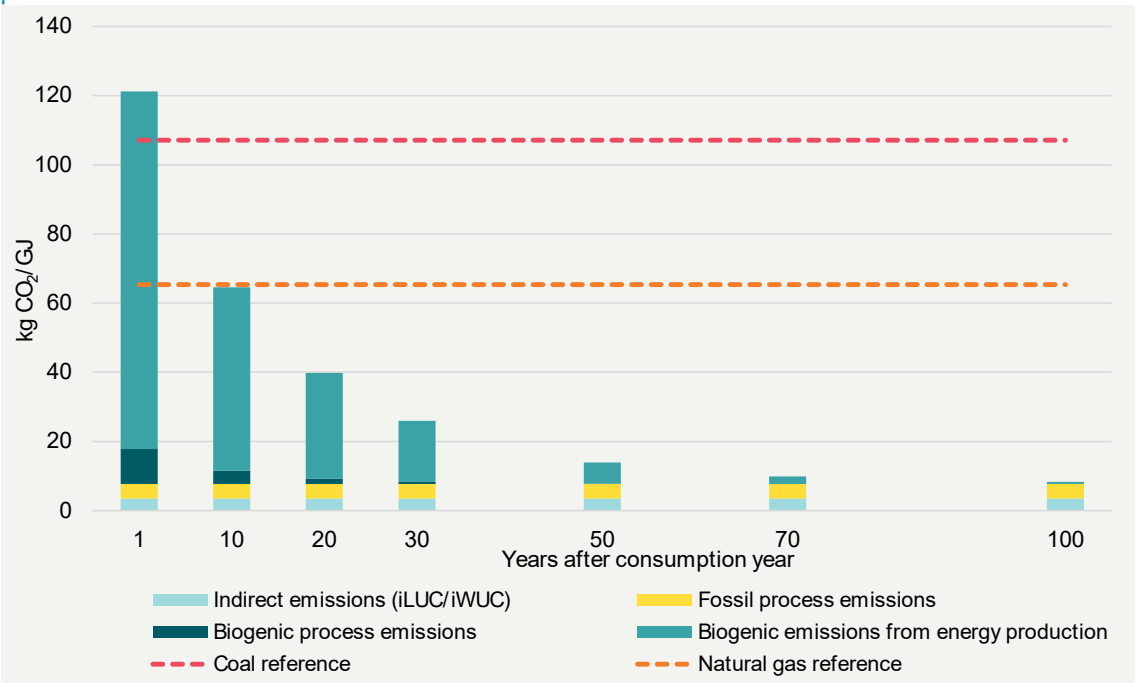
Net emissions from consumption of wood fuels also drop over time when calculated per unit of energy in the fuels, i.e. as an emissions factor, see Figure 23. If emissions are calculated per unit of energy, different types of consumption can be compared independently of the total consumption volume. In consumption year 2022, the total net emissions factor has been estimated at 121 kg CO_2 per GJ, which is more or less the same as consumption year 2021. The emissions factor is higher for wood fuels than for coal and gas in the first years because wood fuels have higher emissions per unit of energy, i.e. lower energy density.

After 10 years, net emissions from consumption of wood fuels in 2022 measured per unit of energy is 65 kg CO_2 per GJ, which is on par with emissions from fossil natural gas. After 80 years, total remaining net emissions (i.e. the additional content of CO_2 in the atmosphere from consumption in 2022) consist almost exclusively of fossil emissions from production and transport, for example, as well as permanent biogenic emissions from indirect land-use change[22]. The emissions factor for consumption in

[21] The figures are based on assumptions in IGN (2023) and Nielsen (2024). IGN (2023) and Nielsen (2024) point out that there is a need for more knowledge about the extent of these effects.
[22] 81 years after consumption year 2022, only 1% of the time-dependent biogenic emissions are left as an increased content of CO_2 in the atmosphere. This applies to the total consumption of the fuels included. There are differences between the fuels, which fit 1% after 66-95 years (Nielsen, 2024).

2022 is more or less the same as for consumption in 2021 in the year of consumption and in year 100. However, in between these years, the emissions factor is slightly lower for consumption year 2022, primarily due to a lower share of stemwood in wood fuels. See also section 8.1.3.

Figure 23: CO_2 impacts (net emissions) per unit of energy in the biomass (emissions factor) over time from consumption of wood pellets, wood chips and firewood for electricity and heating production in 2022



Source: (Nielsen, 2024). **Note:** The figure illustrates the CO_2 impacts (net emissions) from the specific quantities and consumption mix of wood pellets, wood chips and firewood used to produce electricity and heating in the collective supply system and in households in consumption year 2022. Production and transport emissions are also included in the reference values for natural gas and coal.

8.1.3 The amount of additional CO_2 in the atmosphere is affected by the type of biomass input

The CO_2 impact associated with consumption of biofuels is very much dependent on the type of biomass used. The amount of additional CO_2 in the atmosphere from burning small wood residues such as branches and tree tops falls quicker than amounts from logs, for example. This is because the alternative emissions from rotting happen faster for thin branches than for thick logs.

Overall, net emissions from wood fuels for energy production are determined by the total volume, the alternative fate of the wood in the form of rotting locally or being used for other harvested wood products, and transport distances.[23]

The most important factor determining the emissions profile of a certain volume of biomass for energy is whether the biomass is a residual product. The rate of degradation of the individual types of residual product also has a strong impact on the

[23] See tables 3 and 4 in the background memorandum on solid biofuels for a review of the conditions that influence the CO_2 impacts (net emissions) of biofuels. See also Figure 6 and section 4.1 in the background memorandum for a description of the current distribution between different biomass types and their respective climate impact.

results, whereas transport and other supply-chain emissions only have minor (but permanent) impacts on the results, (Nielsen, 2024).

9 Biofuels

Biofuels are added to petrol and diesel and thus replace a corresponding amount of fossil fuels. In national emissions inventories, emissions from the use of biofuels are considered carbon-neutral according to the UN IPCC guidelines. However, there are greenhouse gas emissions embedded in the production and transport of biofuels. These emissions occur in the countries and sectors[24] where the biofuels are produced, and in connection with transport of the biofuels, and should be included in the climate accounts of the relevant countries. This chapter presents a cradle-to-grave[25] estimate of bioliquids (pre-processed biomass) consumed in Denmark.

Fossil fuels are linked to emissions in connection with the extraction of crude oil, refining and transport of intermediate products as well as the finished products. These emissions are also dealt with in this chapter and compared with emissions from biofuels.

Main results

9.1.1 Consumption of biofuels has fallen

In 2022, the Danish biofuel blending mandate of 7.6% biofuels was replaced with a CO_2e displacement requirement of 3.4%, which resulted in reduced biofuel consumption in Denmark in 2022 compared with 2021 and 2020, see Table 3.

Table 3: Consumption of biofuels (TJ)

	2019	2020	2021	2022
First generation biofuels	8,016	9,106	9,179	8,434
Advanced biofuels	217	709	800	627
Other second-generation biofuels	700	1,093	1,313	1,140
Total	**8,933**	**10,929**	**11,292**	**10,200**

Source: The Danish Energy Agency on the basis of reports from fuel suppliers. 'Advanced biofuels' and 'other second-generation biofuels' are based on waste and residual products.

The CO_2e displacement requirement is based on cradle-to-grave emissions from fuels used in the transport sector. A fossil reference value for greenhouse gas emissions of 94.1 g/MJ is used. From 2022, these emissions must be reduced by 3.4%. In 2025 the requirement will increase to 5.2%, in 2028 to 6%, and in 2030 to 7%. It is expected that this will increase the use of renewable fuels (biofuels and PtX fuels) with more focus on the use of fuels with high displacement properties (low greenhouse gas emissions measured in g/MJ).

[24] For example, the agricultural sector, industry, the energy sector and the transport sector (when the raw materials and the end products are transported).
[25] Cradle-to-grave emissions comprise emissions associated with the production (growing and processing), transport and use of biofuels.

9.1.2 Reduced biofuel consumption means lower emissions from biofuels

The reduced consumption of biofuels is the most important reason for the drop in cradle-to-grave CO_2e emissions from biofuels from around 0.31 million tonnes in 2020 and 2021 to around 0.25 million tonnes in 2022, see Table 4.

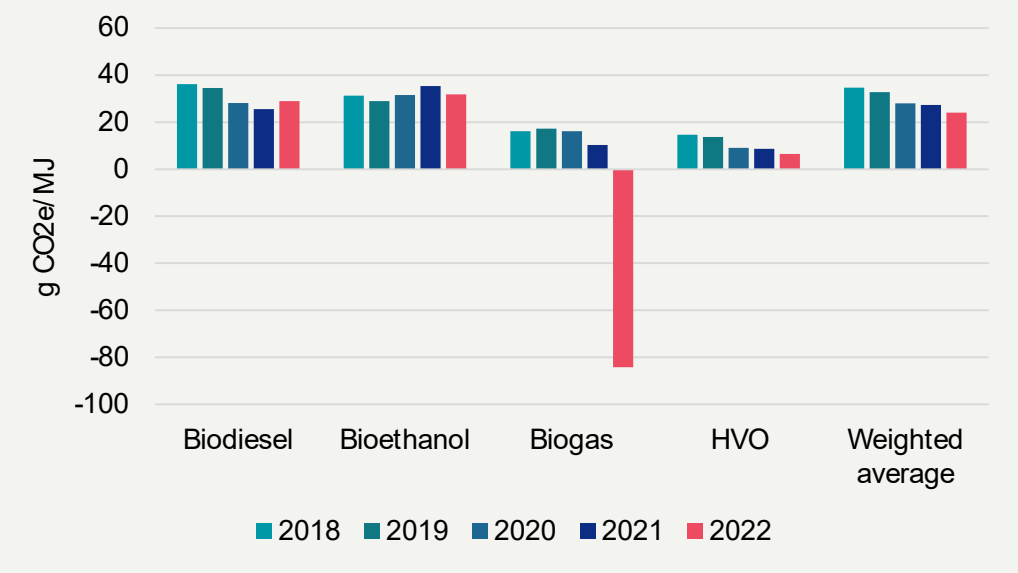
Table 4: Cradle-to-grave emissions from biofuels (million tonnes CO_2e)

	2019	2020	2021	2022
Biofuels	0.29	0.31	0.31	0.25

Source: The Danish Energy Agency on the basis of reports from fuel suppliers.

The biofuels used in 2022 were on average less climate-impacting measured in grams of CO_2e/MJ than in the years before. Thus, the weighted average of biofuels used in Denmark fell from 34.7 g/MJ in 2018 to 24.0 g/MJ in 2022, see Figure 24, which shows the weighted average of biofuels for the individual years.

Figure 24: Average emissions of greenhouse gases from the biofuels used in Denmark, 2018-2022



Source: The Danish Energy Agency on the basis of reports from fuel suppliers.

The negative value for biogas is due to the use of manure and sewage sludge as feedstock, the alternative use of which would lead to increased emissions of methane, for example if manure is applied directly to fields without being processed. The transition to the CO_2e displacement requirement in 2022 means it has become particularly attractive to use biofuels with very low CO_2 emissions in terms of g/MJ, and for biogas even negative emissions[26]. Previously, with a biofuel *blending* mandate, all biogas based on waste and residual products was treated the same with regard to

[26] Negative emissions are achieved if the alternative to using a given raw material in biofuel production is a use that leads to greenhouse gas emissions. For example, the assumed alternative to using manure to produce biogas is applying the manure to fields, where it will cause methane emissions (and these emissions will therefore be avoided if the manure is used to produce biogas, thus providing 'negative emissions').

meeting the biofuel blending mandate, which meant biogas from a mix of different feedstocks.

9.1.3 Indirect land-use change as a result of biofuel consumption leads to emissions abroad

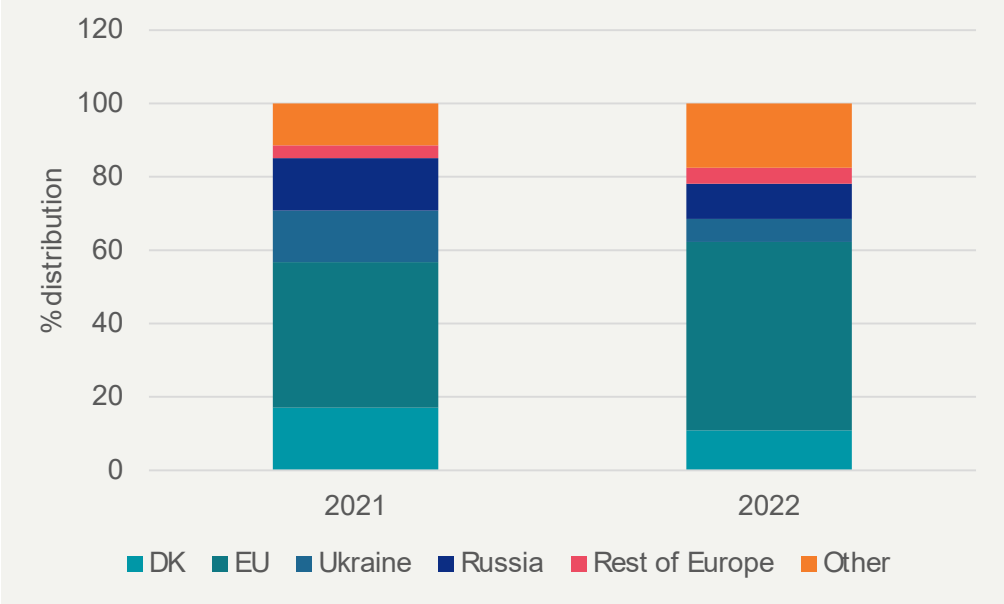
When biomass for biofuels is grown on land that was previously used for food production, the result can be that this food production will be transferred to new land[27], because the demand for food products is unchanged. If previously unfarmed land is converted to agricultural land to produce food crops, greenhouse gases will be released from the land, for example in the case of deforestation. Such impacts are referred to as indirect land-use change (iLUC), and it should be attributed to the biofuels. The extent of iLUC emissions linked to Danish consumption of biofuels in 2022 was marginally lower than in 2021, according to the estimate. This is primarily due to reduced consumption of biofuels. For an elaboration on iLUC impacts, see background memorandum on consumption of biofuels in GR22 located on **the Danish Energy Agency website**.

9.2 60% of biofuels come from Denmark and the EU

Consumption of domestically produced biodiesel fell from 2021 to 2022, and this is likely to be because of a serious fire at a large production plant, which temporarily stopped production of biodiesel. Instead, there has been an increase in the use of biodiesel from the rest of the EU. However, imports from both Russia and Ukraine fell from 2021 to 2022, see Figure 25.

[27] In principle, it may also lead to more efficient production on existing land, substitution (shift to other food types) or reduced consumption.

Figure 25: Country of origin for biofuels, 2021 and 2022



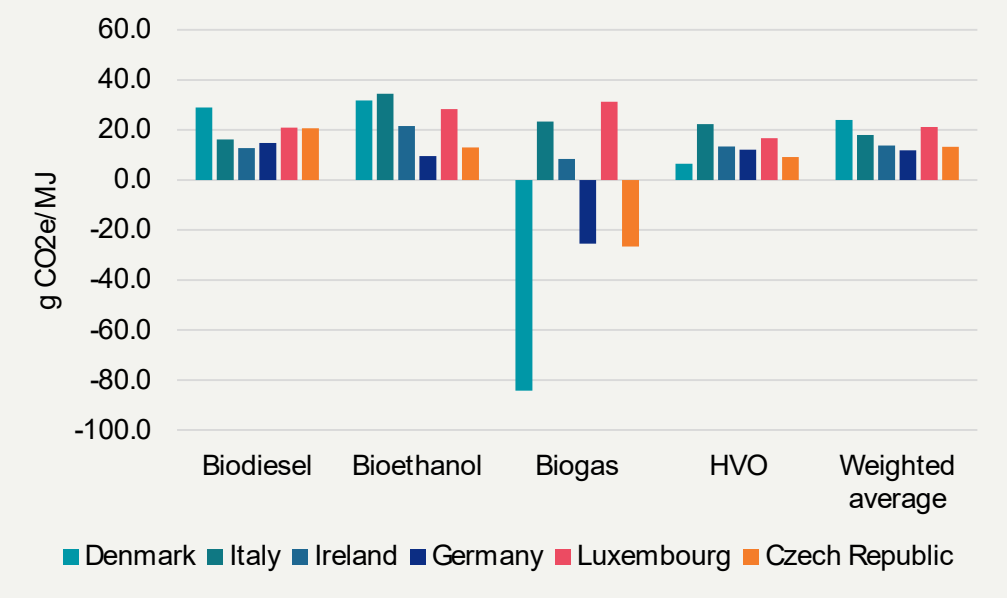
Source: The Danish Energy Agency on the basis of reports from fuel suppliers.

Comparison with other countries

To get an impression of the Danish global climate footprint compared with other countries, data has been included from reports for a number of EU countries. These reports stem from the European Environment Agency. Only a few countries have allowed their reports to be accessible, and this reduces the possibilities for comparisons.

Figure 26 shows the weighted average of cradle-to-grave emissions embedded in the individual types of fuels specified for each comparison country.

