Denmark's Global Climate Impact

Global Report

2023

Danish Energy Agency

Contents

Summary

Denmark's Global Climate Impact – Global Report 2023 (GR23) 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.

GR23 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

GR23 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. There is also an estimate of the climate footprint of Danish public procurement. Finally, there is an analysis of several key indicators for consumption areas with a significant climate footprint as well as a more detailed estimate of emissions associated with Danish consumption of textiles.

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 63 million tonnes CO_2e for the year 2021. This corresponds to around 11 tonnes CO_2e per capita.

According to the estimate, greenhouse gas emissions per DKK spent have halved since 1990. This is due in particular to transitioning of the Danish energy sector, which is a contributing factor to the falling trend in Danish emissions from Danish consumption. The estimate shows that most emissions are linked to the supply of goods and services for consumption from the following industry groups: food and beverages as well as raw materials and products (goods from the pharmaceutical industry, the metal industry and the clothing industry, for example). Furthermore, greenhouse gas emissions from households are particularly associated with transport as well as food and beverages.

The estimate shows that more than half of emissions associated with Danish consumption occurred in countries outside Denmark. Danish consumption has the largest climate footprint in Europe and Asia. At country level, the footprint is largest in China and Germany. The footprint is particularly large in the electricity sectors of these countries.

Projection of the climate footprint of consumption presents the results of the first 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 rest of the world. Depending on developments in the rest of the world, the projection predicts that Denmark's consumption-based climate footprint will drop to somewhere between 25-46 million tonnes CO_2e by 2035. In the scenarios in which the global temperature rise is limited to 2.0°C or 1.5°C by 2100, the consumption-based climate footprint is projected to be at around 30 or around 25 million tonnes CO_2e, respectively, by 2035. In the scenarios in which the global temperature increases to between 3.1°C and 5.1°C by 2100, the consumption-based climate footprint is projected to be at around 46 million tonnes CO_2e by 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. Many of these key indicators show increased consumption over time, with passenger transport by car and aircraft having increased the most, if the effects of Covid-19 lockdowns are excluded. For 2022, meat consumption has been calculated at about 54 kg per capita, which represents a drop of 2 kg per capita since 2013. Sales of electronics were 29 kg per capita in 2021, corresponding to an increase of eight kg since 2012. Total electricity and heating consumption by households was 32 GJ per capita in 2021, with a renewables share of 69%. Household electricity and heating consumption was lower than in 1990, and the renewables share increased significantly over the period.

The climate footprint of Danish imports has been estimated to be 103 million tonnes CO_2e in 2021. 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 imported goods and services that are exported onwards from Denmark.

The largest share (36%) of emissions embedded in Danish imports in 2021 were related to raw materials and products (imports from oil refineries, the pharmaceutical industry and the clothing industry, for example). Transport also accounts for a large share of the emissions (31%). This is because Danish shipping companies often buy freight services from foreign carriers.

The majority of Danish imports emissions occurred in Europe (51 million tonnes CO_2e) and in Asia (27 million tonnes CO_2e). Looking at specific countries, the estimate shows that the largest climate footprints from Danish imports were made in Germany and China. According to the estimate, over the past decade, the climate footprint of Danish imports per DKK imported has decreased.

The climate footprint of Danish exports has been estimated at 129 million tonnes CO_2e in 2021. Around half of these emissions have been estimated to occur in countries outside Denmark in the form of imported goods that are either included in products Denmark then exports or are directly re-exported. 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. The climate impact per DKK exported decreased in the period from 2006 to 2016, but has remained relatively constant since then. Just under half of Danish exports emissions were embedded in products exported to Europe. According to the estimate, the majority of emissions from Danish exports at country level occurred in the US and Germany; countries which are also Denmark's largest export markets.

The climate footprint of Danish public procurement in 2021 has been estimated at 16 million tonnes CO_2e. Public procurement by central government accounted for 30%, regional government 27% and local government 42% of emissions. Building and construction accounted for a major share of total public procurement emissions. The climate footprint of public procurement rose by about 12% from 2019 to 2021. The total climate footprint of public procurement has been projected to be 14.6 million tonnes CO_2e in 2030, a reduction of 1.4 million tonnes CO_2e from 2021.

The climate footprint of Danish textile consumption for the entire production chain and the transport of textiles bought in 2021 has been estimated at 2.5 million tonnes CO_2e. A little under 95% of these emissions occurred outside Denmark. Clothes account for the largest share of textile consumption (78%) and also contribute most to the climate footprint. The climate footprint of laundering, drying and ironing clothes bought in 2021 has been estimated at 0.15 million tonnes CO_2e. According to the estimate, about 59% of used textiles end up at waste incineration plants.

Energy and transport

Energy and transport have a significant climate impact both inside and outside Denmark. GR23 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 GR23 includes an estimate of the net emissions related to solid biomass fuels, 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 aviation and shipping, 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 2020, Denmark imported 761 PJ of fuels and exported 451 PJ of fuels. The greatest share of fuels exported from Denmark goes to Sweden and the greatest share of fuels imported to Denmark comes from Norway. Total greenhouse gas emissions since 2013 linked to burning fuels imported to Denmark have been estimated as higher than the emissions linked to burning fuels exported from Denmark. If anticipated future PtX products produced in Denmark replace fossil fuels abroad, Denmark will contribute to reducing emissions abroad. The largest reduction abroad (104 gCO_2e/MJ) is likely to be through the direct replacement of natural-gas based hydrogen with PtX products.

The estimate shows that, in 2021, Danish electricity imports were associated with 0.7 million tonnes CO_2e emissions outside Denmark, while Danish electricity exports in 2021 were associated with 0.2 million tonnes CO_2e emissions in Denmark. The emission factor and, thus, the embedded CO_2e emissions, are higher for electricity imported to Denmark than for electricity produced in and exported from Denmark. Danish electricity exports primarily comprise electricity from wind power. The estimate also shows that, although the electricity production of countries outside Denmark is becoming greener by the day, Danish electricity exports will reduce emissions in countries outside Denmark in 2035, because Danish electricity exports will have a lower emission factor than the electricity produced in countries outside Denmark.

Solid biomass fuels have, since 1990, been used increasingly in place of fossil fuels. 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 guidelines from the IPCC. This is to prevent double counting of emissions from biomass. It is the same principle as when emissions from production of goods are included in the emissions of the country of production rather than in the emissions of the country where the goods are used. GR23 takes a different perspective on emissions from biomass, in that it presents an overall estimate of all emissions associated with the use of biomass in the Danish utilities sector.

According to this estimate, Danish consumption of wood pellets and wood chips for electricity and district heating in 2021 led to emissions of 10.6 million tonnes CO_2 in the year of consumption. The emissions linked to the use of fossil fuels from production and transport amounted to 0.5 million tonnes CO_2 in the year of consumption, and biogenic emissions from biomass burning, etc. amounted to 10.1 million tonnes CO_2. Net emissions, i.e. the impact on the atmosphere, from consumption of wood pellets and wood chips in 2021 is estimated to fall exponentially over time. After ten years, the

amount of CO_2 in the atmosphere associated with the specific consumption in 2021 will have fallen to 5.8 million tonnes (a fall of 45%), after 20 years to 3.5 million tonnes (a fall of 67%), and after 30 years, net emissions will have fallen to 2.3 million tonnes (a fall of 78%).

Amongst other things, this is because emissions from burning the wood are 'overtaken' by the decomposition of the wood residues, etc. that would otherwise have taken place had the wood *not* been removed from the forest and burned. This means that, after 70-80 years, the remaining net emissions will consist primarily of the fuels linked to the use of fossil fuels in production and transport of the solid biomass fuels.

Biofuels are used as an alternative to fossil fuels and they therefore contribute to reducing greenhouse gas emissions from the transport sector in Denmark. GR23 estimates emissions associated with biofuels used for transport in Denmark, including emissions associated with the production (growing and processing), transport and use of these biofuels. The cradle-to-grave emissions of CO_2e from biofuels in 2021 have been estimated at 0.31 million tonnes. Biofuels, with the exception of bioethanol, have generally become 'less emitting' over time. If indirect emissions from land-use change are included in the estimate, the amount of emissions from biofuels more than double.

International transport estimates the share of emissions from international shipping and aviation related to Denmark and Danish businesses. Because of international trade, many goods cross one or more national borders via the air or sea, and international shipping, in particular, moves large freight volumes. With regard to international aviation, passenger flights account for the majority of the aviation activity and, thus, for the majority of greenhouse gas emissions from the sector. Emissions in 2021 from bunkering abroad by Danish air carriers and from the flights of Danish and foreign air carriers to and from Denmark have been estimated at 3 million tonnes CO_2e. Emissions from bunkering by ships related to Denmark have been estimated at 33.5 million tonnes CO_2e in 2020.

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. Nevertheless, the figures for 2021 reveal that global activity in both sectors increased subsequently, and, with this, emissions of greenhouse gases.

Climate action by the business sector

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. GR23 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 future 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 2022, Denmark exported green energy technology worth around DKK 63 billion and green environmental technology worth around DKK 23 billion. Over the entire lifetime of the individual technology, it is estimated that Danish exports of energy technologies in 2022 have potential to reduce emissions by between 119 and 218 million tonnes CO_2. This corresponds to 5-8 million tonnes CO_2 in any given year of the individual technology's lifetime. Wind technologies and hydro/wave dominate Danish green exports. In 2022, Germany was the largest buyer of Danish green energy technologies, as they bought technology worth a total of DKK 9 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. A total of 14% of the 110 businesses have been assessed to place at the highest level on the maturity scale, as they report emissions under scopes 1 and 2 and estimate all scope 3 categories.

Most of the businesses base their work on the accounting standards outlined in the Greenhouse Gas Protocol (GHG Protocol). A small share of the businesses have their climate accounts verified by third parties. As many as 70% of financial as well as 70% of non-financial businesses have 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 done through knowledge exchange and climate diplomacy initiatives, via bilateral and multilateral cooperation and via the EU. GR23 includes a review of a number of selected initiatives for 2022 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 COP27, for example, Denmark hosted the May Ministerial Meeting on Implementation, which focussed on enhanced ambitions and implementation, and counted almost 50 participating countries. During COP27, with Denmark as the facilitator, the parties agreed on a work programme for increased reductions. Furthermore, in connection with COP27, Denmark launched a new global offshore wind alliance, the aim of which is to increase the level of ambition for offshore wind deployment.

During the UN General Assembly in September 2022, Denmark launched a DKK 100-million climate loss and damage fund. In October 2022, in cooperation with Germany, Denmark launched a 'Group of Friends', the aim of which is to advocate a more ambitious approach to global climate diplomacy work in the EU.

Denmark supports global reductions by providing climate assistance for a range of multilateral and bilateral initiatives. Denmark is working to ensure that the largest emitters reduce their emissions, and that developing countries follow sustainable development paths. In 2022, Denmark provided support for projects that contribute to realising reductions towards achieving zero emissions by 2050 in the partnership countries. For example, Denmark is contributing to the improvement of energy-efficient cooling in 100 cities in India and helping the poorest families in Africa to replace firewood and coal with cleaner cookers and cleaner fuels. Through bilateral cooperation, in 2022, 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 done through bilateral and multilateral channels as part of Danish climate assistance in 2022. In 2022, 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 ensuring access to clean drinking water in countries affected by drought, for example.

Climate assistance and finance looks at Danish climate assistance and mobilised climate finance. In 2021, Danish climate assistance was around DKK 2.8 billion, of which around 47% went to climate change adaptation initiatives and around 53% 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. The IFU (Investment Fund for Developing Countries), which is owned by the Ministry of Foreign Affairs of Denmark, mobilised slightly more than DKK 2 billion in financing in 2021 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 EKF (Denmark's Export Credit Agency) and the IFU, as well as the climate footprint of the shares and corporate bonds held by Danish insurance and pension companies and investment associations in foreign listed companies.[1]

[1] The figures are not directly comparable because of methodological differences (for example, the sector figures from Danmarks Nationalbank do not include scope 3, whereas scope 3 is included in calculations for the EKF and the IFU. Furthermore, note that with regard to private investments, Danmarks Nationalbank does not include a number of

The EKF estimated the total greenhouse gas emissions associated with its portfolio for the first time in 2022. According to the estimate, these emissions amounted to 2.8 million tonnes CO_2e in 2022. The IFU has estimated the climate footprint of its portfolio for 2021 at just below 0.8 million tonnes of CO_2e. Together, Danish investment funds financed emissions totalling around 3.8 million tonnes CO_2e in 2022 through their investments in shares and corporate bonds in foreign listed companies, while insurance and pension companies in the same year financed emissions totalling around 6.7 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, 2022 saw focus on implementing action plans for increased green exports to the EU and the US, as well as on boosting green exports by the Danish food cluster. Besides this, a strategic Water Technology Alliance was forged with the US.

investments, such as other types of bonds, unlisted shares, etc. This means the calculations do not reflect the total climate footprint of the portfolio.

1 About Denmark's Global Climate Impact

1.1 Denmark's global climate impact

Denmark's Global Climate Impact - Global Report (GR23) has its legal basis in the Danish Climate Act. The report provides a picture of global climate impacts and climate action that Danish consumers, businesses and authorities can influence in different ways.

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

Box 1: Purpose of global impact reporting (the Danish Climate Act June 2020)

The purpose of drawing up global impact reports is to make visible Denmark's global impacts 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 report is published as a supplement to Denmark's climate status and outlook report, 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 report provides 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.[2] Source: (ENS, 2021).

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 in the Climate Act is to ensure annual follow-up on whether Danish climate action is supporting fulfilment of the targets in the Climate Act.