Figure 26: Benchmark cradle-to-grave emissions of greenhouse gases (CO_2e in g/MJ) in 2022

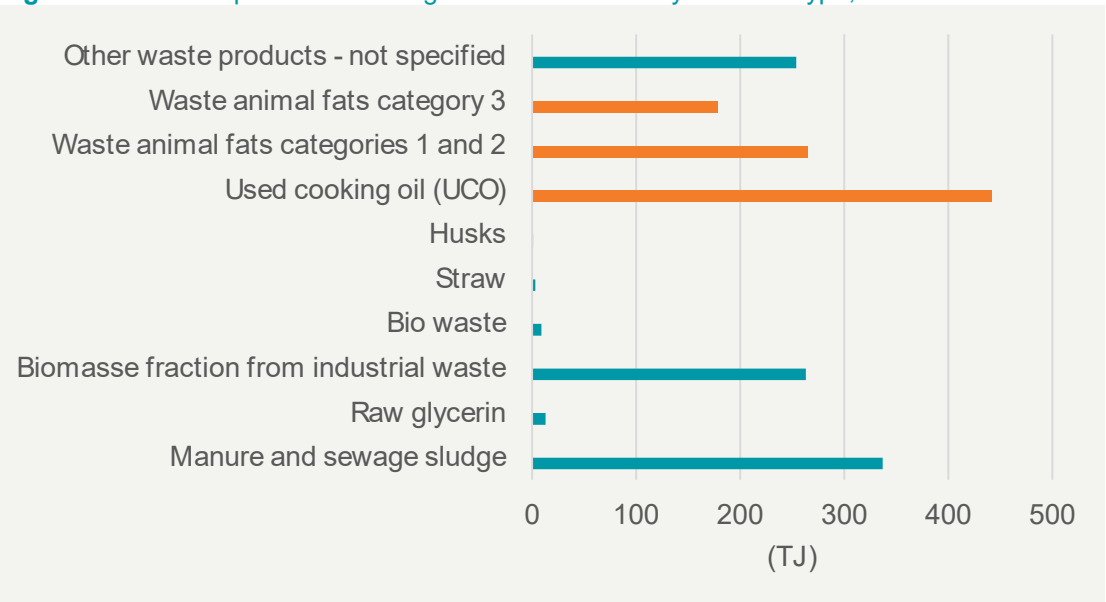


Source: The Danish Energy Agency.

Emissions embedded in second-generation biofuels

In 2022, around 17% of biofuels used in Denmark were second-generation biofuels, and around half of these biofuels were based on waste animal fats and waste vegetable oils, see Figure 27, covering around 0.5% of energy consumption in road transport (biofuels based on waste animal fats and waste vegetable oils may contribute a maximum of 1.7% to meeting the Danish displacement requirement).

Figure 27: Consumption of second-generation biofuels by biomass type, 2022



Source: The Danish Energy Agency.

For the year 2022, waste animal fats and waste vegetable oils have been included in FAME biodiesel and HVO biodiesel, although not in biogas.

Waste animal fats are categorised according to risk. Category 1, for example, includes animal fats from dead animals that under no circumstances may enter the food chain, while category 3 includes animal fats that may, to some extent, be used as animal feed.

Used cooking oil (UCO) has alternative uses (e.g. for soap and cosmetics, solvents, bioplastic and fertilizers). In many cases, the alternative fate of these waste oils is inappropriate disposal, for example via the wastewater, as residual waste, or simply directly in nature. Today, UCO is collected for use in biodiesel production. It would probably not be financially worthwhile to maintain a collection system for other types of reuse.

There are huge differences in the degree of organisation of UCO collection across countries. In Spain, it is estimated that around 70% of UCO from restaurants is collected, while only around 5% is collected from households. Belgium is estimated to have one of the highest collection rates at around 60% of the total amount of waste vegetable oils (REPSOL, 2023). Denmark has an industrial collection system in place (food production, including restaurants etc.) but household collection is very limited.

10 International transport

This chapter looks at emissions from international shipping and aviation. In 2022, these two categories each accounted for around 2% of global CO_2 emissions from energy consumption (IEA, 2024a) (IEA, 2024b). In 2020 and 2021, the Covid-19 pandemic had a major impact on both activity levels and emissions in aviation, while shipping was less affected. The most recent international aviation and shipping emissions data however shows that both sectors are again in growth. In 2022, shipping exceeded its 2019 emission level, and emissions from the sector are expected to continue to increase. For aviation, emissions were still lower in 2022 than before the pandemic, but the sector saw strong growth in activity levels in the years following 2020 in step with restrictions being phased out (IEA, 2024a) (IEA, 2024b).

Emissions from international shipping and aviation are not included in the individual estimates of territorial emissions reported by countries under the UN Framework Convention on Climate Change, see the UN IPCC guidelines. Reduction targets for international shipping and aviation are also not included in national targets under the Paris Agreement. For EU Member States, emissions of CO_2 from aviation and shipping covered by the EU Emissions Trading System (EU ETS) are included as part of the EU reduction target under the Paris Agreement, cf. EU Member States' Nationally Determined Contributions (NDCs).

Emissions from international shipping and aviation are, however, included in the UN IPCC's climate reports. The international climate targets and associated strategies for the two sectors are set out under the auspices of the UN by ICAO[28] (for aviation) and by IMO[29] (for shipping).

In this chapter, Danish activity includes transport by Danish-operated ships or aircraft, flights to and from Denmark, and ships bunkering in Denmark. Estimates in this chapter therefore depend on the definition applied as to what parts of aviation and shipping *can be attributed to Denmark*, and on whether there are data registers available to specify the activities and, thus, the emissions when applying the definition at hand.

[28] The International Civil Aviation Organization is an organization under the UN that promotes uniform standards for civil aviation legislation in member countries.
[29] The International Maritime Organization is an organization under the UN dealing with international matters related to shipping.

Main results - international aviation

10.1 Aviation emissions are approaching pre-Covid-19-pandemic levels

Activities by Danish air carriers are determined on the basis of flights abroad as well as on Danish and foreign air carriers' flights to and from Denmark. Focus is solely on emissions from the flights themselves and not on emissions associated with operations at airports, at other aviation-related businesses or in supply chains behind the aviation fuels used.

Box 7: Regulation of greenhouse gas emissions from international aviation

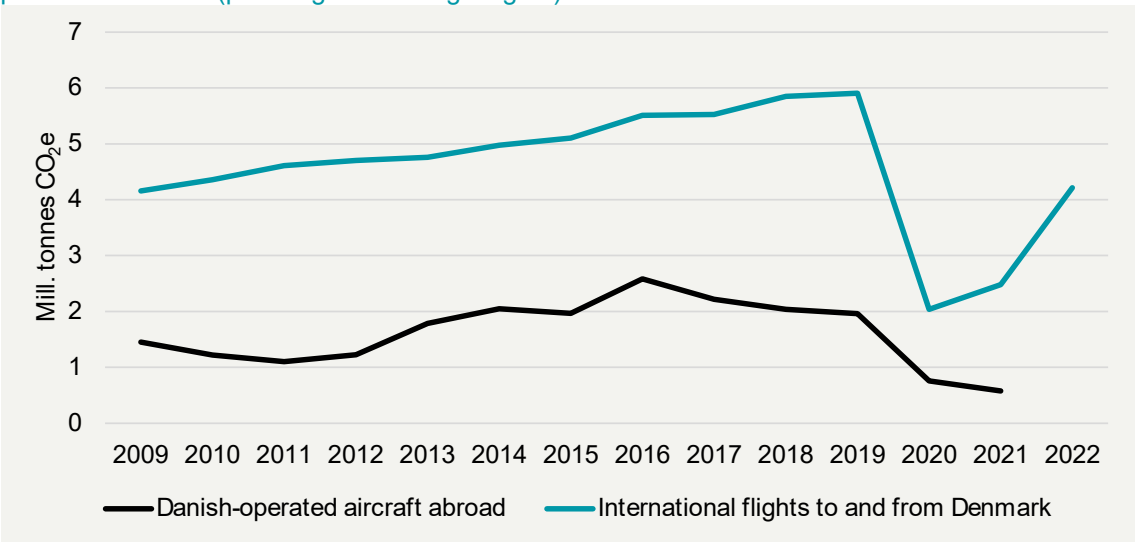
Regulation of greenhouse gas emissions from aviation at global level is through the CORSIA mechanism (Carbon Offsetting and Reduction Scheme for International Aviation) under ICAO, in the form of a compensation model to ensure that the aviation sector compensates for any emissions exceeding a fixed level (with 2019 as the baseline year).

At EU level, regulation is through the EU Emissions Trading System (EU ETS) as well as through the ReFuelEU Aviation Regulation and the Alternative Fuel Infrastructure Regulation (AFIR), which set out requirements for sustainable fuel blending and for infrastructure at airports. Furthermore, the European Commission is preparing a revision of the Energy Taxation Directive and new regulation of air traffic management that incorporates climate considerations in flight itinerary planning.

At national level, in December 2023, the government, together with the Green Left and the Red-Green Alliance, entered into an agreement on green aviation (*Grøn Luftfart i Danmark*). The agreement includes a passenger tax that will be phased in starting with an average tax of DKK 70 per flight in 2025, rising to an average tax of DKK 100 per flight in 2030. The tax will be differentiated so that in 2030, when the scheme has been fully phased in, passengers on domestic and intra-European flights will be charged DKK 50 per flight, while passengers on medium-distance and long-distance flights will be charged DKK 310 and DKK 410, respectively. The passenger tax is likely to lead to a decrease in passenger numbers, which, all else being equal, is expected to lead to reductions in international aviation emissions related to Denmark. The agreement sets out that revenues from the tax will be used to establish a fully green domestic route from 2025, and that all domestic aviation is to be green by 2030.

Figure 28 shows an estimate of emissions from international passenger and/or cargo flights, regardless of airline and ownership details, on flight legs between a Danish airport and a given non-Danish airport. Furthermore, Figure 28 shows emissions from bunkering abroad by Danish-operated aircraft. As some bunkering abroad by Danish-operated aircraft takes place prior to flights to Denmark, there will be an overlap with the estimate of emissions related to flights to and from Denmark. The two figures can therefore not be added together. Figure 28 only shows CO_2 emissions from fuel combustion.

Figure 28: Greenhouse gas emissions associated with international flights to and from Denmark in the period 2009-2022 and with bunkering abroad by Danish-operated aircraft in the period 2009-2021 (passenger and cargo flights)



Source: The Danish Energy Agency on the basis of the Danish Civil Aviation and Railway Authority (2023) and Statistics Denmark (2023). **Note:** The estimate of international flights to and from Denmark includes passenger and cargo flights, regardless of airline and ownership details, on flight legs between a Danish airport and a given non-Danish airport. There is no way to attribute emissions to the specific nationality of passengers onboard flights or to the specific production or destination country of the freighted goods. Data from Statistics Denmark includes data up to and including 2021, while energy statistics data includes data up to and including 2022.

The period 2009 to 2019 saw an approximately 50% increase in greenhouse gas emissions linked to flights to and from Denmark. This increase in emissions reflects a general growth in demand for international air transport. Emissions were at around 6 million tonnes CO_2e in 2019 but then fell significantly in 2020 to around 2 million tonnes CO_2e due to the Covid-19 pandemic. In 2022, emissions increased to around 4.2 million tonnes CO_2e in step with the easing of Covid-19 restrictions and reopening after the Covid-19 lockdown.

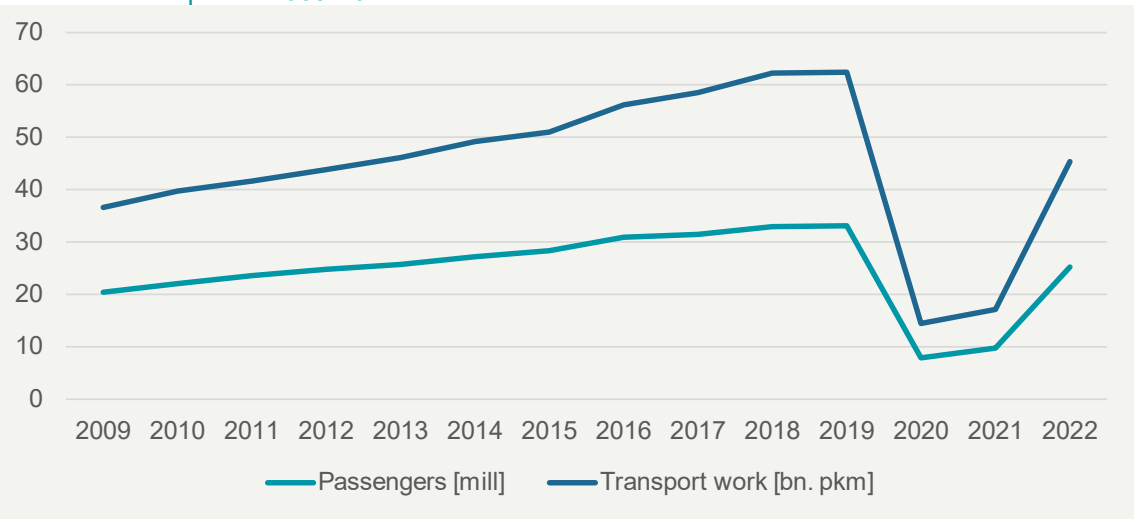
The increase in emissions from 2009 to 2019 can be attributed to two trends: Emissions from Danish-operated aircraft abroad increased up to 2016, then fell by around 20% leading up to 2019 and fell additionally as a consequence of the Covid-19 pandemic in 2020. This development can be attributed to changes in global demand for air travel, but also to changes in Danish market shares in the global market.

Besides impacting the climate due to CO_2 emissions, aviation also significantly impacts the climate due to fuel combustion at high altitudes, referred to as non-CO_2 effects. Non-CO_2 effects are due to contrails from aircraft, among other things, but despite their significance, these effects can be difficult to measure precisely. See the background memorandum on international transport for a more detailed account of aspects related to non-CO_2 effects.

10.1.1 Increased air transport to and from Denmark

The general increase in demand for international air transport is reflected in increased passenger numbers and increased transport[30] in relation to flights to and from Denmark.

Figure 29: Passenger numbers and transport related to international flights to and from Denmark in the period 2009-2021



Source: The Danish Civil Aviation and Railway Authority, 2023. **Note:** Transport work is calculated as the number of kilometres flown times the number of passengers (pkm = passenger-kilometres).

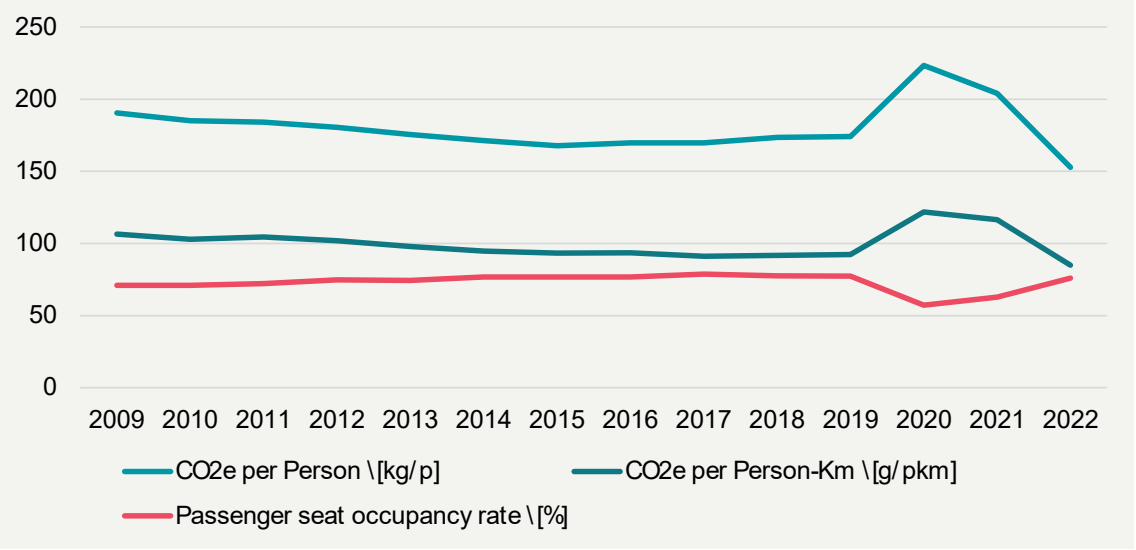
The number of passengers on international flights to and from Denmark thus increased from around 20 million in 2009 to around 33 million in 2019, see Figure 29. The Covid-19 pandemic had a significant effect in 2020, when passenger numbers fell to around 9 million. In 2022, passenger numbers were again at around 25 million. Similarly, transport work almost doubled in the period from 2009 to 2019, and, following the dip in 2020-2021, transport work increased to 45 billion passenger-kilometres in 2022.

[30] Transport is defined as passenger numbers/tonnes of cargo relative to the total number of kilometres the passengers/cargo are/is carried.

10.1.2 Aviation to and from Denmark has become less greenhouse-gas-intensive

To illustrate overall efficiency developments in international aviation to and from Denmark, emissions have been compared with activity, as shown in **Fejl! Henvisningskilde ikke fundet.** 30[31]. Emissions are affected by technical developments, the size of aircraft, as well as by passenger seat occupancy and travel distance.

Figure 30: Developments in indicators of developments in efficiency in international aviation (passenger flights) to and from Denmark in the period 2009-2022



Source: The Danish Civil Aviation and Railway Authority, 2023.

Emissions from flights to and from Denmark in the period 2009 to 2019 fell from 107 g CO_2e/passenger-kilometres in 2009 to 92 g CO_2e/passenger-kilometres in 2019. The significant changes in 2020 and 2021 are assessed to be related to half-empty flights and, thus, lower passenger seat occupancy rates during the Covid-19 pandemic. In 2022, emissions per passenger-kilometre fell to below a pre-pandemic level of 85 g CO_2e/passenger-kilometre.

Main results - international shipping

Ships linked to Denmark account for a relatively large share of international shipping emissions. In 2024, Denmark ranks 10 on the list of the world's largest shipping nations, measured by operated tonnage.

[31] Read about additional indicators in the background memorandum on international transport.