1.2 Structure of Denmark's Global Climate Impact 2023

GR23 comprises a main report, including annexes, as well as 22 background memoranda that provide more detailed descriptions of the topics investigated in the main report. The main report primarily focuses on the main results. For descriptions of

[2]The international methodologies for estimating greenhouse gas emissions are based on guidelines from the UN Intergovernmental Panel on Climate Change (UN IPCC) (IPCC, 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.

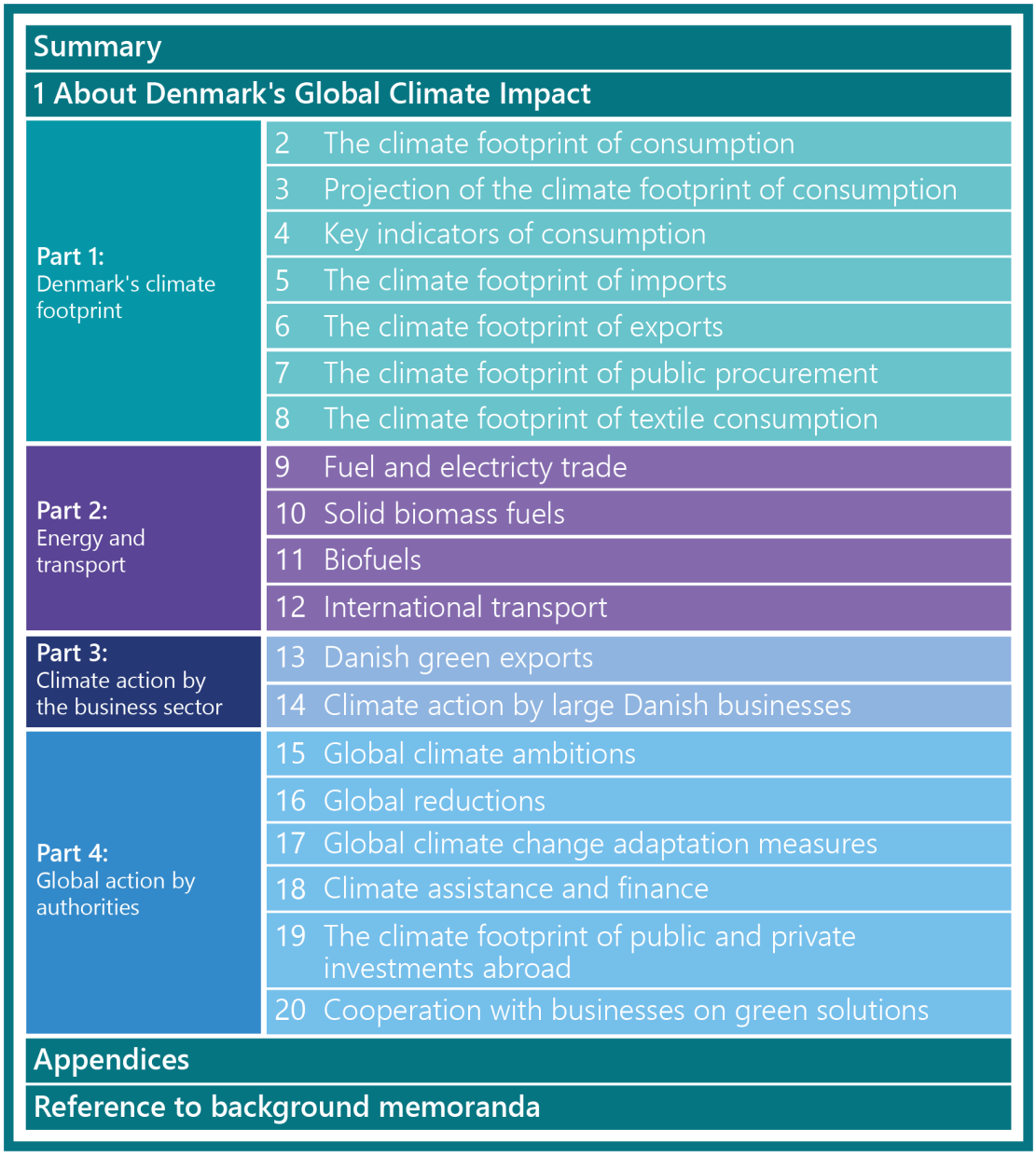
supplementary results, methodology approach, data basis, etc., consult the background memoranda.

Box 3: Global climate action by authorities

Denmark has launched a series of initiatives to reduce global greenhouse gas emissions. Chapters 15-20 report on global climate action by Danish authorities. Furthermore, there is also a leaflet about Denmark's global climate impact (only available in Danish) (KEFM, 2023).

GR23 has four parts: 1) Denmark's climate footprint, 2) Energy and transport, 3) Climate action by the business sector, and 4) Global action by authorities, see figure 1.

Figure 1: Structure of GR23



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, and also delves deeper into a number of specific areas of consumption. 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 associated with Danish exports of green energy technologies and environmental technologies. Finally, part 4 outlines initiatives by Danish authorities to reduce global greenhouse gas 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 climate impacts are covered. However, the methodology and data basis for estimating Denmark's global climate impact will be improved on a continuous basis.

1.3 How we estimated Denmark's global climate impact

The results in GR23 are based on a number of different data sources and methodologies. Read more about these in detail the background memoranda.

Denmark's emissions related to consumption, imports and exports have been calculated using an input-output model. The basic model is the same used by the Danish Energy Agency for last year's global impact report. This method is based on a simplified SNAC approach (Tukker, et al. 2018) and it combines data from Statistics Denmark and 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 (Danish Research Institute of Economic Analysis and Modelling) makes forecasts of the Danish economy using the *GrønREFORM* model, an environmental and climate-economic model in which Danish territorial emissions are calibrated against last year's Climate Status and Outlook report. This is combined with seven 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, Danish Producer Responsibility (DPA), Euromonitor and the Danish Energy Agency.

The climate footprint of Danish textile consumption focusses on consumption of clothing and home textiles. The analysis gives an estimate of the climate footprint of Danish textile consumption based on the physical flow of textiles estimated by Statistics Denmark and the Danish Environmental Protection Agency. The analysis covers production, use and disposal of textiles.

The energy balance describes Denmark's fuel balance and electricity trade. The fuel balance describes Danish imports and exports of fuels. The estimate includes fossil fuels and fuels from renewable energy sources, and also considers 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 2023 (CSO23). 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 2023 (CSO23).

Emissions related to Danish consumption of *solid biomass fuels* are based on reported data on consumption of solid biomass fuels in Denmark, as well as on calculations by the Department of Geosciences and Natural Resource Management, University of Copenhagen, and Nielsen (2023).

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 emission reductions related 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).

The chapter on political agreements with global impacts has not been included in this year's report. It is being considered whether to develop a methodological basis for a quantitative assessment of these impacts.

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 a public consultation, see Annex 1. The full GR23 report underwent a public consultation in April/May 2023.

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 GR23 describes 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. Additionally, 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. Because the majority of emissions embedded in textiles occur outside Denmark, there is also a chapter on emissions linked to Danish consumption of textiles.

Chapter 2: *The climate footprint of Danish consumption* is 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 3: *Projection of Danish consumption* describes seven different scenarios for developments in foreign greenhouse gas emissions embedded in Danish consumption up to 2035 and one scenario for developments in Danish emissions.

Chapter 4: *The climate footprint of Danish imports*[3] is an estimate of greenhouse gas emissions embedded in Danish imports. This includes foreign production and carriage of goods and services to the point where they are transferred to Danish hands. Danish imports can either be consumed in Denmark or be exported onwards for consumption

[3] The climate footprint estimated for imports and consumption and the projections of consumption and exports do not include emissions as a result of land-use change (LUC). Furthermore, in accordance with the UN IPCC methodology, biomass is included as "zero emissions" in all estimates. Biomass is dealt with in more detail in chapter 10.

abroad. 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* is 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.

Chapter 7: *Key indicators for consumption areas* is a series of key indicators for consumption areas with a significant climate footprint. These consumption areas are transport, food products, electronics and energy.

Chapter 8: *The climate footprint of textile consumption* is an estimate of the greenhouse gas emissions associated with consumption of textiles in Denmark.

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 background memoranda on consumption, projections, indicators of consumption, imports, exports, the climate footprint of public procurement, and the climate footprint of textile consumption, respectively.

2 The climate footprint of consumption

This chapter looks at the greenhouse gas emissions associated with Danish consumptions. Denmark's consumption-based climate footprint is an estimate of 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 embedded in Danish imports*, and the emissions from lighting and heating the shop in Denmark are considered *Danish emissions*. Greenhouse gas emissions embedded in 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.

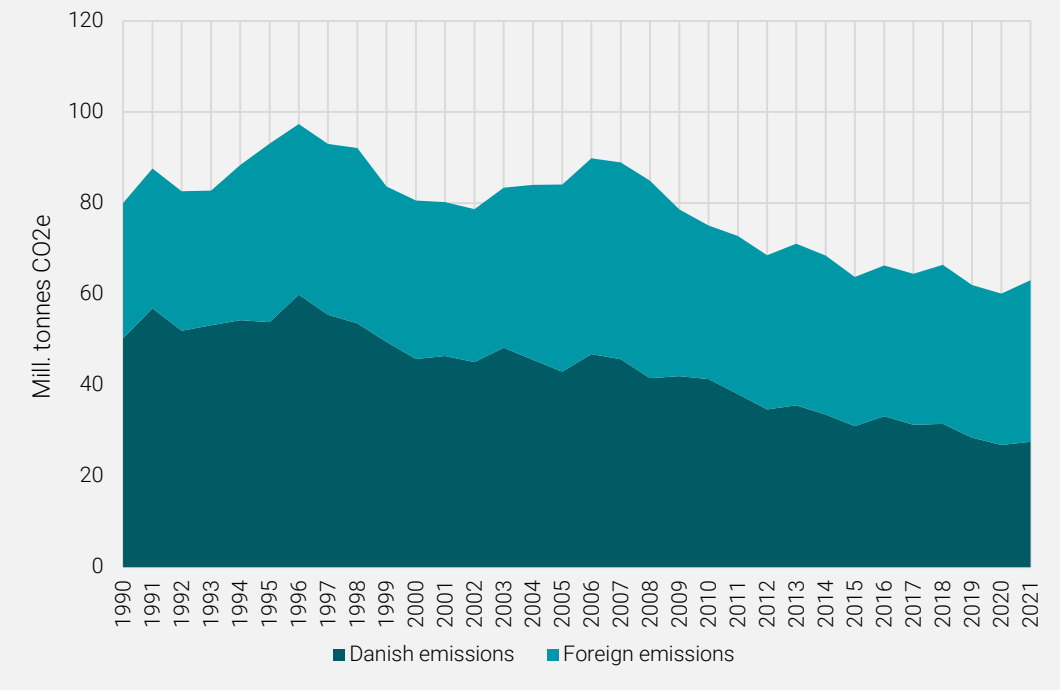
2.1 Main results

2.1.1 Denmark's consumption-based climate footprint was 63 million tonnes CO_2e in 2021

Denmark's consumption-based climate footprint in 2021 was 63 million tonnes CO_2e. This corresponds to around 11 tonnes CO_2e per capita. The consumption-based climate footprint increased by 3 million tonnes CO_2e, corresponding to 5%, from 2020 to 2021.[4] The year 2020 was extraordinary due to the socio-economic implications of the Covid-19 pandemic. Figure 2 shows that 44% of Denmark's total consumption-based climate footprint for 2021 was from Danish emissions and 56% 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.

[4] The 2020 figure for Denmark's consumption-based climate footprint is different in GR22 (63 million tonnes CO_2e) than in GR23 (60 million tonnes CO_2e). This is due to improved methodology and data in GR23. Differences between GR22 and GR23 are described in more detail in the background memorandum on Denmark's consumption-based climate footprint.

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



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

2.1.2 Danish emissions embedded in Danish consumption are decreasing

The estimate shows that Danish emissions linked to Danish consumption almost halved during the period from 1990 to 2021. However, the foreign emissions embedded in Danish consumption increased by around one-fifth during the same period. Amongst other things, the decrease in Danish emissions is because the climate footprint of the Danish energy sector has decreased, underpinned by an increasing share of renewable energy.

Box 4: Danish territorial emissions and Denmark's consumption-based climate footprint

Denmark's consumption-based climate footprint is around 40% higher than Denmark's territorial greenhouse gas emissions. In 2021, Danish territorial emissions were estimated at 46 million tonnes CO_2e, corresponding to almost 8 tonnes of CO_2e per capita (ENS, 2023). 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.

2.1.3 Consumption of biomass and deforestation abroad affect Denmark's climate footprint

Emissions from consumption of biomass in Denmark and deforestation activities outside Denmark are not included in the consumption-based climate footprint. However, burning biomass for energy releases CO_2, just as greenhouse gases are emitted when

Danish consumption leads to deforestation (i.e. land-use change). According to the estimate in chapter 10, net emissions from the use of biomass (i.e. wood pellets and wood chips) for electricity and district heating production were 10.6 million tonnes CO_2e in 2021 falling to 0.7 million tonnes CO_2e over a 100-year period. Note that, according to the UN IPCC methodological principles, emissions from biomass harvested abroad are to be included in the territorial inventories of the country of origin. Net emissions from biomass use cannot readily be added to the consumption-based climate footprint because net emissions depend on the chosen time perspective and methodology. GR22 estimated emissions from land-use change in the form of deforestation in two ways, showing climate footprints of 1.9 and 5.2 million tonnes CO_2e per year, respectively. The climate footprint of land-use change is particularly related to production of food products and animal feed in other countries.

2.1.4 Household emissions are most prominent and are linked to transport and to food and beverages in particular

In 2021, 63% of consumption-based emissions were related to the consumption of goods and services by households. A total of 24% of consumption-based emissions were related to investments[5] (by public bodies and by businesses), whereas 13% 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 7. The two figures can therefore not be compared. The difference in methodology is described in the box below.

Box 5: Different methodologies for estimating Denmark's consumption-based climate footprint and the climate footprint of Danish public procurement

The Danish Energy Agency prepares an annual estimate of the climate footprint of Danish public procurement. The estimate is published as part of the global impact report for the relevant year, and is presented in chapter 7 of this year's report. 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 are 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 emission factors and in the data basis. See the background memorandum on Denmark's consumption-based climate footprint for more about this.

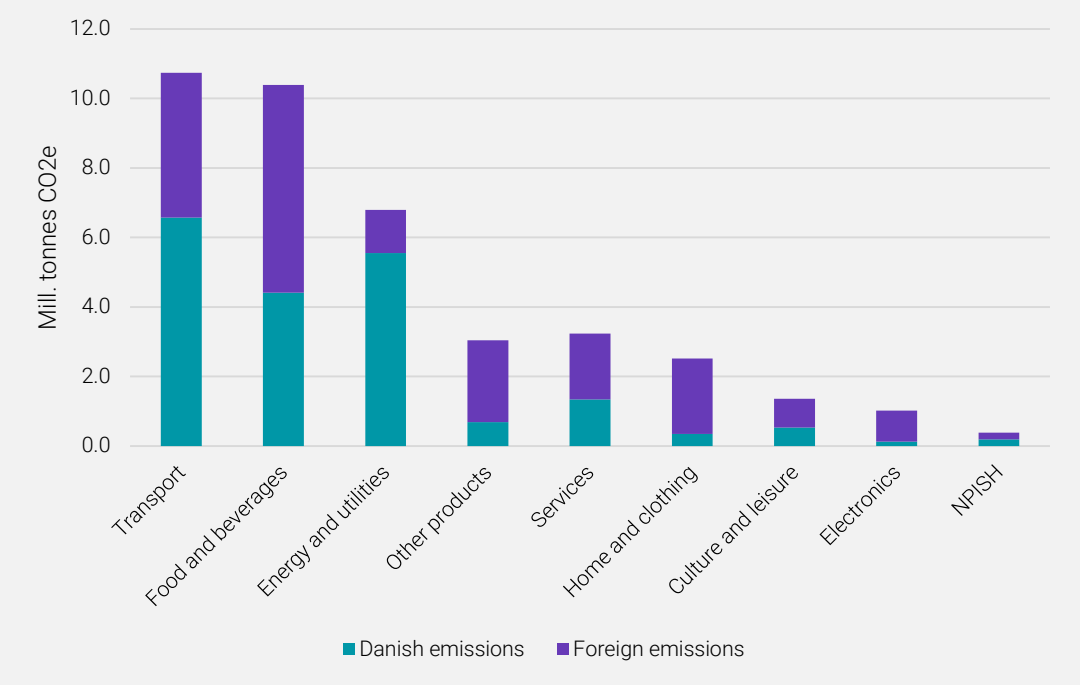
Figure 3 shows that the majority of emissions by households in 2021 stemmed from consumption for transport and for food and beverages. These two categories account for just under 11 million tonnes CO_2e each. Petrol for vehicles, followed by transport services (air and train travel, for example), and the production of vehicles comprise the largest items for transport.

[5] 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.

2.1.5 Half of household emissions occur abroad

Around half of emissions embedded in consumption by households in 2021 occurred abroad, according to the estimate. Foreign emissions make up by far the majority of emissions embedded in household goods and clothing, electronics and 'other products'. This is because most of the production for these consumption categories is located abroad. Conversely, there are more Danish 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. See figure 3.

Figure 3: Greenhouse gas emissions arising from consumption by households in 2021 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.

2.1.6 Food and beverages and raw materials and products are associated the majority of embedded emissions

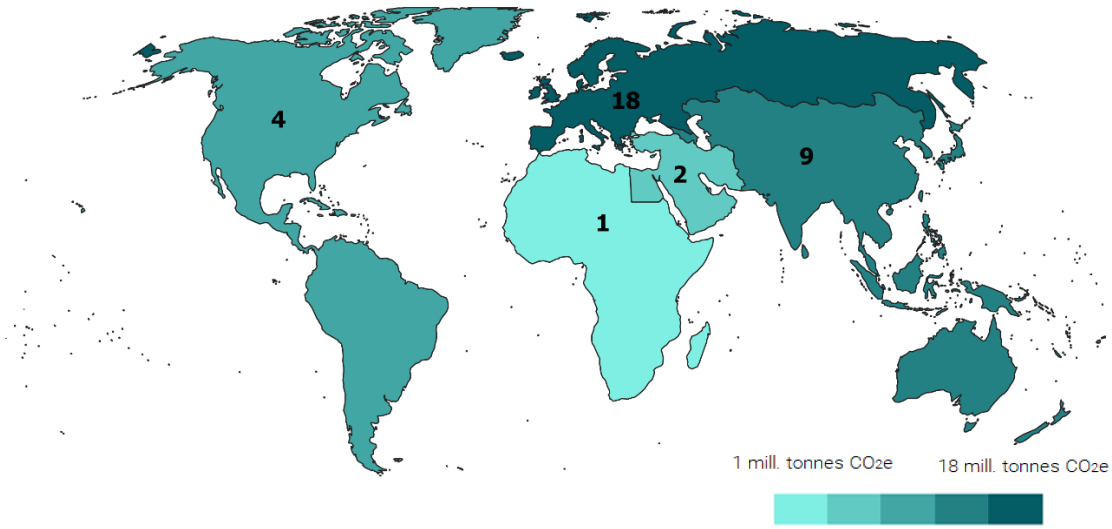
Denmark's consumption-based climate footprint can also be estimated by industry group, specifying the greenhouse gas emissions embedded in goods and services supplied by the individual industry group for Danish consumption. For example, emissions related to the transport of clothes and shoes will not be included as transport sector emissions but rather as wholesale and retail emissions, because wholesale and retail is the industry group that sells the clothes and shoes. With this perspective, the greenhouse gas emissions embedded in raw materials and products are most prominent (17%), with the supply of products and services from the pharmaceutical industry, the manufacture of metal products, as well as the clothing industry in general

accounting for considerable emissions. The second largest climate footprint stems from the food and beverage sector (16%).

2.1.7 The climate footprint of Danish consumption is largest in Europe and Asia

The majority of emissions embedded in Danish consumption in 2021 occurred in Europe (around 18 million tonnes CO_2e) followed by Asia (around 9 million tonnes CO_2e). A smaller share of foreign emissions occurred in America, Africa and the Middle East. See figure 4.

Figure 4: Foreign emissions from Danish consumption by regions (million tonnes CO_2e)



Source: The Danish Energy Agency. Note: Breakdown of the world into regions is based on EXIOBASE, version 3.8.2. Figures have been rounded.

2.1.8 At country level, the climate footprint of Danish consumption is largest in China and Germany

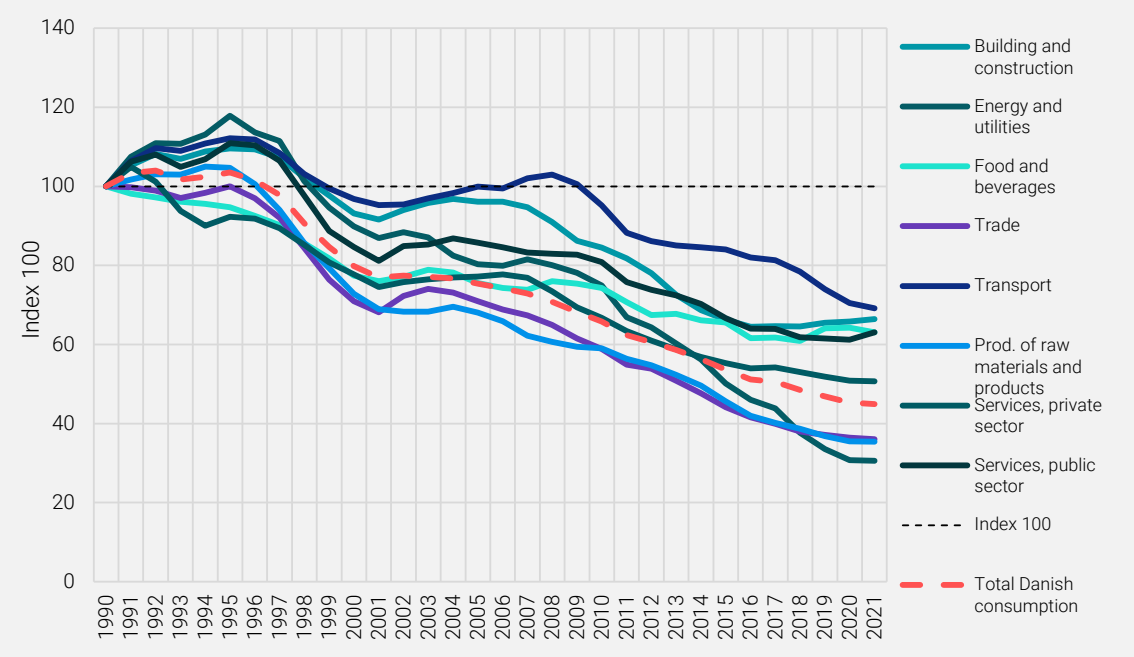
Broken down by country, the 2021 climate footprint of Danish consumption was largest in China, with 4.5 million tonnes CO_2e. This corresponds to around 7% of Denmark's total consumption-based climate footprint. One-quarter of these emissions occurred in the Chinese electricity supply sector. This is because electricity is the predominant source of energy in the production of goods in China, and Chinese electricity production is primarily based on coal. According to the estimate, around one-fifth of emissions were related to the manufacture of metal. Metal manufacturing requires high temperatures, which are typically obtained by burning fossil fuels such as coal and gas.

The estimate shows that the second-largest amount of emissions embedded in Danish consumption occurred in Germany (around 3.5 million tonnes CO_2e). As in China, the majority of these emissions (23%) occurred in the electricity supply sector, followed by agriculture and horticulture (18%).

2.1.9 Greenhouse gas emissions per DKK spent have halved since 1990

The relationship between consumption-based greenhouse gas emissions (Danish and foreign) and the size of Danish consumption can be estimated as kg CO_2e per DKK spent. According to the estimate, the greenhouse gas intensity of Danish consumption more than halved, from 68 kg CO_2e/DKK 1,000 spent in 1990 to 31 kg CO_2e/DKK 1,000 spent in 2021. Figure 5 shows that the supply of products and services from all eight industry groups caused lower emissions per DKK spent in 2021 than in 1990. This is an indication that the production of goods consumed by Danes today generally has a smaller climate footprint than previously.

Figure 5: Indexed development in greenhouse gas intensity over time by industry group and for Danish consumption in total



Source: The Danish Energy Agency. Note: Index year = 1990. The greenhouse gas intensities of industry groups have been calculated on the basis of the value of the industry group's supply of products and services for final consumption in Denmark stated in chain-linked values, 2010 prices. Total greenhouse gas intensity has been calculated as total final domestic use in chain-linked values, 2010 prices. Developments are stated as a cumulative average, due to the volatility of greenhouse gas intensity. The cumulative average has been calculated as an average from one year before to one year after the relevant year. Figures for 1990 and 2021 have not been calculated as cumulative averages.

3 Projection of the climate footprint of consumption

This chapter presents the results of the very first 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.

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.

3.1 Main results

3.1.1 Depending on developments in the rest of the world, Denmark's consumption-based climate footprint is projected to fall to somewhere between 25 and 46 million tonnes CO_2e in 2035

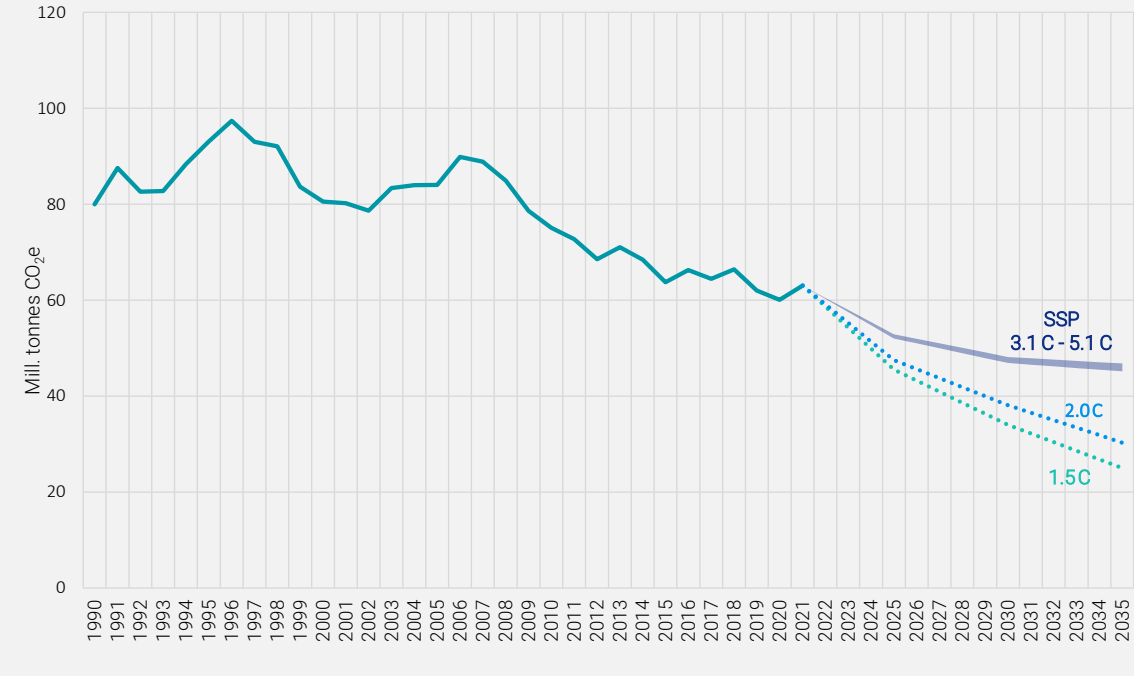
The future climate footprint of Danish consumption depends on developments in Denmark and in the rest of the world. The consumption-based climate footprint has been projected on the basis of one scenario for developments in Denmark and seven scenarios for developments in the rest of the world. The scenarios for developments in the rest of the world include five SSPs (Shared Socio-economic Pathways), in which global temperatures rise by between 3°C and 5°C. The SSPs describe different socio-economic developments up to 2100. In addition to these SSPs, there are two other scenarios with a more ambitious green transition in the rest of the world and with global temperature rises limited to 1.5°C and 2°C, respectively.