Shipping that can be related to Denmark can be calculated according to different scoping approaches and the choice of approach is decisive for estimates of energy consumption and emissions. For example, emissions from shipping that relate to Denmark can be scoped as follows:[32]

- Danish-flagged vessels: Vessels registered in DAS (the Danish Shipping Register) or DIS (the Danish International Register of Shipping) navigating under Danish supervision and where the shipping company must have its offices in Denmark.
- Danish-owned vessels: Vessels owned by Danish shipping companies.
- Danish-operated vessels: Vessels operated by Danish shipping companies for longer or shorter periods of time and regardless of ownership and flag state, however, not counting vessels operated by Danish-owned subsidiaries outside Denmark.

Box 8: Regulation of greenhouse gas emissions from international shipping

International shipping takes place across countries and continents. Standards and rules concerning safety, and energy and environmental conditions for example are developed through international organisations. Regulation of international shipping is constantly evolving with new initiatives and targets at both EU and UN levels.

Global guidelines for shipping are laid down by the UN International Maritime Organization, IMO. IMO comprises 175 member countries which, based on their participation, commit to following the rules and targets set. In 2023, IMO raised the level of ambition in its climate strategy up to 2050. The new targets aim for international shipping (ships over 5,000 gross tonnage) to achieve either full or near-net-zero greenhouse gas emissions by 2050. In the short and medium terms, the strategy sets an indicative reduction target of 20-30% by 2030 relative to 2008 levels and correspondingly a 70-80% reduction by 2040. Furthermore, the strategy includes a target of 40% reduction in emissions per transport work by 2030, relative to 2008. Finally, the climate strategy includes a target of zero or near-zero fuels making up at least 5%, and aiming for 10%, of demand by 2030, as part of promoting the incorporation of alternative fuels in the sector. IMO is working to provide regulation in the form of a global price mechanism to support the stipulated targets.

At EU level, shipping will be included in the EU ETS from 2024 (Europa-Kommissionen, 2024). This means the shipping industry is contributing to and included in the EU's climate targets. The phase-in of shipping into the EU ETS affects all large ships.

2023 saw the completion of negotiations on the European Commission's FuelEU Maritime proposal. For example, the agreement means that large ships will be subject to a CO_2 displacement requirement of 2% in 2025, rising to 80% in 2050, as well as a requirement for container and passenger ships to use onshore power supply at berths from 2030.

[32] See the background memorandum on international transport for a more detailed explanation (section 4.6 on methodology).

10.1.3 Emissions from bunkering relating to Denmark

The second of the two trends is seen in the curve showing emissions from Danish-operated ships abroad. This curve shows emissions from bunkering abroad by Danish-operated ships prior to international voyages, and these emissions fluctuate more over the same period.

Figure 31 below illustrates two different trends: One trend is that emissions related to fuel bunkered in Denmark, whether used for international voyages by Danish or by foreign ships, have remained more or less the same since 2010[33]. The second of the two trends is seen in the curve showing emissions from Danish-operated ships abroad. This curve shows emissions from bunkering abroad by Danish-operated ships prior to international voyages, and these emissions fluctuate more over the same period.

Figure 31: Developments in emissions associated with bunkering Danish-operated ships abroad, as well as emissions associated with bunkering in Denmark by international shipping

Source: The Danish Energy Agency, 2023, Statistics Denmark, 2023. **Note:** Data from Statistics Denmark includes data up to and including 2021, while energy statistics data includes data up to and including 2022.

Despite fluctuations, the general trend is that emissions have increased. The period 1990 to 2007 saw a significant increase in emissions, which can generally be ascribed to global economic growth and an associated increase in demand for shipping services. Emissions peaked in 2007 at 42 million tonnes CO_2e. After a drop in emissions up to 2014, in 2021, which is the most recent year with data, emissions increased to around 37.5 million tonnes CO_2e.

Note that the changes in emissions from Danish-operated ships are not necessarily due to changes in operating efficiency or in global demand for shipping services but may also be due to changes in the market shares of Danish-operated ships.

Over a longer period, a decoupling of emissions from continued growth in freight volumes is evident. The increased efficiency is due primarily to better utilisation of

[33]Emissions from bunkering by ships only include emissions associated with the fuel combustion itself. The estimate of emissions by shipping in the GR24 chapter on exports (Chapter 5) includes emissions from the entire value chain for fuels as well as port activities associated with exports.

ships; optimisation of speed, operations and routes; new designs; as well as larger and more efficient ships. Looking at the transport work of Danish-flagged container ships, for example, these ships accounted for around 5.9% of the total transport work of the world fleet of container vessels in 2022[34]. This applies even though Danish container ships only account for 4% of total emissions from the container fleet. Part of the reason for this is that Danish-flagged container ships are among the largest in the world, and this contributes to lowering emissions per tonne of freight. Besides efficiency improvements, efforts are beginning to implement new engine technologies and fuels, which is crucial to transitioning international shipping. For example, in 2023, a Danish ship was launched as the world's first container ship powered by methanol, and many more methanol ships are on the way. Green methanol and ammonia are widely considered as among the most promising technologies for reducing CO_2 emissions from the sector.

[34] In the absence of data, transport work is based on the deadweight tonnage (DWT) of ships; that is, the maximum load capacity of ships rather than their actual cargo, data on which is not available in the data used.

Climate action by businesses

This part of GR24 looks at the climate action of businesses. Businesses greatly influence global greenhouse gas emissions as there are emissions associated with everything from production, operation and transport to final consumption of the products sold. The climate footprint of activities by Danish businesses is included in the estimates of emissions associated with consumption, imports and exports in chapters 1, 4 and 5. In the following, focus is instead on the efforts of the largest Danish businesses with regard to reporting their greenhouse gas emissions, as well as on the potential positive impact of Danish exports of green energy and environmental technologies on greenhouse gas emissions abroad.

Chapter 11 *Danish green exports* describes the monetary value of Danish exports of green solutions as well as the potential for CO_2 emissions reductions in the countries to where the solutions are exported.

Chapter 12 *Climate action by large Danish businesses* surveys the progress of large Danish businesses towards reporting on their climate action and setting reduction targets. The survey is topical following the upcoming requirements for businesses to report on their climate action under the new EU Corporate Sustainability Reporting Directive (CSRD).

The background memoranda for Danish green exports and the climate action of large Danish businesses related to these chapters include descriptions of the methodologies applied, more detailed results, as well as a description of the uncertainties associated with the results of the analyses.

11 Danish green exports

This chapter looks at the economic and climate-related value of Danish green exports. First, the chapter looks at the export turnover of green energy and environmental technologies, such as wind and heat pump technologies. This is followed by an estimate of the potential for CO_2 emissions reductions in the use phase as a result of green energy technologies exported from Denmark.

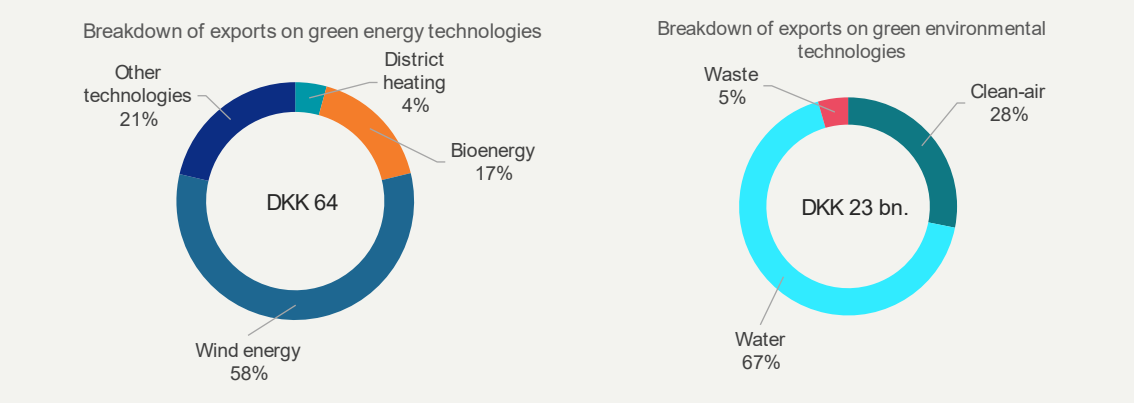
Main results - the value of Danish green exports

Green exports cover green energy and environmental technologies and related services,[35] i.e. exports that can contribute positively to reductions in global emissions or to environmental and resource savings.

11.1.1 Wind and water technologies dominate Danish green exports

In 2023, Denmark exported green energy technology worth around DKK 64 billion and green environmental technology worth around DKK 23 billion. This corresponds to around 2% and 6%, respectively, of total Danish goods exports that year[36]. For green energy technologies, this constitutes an increase of 2%, whereas for green environmental technologies it constitutes a fall of 3%, relative to the previous year. Note, in this context, that Danish energy technology exports typically comprise few but large orders and that the value of annual exports can therefore fluctuate considerably from year to year, depending on whether an order falls just before or just after the new year. Figure 32 shows the breakdown by type of technology within green energy and environmental technologies in 2023. The figure shows that wind and water technologies dominate Danish green exports.

Figure 32: Exports of green energy technology and green environmental technology in 2023 by type of technology



Source: The Danish Energy Agency based on data from Eurostat.

[35] Green services cover services such as consultancy or auxiliary services for products within green energy and environmental technologies. 'Green' in this context means Eurostat's definition of green products and all products within bio and wind technology.
[36] There may be overlap between exports of green environmental technology and exports of green energy technology, and these figures can therefore not be added together without risking double counting.

11.2 Germany is the largest buyer of green energy and environmental technologies from Denmark

In 2023, Germany was the largest buyer of Danish green energy technologies, as Germany bought technology worth a total of DKK 10 billion. This corresponds to 15% of all Danish green energy technology exports. Germany was also the largest buyer of Danish green environmental technology, as they bought technology worth DKK 3 billion, corresponding to 12% of total Danish exports of green environmental technology.

In addition to green technologies, Denmark exported green environmental services worth around DKK 6 billion, and green energy services worth DKK 15 billion. Green environmental and energy services include auxiliary services delivered for the exported green products, as well as consultancy services for energy and environmental technologies.

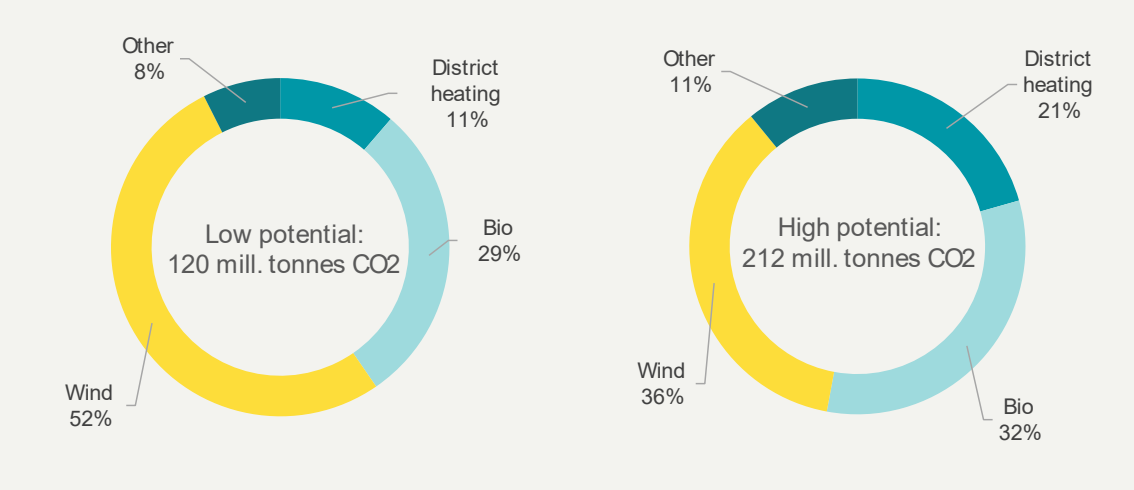
Main results - CO_2 emissions reductions made possible by Danish green energy technology exports

This section describes the CO_2 emissions reductions abroad made possible by Danish green energy technology exports. The analysis looks at greenhouse gas emissions in the use phase and is based on a comparison with a hypothetical reference scenario with no Danish green energy technology exports. The reference scenario assumes the continued use of existing technologies and therefore does not look at whether an energy technology similar to the one exported by Denmark could have been imported from elsewhere. Thus, the analysis looks at the CO_2 emissions reductions made possible by Danish green energy technology exports rather than provide an estimate of actual CO_2 emissions reductions.

Greenhouse gas emissions reductions of up to 212 million tonnes CO_2 made possible by Danish green energy technology exports in 2023

In a single given year within the lifetime of the exported technologies, Danish green energy technologies exported in 2023 have been estimated to make it possible to reduce global emissions by between 4 and 8 million tonnes CO_2. Over the entire lifetime of the technologies, the potential is greater, because exports within a given year entail reductions several years into the future. Over the entire lifetime of the individual technology, Danish exports of green energy technologies in 2023 have been estimated to make it possible to reduce emissions outside Denmark by between 120 and 212 million tonnes CO_2, depending on what technology the exported Danish technology replaces.

Figure 33: CO_2 emissions reductions made possible, broken down by type of technology exported, over the lifetime of the technology



Source: The Danish Energy Agency. **Note:** The diagram on the left shows the percentage distribution of the four categories of technology at a minimum for the potential and the diagram on the right shows the distribution at a maximum for the potential.

11.3 Wind technologies account for the largest share of the potential for CO_2 emissions reductions from exports

Figure 33 shows that wind technologies dominate in the low range, according to the estimate. This is because wind technologies make up by far the largest share of Danish green exports, see above. Both wind energy and bioenergy make up large shares in the high range. This is because, in the high range, the figure for bioenergy (bio) reflects the replacement of coal-based CHP with biomass-based, whereas in the low range, the figure for bioenergy (bio) reflects the replacement of natural gas with biogas.

12 Climate action by large Danish businesses

Direct emissions from the production and operation of Danish businesses, and from the value chain of their products, influence the world's greenhouse gas emissions. These emissions include emissions embedded in goods and passenger transport, resource extraction and processing and end-use consumption of the products sold. Danish businesses also have an impact outside Denmark when they buy and sell goods and services across borders. For example, Danish businesses can make demands on their foreign suppliers and, thus, indirectly reduce emissions outside Denmark.

The upcoming EU Corporate Sustainability Reporting Directive (CSRD) makes it mandatory for large European businesses to report on their greenhouse gas emissions, for example, throughout the value chain. The ESRS reporting standards under the CSRD include a large number of general sustainability reporting obligations for European businesses. However, this analysis concerns only climate reporting.

A total of 2,300 Danish businesses are expected to be covered by the new reporting rules, including a significant proportion of Danish financial businesses. The reporting requirements will come into effect in the period 2024 to 2028, depending on company size.

For this analysis of the climate reporting maturity of large Danish businesses, just as last year, a survey was conducted to identify the degree to which the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses have reported on their climate footprint and have set targets to reduce their climate footprint. The primary focus of the survey is the extent to which businesses are reporting on some of the general reporting requirements under the CSRD.

Main results

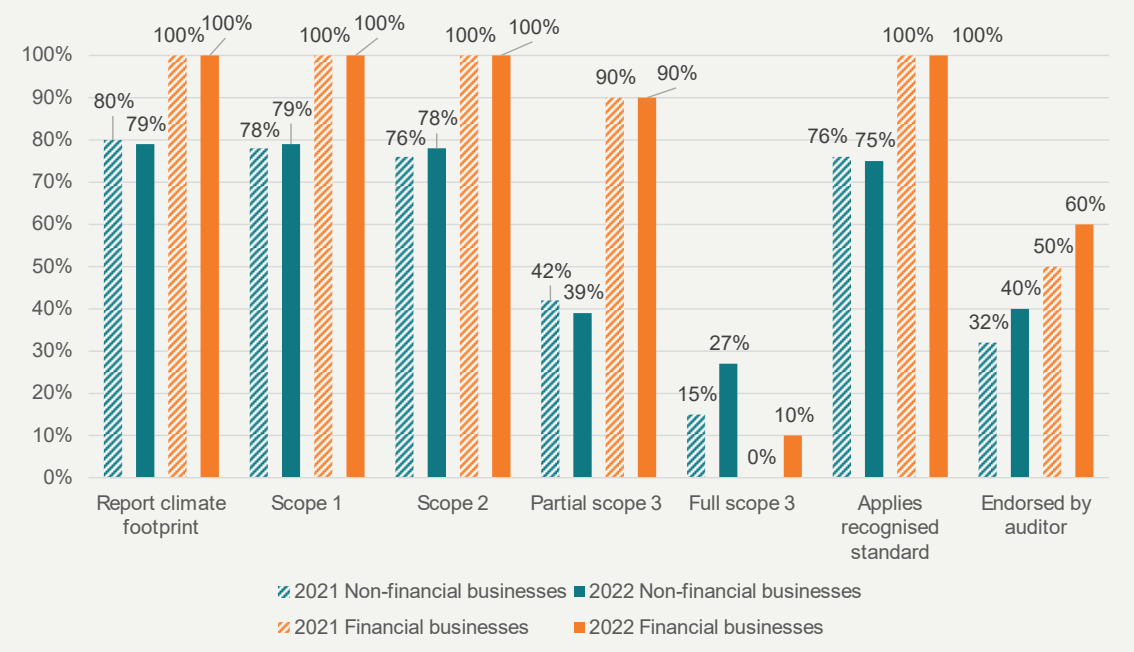
The survey of reporting in 2022 shows continued discrepancies in the extent to which, and whether at all, Danish businesses report on their CO_2e emissions. However, far more businesses are completing so-called full scope reporting. Unfortunately, a large number of businesses still have yet to start reporting.