The projection of Danish emissions is based on a frozen-policy scenario[6] calibrated against Denmark's Climate Status and Outlook 2022. Danish emissions are therefore constant across the seven scenarios for developments in the rest of the world.

In all scenarios, Denmark's consumption-based climate footprint is projected to fall until 2035, thus continuing the trend since the mid-2000s. If Danish consumption follows the projected path, and the rest of the world develops according to the five SSPs, Denmark's consumption-based climate footprint will be around 46 million tonnes CO_2e in 2035, see figure 6. If, however, the rest of the world follows scenarios with higher reduction ambitions and in which the global temperature rise is kept at either 2.0°C or 1.5°C in 2100, then the consumption-based climate footprint will be around 30 million tonnes CO_2e or around 25 million tonnes CO_2e in 2035, respectively.

[6] A frozen-policy scenario calibrated against CSO22 means that the projection takes account of policies adopted up to 1 January 2022.

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



Source: The Danish Energy Agency.

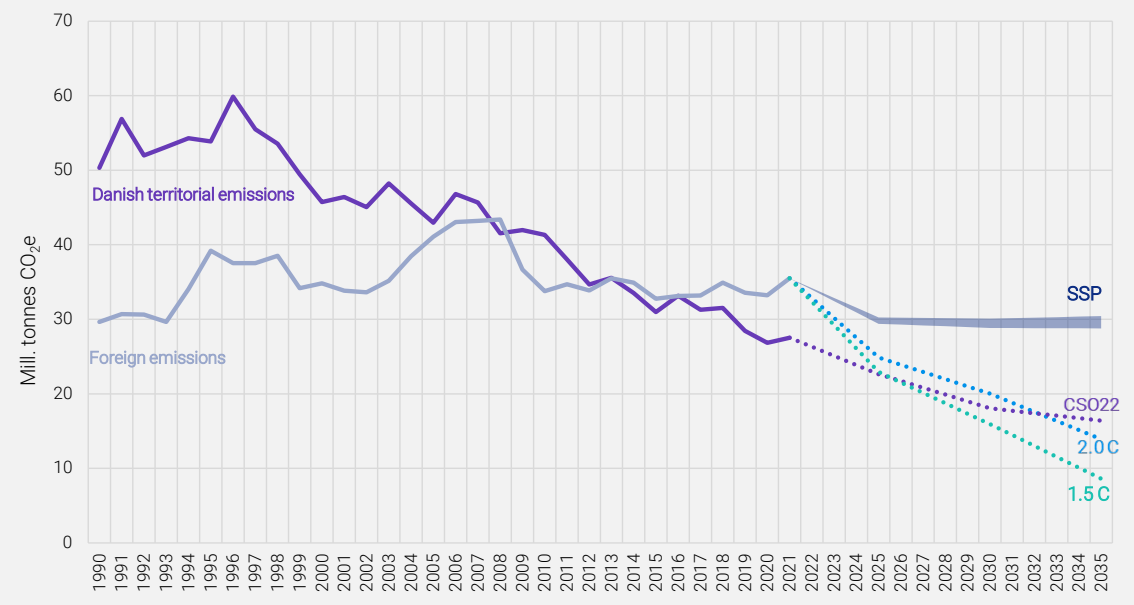
Box 6: Economic forecast for Denmark

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 24% (constant 2019 prices) from the projection's baseline year (2019) to 2035. The increase will be greatest for household consumption and consumption by public bodies, whereas the increase related to investments will be smaller. Developments in Danish consumption and in import volumes are the same in all the scenarios for developments in the rest of the world.

3.1.2 Both Danish and foreign emissions are projected to fall until 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 the most until 2030 and then less so after this time because the projection is based on a frozen-policy approach. In all scenarios, foreign emissions are lower in 2035 than in 2021. The SSPs show falling foreign emissions only until 2025, after which foreign emissions remain relatively constant until to 2035. For the 1.5°C- and 2.0°C-scenarios, the fall in foreign emissions continues to 2035.

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



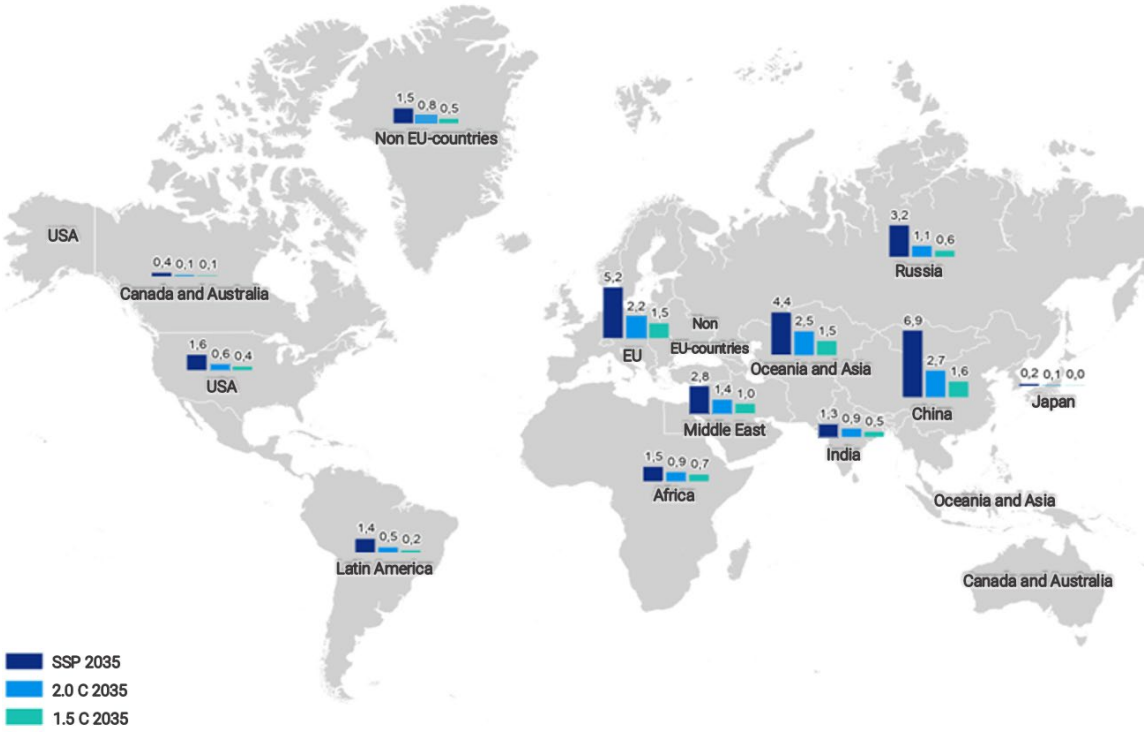
Source: The Danish Energy Agency.

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

The projection of developments in the rest of the world is categorised into 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 China, the EU, as well as Oceania and Asia across all three scenarios. See figure 8.

Figure 8: Foreign emissions in 2035, by scenario (3) and region (12)



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

4 Key indicators of consumption

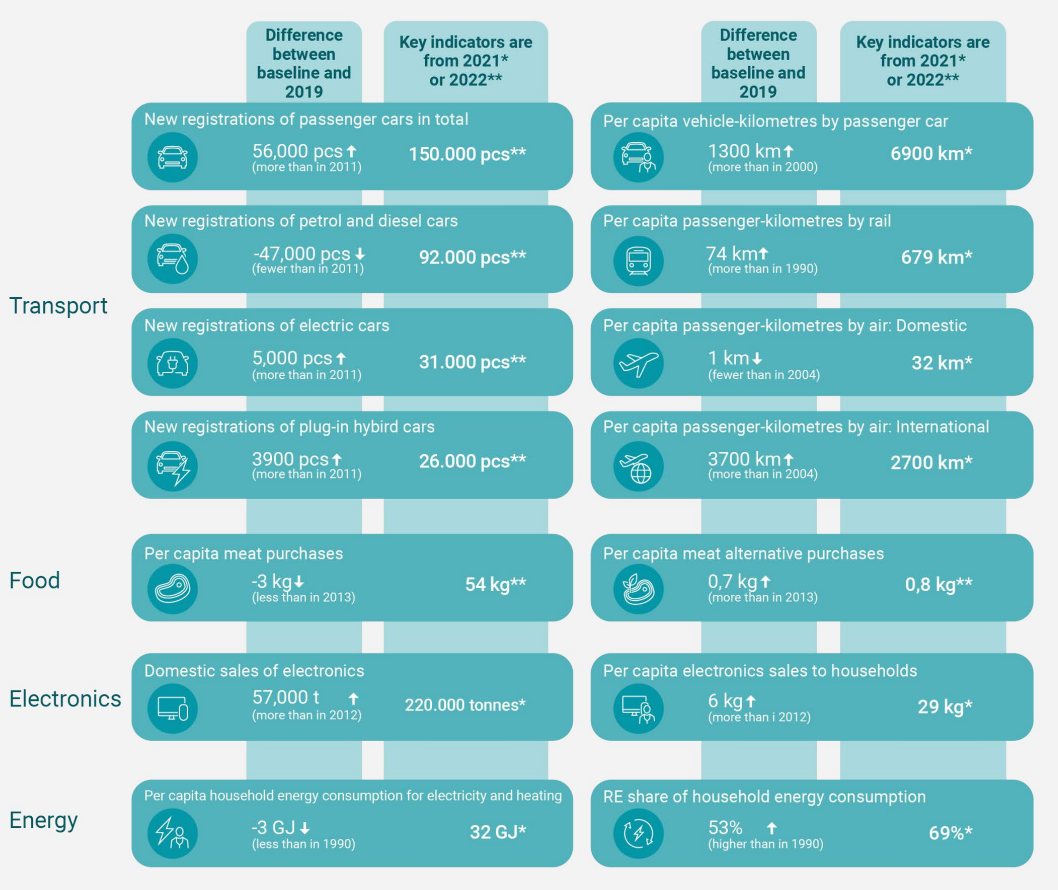
To give a more detailed understanding of Denmark's consumption, this chapter describes a number of key indicators for consumption areas with a significant climate footprint. These consumption areas are transport, food products, electronics and energy. The key indicators are of specific activities such as 'aircraft-kilometres flown' or 'tonnes electronics sold'. Where possible, 1990 has been chosen as the basis for developments in key indicators in the analysis.

4.1 Main results

4.1.1 Developments in key indicators are attributable to the general economic development

In general, developments in the individual key indicators are attributable to economic development in society. Consumption is affected by a generally increasing level of wealth. However, economic fluctuations have also affected developments. The onset of the financial crisis in 2008 and of the Covid-19 pandemic in 2020 affected the key indicators in the relevant years. Most of the key indicators reflect an increase in the level of activity for consumption.

Figure 9: Key indicators for 2021 and 2022 and developments in each key indicator



Source: The Danish Energy Agency, Statistics Denmark, Danish Producer Responsibility (DPA), Euromonitor. **Note:** Where possible, the arrow indicates a development from 1990. Developments in the following indicators are based on later years for data accessibility reasons. New registrations of passenger cars: 2011, aviation passenger-km: 2004, Sale of meat and meat substitutes: 2013, Sale of electronics: 2012.

4.1.2 Passenger transport by car and aircraft is increasing

The key indicators for transport show that the most emissions-intensive passenger transport is increasing, if the effects of lockdowns during the Covid-19 pandemic in 2020 to 2021 are excluded, as these influenced transport by passenger car and aircraft significantly. The annual number of per capita passenger-kilometres travelled by aircraft increased by around 3,500 from 2004 to 2019. This increase is attributable exclusively to international aviation, as domestic aviation passenger-kilometres have gone down by 30% since 1990. The period from 2000 to 2009 saw a relatively modest increase in the number of per capita vehicle-kilometres, but from 2010 to 2019 the number increased considerably and was around 1,100 km higher in 2019 than in 2010. New registrations of passenger cars also saw a general increase up to 2019.

Since 2019, new registrations of plug-in hybrid cars and electric cars have increased, whereas new registrations of petrol and diesel cars have declined, although petrol and diesel cars are still being sold in far larger numbers than plug-in hybrid cars and electric cars. There was an overall fall in new registrations of vehicles in the period 2020-2022. The number of passenger-kilometres by rail followed a slight upwards trajectory from 1990 and onwards but fell steadily from 2013 to 2019. From 2019 and onwards, passenger-kilometres by rail have declined considerably.

4.1.3 A slight drop in meat consumption

The key indicator of consumption of food products describes annual purchases of meat per person in Denmark. Developments show a slight drop of 2 kg per person in the period 2013 to 2022. In 2013, the average quantity of meat per person was 56 kg, and, in 2022, it was 54 kg. The drop is most prominent for purchases of pork, which is paralleled by an increase in purchases of poultry. The slight total decrease in meat sales indicates a trend towards smaller per capita meat consumption. Furthermore, data shows that meat substitutes are gaining traction with average per capita purchases of 0.8 kg in 2022.