12.1 Many businesses are already well underway in climate reporting

Businesses can report on Scopes 1, 2 and 3 emissions: Scope 1 (direct emissions from own activities), Scope 2 (indirect emissions from electricity and district heating) and Scope 3 (indirect emissions in the value chain). Businesses usually start by calculating emissions sources covered by Scope 1 and Scope 2. This is typically because these emissions are the easiest to estimate fairly and they stem from relatively few sources. Scope 3 emissions on the other hand take place outside the business itself and they often stem from many different sources.

This is reflected in the survey, the main results of which are summarised in Figure 34. As many as 79% of non-financial businesses in the survey reported on Scope 1 emissions in 2022, while 78% reported on Scope 2 emissions, which, with regard to both figures, represents an increase from 2021. As was also the case in the previous year, *all* financial businesses reported on both Scope 1 and Scope 2 emissions. For Scope 3 emissions, the figures are slightly lower but still represent increases compared to 2021. As many as 66% of non-financial businesses and all the financial business in the survey reported their Scope 3 emissions in 2022, either partially or in full, as opposed to 57% and 90%, respectively, in 2021.

Figure 34: Climate accounting work by large Danish businesses, 2021 and 2022



Source: The Danish Energy Agency.

12.2 The Greenhouse Gas Protocol is the most commonly applied reporting standard

The survey also shows that the majority of businesses preparing climate accounts today do so on the basis of the accounting standards provided by the Greenhouse Gas Protocol (GHG Protocol).[37] These are the de facto climate accounting norms and are likely to be recommended in upcoming climate reporting standards. A total of 78% of non-financial businesses based their 2022 climate accounting on the GHG Protocol or an equivalent standard, according to their annual climate accounts. All ten financial businesses in the survey based their climate accounting on the GHG Protocol.

12.3 Many businesses have their climate reporting endorsed

According to the CSRD, businesses are required to have their sustainability report endorsed by an independent third party[38]. As can be seen from Figure 34, 40% of non-financial businesses had their annual climate reporting for 2022 endorsed by an auditor, as opposed to 32% in 2021. For the financial businesses, the figure was 60% in 2022 against 50% in 2021.

12.4 More than one-half of businesses calculate Scope 3 emissions

Scope 3 emissions comprise all emissions associated with production, consumption and transport activities by the business, as well as emissions associated with the sale, use and disposal of the products produced by the business. Reporting on all Scope 3 emissions is therefore an extensive and complex task. The GHG Protocol distinguishes between 15 different Scope 3 categories. The survey divides the Scope 3 calculations of businesses into two categories: Full Scope 3 reporting, and partial Scope 3 reporting. Full Scope 3 reporting entails either calculating emissions from all 15 categories or confirming their irrelevance for the business.

The survey reveals that 65% of the 100 non-financial businesses and all the financial businesses reported Scope 3 emissions at some level or other in 2022. A total of 27% of the non-financial businesses prepared full Scope 3 emissions accounts and therefore reported on their emissions from all 15 Scope 3 categories (or provided reasons for not reporting). This represents a considerable increase compared with 2021 when only 15% of businesses did so, see Figure 34.

[37] The Greenhouse Gas Protocol (GHG Protocol) is a voluntary accounting standard for calculating greenhouse gases. The standard is globally recognised by businesses. The purpose of the protocol is to help define the direct and indirect greenhouse gas emissions of businesses, and to ensure a uniform approach to calculating the overall climate footprint.
[38] This entails having an independent third party review the information in the climate accounts and assure the quality of the accounts.

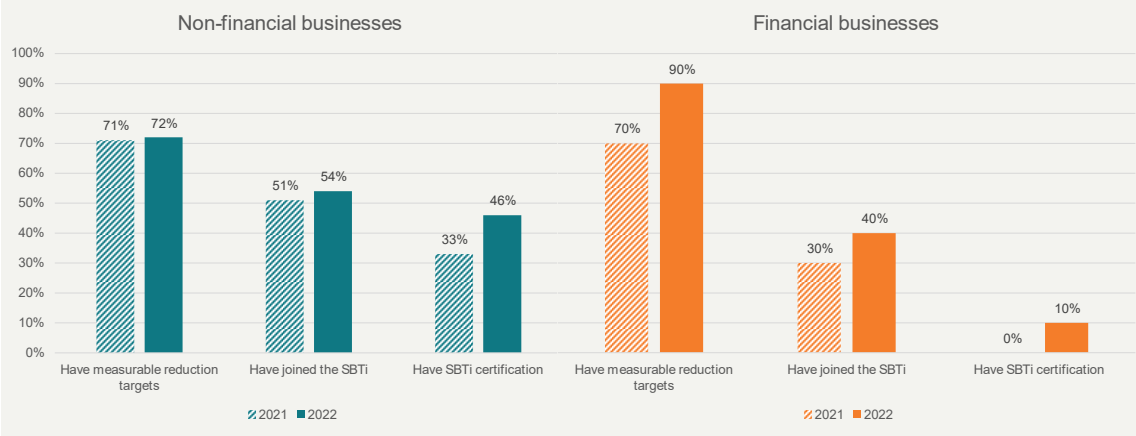
12.5 Several businesses have set reduction targets

Having gained an idea of the size of their climate footprint, the obvious next step for businesses is to initiate action to reduce their footprint. Businesses can do this by setting reduction targets for themselves and then launch initiatives to reduce their greenhouse gas emissions, for example. Typically, businesses will present their reduction targets in their annual climate reporting. However, there are also various initiatives that help businesses reduce their emissions. The most common of these is the Science Based Target initiative (SBTi). This is a private-sector initiative through which businesses can establish reduction targets based in climate science and in support of the 1.5-degree Celsius goal of the Paris Agreement. As part of the SBTi, businesses can set reduction targets and subsequently obtain SBTi certification, which has become a recognised climate action and responsibility standard among businesses and investors.

As can be seen from Figure 35, the survey reveals that 72 of the 100 largest non-financial businesses surveyed set measurable reduction targets in their most recent annual climate reporting. Of these, by far the majority (54 businesses) have joined the SBTi. A total of 46 businesses set specific SBTi reduction targets and obtained SBTi certification, while 12 businesses are still in the process of establishing SBTi reduction targets.

Furthermore, nine out of the ten financial businesses in the survey set measurable reduction targets in 2022 and three financial businesses had joined the SBTi, while one business obtained SBTi certification of its reduction target.

Figure 35: Reduction targets and SBTi membership, 2021 and 2022



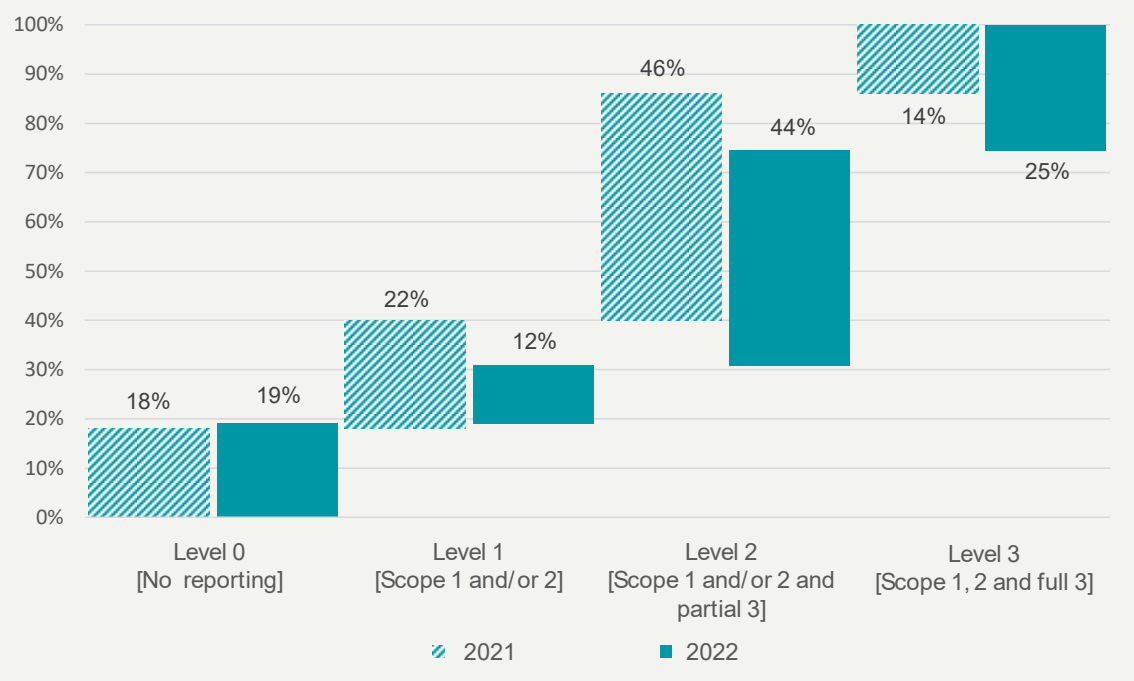
Source: The Danish Energy Agency and the Science Based Target initiative. **Note:** The figures on SBTi membership and certification are based on data from the SBTi on the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses. The data was extracted from the SBTi database at the end of 2023. Any changes in membership and certifications dated 2024 are therefore not reflected. Some of the businesses are part of large international groups and are committed to the SBTi through the group, but the majority of the businesses are committed to the SBTi directly as a Danish subsidiary. The SBTi figures in this survey are therefore not directly comparable with figures on the overall number of Danish businesses that have joined the SBTi, because the figures in the survey include both Danish and international SBTi certifications.

To assess the overall degree of maturity of the surveyed businesses with regard to climate reporting, the businesses have been grouped according to three levels of maturity: 0 to 3. The levels reflect the steps towards full climate reporting maturity typically taken by businesses:

- Level 0 if they have no climate reporting activities.
- Level 1 if they report on Scope 1 or Scope 2 emissions, or on both.
- Level 2 if they report on Scope 1 and/or Scope 2 emissions, and to some extent also on Scope 3 emissions.
- Level 3 if they report on Scope 1 and Scope 2 emissions and also provide full estimates of all Scope 3 categories.

Applying this three-level maturity scale, we see that, among the 110 businesses in the 2022 survey, 19% place at level 0; 12% place at level 1; 44% at level 2; and 25% at level 3, see Figure 36 below. Compared to 2021, the maturity of businesses has increased, with a higher share proportion of businesses at levels 2 and 3. However, the proportion of businesses at the lowest level of maturity remains more or less the same.

Figure 36: Assessment of the maturity of the 110 businesses in the survey, 2021 and 2022



Source: The Danish Energy Agency. **Note:** The assessment is based on data in the annual reports of the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses.

Global action by authorities

The Paris Agreement and the UN Sustainable Development Goals form the framework for Danish global climate action. Danish global climate action largely falls into five tracks,[39] reflecting Denmark's various targets: 1) Raise Denmark's global climate ambitions; 2) Reduce global greenhouse gas emissions through spearheading the green transition; 3) Promote adaptation and resilience initiatives to combat climate change; 4) Make black global financing green; and 5) Cooperate with businesses on green solutions that make a difference. The five long-term strategic targets are realised in concrete annual initiatives described in the global strategy in the government's Climate Programme. The five tracks form the overall framework for the chapters in this part of GR24, which provides a status report on a selection of international climate actions by the authorities, focussing on initiatives realised in 2023.

Chapter 13 *Global climate ambitions* investigates examples of Danish climate diplomacy initiatives to raise global climate ambitions.

Chapter 14 *Global reductions* investigates examples of Danish initiatives under the auspices of Danish climate assistance, as well as Danish authority cooperation aimed at reducing CO_2 emissions globally.

Chapter 15 *Global climate change adaptation action* investigates examples of initiatives under the auspices of Danish climate assistance that aim to underpin climate change adaptation in vulnerable countries.

Chapter 16 *Climate assistance and climate finance* provides a quantitative account of Danish climate assistance and mobilised climate finance.

Chapter 17 *The climate footprint of public and private investments abroad* describes the climate footprint of Danish public co-financing of green projects internationally, for

[39] See the previous government strategy: *The government's long-term strategy for global climate action, A Green and Sustainable World*

example wind and solar farm projects, and provides examples of the climate footprint of private investments.

Chapter 18 *Cooperation with businesses on green solutions* investigates examples of authority initiatives to promote the use of climate solutions developed by Danish businesses in the global green transition.

Descriptions of supplementary initiatives, explanation of data, etc. are in the following background memoranda: climate diplomacy, reduction efforts supported through Danish climate assistance, bilateral energy cooperation, bilateral environmental cooperation, bilateral food cooperation, climate change adaptation, climate finance, and finance for investments globally.

Difficult to quantify the climate impacts of global climate action by authorities

It is difficult to quantify the climate impacts of global action by authorities. This is due in particular to two factors which characterise Danish efforts to influence the global climate agenda:

1. *Denmark can influence partners but does not make the decisions:* The purpose of Danish global climate action is often to influence relevant stakeholders, such as foreign governments, to make more ambitious policy decisions with regard to their climate agenda. For example, this could be through capacity-building cooperation with partners or through negotiations. It is up to the cooperation partners (the authorities in a specific country, for example) to decide in practice whether they want to raise their ambitions, implement new legislation and/or reduce their national emissions.
2. *Denmark cooperates with others:* Many global climate initiatives initiated by Denmark are implemented in cooperation with other countries, for example the EU, the other Nordic countries, or alliances and coalitions such as the High Ambition Coalition and the Powering Past Coal Alliance. Because it is a collective effort, it is difficult to demonstrate a direct correlation between Danish initiatives and any raised global ambitions, but by cooperating, Denmark adds momentum to efforts to influence the countries that Denmark wants to influence.

13 Global climate ambitions

Leading by example with its national actions, Denmark can serve to inspire and encourage other countries and players abroad to also raise their climate ambitions. Danish global climate action focusses on influencing countries and other players in the context of the EU (through bilateral and multilateral partnerships, and through global initiatives) to commit to ambitious targets to reduce global emissions. Below is a description of some of the initiatives realised in 2023.

Main results

13.1 Denmark's facilitator role at first ever Global Stocktake at COP28

The Global Stocktake is a key element of the Paris Agreement's ambition mechanism, obliging the parties to take stock every five years of efforts to achieve the Paris Agreement's long-term goals and to set the direction for how to get there. After two years of preparatory work, COP28 agreed on a decision text for the first Global Stocktake (GST) since the adoption of the Paris Agreement. Denmark once again played an important part in the negotiations at the COP, especially in the context of negotiations on the global stocktake. As part of these targeted efforts, Denmark hosted the Copenhagen Climate Ministerial (CCM) again in 2023 and the ministerial was instrumental in initiating political discussions about COP28 early in the year. The Minister for Development Cooperation and Global Climate Policy was asked to facilitate consultations on the global stocktake leading up to the COP and was also asked to continue in the role of facilitator at the COP itself.

Based on the consultations, the COP28 Presidency drafted what became the final outcome text for COP28. The final text reinforces the importance of achieving the 1.5-degree target and the urgent need for action and support. It contains specific text on the need to reduce emissions and asks the parties to contribute to global initiatives to:

- Triple the share of renewable energy
- Double energy efficiency globally up to 2030
- Transition away from fossil fuels in energy systems

13.2 Denmark leads the way for climate loss and damage repair with a DKK 350 million contribution

Climate-induced loss and damage is a key agenda for the most climate-vulnerable and least developed countries in the world. Therefore, the adoption of decisions at COP28 on new financing arrangements and a fund to repair loss and damage is essential. Denmark has been an active member of the committee that has prepared the recommendations behind the adoption of the fund, and, on the day of the fund's adoption, Denmark announced a pledge of DKK 350 million for loss and damage repair, of which DKK 175 million will go to the new fund. Besides the fund, Denmark pledges to support other loss and damage projects with an additional DKK 175 million.

Amongst other things, this money will go to another initiative to support access to early warning systems for all before 2027.

Furthermore, after four years of negotiations, the final details in the formal establishment of the Santiago Network on loss and damage were agreed upon, including determining the hosting of the secretariat that will be serving the network. This means that the USD 8 million that Denmark pledged at COP26 for the network's fund for technical assistance will likely be paid in 2024.

13.3 New fund to help countries phase out oil and gas

As the co-chair of the Beyond Oil and Gas Alliance (BOGA), Denmark has been a driving force in consolidating the alliance since its launch at COP26. BOGA is working to promote fair and controlled phase-out of oil and gas production in line with the Danish North Sea Agreement from 2020 (KEFM, 2020). Seven new countries joined the alliance in 2023. Oil and gas producing countries in the Global South have been a special focus area for the alliance, as was already evident at COP27 with the launch of the BOGA fund of USD 10 million. The purpose of the fund is to provide technical assistance to producer countries in the Global South that want to explore alternative development paths away from oil and gas. At COP28, Columbia and Kenya were announced as the first recipient countries of a combined USD 1 million of the fund's resources.

13.4 Denmark among primary donor countries for Accelerated Partnership for Renewables in Africa (APRA)

Denmark and Germany have been the primary donor countries to support the establishment of the Accelerated Partnership for Renewables in Africa (APRA) initiative. The initiative was presented at the Africa Climate Summit in September 2023 by Kenyan President William Rutu and formally launched at COP28 in Dubai with the participation of Prime Minister Mette Frederiksen. The aim is to establish an African-led coalition of countries that have set ambitious targets for a green energy transition to drive sustainable development and industrialisation of their countries in accordance with the Paris Agreement. Among other things, these countries must present plans for their green energy transition, along with their needs for the technical assistance and financing required to accelerate the implementation of these plans. The first six countries to participate are Ethiopia, Kenya, Namibia, Rwanda, Sierra Leone and Zimbabwe, but more countries are expected to be included. The International Renewable Energy Agency, IRENA, is the main supporter and facilitator of work across countries. APRA is also intended to play an important role in supporting African countries in reaching the goal of tripling their renewable energy capacity by 2030, which was a key decision at COP28.