4.1.4 Sales of electronics have gone up for both households and businesses

The key indicator for electronics shows that sales of electronics in Denmark have gone up since 2012. There has been an increase in household electrical and electronic equipment, particularly within the categories large and small equipment, such as vacuum cleaners, washing machines, dish washing machines and tools. Furthermore, per capita purchases of electronics have increased in volume by around 8 kg annually from 2012 to 2021. The most dramatic increase is in the period 2019 to 2020, reflecting large demand for electrical and electronic equipment during the Covid-19 lockdowns. The largest increase in the business sector covers purchases of refrigerators and production equipment.

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

Danish energy statistics show that overall electricity and heating consumption per capita in households was lower in 2021 than in 1990, and the renewables share increased

considerably during the period. 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 2010-2021 saw a clearer overall decrease, with consumption falling to 32 GJ per capita in 2021. The share of renewable energy in household energy consumption increased consistently between 1990 and 2021. In 1990, the renewables share in household energy consumption was 10%; in 2021 it was 69%. Solid biofuels accounted for around 60% of the renewable energy share in 2021, while the remaining around 40% was attributable to other renewable energy sources such as wind, solar and hydro, as well as other bioenergy.

5 The climate footprint of imports

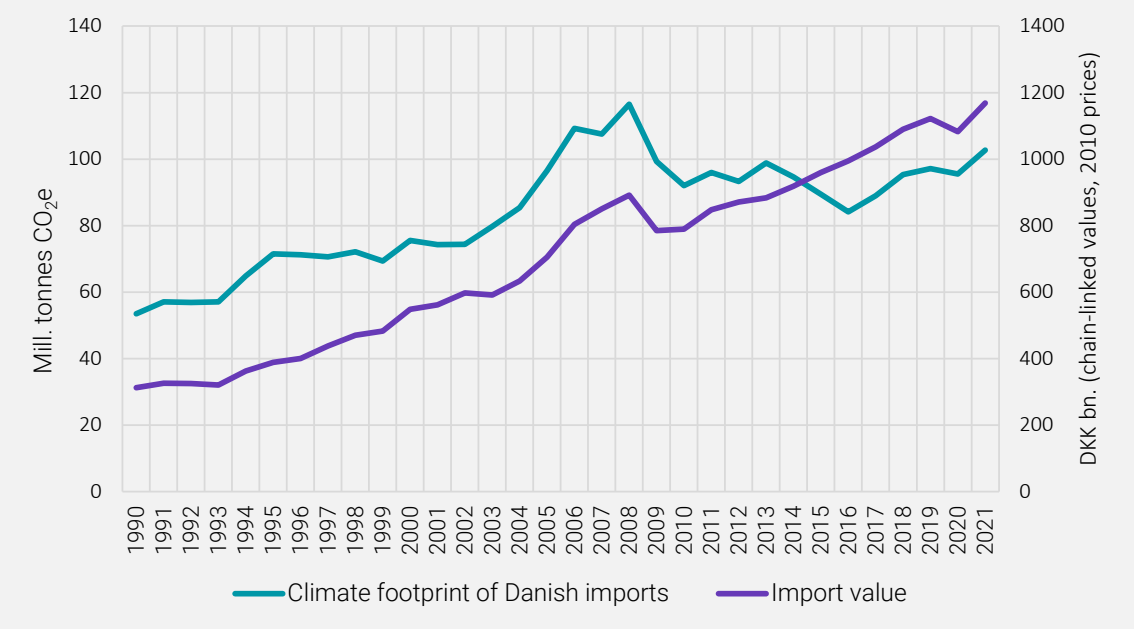
This chapter describes greenhouse gas emissions embedded in Danish imports in the period 1990 to 2021. The estimate includes the entire value chain for imported goods and services up to the point where they transfer from foreign to Danish hands. A German car bought in Denmark will be associated with 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.

5.1 Main results

5.1.1 Emissions from Danish imports in 2021 were 103 million tonnes CO_2e

Emissions embedded in imported goods and services have been estimated at 103 million tonnes CO_2e in 2021. This corresponds to around 1.5 times Denmark's consumption-based climate footprint. The estimate shows that around 65% of emissions embedded in Danish imports were embedded in goods and services exported onward again from Denmark, while the remaining emissions were associated with consumption of the goods and services in Denmark. The estimate also shows that emissions from imports have nearly 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 and then dipped abruptly. From 2020 to 2021, emissions increased by 7 million tonnes CO_2e. This increase is related to a significant increase in imports from 2020 to 2021 in monetary terms, among other things due to less world trade in 2020 as a result of the Covid-19 pandemic.

Figure 10: Developments in emissions embedded in Danish imports in DKK



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

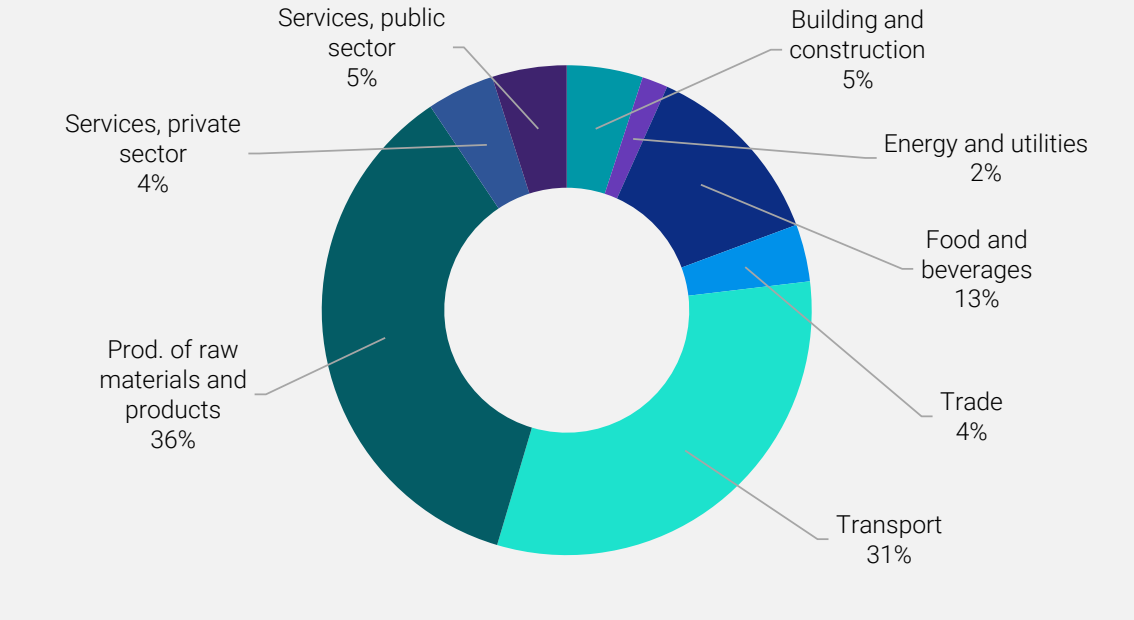
5.1.2 Climate footprint of Danish imports per DKK imported has decreased

The value of Danish imports puts emissions from imports into perspective. Figure 10 shows that the value of Danish imports has been following an upward trend since the financial crisis, and emissions in 2021 have been estimated at around the same level as after the financial crisis. Thus, according to the estimate, over the past ten years, the climate footprint of Danish per DKK imported has decreased.

5.1.3 Emissions from imports are associated in particular with raw materials and products, as well as transport

The largest share (36%) of emissions embedded in Danish imports in 2021 was related to imports of raw materials and products. Raw materials and products include imports from oil refineries, the pharmaceutical industry and the clothing industry, for example. See figure 11.

Figure 11: Share of emissions from Danish imports by foreign industry groups (%)



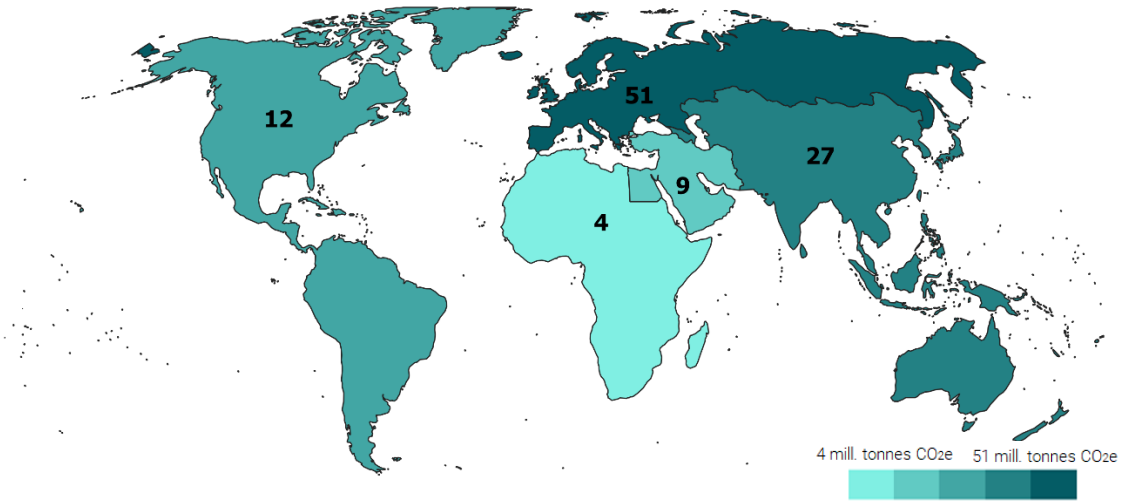
Source: The Danish Energy Agency.

The estimate shows that 31% of emissions embedded in Danish imports were related to foreign transport sectors, the majority of which are due to shipping. The large share attributable to shipping is a consequence of the relatively large size of Denmark's transport fleet. Denmark's transport fleet buys significant amounts of fuel abroad, and also buys transport services from foreign transport companies. These purchases are categorised as imports. By far the majority of emissions related to transport sector imports are exported onward again to other countries in situations in which Danish shipping companies carry goods that are not consumed in Denmark (see chapter 6 on exports).

5.1.4 The majority of Danish imports emissions occurred in Europe

Denmark imported goods and services from large parts of the world in 2021. Figure 12 shows that around half of emissions embedded in Danish imports occurred in Europe (around 51 million tonnes CO_2e), followed by Asia (around 27 million tonnes CO_2e).

Figure 12: Emissions from Danish imports by five regions in 2021 (million tonnes CO_2e)



Source: The Danish Energy Agency. Note: Breakdown of the world into regions is based on EXIOBASE, version 3.8.2. Figures have been rounded.

At country level, the largest climate footprint from Danish imports was in Germany with around 12 million tonnes CO_2e. The majority of these emissions occurred in the German shipping industry, which transports goods to Denmark and also transports goods to other countries on behalf of Danish shipping companies. This is followed by the electricity supply sector and the agriculture sector. The second-largest climate footprint at country level was in China with around 11 million tonnes CO_2e. The largest share of emissions from Danish imports from China occurred in the Chinese electricity supply sector, which supplies the electricity used to produce the products that China exports to Denmark. This is followed by metal manufacturing, which relies directly on fossil energy such as coal and gas for a number of processes that require very high temperatures.

6 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.

6.1 Main results

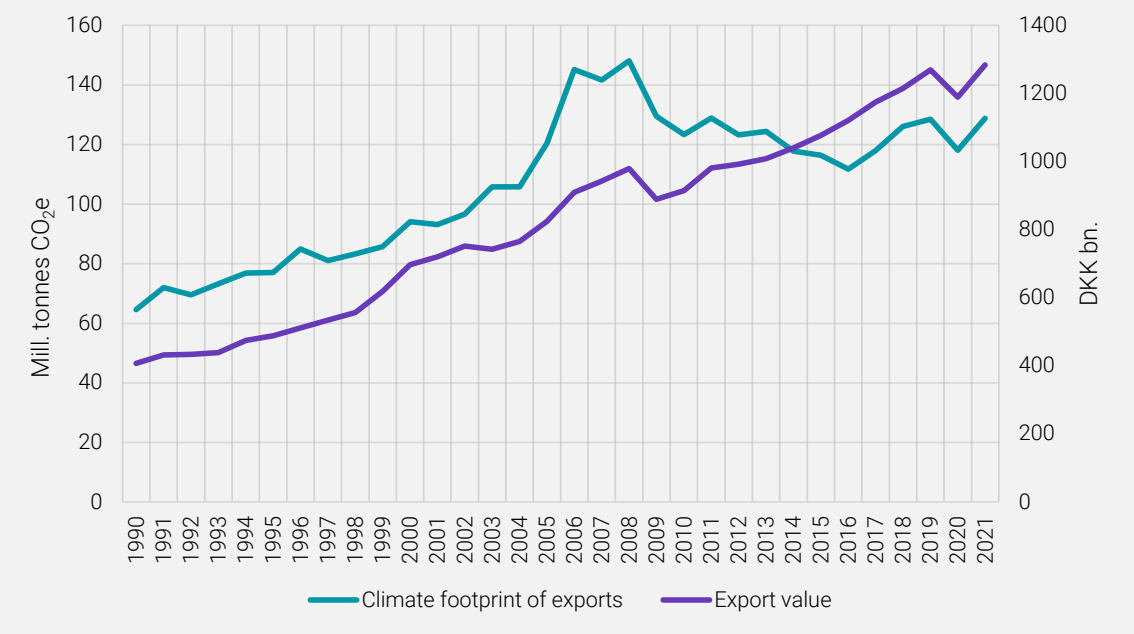
6.1.1 Emissions from Danish exports in 2021 were 129 million tonnes CO_2e

Emissions from Danish exports in 2021 have been estimated at 129 million tonnes CO_2e. This corresponds to almost two times Denmark's consumption-based climate footprint. In other words, Danish exports are associated with more emissions than Danish consumption, which is because Denmark has an open economy and extensive trade with the rest of the world. Around 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 included in products that Denmark produces and exports. The remaining half of the emissions occur on Danish territory.[7] A large part of emissions from Danish exports is associated with freight of goods by Danish shipping companies using Danish-operated ships.

Figure 13 shows that emissions embedded in Danish exports have doubled since 1990, which is linked to increased exports measured in terms of monetary value. From 2020 to 2021, the climate footprint of Danish exports increased by 11 million tonnes CO_2e. Emissions in 2021 have been estimated at around the same as in 2019, reflecting a significant dip in 2020 as a consequence of the challenges facing global trade in the wake of the Covid-19 pandemic. The increase in 2021 is therefore primarily due to the increased freight activity of Danish shipping companies.

[7] Danish 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.

Figure 13: Developments in emissions from Danish exports and export value



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

6.1.2 Climate footprint of Danish exports per DKK exported has decreased

The climate footprint per DKK exported decreased in the period from 2006 to 2016, but has remained relatively constant since then. Emissions from exports include both Danish Danish and foreign emissions. Changes in production structures abroad may therefore be a contributing factor behind the climate impact remaining constant in recent years.

6.1.3 The transport sector accounts for around one-half of emissions from Danish exports

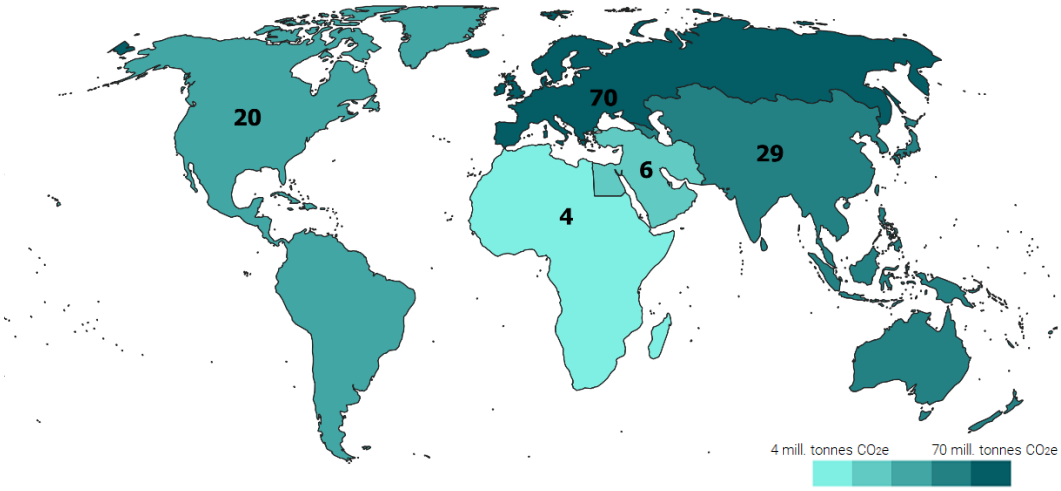
In 2021, export activities by the Danish transport sector accounted for around half of emissions from Danish exports, according to the estimate. Danish-operated ships within shipping are estimated to account for 89% of these emissions. The reason that shipping accounts for a large share of Danish exports 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 products from oil refineries, pharmaceutical products as well as wind turbines and engines are estimated to account for a significant share.

6.1.4 Half of emissions from Danish exports went to Europe

In 2021, Denmark exported goods and services to several different countries. Figure 14 shows embedded emissions by five regions of the world 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, around half of

emissions embedded in Danish exports related to exports to Europe. The second-largest recipient was Asia.

Figure 14: Emissions from Danish exports by five regions of the world in 2021 (million tonnes CO_2e)



Source: The Danish Energy Agency. Note: Breakdown of the world into regions is based on EXIOBASE, version 3.8.2. Figures have been rounded.

The US and Germany are Denmark's two largest export markets, and Danish goods and services exported to these countries are estimated to account for the largest amount of embedded emissions, with 14 and 13 million tonnes CO_2e, respectively. For both countries, purchases of services within shipping caused the largest amount of emissions. In the US, a large share of these emissions was embedded in exports from the pharmaceutical industry, while a significant share of emissions embedded in exports to Germany was related to exports from the food sector.

7 The climate footprint of public procurement

This chapter describes the climate footprint of public procurement, including a projection to 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 2. The results can therefore not be directly compared.

7.1 Main results

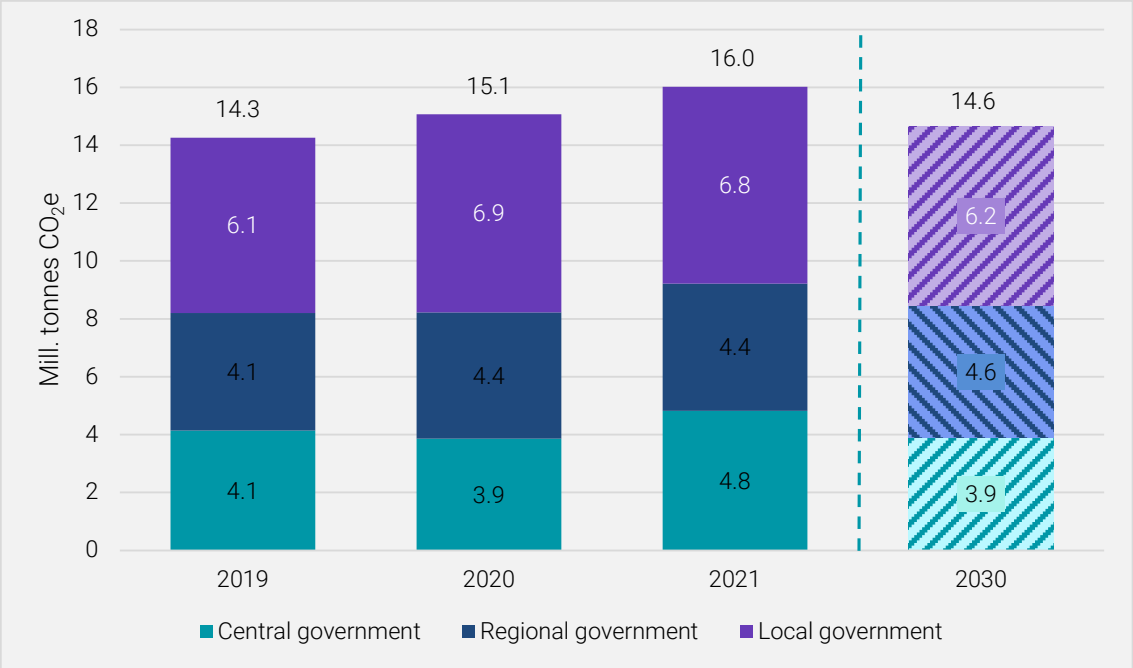
7.1.1 The climate footprint of public procurement increased to 2021, but is expected to decrease going forward

Figure 15 shows the climate footprint of Danish public procurement in 2019, 2020 and 2021, as well as a projection to 2030. The climate footprint of public procurement for 2021 has been estimated at 16 million tonnes CO_2e. The footprint has increased by 12% since 2019, see figure 15. This increase is due in particular to investments in building and construction as well as procurement of 'other goods', which includes increased expenditure on pharmaceuticals and medical devices during the Covid-19 pandemic. Public procurement by central government accounted for 30% of the climate footprint of public procurement in 2021, while regional and local governments accounted for 27% and 42%, 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 14.6 million tonnes CO_2e in 2030, which is 0.3 million tonnes higher than in 2019 and 1.4 million tonnes lower than in 2021. The baseline chosen for the projection is 2019. This is because of the extraordinary circumstances caused by the Covid-19 pandemic in 2020 and 2021.

Seen in isolation, a predicted greener energy mix in 2030 will reduce the climate footprint. However, this effect will be offset by an expected increase in public procurement, particularly within building and construction. The projection of public procurement is based on the Danish Ministry of Finance's medium-term projection of spending limits, "*2030-planforløb: Grundlag for udgiftslofter 2026*". 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 level is expected to increase from DKK 197 billion in 2019 to DKK 216 billion in 2030 (both in constant 2021 prices).

Figure 15: The climate footprint of public procurement by central, regional and local government in 2019, 2020 and 2021, as well as projected to 2030



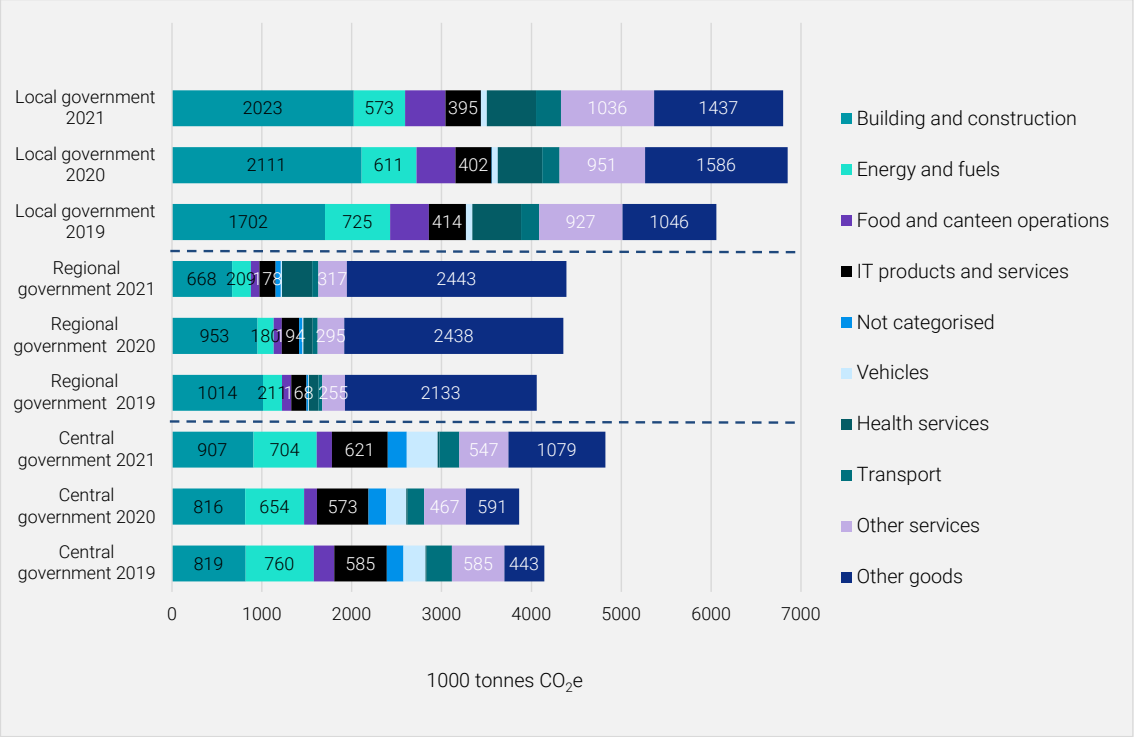
Source: The Danish Energy Agency.

The projection assumes a higher percentage of renewable energy in Denmark and other countries, but does not take into account possible technological advancements in the production of goods and services. Nor does it take into account possible implementation of 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.

7.1.2 Building and construction is a large emitter

Figure 16 shows the climate footprint of Danish public procurement in 2019, 2020 and 2021 by procurement area. The climate footprint increased from 2019 to 2021 in all categories except for 'energy and fuels' and 'food and canteen operations', see figure 16. 'Building and construction' is one of the largest emitters across all categories of public procurement. In addition to being a major financial item, this category has a relatively high emissions per DKK ratio. The procurement categories 'other goods' and 'health services' have seen the largest percentage increases in emissions from 2019 to 2021. This is due to procurement of pharmaceuticals and medical devices during the Covid-19 pandemic.

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



Source: The Danish Energy Agency.

The model used for the estimate is based on recognised methods of calculation. However, the current data basis has a limitation in that it does not allow for distinction between different product alternatives and therefore does not allow for taking account of procurement of products with smaller climate footprints. For this reason, at present, the model does not reflect all developments within the categories. Furthermore, a majority of purchases have been estimated in monetary terms, and the results are therefore sensitive to price changes. In overall terms, more expensive procurement will result in a larger climate footprint in the current calculation model. This is a limitation of the model, in particular in cases in which an alternative, green product is more expensive than the conventional product.

8 The climate footprint of textile consumption

This chapter focuses on textile purchases, i.e. clothing and home textiles, in Denmark in 2021, and the associated climate footprint. The chapter describes the flow of textiles in three steps: production, use, and waste management/reuse. The emissions embedded in each step have been estimated. The flow of textiles is based on data from the Danish Environmental Protection Agency and Statistics Denmark.

There is a general lack of data on the textile sector. The analysis is therefore associated with significant uncertainty, and it has not been possible to calculate greenhouse gas emissions for all the components of the overall flow of textiles. Textile production is also associated with a number of other environmental consequences; however, these are not addressed in this report.

The results are not directly comparable with the results of the estimate of Denmark's consumption-based climate footprint because the methodologies applied differ.

8.1 Main results

In 2021, households, businesses and the public sector bought newly manufactured clothes and home textiles corresponding to around 116,000 tonnes textiles. Of these, around 93% were produced abroad,[8] see figure 17. The estimate only considers the flow of textiles up to the *first user*. In other words, the estimate does not consider that reused clothes also eventually become waste.

Clothing and home textiles can consist of many different types of fibres in the form natural fibres such as cotton or plastic fibres such as polyester. It has been estimated that 60% of the fibres in clothes were plastic fibres in 2017. For home textiles the figure was 70% (EEA, 2021).

8.1.1 The majority of emissions are associated with the production of clothes outside Denmark

The climate footprint of the entire production chain and transport of textiles bought in 2021 has been estimated at 2.5 million tonnes CO_2e. A little under 95% of these emissions occurred outside Denmark. Clothes account for the largest share of the supply of textiles (78%) and also contribute most to the climate footprint.