13.5 Active participation in the G20 Summit on workstreams for energy transition and the environment and climate

During the Indian G20 Presidency, Denmark was invited to take part in the G20 negotiations for the first time and participated in the formal working groups on energy transition and the environment and climate. The Ministry of Climate, Energy and Utilities, including the Danish Energy Agency, participated actively in the negotiations, together with the Ministry of Foreign Affairs and the Ministry of Environment. Each workstream involved a series of negotiation sessions on Ministerial Declarations, four formal working group meetings and associated ministerial meetings attended by the Minister for Development Cooperation and Global Climate Policy. The purpose of the working groups was to negotiate key points in relation to the two workstreams, and these key points were eventually included in the final document submitted for adoption at the G20 Summit in September 2023. Denmark had special focus on pushing the G20 in a greener direction, and the final document on the energy transition included a goal to work towards a global tripling of renewable energy by 2030. The final document on the environment and climate included wording on combating deforestation and plastic pollution as well as restoring at least 30% of impaired ecosystems by 2030. Denmark's active participation at the G20 Summit was instrumental in Denmark subsequently being invited to take part in the green workstream at the G20 Summit in Brazil in 2024.

13.6 Work to promote offshore wind deployment

The Global Offshore Wind Alliance (GOWA) was launched at COP27 by Denmark, the International Renewable Energy Agency (IRENA) and the Global Wind Energy Council (GWEC) with the objective of achieving a dramatic acceleration of global offshore wind deployment. Since its launch, GOWA's circle of members has grown from 12 to 30. The circle of members includes a total of 17 member states. During COP28, a high-level event was held with several ministers, other government representatives and private sector representatives. The event served as a platform for announcing new members and highlighting offshore wind's contribution to the goal of tripling renewable energy by 2030.

13.7 New global alliance for negative emissions targets

COP28 saw the launch of the Danish-initiated Group of Negative Emitters (GONE) alliance. The alliance is working to highlight the need for negative emissions to meet the Paris Agreement's goal of limiting the temperature rise to 1.5 degrees Celsius. The alliance is working actively to encourage more countries to set negative emissions targets up to renewal of their national climate targets before COP30, and to develop the policy frameworks and technical solutions needed to achieve negative emissions. Nature-based solutions and carbon management, including carbon capture and storage, are in focus.

14 Global reductions

Denmark is working for a global green transition and a key ambition is to ensure that the largest emitting countries reduce their emissions and that developing countries are supported in following sustainable economic growth paths. Efforts are broad and take place through multilateral fora, with support from multilateral funds and organisations, as well as through bilateral initiatives, through which Danish authorities share their knowledge and experience in order to build capacity in partnership countries in the areas of energy, environment and food. This chapter reviews selected initiatives for 2023.

Main results

14.1.1 Danish climate assistance underpins the emissions reduction targets of the Paris Agreement

Danish climate assistance for 2023 is given to initiatives that underpins the emissions reduction targets of the Paris Agreement. Projects cover a large number of initiatives. The table below shows some of the most important topics that also contribute to Denmark's development cooperation strategy and long-term strategy for global climate action (Regeringen, 2020), as well as Sustainable Development Goal 7 (SDG7) on sustainable energy and Sustainable Development Goal 13 (SDG13) on climate action (United Nations, 2015).

Table 5: Examples of results of climate assistance

Topic	Examples of results
National capacity building, NDCs, energy transition and an inclusive green transition Nationally Determined Contributions (NDCs) are national climate action plans that the signatories to the Paris Agreement have committed to prepare and subsequently update at least every five years.	**Co-Chair of the NDC Partnership** In connection with COP28, Denmark took over co-chairmanship of the NDC Partnership for the period 2024-2025. The other Co-Chair is Rwanda in 2024, while another developing country will be Co-Chair in 2025. The Partnership supports developing countries in improving their NDCs by incorporating climate in planning, budgeting and investment processes. **New support for the green transition through international initiatives** New support for the green transition through international initiatives such as the NDC Partnership (NDCP), the International Renewable Energy Agency (IRENA), Just Energy Transition Partnerships (JETPs) and the Accelerated Partnership for Renewables in Africa (APRA).
Access to clean and renewable energy Danish climate assistance has been instrumental in underpinning access to clean energy in Ukraine as well as in some of the least developed countries in the world, including in Africa.	**Initiatives in Ukraine** In 2023, Denmark made two contributions to the Ukraine Energy Support Fund (UESF): a general contribution of DKK 52.8 million and a contribution of DKK 30.2 million earmarked for redevelopment of Ukraine's renewable energy transition. The purpose of the fund is to provide support for repair and redevelopment of the energy supply in Ukraine. Amongst other things, the fund is working with requirements clarification and procurement of the equipment and services needed to repair infrastructure and maintain energy and heat supply. **Support for the green energy transition in Africa** In 2023, as part of realisation of a grant of DKK 100 million for the period 2021-2030 to the Sustainable Energy Fund for Africa 2.0 (SEFA 2.0), Denmark supported the work of African countries to exploit new inclusive green energy opportunities. One focus area entailed supporting the Africa Super ESCO Acceleration Program (ASAP) in Rwanda, Senegal and South Africa by channelling funds for public investments in energy efficiency improvement.
Linking emissions reductions and climate change adaptation is important in climate change adaptation efforts in developing countries, where efforts in this area help to ensure access to weather information, water and cooling.	During the African Climate Summit in September 2023, Denmark announced a planned doubling of Danish support for the Green Climate Fund (GCF) for 2024-2027 by a total of DKK 1.6 billion. The GCF is the world's largest climate fund under the UNFCCC, with a mandate to support developing countries in moving towards low-carbon and climate-resilient societies. Denmark has funded the GCF since 2016.
Decarbonisation and emissions reductions across sectors address initiatives to help reduce emissions in sectors such as agriculture, building and construction, transport and industry, as well as initiatives to help stop deforestation and prevent more CO_2e from being released to the atmosphere[40].	**Higher climate ambitions in shipping** In 2023, Denmark launched support for work by the International Maritime Organization (IMO) on capacity building in, and technical cooperation with, developing countries in the context of IMO's climate strategy, as well as support for exploration and development of shipping routes for low-emissions ships in developing countries. The goal is to pave the way for greener shipping and, thus, CO_2 reductions, etc. The launch of Danish support comes in the wake of IMO setting more ambitious targets for climate-neutral shipping in July 2023; a goal that Denmark has been working towards since COP26 in 2022.

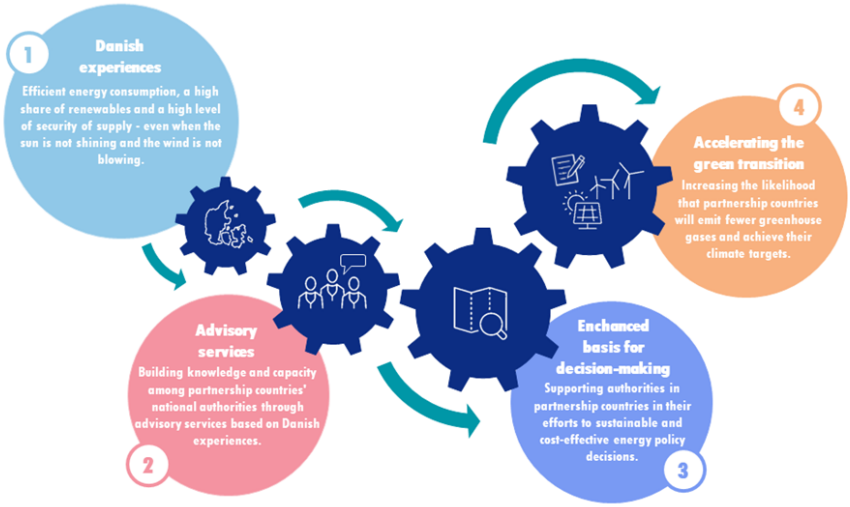
Source: The Ministry of Foreign Affairs of Denmark.

[40] Initiatives in this area can take the form of nature-based solutions such as forest and other nature conservation and restoration, electric mobility/transport, decarbonisation of cement/concrete, shipping/maritime transport, artificial fertilisers, and promotion of green value chains in general.

14.1.2 Denmark cooperates with other countries to support sustainability transitions

Denmark is involved in various bilateral authority cooperation efforts to support the green transition in partnership countries. Denmark shares its knowledge and experience in energy, the environment and food and thereby contributes to building capacity and encouraging reform of regulatory frameworks for developments in relevant sectors. In 2023, the Ministry of Foreign Affairs of Denmark and the Ministry of Climate, Energy and Utilities signed a four-year framework agreement for cooperation between the Danish Energy Agency and authorities in Brazil, Columbia, Egypt, Kenya, China and Turkey, as well as for cooperation between the Danish Meteorological Institute and authorities in Ghana. By helping to build the knowledge and capacity of national authorities in partnership countries, Denmark helps to improve the quality of policy decisions regarding sector-relevant climate aspects.

Figure 37: Denmark is the green cog that drives the global transition – for example in the form of bilateral energy cooperation



Source: Note: Denmark contributes to accelerating the green energy transition globally through cooperation with the authorities in partnership countries. Denmark has unique experience with the energy transition, including with ensuring a high level of security of supply, a high share of renewables, as well as efficient energy consumption. Through sharing experience with partnership countries, Denmark supports them in their efforts to create the best framework for a green transition. Danish authority cooperation therefore helps establish strong decision bases and makes it easier for partnership countries to set and achieve ambitious climate targets. Cooperation efforts also support Danish climate diplomacy.

14.1.3 Cooperation in the energy area

Denmark is considered one of the leading countries in the world in the green energy transition. Due to many years' experience with the green transition of the energy system, Denmark can guide and assist other countries in their efforts to reduce emissions linked to the production and consumption of energy.

It is a top priority for Denmark that Danish experience and knowhow contribute to the reduction of global emissions through bilateral authority cooperation. Efforts are with central, regional and local governments in a total of 24 countries, which, together, emit around 70% of the world's CO_2. Each country has a different context, and this is taken into account when designing the individual work programmes. The overall thematic areas are: Long-term energy planning, framework conditions for renewable energy, integration of renewable energy in the electricity grid, energy efficiency and district heating. The background memorandum to this chapter describes cases for each of these overall areas as examples of the climate impacts of cooperation.

From 2015 to 2021, the use of renewable energy sources in the 24 Danish partnership countries rose by 57%, and renewable energy sources on average account for 37% of total electricity production in these countries. However, overall CO_2 emissions in the countries rose in the period because of economic growth[41].

Besides the authority cooperation funded through development assistance, since 2017, in cooperation with the Ministry of Foreign Affairs, the Danish Energy Agency has launched 11 commercial authority cooperation schemes focusing on energy with authorities in the USA, Germany, Poland, the United Kingdom, Japan, South Korea, France, the Netherlands, Estonia, Latvia and Lithuania.

[41] The share of renewables in electricity production is based on the IEA's online database for the indicator titled: "Share of renewables, low-carbon sources and fossil fuels in power generation, World 1990-2020". Renewable energy production: Based on IRENA Renewable Energy Statistics 2023

Box 9: Danish expertise contributes to new roadmap for transition of the energy sector in Indonesia

A political agreement was signed in November 2022 on how more than USD 20 billion is to help convert the fossil-intensive energy sector in the world's fourth most populous country: Indonesia. Since the agreement was made, experts from Indonesia and the international partnership group have worked to draw up a plan for how Indonesia can realise its zero-emissions target for the electricity sector ahead of time, i.e. by 2050. Danish experts have played an important role in this context. This applies to Danish energy advisors posted to Jakarta and experts from the Danish Energy Agency in Copenhagen, who have been key in work headed by the International Energy Agency (IEA) to prepare a realistic and ambitious plan for a major green transition of the Indonesian electricity system.

The official roadmap, the Comprehensive Investment and Policy Plan (CIPP), was issued in November 2023, and it shows the way to reaching the new, earlier target. If the plan is realised, by 2030 Indonesia will already have reduced its CO_2 emissions by 55 million tonnes annually in just the electricity system, compared with previous projections. This corresponds to almost two-times Denmark's total CO_2 emissions from energy consumption across sectors.

With the final roadmap, the parties will now work together to realise the roadmap. Both with regard to helping Indonesia to implement the reforms necessary, and with regard to determining how the financial resources are to be used to catalyse the major green transition. Under the Just Energy Transition Partnership, Denmark, with the G7 countries, the EU and Norway, will support Indonesia to accelerate its green transition.

Source: The Danish Energy Agency.

14.1.4 Cooperation in the environment area

Via bilateral authority cooperation, the Ministry of Environment contributes globally within the water and environment area to reduce global greenhouse gas emissions and promote climate-change adaptation and resilience in vulnerable countries.

Globally, the water sector accounts for around 4% of total energy consumption. In Denmark today, 1.9% of Danish electricity production goes to the water sector (IEA, 2018). It is expected that, in a few years, the water sector will produce more energy than it consumes. There is a large global potential for energy savings and, thus, reduced climate impacts from the water sector.

Globally, there is also a huge potential to promote a more circular economy, and, thus, reduce resource consumption, for example by collecting, recycling and reusing products. This will reduce the amount of residual waste sent to landfill and will lower the use of resources, which will also contribute to reducing global emissions. Around half of total global greenhouse gas emissions, and more than 90% of biodiversity loss and impacts on water resources, come from extracting and processing natural resources (MiM, 2021).

The Danish Environmental Protection Agency is currently involved in long-term agreements on water and the environment with five developing countries. Denmark has agreements pertaining to the water area with India, China, South Africa, Ethiopia and Morocco. With regard to waste and the circular economy, Denmark has agreements

with Indonesia and Kenya. Furthermore, two new cooperation agreements are being set up, one in Kenya for water, and one on the circular economy and waste in Thailand.

Besides cooperation financed through development assistance, in 2021, the Ministry of Environment, in collaboration with the Ministry of Foreign Affairs, launched five commercial authority cooperation agreements with the USA, Germany, Poland, Italy and Spain, all on the water area.

The agreements focus on a green and sustainable transition for water, waste and resources. Another focal point for all authority cooperation is direct or indirect capacity building and transfer of experience with specific legislation, as well as presentation, testing and demonstration of sustainable solutions and technologies for the environment area.

14.1.5 Cooperation in the food area

The Danish agri-food sector has achieved important results with regard to innovative and sustainable food product solutions. Promoting the deployment of these solutions to other countries constitutes a huge potential. Denmark is working to realise this potential through bilateral authority cooperation in the food area with China, Kenya, Ukraine, India, Mexico, Nigeria, Indonesia, Vietnam, South Africa and Bangladesh.

In 2023, implementation commenced of a new three-year framework programme for authority cooperation in the food and agriculture area established between the Ministry of Foreign Affairs of Denmark and the Ministry of Food, Agriculture and Fisheries of Denmark. This framework programme describes how climate action in the food area involves increased focus on three central work areas in Strategic Sector Cooperation: 1) food waste and food losses; 2) agro-ecology and organic production methods, and 3) One Health, including animal health and combatting antibiotic resistance.

There has been work to operationalise the green targets for authority cooperation within the food sector to enhance focus on green results.

Box 10: Danish-Kenyan cooperation reduces food losses and improves efficiency in the food sector

Danish-Kenyan strategic authority cooperation in the food area supports Kenyan efforts to improve food inspection, including veterinary and plant-health inspection and monitoring. More than ten central governments and 47 counties are responsible for food and veterinary inspection in Kenya, but regulations are incoherent, and the inspection programme has both overlaps and redundancies. Inspection primarily focusses on end products, and focus is therefore on identifying, rather than preventing, errors. This leads to unnecessary food waste as large quantities of food on the shelves in shops are discarded.

The focus of cooperation with Kenya is on prevention of food losses and on modernising Kenyan food legislation to establish a less CO_2-emitting food sector. Furthermore, cooperation efforts focus on helping to build resilience to climate change by ensuring appropriate framework conditions for food security.

Source: The Danish Veterinary and Food Administration.

15 Global climate change adaptation action

Denmark works to inspire and promote adaptation and resilience initiatives through development cooperation and export promotion efforts. GR24 focuses on Denmark's contribution to climate change adaptation action, supported through bilateral and multilateral channels as part of Danish climate assistance in 2023. The following describes important results from Danish climate change adaptation action in 2023.[42]

Main results

Danish climate assistance targeting climate change adaptation and resilience initiatives is realised according to the targets in Denmark's development cooperation strategy (*The world we share*) and the former government's long-term strategy for global climate action:

- Strengthen efforts for climate change adaptation, nature and the environment, and resilience in the poorest and most vulnerable countries.
- Increase the mobilisation of financing and promote Danish green solutions within climate, nature and the environment.
- The climate and the green agenda are included as a key priority in all Danish bilateral country strategies, relevant organisation strategies and as a cross-authority consideration in Danish initiatives.

Adaptation and resilience initiatives via export promotion are described in more detail in Chapter 18.

[42] This chapter is based on the background memorandum on climate change adaptation action supported through Danish climate assistance and export promotion.