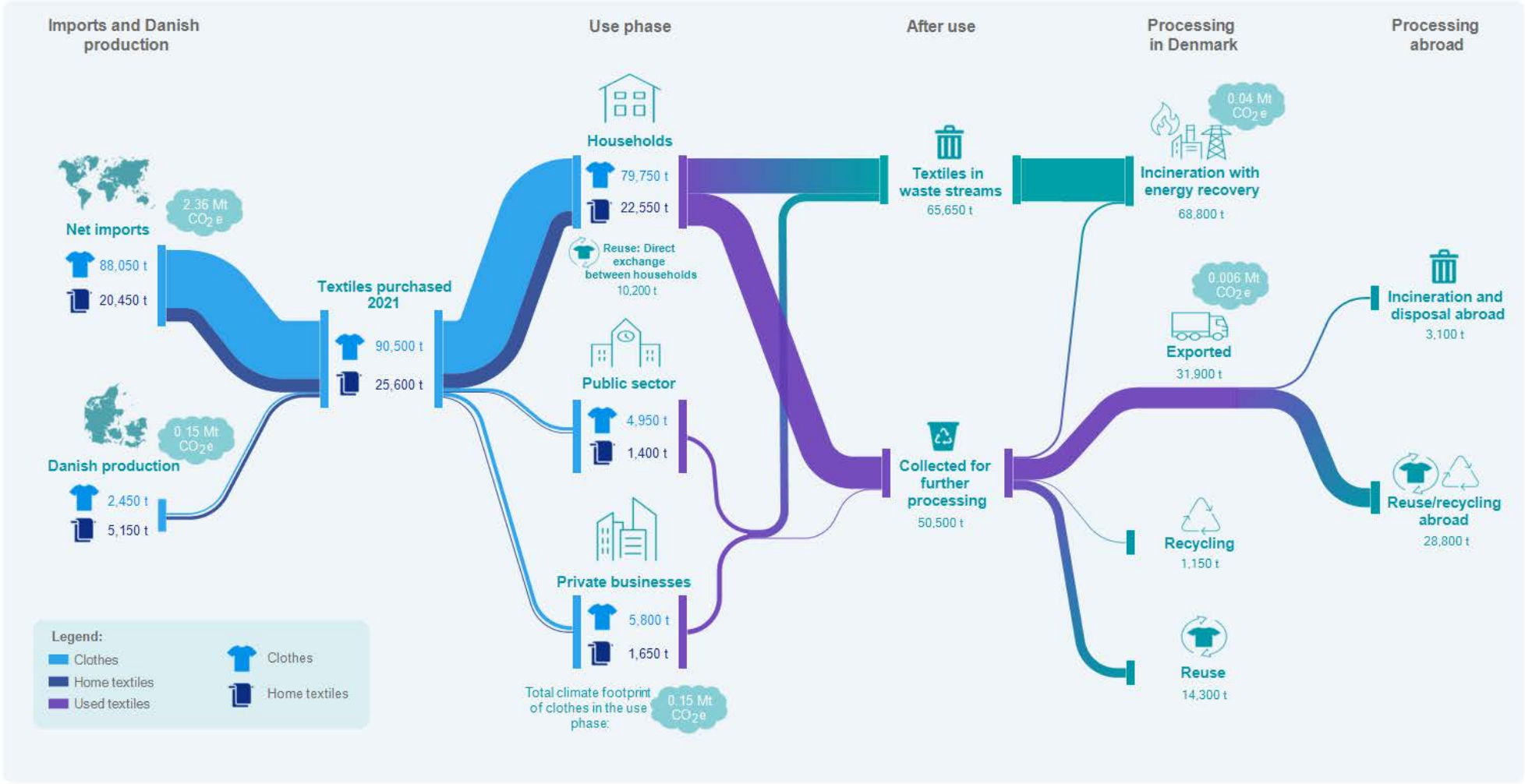
8.1.2 Washing, ironing and tumble-drying clothes also leave a climate footprint

The use phase of clothes causes greenhouse gas emissions when electricity is used to wash, iron and tumble dry the clothes. The use phase of the clothes bought in 2021 has been estimated to entail emissions of around 0.15 million tonnes CO_2e over the estimated lifetime of clothes. The relatively small climate footprint is because the

[8] Clothes include trousers, shirts, underwear, etc., but not shoes or clothes made from leather. Home textiles include towels and bedding, but not textiles that are a part of another product, such as sofas or car upholstery.

climate footprint was only estimated for *the textiles bought in 2021* and not for all textiles already in use. Furthermore, electricity consumption for washing and tumble drying only accounted for around 9% of total power consumption (excluding electricity for heating) in Danish households in 2021.

Figure 17: Flow of textiles and emissions associated with textiles bought in 2021 for consumption in Denmark



Source: The Danish Energy Agency, based on data from the Danish Environmental Protection Agency and Statistics Denmark. Note: It has not been possible to estimate the climate footprint of a number of processes, including recycling, transport to the consumer, washing and sales of reused textiles. Rounded to the nearest 50.

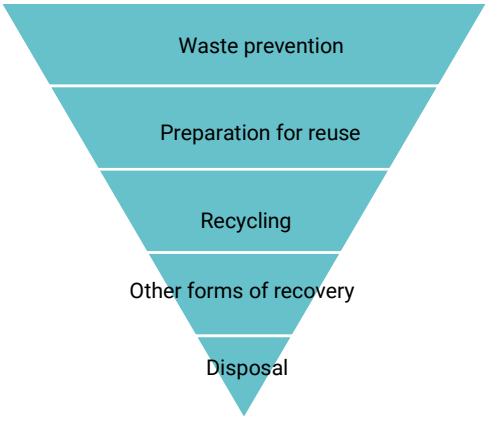
8.1.3 Most textiles end up at waste incineration plants

Several things can happen to textiles after the use phase. Figure 17 shows that most used textiles end up at waste incineration plants (around 59%). Incineration of the textiles bought in 2021 has been estimated to cause emissions corresponding to around 0.04 million tonnes CO_2e.[9] Denmark has decided that local governments are to collect textiles separately from households from 1 July 2023.

Around 12% of textiles go on to be reused in Denmark. Moreover, around 10,000 tonnes go on to be reused by households, for example they are exchanged between friends and family or via online platforms for second-hand clothes. Only a very small share of textiles are estimated to be recycled in Denmark (<1%).

Box 7: Waste hierarchy

When textiles become waste, they can be recovered in different ways. Of course, preventing textile waste altogether will create the greatest value. For example, if we reduce the quantities of clothes bought in the first place, or if we use clothes for a longer period before discarding them, we can reduce the quantities of textile waste.



Source: The EU Waste Framework Directive (European Commission, 2023.

Next after prevention comes reusing clothes. For example, passing on clothes no longer needed to friends or family or to charity. Clothes suitable for use for longer or for reuse must be of a certain quality with regard to durability, quality of fibre, etc.

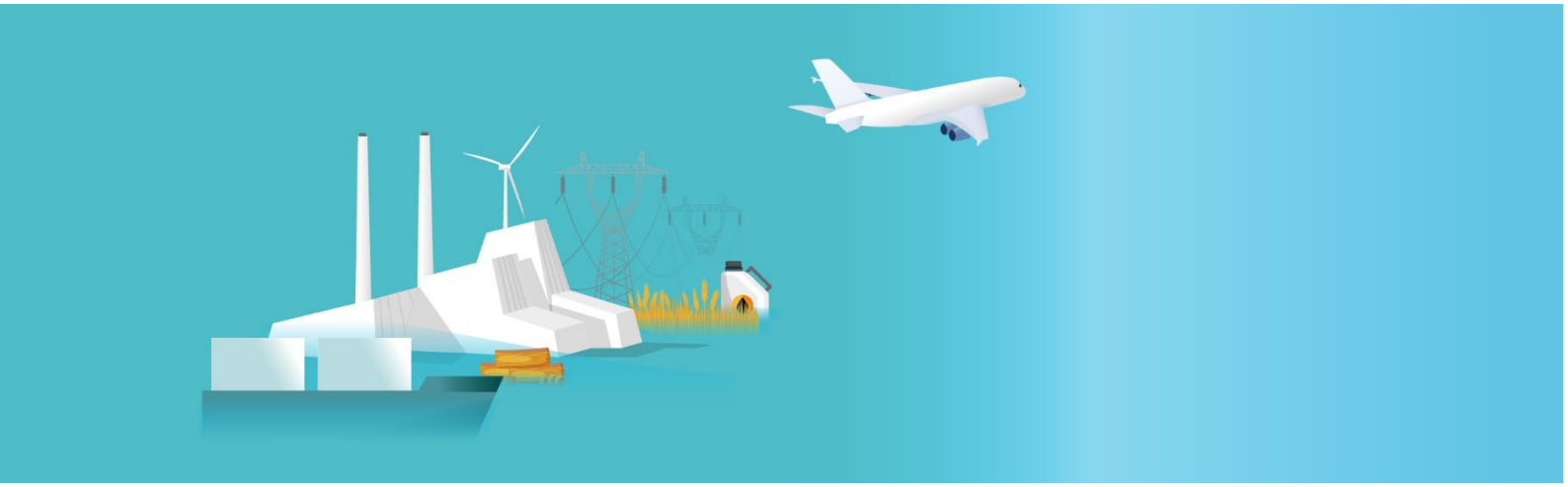
If clothes are not suitable for reuse, they could be recycled. When clothes are recycled they are decomposed and the fibres are used to produce new products. For example, recycled materials, insulation materials, or something completely different. Clothes are only suitable for recycling if they are homogeneous products; that is, made up of the same type of fibres.

Upon recycling, the quality of the fibres deteriorates, which means that the lifetime of the recycled product is poorer than the original products.

If a piece of textile is neither suitable for reuse nor for recycling, it may still be recovered in some other way. For example, it may be exploited for energy through incineration at CHP plants and, thus, contribute to the production of electricity and district heating. Finally, at the bottom of the hierarchy, there is disposing of the clothes at landfills or similar.

Around one-quarter of textiles are exported to countries outside Denmark. Textile exports entail emissions from transporting the textiles. These emissions have been estimated at around 0.006 million tonnes CO_2e (6,000 tonnes CO_2e) for transport of the textiles to the first stop outside Denmark. It has not been possible to estimate emissions abroad from incineration, landfilling and recycling abroad.

[9] This includes upstream emissions, for example electricity to run the waste incineration plant or ongoing maintenance of plant. Biogenic emissions are not included in the estimate.



Energy and international transport

This part of GR23 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, this chapter looks at Denmark's energy balance and consumption of biomass and biofuels. With regard to transport, the chapter looks at international transport within shipping and aviation related to Denmark.

Chapter 9 *Fuel and electricity trade* describes Denmark's imports and exports of fuels and the electricity trade between Denmark and other countries.

Chapter 10 *Solid biomass fuels* describes greenhouse gas emissions related to Danish consumption of biomass, focussing on electricity and district heating production. The estimate of Denmark's consumption-based climate footprint only includes emissions from transport and processing of the biomass, whereas the estimate in this chapter also includes biogenic emissions from biomass burning as well as indirect impacts.

Chapter 11 *Biofuels* describes greenhouse gas emissions related to production of biofuels used in Denmark. This chapter is based on Denmark's EU reporting on emissions from biofuels.

Chapter 12 *International transport* describes the greenhouse gas emissions related to international aviation and shipping. Emissions from aviation include emissions related to international flights into and out of Denmark as well as bunkering abroad by Danish-operated aircrafts. 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 trade, electricity trade, solid biofuels, fuels for transport including biofuels, and international transport.

9 Fuel and electricity trade

For the first time in Denmark's global climate impact reporting, this chapter presents estimates of Denmark's electricity trade *and* Denmark's fuel trade. GR23 therefore provides a more nuanced picture of energy flows into and out of Denmark than GR22.

The chapter on fuel trade provides an outline of Danish imports and exports of coal, oil, natural gas, solid biomass, bioliquids and other fuels. Danish 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. For other fuels, the chapter describes emissions from burning fuels, which means another approach is used for these fuels than for the estimate pertaining to PtX.

The chapter on electricity trade describes Danish electricity imports and exports, including their global embedded emissions. 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 2022 (CSO22).[10]

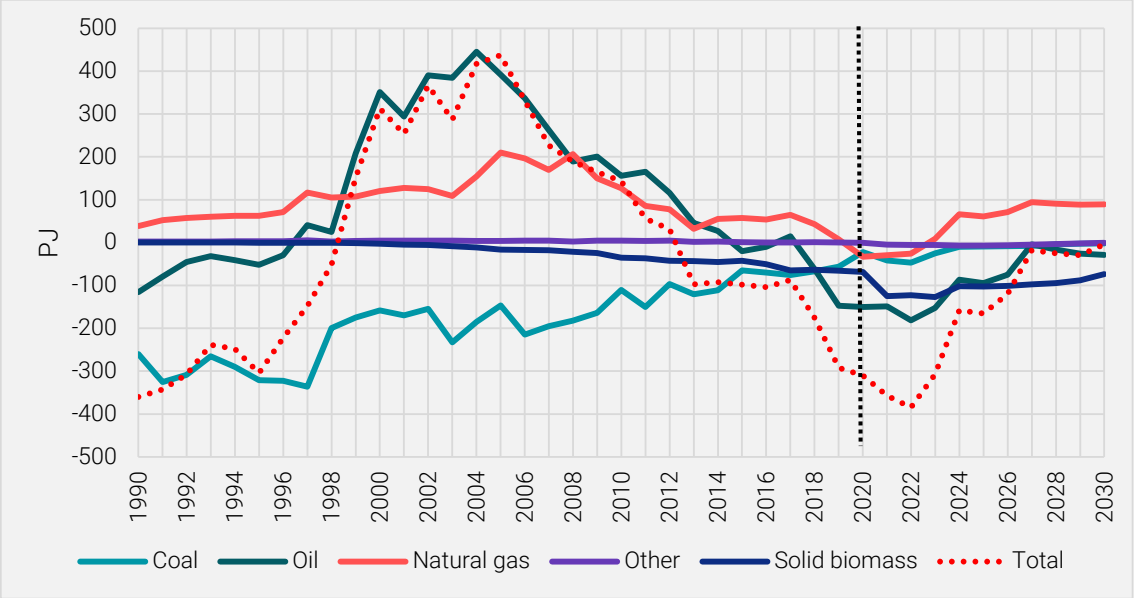
9.1 Main results - fuel trade

9.1.1 Denmark today imports more fuel than Denmark exports

The balance between Danish imports and exports of fuels has fluctuated, tipping towards exports or imports across all fuels since 1990, but with oil and natural gas as the consistently dominant fuel in total imports/exports. In step with falling oil production, in overall terms, Denmark has become a net importer across all fuels, and in 2020 Denmark imported 761 PJ of fuels and exported 451 PJ of fuels. For all fuel categories (coal, gas, oil, biomass and biofuels, etc.), Denmark had greater imports than exports in 2020, see figure 18.