Table 6: Examples of results of support for climate change adaptation

Topic	Examples of results
Increased resilience to climate change for vulnerable and poor countries	**In front with assistance for loss and damage** In 2023, Denmark actively participated in the international committee set up to monitor the COP27 decision to establish new financing schemes and a loss and damage fund. This work culminated in a draft decision, which, quite exceptionally, was adopted on the first day of COP28. Denmark was one of the first countries to declare a contribution of DKK 175 million for the fund and DKK 175 million for other loss-and-damage projects. In 2023, Denmark was also actively involved in operationalising the Santiago Network on loss and damage, on which a final decision was taken at the COP28 **Support for the Early Warnings for All (EW4ALL) initiative** There has been increasing focus in 2023 on the need for early warning. The climate disasters in Derna in Libya, Madagascar, Malawi and Mozambique, and the severe flooding that hit the Horn of Africa after many years of drought, underscored that the world is neither ready for, nor resilient to, the ever more serious consequences of the climate crisis. In 2023, Denmark decided to make a new contribution of DKK 40 million to the Early Warnings for All (EW4All) initiative to support access to early warning systems for all before 2027. Danish support will help cement and roll-out the EW4All initiative in five countries in Africa (Niger, Somalia, South Sudan, Tanzania and Uganda). The support is being implemented by the World Meteorological Organization (WMO), and it will help to strengthen regional capacity in Africa to determine climate change impacts, carry out risk analyses and climate change mitigation measures. Furthermore, a small part of the support will go to global activities with focus on improving the framework for implementation of early warning and action in fragile and vulnerable contexts.
Access to clean drinking water	**Access to water in dry areas in Kenya** For many years, Denmark has worked with the Kenyan water authorities to strengthen resilience in local communities in the dry areas in north-eastern Kenya. The project brings local authorities, water utilities and the local population together to assess and agree on the specific needs for access to water and how climate change affects the areas. With support from Denmark of DKK 70 million for the period 2021-2025, among other things the project has established large rainwater collection tanks to ensure water in times of drought. Furthermore, water pipes have been laid to villages, and photovoltaic solar modules have been established to run large desalination plants to secure clean drinking water in coastal areas. Finally, the local community has been trained in how to best and most efficiently use the sparse water supply. The project has given 15,000 people better access to clean water and thus helped to develop resilience to climate change.
Promotion of initiatives that incorporate climate, the environment and biodiversity	**Stronger initiatives benefitting forests and biodiversity** In 2023, Denmark launched stronger initiatives benefitting forests and biodiversity. The Finance Act for 2024 earmarked DKK 350 million as part of a forest and nature initiative of around DKK 1 billion for the period 2024-2027. Support will go primarily to vulnerable areas under increasing pressure from deforestation and forest degradation. The objective of the programme is to contribute to climate change adaptation, protection of biodiversity, reductions in CO_2 emissions, as well as to social and economic development of local communities, including indigenous peoples.

Source: The Ministry of Foreign Affairs of Denmark.

Box 11: Mobilisation of private finance for climate change adaptation in Uganda

Mobilisation of private finance is an important element in climate change adaptation action in the world's most vulnerable countries. However, attracting private finance for climate change adaptation action has proven extremely difficult. Denmark has therefore added its assistance by developing a new financing model through the Africa Rural Climate Adaptation Finance Initiative Mechanism (ARCAFIM) project. The objective of the project is to mobilise finance for climate change adaptation in East Africa, and a goal is to reach 1.4 million farmers in the region as well as a number of businesses and other stakeholders with a view to establishing climate-adapted agriculture and thereby better food security.

Denmark is contributing DKK 50 million to prepare and implement the project, and in 2023 Denmark contributed specifically developing the model and to work on analysing and integrating climate change adaptation considerations at banks and financial institutions. In future, Danish assistance will help small-holders and minor producers with methods for climate change adaptation in agricultural and food production.

Source: The Ministry of Foreign Affairs of Denmark.

Box 12: Climate-resilient agriculture, food systems and food security

Climate change causes extreme weather, flooding or drought, which impacts agriculture and leads to food crises in many of the world's most vulnerable countries, not least in Africa. At the same time agriculture and food production account for one-third of global greenhouse gas emissions and 70% of global deforestation.

Securing a green transition and development of climate-resilient food systems and food security is therefore an important part of Danish climate action. In 2023, Denmark supported the World Bank's Food Systems 2030 Multi-Donor Trust Fund with DKK 100 million to assist countries with green transition of their food systems and to strengthen global food security.

Through the UN World Food Programme (WFP), the UN Food and Agriculture Organisation (FAO) and the International Fund for Agricultural Development (IFAD), in 2023 Denmark also supported programmes relating to improving resilience, climate change adaptation efforts and long-term food security.

Source: The Ministry of Foreign Affairs of Denmark.

16 Climate assistance and finance

As part of development cooperation, Denmark provides climate assistance for developing countries to support their green transition and adaptation to climate change. In addition to the assistance provided through development cooperation, Denmark also mobilises climate finance for developing countries through multilateral development banks, as well as through various instruments managed by IFU (Investment Fund for Developing Countries). Danish climate finance supports enhanced climate ambitions globally. Furthermore, it ensures that Denmark honours its international obligations under the UN Framework Convention for Climate Change to support the climate ambitions of developing countries, and to mobilise finance for climate projects in developing countries. Through this, Denmark contributes to the common goal of mobilising USD 100 billion per annually for developing countries from 2020.

This chapter accounts for the scope of Danish climate assistance, as well as the scope of climate finance mobilised by Denmark through IFU and multilateral development banks, for example. Figures for 2023 will not be available until September 2024, which is after completion of this report. The most recent figures are for 2022.

Main results

16.1.1 Total Danish climate assistance and mobilised climate finance

Climate assistance in 2022 amounted to around DKK 1.9 billion, see table 7, corresponding to 16.3% of all assistance to developing countries under section 6.3 of the Danish Finance Act.

There has been a drop in the bilateral climate assistance compared with 2021. The decrease was expected, and it is primarily because of re-prioritisation in 2022 of the overall appropriation of development assistance to finance relevant costs related to receiving displaced persons from Ukraine.

Climate assistance for 2023 is expected to rise to around DKK 3.3 billion, see the Danish Finance Act 2023. In its 2024 Finance Bill, the Danish government has moreover allocated a total of DKK 5.1 billion to climate assistance, which is the highest level ever.

Besides the climate assistance agreed under section 6.3 of the annual Finance Act, a total of DKK 601 million in climate assistance can fall to Denmark through the EU's global instruments in 2022. Furthermore, Denmark mobilised around DKK 1.9 billion in climate finance for developing countries through the Investment Fund for Developing Countries (IFU), while climate finance mobilised through the multilateral development banks was around DKK 4.5 billion in 2022, see Table 7.

Table 7: Total Danish climate assistance and mobilised climate finance 2020-2022 in DKK '000,000

	2020	2021	2022
Total climate assistance	2,036	2,871	1,949
Climate assistance as a percentage of development assistance[43]	13.7%	20.3%	16.3%
Adaptation as a percentage of climate assistance	56%	47%	60%
Climate assistance through the EU's global instruments	378	372	601
Climate finance mobilised through IFU	1,269	2,149	1,923
Climate finance mobilised through the multilateral development banks, including mobilised private finance[44]	4,480	4,480	4,480
Total	**8,163**	**9,872**	**8,953**

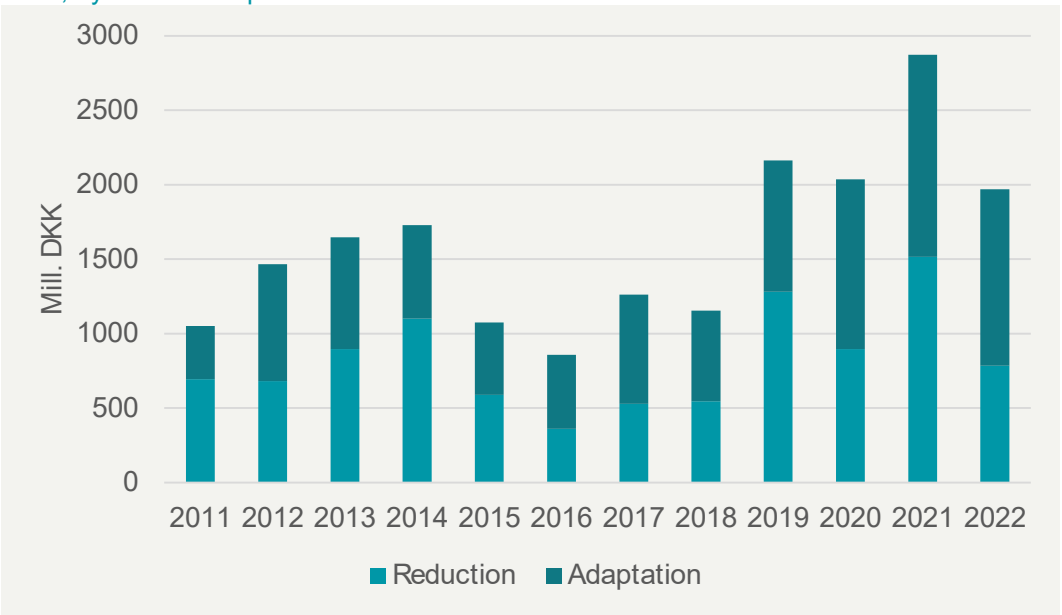
Source: The Ministry of Foreign Affairs of Denmark.

16.2 Danish bilateral climate assistance 2011-2022

In 2022, 60% went to adaptation. As can be seen in Figure 38, climate assistance increased considerably from 2011 (DKK 1,052 million) to 2022 (DKK 1,949 million). Figure 38 also shows the break down between initiatives to support climate change adaptation and initiatives aimed at reducing emissions in the longer term. The share of climate assistance for adaptation increased to 60% in 2022.

[43] $06.3. Assistance for developing countries set aside in the Finance Act.
[44] Figures for climate finance mobilised through the multilateral development banks in 2021 and 2022 are set at the same level as in 2020 because the specific figures for Denmark's share are not yet available.

Figure 38: New pledges for climate projects in developing countries given in the period 2011 to 2022, by climate adaptation and emissions reduction



Source: The Ministry of Foreign Affairs of Denmark, 2022. **Note:** Figures for 2022 not available until September 2023.

The Danish state owns or co-owns a number of financial institutions that can provide finance for projects that are often difficult to finance solely through private sources, typically due to uncertainties in the projects. Public financing helps reduce the risks associated with a given project and, thus, helps mobilise private financing, so that the investment can be realised.

One of the most important Danish public financial institutions with an international outlook is the Investment Fund for Developing Countries (IFU), which is owned by the Ministry of Foreign Affairs. In 2022, IFU mobilised around DKK 1.9 billion in financing for climate projects, see Table 7.

In 2023, Denmark launched efforts to strengthen IFU, which up to 2030 will mobilise DKK 20 billion. The capitalisation will strengthen IFU's climate engagement considerably, aiming to attract private investment in the climate, the green transition and sustainable development.

Box 13: Example: Blended Finance for Energy Transition (BFET)

Denmark and a number of other countries launched the new Blended Finance for Energy Transition (BFET) mechanism at COP28. The aim of the mechanism is to generate investment in the green transition, including new wind and solar energy farms in countries with increasing energy needs such as India, Indonesia and Vietnam.

More specifically, a number of countries will place public capital as collateral so that private players can invest in the green transition. Denmark is contributing DKK 100 million, which is being invested by IFU in two private equity funds: ResponsAbility and Eversource Capital.

With further public capital from development finance institutions in the Netherlands, the USA, Germany and other countries, the public capital totals around 40% of the funds, which mobilise around 60% private capital, totalling around DKK 9 billion.

Experience from BFET has been further boosted in the Investment Mobilization Collaboration Alliance (IMCA), also launched at COP28. The IMCA is a new blended finance collaboration mechanism between the USA, Denmark, Sweden and Finland with an ambition to mobilise billions of dollars in new climate finance before 2026.

Source: The Ministry of Foreign Affairs of Denmark.

16.2.1 Climate finance mobilised through multilateral development banks

Multilateral finance institutions are essential instruments for Denmark in mobilising both public and private climate finance for developing countries. More than half of the climate finance mobilised by OECD countries for climate investments in developing countries is mobilised through the multilateral development banks (OECD, 2020).

In 2022, Denmark contributed around DKK 4.5 billion to the climate finance mobilised through the multilateral development banks, see Table 7. Of this amount, around DKK 3.6 billion was mobilised through the banks' own gearing of their investments, and around DKK 0.88 billion was mobilised as co-financing from the private sector.

17 The climate footprint of public and private investments abroad

This chapter describes the climate footprint of Danish public investment and financing in other countries through the Export and Investment Fund of Denmark (EIFO) and the Investment Fund for Developing Countries (IFU). Furthermore, there is an estimate of the climate footprint of Danish insurance and pension companies and investment associations, as well as the portfolio of shares and corporate bonds in non-Danish listed companies held by banks and mortgage-credit institutions. Reporting on the climate footprint of investments and financing in other countries provides a picture of efforts by Danish public and private players to help accelerate the transition to green, climate friendly investments. Reporting covers Scope 1, Scope 2 and Scope 3 emissions[45]. Note that the climate footprints of the portfolios of the individual players are not directly comparable with each other because of methodological differences. The primary objective of the estimates is to illustrate trends over time for EIFO, IFU and the private financial players included in global impact reports. Note also that this chapter does not describe CO_2e reductions abroad that Danish financial players have helped realise through their significant green investing and financing.

Main results

17.1 The Export and Investment Fund of Denmark (EIFO) estimates the climate footprint of its portfolio for the second time.

In April 2023, EKF Denmark's Export Credit Agency became part of the Export and Investment Fund of Denmark (EIFO). EIFO was founded through a merger of EKF Denmark's Export Credit Agency, Danish Growth Fund (*Vækstfonden*), and the Danish Green Investment Fund (DGIF). Among other things, EIFO provides finance for exports and internationalisation activities by Danish businesses, so that Danish businesses are better protected against the financial and political risks that can be associated with export activities.

In 2022, EKF Denmark's Export Credit Agency for the first time estimated the total greenhouse gas emissions linked to its portfolio as a step toward setting intermediate targets and defining the course to climate neutrality. In 2023, the total climate footprint of EIFO from financing projects internationally was 2.97 million tonnes CO_2e, see table 8. The table compares the climate footprints of EIFO (2023) and EKF (2022). The estimate includes all international projects, whether already up and running or being established.[46] Developments in financed emissions are primarily due to movements in

[45] Scopes 1, 2 and 3 are defined in the Greenhouse Gas Protocol (GHG Protocol), which is a voluntary accounting standard for calculating greenhouse gases. The GHG Protocol distinguishes between three 'scopes' categorising the emissions of a business. Scope 1: Includes direct greenhouse gas emissions from sources owned or controlled by the business. Scope 2: Includes indirect greenhouse gas emissions embedded in production of electricity and district heating consumed by the business. Scope 3: Includes all other indirect greenhouse gas emissions embedded in activities in the value chain.

[46] For more information on the methodology for calculating CO_2e footprints, see EIFO's 2023 annual report (EIFO, 2024).

the portfolio, including new activities, as well as instalments on existing transactions. Furthermore, the climate footprint is sensitive to what data is available about individual transactions. Project-specific emissions are preferable, but emissions estimates are often based on models that reflect emissions within broad groups of countries and sectors. EIFO is working to improve collection of emissions data about individual transactions.

CO_2e emissions in connection with projects related to renewable energy make up 26% of EIFO's total emissions. These emissions are largely attributable to the materials (including cement and steel) used when erecting wind turbines. The large climate footprint from renewable energy is primarily due to the scope of EIFO’s activities within renewable energy. At the end of 2023, these activities were worth about DKK 97 billion, corresponding to 75% of all EIFO's international activities. However, if considered relative to the amount financed, the financed emissions are lower: i.e., 8 million tonnes CO_2e per DKK million financed.

Fossil energy production has a large footprint per DKK million financed. However, EIFO has a relatively small exposure to these activities: DKK 0.5 billion in 2023. Total financed emissions from fossil energy production are therefore lower than for renewable energy activities.

Table 8: The total climate footprint of EIFO from international activities in 2022-2023

	CO_2e footprint, tonnes CO_2e (1) (2022)	CO_2e footprint, tonnes/DKK mill. (2022)	CO_2e footprint, tonnes CO_2e (2023)	CO_2e footprint, tonnes/DKK mill. (2023)
Oil and gas (2)	15,584	46	4,796	15
Mining operation	79,705	64	184,759	192
Food and agriculture	199,172	122	187,777	104
Chemicals	56,781	296	72,458	298
Metals and minerals	766,303	511	654,458	463
Fossil energy production	469,415	726	68,410	146
Renewable energy	771,136	9	772,186	8
Infrastructure and transport	232,967	18	459,413	29
Other	243,676	68	562,381	70
Total	**2,834,740**	**25**	**2,966,636**	**24 (3)**

Source: EIFO **Note**. **(1)**: CO_2e footprint containing Scopes 1, 2 and 3 emissions and relative to EIFO's percentage of the investment. **Note: (2):** The oil and gas sector covers financing of projects related to extraction and production of oil and gas. **Note: (3):** Total, CO_2e footprint, tonnes CO_2e/DKK mill. Indicates average tonnes CO_2e emitted per DKK million financed by EIFO.

17.2 IFU's climate footprint per DKK million invested has decreased since 2020

Through IFU (Investment Fund for Developing Countries), Denmark helps mobilise public and private financing for investments in developing countries and growth markets in Asia, Africa, Latin America and parts of Europe. IFU provides risk capital to financially sustainable businesses that contribute to the green transition and to economic and social development in the countries invested in.

IFU's total portfolio increased 9% from 2021 to 2022. For three consecutive years IFU has calculated the climate footprint of its activities (the most recent calculation is for 2022).[47] IFU's climate footprint was 0.85 million tonnes CO_2e in 2021 and around 0.77 million tonnes CO_2e in 2022, reflecting a drop of 10%, primarily due to better data quality. Note that the climate footprint figures for 2020 and 2021 have been changed

[47] For more information about the calculation method, see the IFU website (IFU 2023) and UNEP's methodology description (UNEP 2021).

compared to the figures presented in GR23. The changes are primarily due to recalculation of the attribution factor for the individual investments[48].

Furthermore, the period saw a series of developments giving rise to decreases as well as increases in emissions. Total emissions from emission-intensive sectors such as cement/concrete, agriculture with livestock and fertiliser production fell from 2020 to 2022. The increase in emissions from the cement sector from 2021 to 2022 is due to a new investment in a cement plant in Ghana in 2021, which will eventually result in reduced emissions per tonne of cement produced, as IFU's investment is in a new production line that will partially substitute cement clinker with local clay and thereby reduce emissions per tonne of cement produced. The drop in emissions from the fertiliser sector is primarily due to a change in the type of data used in calculations, with 2022 figures calculated based on company-specific data instead of sector data.

There was a lower climate footprint from IFU's investment in funds in 2022 compared with 2021, and this is primarily due to a reduction in IFU's ownership and improved data quality. The funds in question are funds other than the Danish Climate Investment Fund and the Danish SDG Fund, both of which are managed by IFU.

The climate footprint from investments in renewable energy is considerably larger in 2022 than in 2021 and 2020. The increase is due to an increase in RE plants under construction and, in particular, in the associated Scope 3 emissions. According to the methodology used, emissions from construction of the plants are included in the first two years of the investment and will therefore fall away after two years of construction.

IFU's climate footprint per DKK million invested fell by 17%, from 133 tonnes CO_2e/DKK million in 2021 to 111 tonnes CO_2e/DKK million in 2022. Furthermore, IFU's investments in funds, cement/concrete, and renewable energy are accountable for almost 50% of IFU's total climate footprint.

48 The attribution factor is calculated based on the ratio between the remaining exposure in a given transaction and the total value of the financed entity (equity + debt).

Table 9: Development in the climate footprint of IFU's portfolio - 2020-2022 (1)

Sector	CO_2e footprint, tonnes CO_2e (1) (2020)	CO_2e footprint, tonne/DKK mill. (2020)	CO_2e footprint, tonnes CO_2e (1) (2021)	CO_2e footprint, tonne/DKK mill. (2021)	CO_2e footprint, tonnes CO_2e(1) (2022)	CO_2e footprint, tonne/DKK mill. (2022)
Renewable energy	15,700	15	82,367	50	121,264	64
Fossil energy	14,605	218	43,111	184	50,046	198
Fertiliser	70,511	1814	80,874	467	39,054	226
Cement/concrete	172,157	1,557	144,501	1,307	202,384	1,005
Agriculture (livestock)	63,452	151	61,673	152	37,450	102
Agriculture (other)	2,582	11	6,054	21	4,860	19
Hotels, restaurants and property	18,217	33	11,850	23	13,202	49
Other industries	50,227	72	54,822	76	96,490	127
Funds (besides those managed by IFU)	163,813	199	217,975	213	132,160	123
Microfinance funds	18,821	67	15,988	56	8,403	28
Other financial institutions	72,951	85	129,262	132	61,963	45
Total	**663,037** (3)	**128** (2)	**848,477** (3)	**133** (2)	**767,278** (3)	**111** (2)

Source: IFU **Note: (1):** Climate footprint containing Scopes 1, 2 and 3 emissions and relative to IFU's percentage of the investment. **Note: (2):** Total, CO_2e footprint, tonnes CO_2e/DKK mill. indicates average tonnes CO_2e emitted per DKK million financed by IFU. **Note: (3):** Rounding difference.

17.3 Calculation of the climate footprint of investments in non-Danish listed companies has been expanded to include banks and mortgage-credit institutions.

Along with Danish publicly owned funds, the financial sector helps to finance activities inside and outside Denmark through loans and investments in businesses that emit greenhouse gases.

For the second successive year, global impact reporting includes emissions stemming from investments in non-Danish listed companies by Danish private institutional investors. Businesses will often have financial activities and associated greenhouse gas emissions in the country where their shares are listed as well as in other countries. The reporting is based on extracts by the Danmarks Nationalbank (Central Bank of Denmark), which, since 2023 has published statistics on emissions stemming from the investments of by Danish insurance and pension companies and investment funds in the shares and corporate bonds of listed companies[49]. The climate footprint of investments by banks and mortgage-credit institutions is also included for the first time. Danmarks Nationalbank expects to incrementally build further on its climate-related indicators and calculations as the quality and availability of data improve.

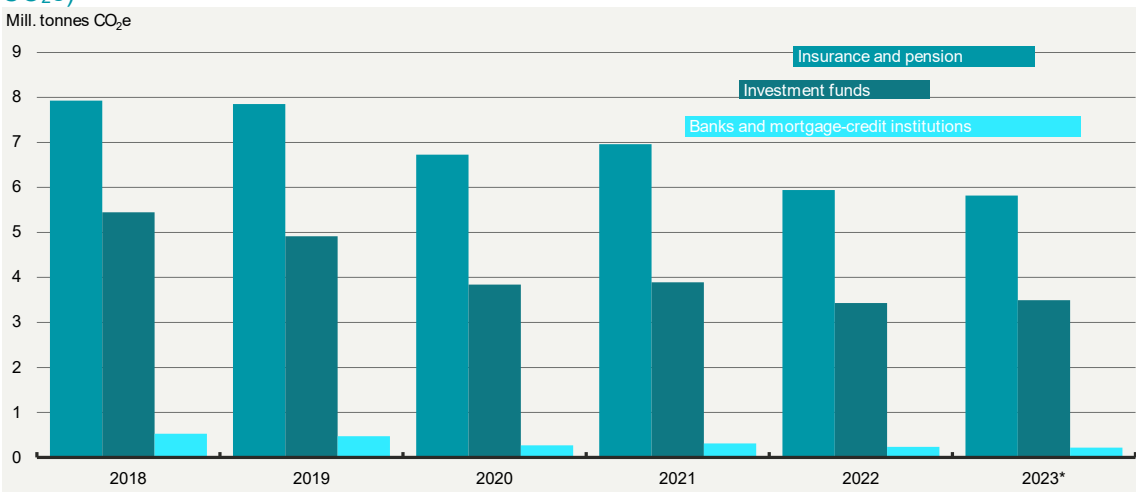
The calculations show that, in 2023, Danish investment funds financed Scope 1 and Scope 2 emissions totalling around 3.5 million tonnes CO_2e through their investments in shares and corporate bonds in non-Danish listed companies, while insurance and pension companies financed emissions totalling around 5.8 million tonnes CO_2e. The significant difference between investment funds and pension companies is partly because insurance and pension companies manage more listed shares and corporate bonds than investment funds.

Banks and mortgage-credit institutions financed Scope 1 and Scope 2 emissions of 0.2 million tonnes CO_2e in 2023 through investments in shares and corporate bonds in non-Danish listed companies. With regard to the level of financed emissions, note that banks and mortgage-credit institutions finance greenhouse gas emissions less through equity investments and corporate bonds and more through their corporate lending. However, commercial lending is not currently described by Danmarks Nationalbank. Together, the financial players covered financed around 9.5 million tonnes of greenhouse gases through their investments in non-Danish listed companies in 2023, see Figure 39. Calculations by Danmarks Nationalbank cover the period 2018-2023, showing the trend over time. Over time, there has been a 27% decrease in emissions financed by insurance and pension companies during the period, while the reduction is 36% for investments in non-Danish companies by investment funds.

The decrease in financed emissions is due to financial businesses having reduced their ownership shares in emissions-intensive businesses (in transport and utility companies in particular), which typically have higher Scopes 1 and 2 emissions than IT companies, for example. Moreover, emissions of greenhouse gases have levelled out or dropped in many companies since 2018.

[49] Note that the calculations do not include all asset classes. Unlisted shares, loans and other sources of financing have not been included. For further information about sources and methodology, see the methodology section in background memorandum 20 and Danmarks Nationalbank (Central Bank of Denmark) (Danmarks Nationalbank, 2024).

Figure 39: Financed emissions abroad (Scopes 1 and 2) related to investments by Danish insurance and pension companies, investment funds and banks and mortgage-credit institutions in shares and corporate bonds in non-Danish listed companies, 2018-2022 (million tonnes CO_2e)



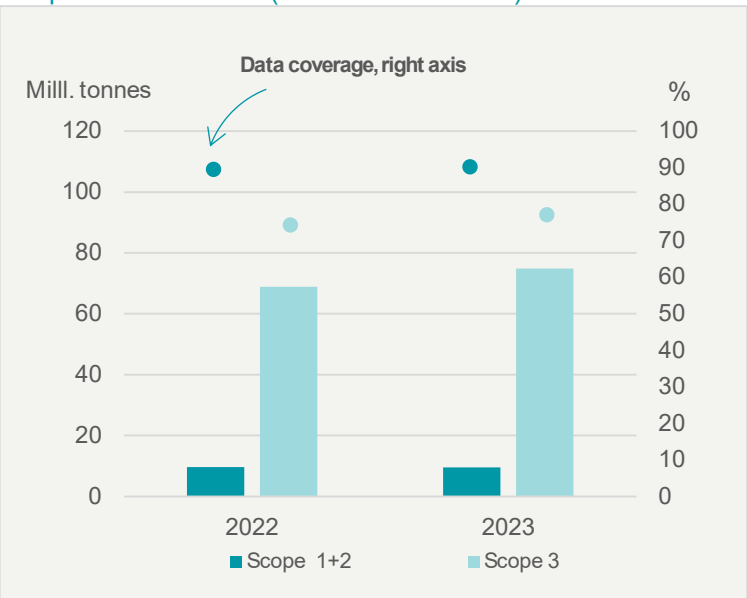
Source: Danmarks Nationalbank (Central Bank of Denmark). **Note:** Financed emissions (Scopes 1 and 2) attributable to investments in shares and corporate bonds in non-Danish listed companies. Annual data is calculated at the end of the year. *Figures for 2023 are preliminary.

A new aspect this year is that statistics from Danmarks Nationalbank also include financed Scope 3 emissions. Financed Scope 3 emissions are significantly higher than financed Scopes 1 and 2 emissions and, in 2023, Scope 3 emissions totalled about 75 million tonnes CO_2e, see Figure 40.

The data coverage, shown on the right axis in Figure 40, is not as high for financed Scope 3 emissions as for financed Scopes 1 and 2 emissions. This is because some businesses do not yet report Scope 3 emissions. Data coverage can affect the level of financed emissions, as unreported emissions are not included in the estimate.

Reporting Scope 3 emissions is also associated with large uncertainty, as it requires mapping emissions throughout the value chain of the business. Calculating financed Scope 3 emissions at portfolio level can also lead to considerable double counting. The estimate of financed Scope 3 emissions can therefore be used to illustrate the extent of these emissions, but the indicator should be interpreted with caution.

Figure 40: Financed emissions broken down by Scopes 1+2 emissions and Scope 3 emissions, respectively, attributable to investments in shares and corporate bonds in non-Danish listed companies 2018-2023 (million tonnes CO_2e)

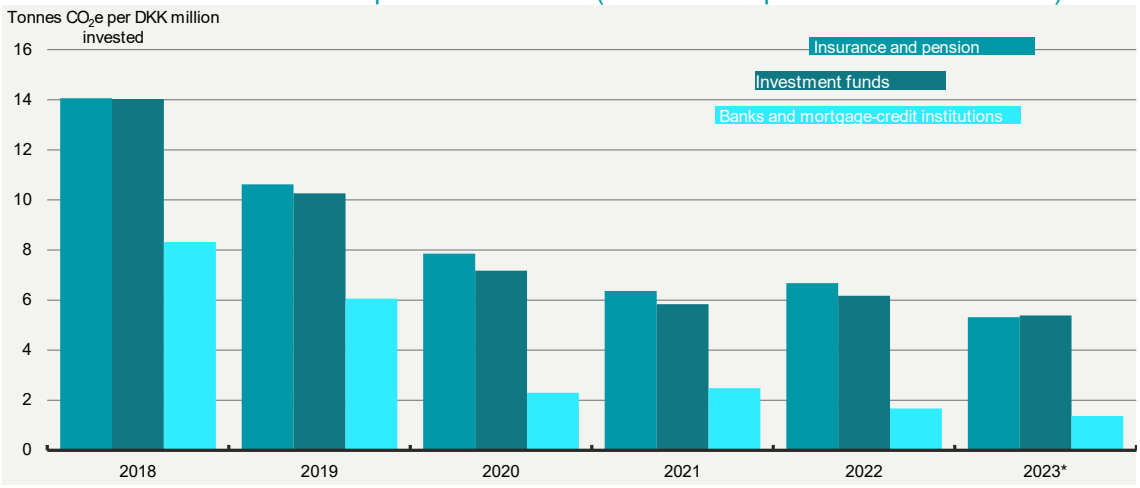


Source: Danmarks Nationalbank (Central Bank of Denmark). **Note:** Financed emissions (Scopes 1+2 emissions and Scope 3 emissions) attributable to investments in shares and corporate bonds in non-Danish listed companies. Data is aggregated for insurance and pension companies, investment funds, as well as banks and mortgage-credit institutions. Annual data is calculated at the end of the year. The dotted markings indicate the coverage of emissions in percent (right axis). *2023 are preliminary figures.

The CO_2e footprint per DKK million invested in non-Danish listed companies has decreased in the period 2018-2023. The CO_2e footprint has been estimated at around 5.3 tonnes CO_2e per DKK million invested by insurance and pension companies in 2023, and around 5.4 tonnes CO_2e per DKK million invested by investment associations. Over the period 2018-2023, there is a drop of around 60% for both the insurance and pension sector, and for investment funds.

For banks and mortgage-credit institutions, the CO_2e footprint decreased by almost 80% from 2018-2023, to an estimated 1.4 tonnes CO_2e per million DKK invested in 2023, see Figure 41.

Figure 41: The CO_2e footprint of investments by Danish insurance and pension companies, investment funds, as well as banks and mortgage-credit institutions in shares and corporate bonds in non-Danish listed companies 2018-2023 (tonnes CO_2e per DKK million invested)



Source: Danmarks Nationalbank (Central Bank of Denmark). **Note:** The CO_2e footprint (Scopes 1 and 2 emissions) attributable to investments in shares and corporate bonds in non-Danish listed companies. Annual data is calculated at the end of the year. *Figures for 2023 are preliminary.

18 Cooperation with businesses on green solutions

Denmark is working to engage Danish businesses in Denmark's global climate action and to ensure that Danish solutions deliver results in Denmark and elsewhere in the world. This is through supporting Danish businesses in selling their green products globally and through establishing framework conditions and regulation that underpin a sustainable focus among Danish businesses in general. Below is a description of examples of initiatives in 2023.

18.1 Export strategies and action plans

The Action Plan for Economic Diplomacy 2022-2023 (Regeringens Handlingsplan for Økonomisk Diplomati, 2022) sets a new common direction for overall promotion of Danish exports, innovation and investment. The action plan has guided the implementation of international initiatives in a number of sector strategies, Denmark's SDG action plan and various exports and stimulus packages adopted by the Danish Parliament (Folketing) in 2020-2021 (Energistyrelsen, 2023). The action plan contained more than 100 activities aimed at delivering on one or more of the dimensions of performance in the triple bottom line. For example, delivering on economic growth and job creation in Denmark, the global sustainability transition, and improved labour rights and labour conditions globally. This means that by far the majority of the initiatives launched in the markets with support from delegations, sector advisors and general economic diplomacy from the Ministry of Foreign Affairs contribute to the global sustainability transition. For example, there is focus on improving the framework conditions, multilaterally as well as bilaterally, for Danish businesses and Danish exports of green solutions. Furthermore, several specific projects have been initiated with the Danish business community aimed at boosting the market position for Danish products and services in large offshore wind turbine projects, sustainable agriculture and food production, and wastewater initiatives with benefits for Danish exports and the climate. The action plan is expected to be continued and expanded in the government's upcoming Globalisation Strategy to be launched in 2024.

18.2 Strategy for the energy area

As part of the Action Plan for Economic Diplomacy, the previous government planned an update of the 2017 Export Strategy for the Energy Area (Klima-, Energi- og Forsyningsministeriet, 2017), which is continued under the current government. Work will be in close coordination and partnership with industry organisations and businesses and is expected to start in spring 2024.

18.3 Action plan for food cluster exports

An action plan for Danish food cluster exports 2022-2023 was launched on 9 September 2022. The action plan specifies how the Danish food cluster will contribute to meeting the triple bottom line and realising the actions set out in the chapter on sustainable food and agritech in the Action Plan for Economic Diplomacy. The action

plan was prepared in close partnership with the industry and focusses on strengthening the Danish food cluster's exports and contributions to the global green transition. The main topics are 1) increased exports of food products with emphasis on enhancing safe, resource-efficient and sustainable food production by Danish businesses; 2) exports of technologies and solutions that contribute to the global green transition; and 3) increased exports of organic products, biosolutions and plant-based food products, including positioning new types of food product on the market to help the green transition. Implementation will be in cross-cutting cooperation with different authorities and in close partnership with the industry, for example through authority cooperation on markets, trade policy and targeted export promotion.

18.4 Stronger export initiatives for water

There is a high global demand for clean drinking water and wastewater treatment, in part due to climate change impacts, population growth and urbanisation. According to the OECD, investment in this area is expected to increase by 55% up to 2050, and the need for global financing to investment in water infrastructure is expected to reach USD 6.7 billion by 2030.

2023 saw the further realisation of Denmark's export strategy for water from 2021 developed in close partnership with the Danish water sector, with the sector-focused water initiatives (Water Technology Alliance (WTA)) serving as the focal point for the continued implementation of the strategy in important markets in the USA, Spain, Italy, Poland and Germany. A purpose of the sector focus in the export strategy for water is to meet the previous government's goal of doubling Danish exports of water technology and water solutions by 2030, as well as to accommodate a request from the Danish water sector (Miljøstyrelsen, 2021). Through sector-specific advice and sales of more energy-efficient solutions, the work contributes to a more energy-efficient and climate-efficient water sector in the cooperation countries using Danish knowledge and strongholds in innovative and sustainable solutions. The technical sector experts located in the WTAs ensure ongoing technical dialogue with the local utilities to understand local needs so that Danish solutions can be better positioned. The technical and commercial knowledge provided by WTA has already provided concrete export opportunities for Danish businesses and is likely to provide more in 2024.

In the last couple of years, several Danish businesses have gained access to deliver Danish technologies and solutions to utilities companies in these countries as a result of the close commercial cooperation with authorities. The 2024 Finance Act provided the Ministry of Foreign Affairs with financing, and the current advisory efforts are therefore expected to be continued.

18.5 Danida Green Business Partnerships

The Danida Green Business Partnerships (DGBP) programme aims to promote the green transition and private-sector-driven inclusive economic growth through innovative partnerships, and in 2023 the programme completed its second call for applications. As in the previous year, there were many well qualified applications from both Danish and international partnerships. In 2023, the external panel of experts recommended the best applications for approval after a critical screening and dialogue with the partnerships. In total, 14 new partnership projects were approved, many of which are within green technology/agriculture and the circular economy. The total budget framework for 2023 was DKK 100 million, and seven Danish partners received funding. The projects are expected to commence during 2024. A new and extended call for applications is being planned for 2024.

18.6 Promoting corporate biodiversity efforts in the value chain

In the early summer of 2023, the Minister for Environment set up a biodiversity partnership focusing on how best to promote effective voluntary corporate biodiversity efforts. In early summer of 2024, the partnership will issue concrete recommendations for businesses, authorities and knowledge institutions on measures to promote voluntary biodiversity efforts by businesses. The partnership consists of 22 members from industry and business organisations, trade unions, knowledge institutions, NGOs and think tanks, with a head of department from the Ministry of Environment as the chairperson. The partnership secretariat is served by an inter-ministerial secretariat headed by the Ministry of Environment, with the participation of the Ministry of Foreign Affairs and the Danish Business Authority. The partnership held three meetings in the second half of 2023.

19 References

Danmarks Nationalbank. (2023a). Klimaaftrykket fra danske investorer er faldet. *Statistik*. Retrieved from https://www.nationalbanken.dk/da/statistik/find_statistik/Documents/Forsikring%20og%20pension/Klimarelaterede%20indikatorer%2020230331.pdf

Danmarks Nationalbank. (2023b). *Klider og metoder - Klimarelaterede indikatorer.* Retrieved from https://www.nationalbanken.dk/da/statistik/find_statistik/Documents/Forsikring%20og%20pension/Kilder%20og%20metoder%20-%20Klimarelaterede%20indikatorer.pdf

Danmarks Statistik. (2022). Statistikbanken. Retrieved from https://www.statistikbanken.dk/statbank5a/default.asp?w=1280

Danmarks Statistik. (2023). *Data trukket via Statistikbanken november 2023 fra Danmarks Statistiks database, der løbende opdateres.*

Dansk Energi. (2016). *Brancheaftale om sikring af bæredygtig biomasse.* Dansk Energi. Retrieved from https://ens.dk/sites/ens.dk/files/Bioenergi/brancheaftale_biomasse-20160623.pdf

Danske Rederier. (2023, januar 3). *Opbremsning i væksten af den danske handelsflåde*. Retrieved from https://www.danishshipping.dk/presse/nyheder/opbremsning-i-vaeksten-i-den-danske-handelsflaade/

EEA. (2021). Plastic in textiles: towards a circular economy for synthetic textiles in Europe. European Environmental Agency. Retrieved from https://www.eea.europa.eu/publications/plastic-in-textiles-towards-a

EKF. (2022). *EKF årsrapport 2022.* Danmarks Eksport- og Investeringsfond. Retrieved from https://eifo.dk/media/niifyrpo/r24018-ekf-aarsrapport-2022_samlet_final.pdf

Energistyrelsen. (2020). *Biomasseanalyse.* Energistyrelsen. Retrieved from https://ens.dk/sites/ens.dk/files/Bioenergi/biomasseanalyse_final_ren.pdf

Energistyrelsen. (2021). *Klimastatus- og fremskrivning.* Energistyrelsen. Retrieved from https://ens.dk/sites/ens.dk/files/Basisfremskrivning/kf21_hovedrapport.pdf

Energistyrelsen. (2022). *Energistatistik 2021.* Energistyrelsen. Retrieved from https://ens.dk/sites/ens.dk/files/Statistik/energistatistik2021.pdf

Energistyrelsen. (2023). *Energistatistik 2022.* Energistyrelsen. Retrieved from https://ens.dk/sites/ens.dk/files/Statistik/energistatistik2021.pdf

Energistyrelsen. (2023). *Klimastatus- og fremskrivning.* Energistyrelsen. Retrieved from https://ens.dk/service/fremskrivninger-analyser-modeller/klimastatus-og-fremskrivning-2023

Energistyrelsen. (2023). *Klimastatus og -fremskrivning 2023*. Retrieved from https://ens.dk/service/fremskrivninger-analyser-modeller/klimastatus-og-fremskrivning-2023

Europa-Kommissionen. (2024). *Redcuing emissions from the shipping sector*. Retrieved from https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

European Commission. (2023). Waste Framework Directive – Waste Hierarchy. Retrieved from https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

IEA. (2022a). *Aviation.* Paris: IEA. Retrieved from https://www.iea.org/reports/aviation

IEA. (2022b). *International Shipping.* Paris: IEA. Retrieved from https://www.iea.org/fuels-and-technologies/international-shipping

IEA. (2024a). *Aviation*. Retrieved from https://www.iea.org/energy-system/transport/aviation

IEA. (2024b). *International shipping*. Retrieved from https://www.iea.org/energy-system/transport/international-shipping

IFU. (2023). Hjemmeside. Retrieved from https://www.ifu.dk/

IGN. (2022). *CO2 emissions from biomass use in district heating and combined heat and power plants in Denmark.* A. T. Nielsen, N. S. Bentsen & T- Nord-larsen, Institut for Geovidenskab og Naturforvaltning.

IGN. (2022). *CO2 emissions from biomass use in district heating and combined heat and power plants in Denmark. Institut for Geovidenskab og Naturforvaltning, Københavns Universitet.* (A. T. Nielsen, N. S. Bentsen, & T. Nord-Larsen, Eds.) Institut for Geovidenskab og Naturforvaltning Københavns Universitet.

IPCC. (2006). *Guidelines for National Greenhouse Gas Inventories.* (S. Eggleston, L. Buendia, K. Miwa, T. Ngara, & K. Tanabe, Eds.) IGES. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

IPCC. (2006). *Guidelines for National Greenhouse Gas Inventories.* S. Eggleston, L. Buendia, K. Miwa, T. Ngara & Tanabe, Red. Retrieved from 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

IPCC. (2019). *Special Report on the Ocean and Cryosphere in a Changing Climate.* Retrieved from https://www.ipcc.ch/srocc/

JRC. (2021). *The use of woody biomass for energy production in the EU.* Joint Research Centre. EU-Commission.

KEFM. (2020). Forslag til lov om klima. Klima-, Energi-, og Forsyningsministeriet. Retrieved from https://www.retsinformation.dk/eli/ft/201912L00117

KEFM. (2023). Danmarks globale klimapåvirkning 2023. Klima-, Energi-, og Forsyningsministeriet.

Klima-, Energi- og Forsyningsministeriet. (2024). *Klimastatus og -Fremskrivning.*

Klimaloven. (2020). *Klimaloven*. Retrieved from https://www.retsinformation.dk/eli/lta/2020/965

Nielsen. (2024). *Recalculation of CO2 emissions from biomass use in district heating and combined heat and power plants in Denmark with 2022 input data.* Nielsen, A. T.

Nielsen, A. T. (2023). *Recalculation of CO2 emissions from biomass use in district heating and combined heat and power plants in Denmark with 2021 input data.*

Nielsen, A. T., Bentsen, N. S., & Nord-Larsen, T. (2022). *CO2 emissions from biomass use in district heating and combined heat and power plants in Denmark.* IGN.

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). *The environmental price of fast fashion.* Nature Reviews Earth and Environment. doi:https://doi.org/10.1038/s43017-020-0039-9

OECD. (2020). *Climate Finance Provided and Mobilised by Developed Countries in 2013-18.* doi:https://dx.doi.org/10.1787/f0773d55-en

Regeringen. (2020, September). *En Grøn og Bæredygtig Verden - Regeringens langsigtede strategi for global klimaindsats.* Retrieved from https://um.dk/udenrigspolitik/aktuelle-emner/regeringens-strategi-for-global-klimaindsats

REPSOL. (2023). *Oil, a culinary treasure that can (and should) be recycled*. Retrieved from https://www.repsol.com/en/energy-and-the-future/future-of-the-world/oil-culinary-treasure-can-and-should-be-recycled/index.cshtml

Trafikstyrelsen. (2022). Luftfartsstatistikken. Retrieved from https://passagertal.dk/

Tukker, A., de Koning, A., Owen, A., Lutter, S., Bruckner, M., Giljum, S., . . . Hoekstra, R. (2018). Towards robust authoritative assesments of environmental impacts embodied in trade: Current state and recommendations. *Journal of Industrial Ecology*. doi:https://doi.org/10.1111/jiec.12716

UNEP DTU Partnership. (2021). *Methodology for the analysis of IFU's climate footprint in 2020.* (M. D. Maso, Ed.) Retrieved from https://www.ifu.dk/wp-

content/uploads/2021/05/IFU-2020-footprint_UNEP-DTU_approach-for-publication-05052021.pdf

United Nations. (2015, september). *The 17 goals*. Retrieved from https://sdgs.un.org/goals

Glossary and abbreviations

Biofuels: Fuels produced from biomass. If the biofuels are produced from crops that could alternatively be used for food or animal feed (rape, palm oil, soybeans, etc.) they are called first generation biofuels and, if they are produced from waste, residues or energy crops (willow, elephant grass, etc.), they are called second generation biofuels.

Biogenic CO_2 emissions: CO_2 emissions arising from burning biomass.

Biomass: An umbrella term for all organic material that is the product of photosynthesis in plants driven by solar energy. The most common products in an energy context are straw, firewood, wood chips, wood pellets, wood waste, biodegradable waste, etc. In Danish global impact reporting, biofuels are defined as biomass.

Bunkers: Bunkering/to bunker = refuelling/to refuel an aircraft or ship – derived from the word for the fuel for international transport: bunker fuels.

CO_2e emissions: Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated greenhouse gases (F gases). The gases have different greenhouse effects but are converted into CO_2 equivalents (abbreviated CO_2e) based on their Global Warming Potential (GWP) over a 100-year time period relative to CO_2. CO_2e emissions are therefore a way in which to estimate greenhouse gas emissions that allows for adding up different greenhouse gases with different impacts on the greenhouse effect with regard to the potency of the gas and the time it is in the atmosphere. With the CO_2e unit, the climate impact of the individual gas is converted to the corresponding impact in units of CO_2.

Denmark's consumption-based climate footprint: The CO_2e emissions that can be ascribed to Danish consumption of goods and services. The calculation includes emissions in Denmark and emissions in other countries.

Danish-operated aircraft/ships: An aircraft or ship operator (not necessarily the owner) determines the crew, specific routes, speed, bunkering, etc.

Direct land-use change - dLUC: Covers changes in the use of an area directly caused by consumption of a given product. For example, forest clearance to grow agricultural crops on a given area.

The GHG Protocol is a voluntary and globally recognised standard for calculating greenhouse gases. It is used by businesses in particular. The purpose of the protocol is to help define the direct and indirect CO_2e emissions of businesses, and to ensure a uniform approach to calculating the overall climate footprint.

Emissions factor for foreign electricity: Emissions factor (kg CO_2/MWh electricity) for the electricity abroad that is marginally displaced or added to production up to 2030 if Denmark increases or reduces net exports of electricity.

Export of energy services includes exports by consulting engineers and other technical advice from manufacturers of energy technology, for example energy planning, renewable energy and other energy tasks.

Energy technology is products used in the energy area. For example, technology used within district heating, bioenergy, wind energy, or energy-saving equipment.

Solid biofuels: Solid biofuels include wood (wood pellets and wood chips, firewood, wood waste), straw and biogenic waste. However, the estimates of climate impacts in chapter 10 only include the biomass types *wood pellets* and *wood chips* for electricity and district heating.

Global emissions: All emissions in the world, i.e. the sum of emissions from all of the countries in the world according to the UN IPCC methodology, including emissions from international transport.

Green energy technology covers two green business areas defined by Eurostat: 1) Use of renewable energy, i.e. goods and technologies linked to onshore and offshore wind power, conversion of biomass for bioenergy, geothermal energy, wave power and solar energy. 2) Better exploitation of energy, i.e. goods, technologies connected to electricity-saving technologies, energy management and storage, green transport technologies and practices, cogeneration technologies, heat pumps, etc.

Green investments: Investments in businesses or projects, the purpose of which is to promote the green transition. This could be in wind farms or in businesses that produce green energy technology or other technologies, products or services which contribute to the green transition.

Hypothetical climate impact is the climate impact that can come from the use of a given (climate) solution. It is therefore possible avoided emissions.

iLUC impact: The climate effect linked to indirect land-use change. The climate effect arises because the carbon balances in the soil and vegetation are affected when the land use is changed. Influencing these balances has climate consequences.

Indirect land-use change - iLUC: Covers the land-use change that occurs indirectly, for example when an agricultural area is converted to cultivate crops for use in energy production. Since it is assumed that the global demand for agricultural goods following this conversion will remain unchanged, theoretically it would be attractive to cultivate agricultural crops elsewhere. Therefore, this may cause land-use change that could entail felling forests.

IO tables (input-output tables): Statistical tables in monetary units that describe how the sectors in a given economy, e.g. the Danish, buy and sell goods and services from and to each other.

Climate impact is the change in CO_2e emissions from a specific action.

Climate neutrality is when there is a balance between CO_2 emissions and the absorption of CO_2 from the atmosphere into carbon sinks. To achieve this, the world's greenhouse gas emissions must be offset by carbon sequestration. Carbon sinks are systems that absorb more CO_2 than they emit. The ocean, soil and forests are the most important carbon sinks.

Environmental technology constitutes products used in connection with the environment, including within clean air, water and waste.

Net electricity exports: Exports of electricity (usually over a period of one year) less imports of electricity. If net electricity exports are negative, there have been more imports than exports in the period.

Baseline scenario shows the amount of CO_2e emissions that would have been emitted if an energy-saving product had not been sold, for example.

Respiration: Biochemical process whereby living cells extract chemical energy from oxygen and organic compounds. CO_2 and water are the products formed by respiration.

Territorial emissions: The greenhouse gas emissions calculated according to the UN IPCC methodology emitted within a country’s national borders. Also called the national emissions.

Goods exports are sales of products by a business to other countries.

Land-Use Change - LUC: An overall term covering changes in land use. For example, this could be when an agricultural area is converted to grow energy crops or when rainforest is cleared to grow agricultural crops. The term does not relate to the cause of the change in land use. Land-use change can be both directly and indirectly linked to a specific consumption (see below).

Abbreviations

GDP	Gross domestic product
CO2e	CO_2 equivalents
DGIF	Danish Green Investment Fund
EKF	EKF Denmark's Export Credit Agency
ENS	The Danish Energy Agency
GR	Global Report
HVO	Hydrotreated vegetable oil
IFU	Investment Fund for Developing Countries
IRENA	The International Renewable Energy Agency
KEFM	The Ministry of Climate, Energy and Utilities
LULUCF	Land Use, Land-Use Change and Forestry
NDC	National Determined Contribution (reduction commitment under the Climate Convention)
OECD	Organisation for Economic Co-operation and Development
PJ	Peta Joule, 1,000,000 GJ or 277,778 MWh
PtX	Power-to-X
TWh	Terawatt-hours, 1,000,000 MWh.
USD	US dollars
RE	Renewable energy

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Annex 1: Legal basis for global impact reporting

In addition to annual climate status and outlook reports, the Climate Act also sets out a requirement for annual reporting on the international impacts of Danish climate action. According to the Climate Act, the purpose of this reporting is to make Denmark's global impact on the climate visible, positive as well as negative impacts (KEFM, 2020).

According to section 6 of the Climate Act, the Minster for Climate, Energy and Utilities must annually prepare a climate status and outlook report, which must include global impact reporting on the international impacts of Danish climate action. According to the explanatory notes to the Act, the Danish Energy Agency is responsible for drawing up the annual climate status and outlook report.

The Climate Act does not lay down the exact content of global impact reports, but according to the explanatory notes, the reports should include information on reductions within international shipping and aviation and reductions from exports of electricity from renewable energy sources. Moreover, the impacts of Danish bilateral energy cooperation with large CO_2 emitters can be included, and the impacts of Danish imports and consumption should be described. Furthermore, there should be an account of Danish climate assistance.

The areas highlighted in the explanatory notes have therefore all been described in this report. The areas mentioned are not an exhaustive list with regard to mapping Denmark's global impacts on the climate. As in previous reports, GR24 also describes additional areas.

The Climate Act also states that global impact reports are to be submitted for external consultation, so that external players can comment on assumptions, etc. The Climate Act stipulates that, in connection with the consultation, a meeting is to be held at which the assumptions underlying the projections are presented.

List of figures