[10] 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 2023, or arising out of binding agreements. The estimate therefore does not reflect the likely to real developments, including the likely effect on foreign emissions, in that the planned energy island in the North Sea, for example, has not been included in CSO23. Furthermore, foreign development trends are based on data from 2020. CSO23 therefore include significant limitations with regard to estimating future impacts.

Figure 18: Net exports of coal, oil, natural gas and solid biomass in the period 1990-2030



Source: The Danish Energy Agency. Note: Positive figures signify greater exports than imports by Denmark of the fuel in question. Figures for 2022-2030 have been projected based on CSO22. The vertical, dotted line marks where the projection starts. Bioliquids and other fuels (including PtX) are included under "Total" but have not been illustrated separately in the figure because they are only exported in insignificant amounts compared with the rest of the fuels.

Danish imports and exports of fuels are expected to remain more or less in balance up to 2030, due, for example, to an increase in extraction of natural gas domestically. However this also depends on the date of commissioning of the new Tyra field in the North Sea.

9.1.2 Fuel imports reliant on fewer countries than previously

Historically, Denmark has imported fuels from a large number of countries. However, in recent years, Denmark has imported relatively larger quantities of fuels from fewer countries. That Denmark imports fuels from fewer countries may be due to a number of factors, including that the need to import fossil fuels has fallen and been replaced by a need to import biomass.

This applies to coal imports, for example. Previously, the country accounting for the largest share of imported coal to Denmark varied from year to year. Since the 1990s, however, this has changed so that, in recent years (2016-2021), coal imports have stemmed primarily from Russia.

9.1.3 Exports to Sweden and imports from Norway dominate

Measured in total import/export quantities, Norway and Sweden are the dominant trading partners. This trend is illustrated in table 1, which 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).

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

Exports		
1990-2000	Sweden	6,907
	The Netherlands	3,021
	Germany	2,643
2000-2010	Sweden	3,310
	The Netherlands	1,579
	Germany	1,366
2010-2020	Sweden	2,386
	The Netherlands	1,115
	United Kingdom	744

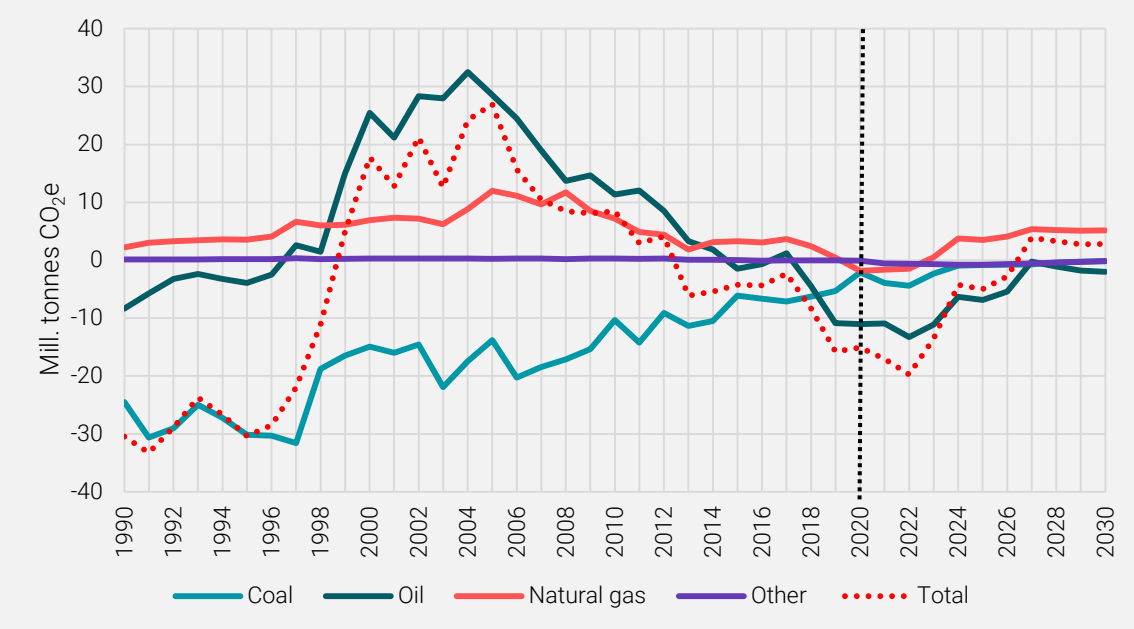
Imports and consumption		
1990-2000	Norway	5,689
	Russia	2,546
	Sweden	1,964
2000-2010	Norway	1,810
	Sweden	799
	Russia	759
2010-2020	Norway	2,061
	Russia	1,459
	Sweden	482

Source: The Danish Energy Agency.

9.1.4 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 since 2013. This is largely due to imports of oil products. However, this is expected to change up to 2030, with emissions from imports becoming smaller than emissions from exports. Emissions from imports are estimated on the assumption that all the fuels are burned. I.e. the import of 1 PJ of natural gas has been estimated to emit what is emitted when burning 1 PJ of natural gas. Figure 19 shows developments in emissions.

Figure 19: Illustration of emissions linked to net exports of fuels from 1990 to 2030



Source: The Danish Energy Agency. Note: Positive figures signify net Danish exports of the fuel in question. Solid biomass, bioliquids and PtX are assumed to be CO_2 neutral. Figures for 2022-2030 have been projected based on CSO22. The vertical, dotted line marks where the projection starts. 'Other' includes waste and liquefied petroleum gas (LPG).

9.1.5 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 2022 (CSO22), Denmark will be a net exporter of PtX from 2023.

Exports of PtX products can potentially reduce CO_2 emissions abroad. However, the size of this reduction potential depends on the fuels replaced by the PtX product and on any conversion losses. Simplified case-calculations demonstrate a general potential for Danish exports of PtX products to reduce CO_2 emissions abroad. The case-calculations 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, at around 104 gCO_2e/MJ, because this case has the lowest conversion loss. In other words, a PtX capacity of 900 MW in Denmark has been calculated to produce 16,300 TJ of hydrogen per year that, if exported to Germany, can replace natural-gas-based hydrogen corresponding to 1.5 million tonnes CO_2e.

If Danish PtX products replace biofuels, there will be a displacement of emissions related to land use (the LULUCF sector). However, the estimate only looks at emissions from burning the relevant fuel, and in this case there will be no reduction in emissions from the displacement of biofuels by PtX.

9.2 Main results - electricity trade

9.2.1 Danish electricity imports contribute to global emissions – also when electricity exports are deducted

Electricity trade between countries is important. For example it helps ensure the sale of cheap green electricity and it reduces the need to establish electricity production capacity. Over the last ten years, Denmark has been a net importer of electricity. In the period 2019 to 2021, Denmark imported electricity corresponding to between 14% and 22% of domestic electricity consumption. Production of electricity imported or exported by Denmark is associated with emissions.[11] Electricity imports are associated with emissions abroad and electricity exports are associated with emissions in Denmark. The estimate shows that, in 2021, Danish electricity imports were associated with emissions of 0.7 million tonnes CO_2e outside Denmark. Danish electricity exports in 2021, on the other hand, were associated with emissions of 0.2 million tonnes CO_2e in Denmark.

According to the estimate, net emissions from electricity trade were between 0.5 and 0.8 million tonnes CO_2e in the period 2019 to 2021. The estimate of net emissions therefore shows that emissions abroad from electricity imported and consumed in Denmark are

[11] The emissions linked to electricity production do not include upstream and downstream emissions. Furthermore, biomass is considered CO_2 neutral.

higher than emissions in Denmark from electricity exported and consumed abroad. Even though 2020 was a so-called 'wet year',[12] in which Denmark reduced its electricity production in favour of electricity based on hydropower imported from Norway, for example, the COBRA cable, which was new at the time, meant that Denmark also imported electricity with a high emission factor from the Netherlands. In combination with relatively low exports, this meant that Denmark overall had higher net emissions in 2020. However, these fell back to the 2019 level in 2021. Table 2 shows the estimate of emissions.

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

Key indicators	Type	2019	2020	2021
Net imports TWh	Imports of electricity	6.3	8.4	6.8
	Exports of electricity	1.9	1.3	2.0
	Net imports	**4.4**	**7.2**	**4.7**
Average emission factors, g CO_2e/kWh	Abroad from Danish imports	114	101	99
	In Denmark from Danish exports	98	71	84
Estimate of emissions, mill. tonnes CO_2e	From Danish electricity imports, emissions abroad	0.7	0.9	0.7
	From Danish electricity exports, emissions in Denmark	0.2	0.1	0.2
	Net emissions	**0.5**	**0.8**	**0.5**
Key indicators: Renewables share (incl. biomass) when Denmark exports, %		83	88	86
Average foreign emission factor when Denmark exports, g CO_2e/kWh.		80	178	272
Key indicators: Reduced emissions abroad from Danish electricity exports, mill. tonnes CO_2e.		0.2	0.2	0.5

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

9.2.2 Higher emission factor for Danish electricity imports than for Danish electricity exports

The estimate shows that the electricity imported to Denmark has a higher emission factor, and, thus, higher CO_2e emissions, than the electricity produced and exported by Denmark. The estimate also shows that the emission factors differ depending on which country Denmark imports electricity from. Thus, the majority of emissions in Danish electricity imports are from Germany, although Denmark imports more electricity from Norway and Sweden. This is because the emission factor for German electricity production is higher than for Swedish and Norwegian electricity production.

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

[12] A 'wet year' is a year with at least 10% more precipitation than normal.

9.2.3 Large share of renewable energy in Danish electricity exports

Danish electricity exports primarily comprise electricity from renewable energy sources.[13] The renewables share in electricity exports was between 80% and 90% in the period 2019 to 2021, which is 4 to 6 percentage points higher than for Danish electricity production on average. This is because the share of renewables is high when Denmark exports electricity. The renewables share in electricity exports was higher in 2020 than in 2021 because there was less wind-based energy production in 2021 than in 2020.

The estimate shows that the renewables share of electricity exports is expected increase in years to come, and that Danish electricity exports are expected to be based almost exclusively on renewable energy in the long term. This is due to expected renewable energy deployment in Denmark, and because hours with high electricity production from wind and solar are likely to lead to Danish exports of electricity. Wind and solar are projected to account for 61% and 37% of electricity exports, respectively, in 2035.

9.2.4 Danish electricity trade likely to benefit the emissions accounts of other countries in future years

Danish electricity exports lead to emissions reductions abroad, as the electricity production of countries buying Danish electricity can then be reduced. The projection also indicates that Danish electricity leads to reductions in the territorial emissions of other countries. This is because Denmark will export relatively large amounts of electricity due to massive deployment until 2035, and because the electricity exported by Denmark has a lower emission factor than the electricity produced in the recipient country. This, in turn, is because Denmark exports electricity during windy hours in particular, and the electricity mix is therefore greener.

9.2.5 Danish electricity exports will continue to reduce global greenhouse gas emissions in future

Danish electricity exports reduce emissions outside Denmark when the electricity exported displaces production based on fossil fuels. The estimate shows that, although the electricity production of countries outside Denmark is becoming greener by the day, Danish electricity exports are expected to also reduce emissions in countries outside Denmark in 2035. The reason for this is that the electricity exported by Denmark is expected to have an emission factor of around 6 g CO_2e/kWh, while the electricity produced abroad during hours when Denmark exports electricity has been estimated to have an emission factor of around 13 g CO_2e/kWh.

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

10 Solid biomass fuels

Since 1990, Denmark has replaced a significant part of its fossil fuel consumption in electricity and heating production with solid biomass fuels (biomass) (ENS, 2020).

Under the UN IPCC guidelines, harvesting of wood and other biomass is accounted for 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 accounted for in connection with harvesting the biomass, see the UN IPCC guidelines (IPCC, 2006). Emissions from Danish-produced biomass are therefore included in Denmark's official climate accounts, whether the biomass is consumed domestically or exported. 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. Furthermore, biomass used for energy production in Denmark must comply with a number of EU sustainability criteria, as well as strict Danish requirements.

GR23 takes a different perspective on emissions from biomass, in that it presents an overall estimate of all emissions associated with the use of biomass in the Danish utilities sector. The chapter focusses on wood pellets and wood chips, which are used in production of electricity and district heating in the collective supply system.[14] Wood accounts for the majority of solid biomass fuels in the Danish utilities sector. Most of these fuels have been imported.[15]

Emissions from burning biomass can be estimated in many 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. Of these assumptions, 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.[16]

A description of the climate impact of Danish consumption of solid biomass fuels in 2021 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 solid biomass fuels presented in this chapter cannot be directly added to Denmark's consumption-based climate footprint presented in chapter 2.

[14] Consumption by manufacturing industries and households of woody biomass for electricity and heat production has not been included in the calculations.
[15] Imports account for 52% of total Danish consumption of wood pellets, wood chips, firewood and wood waste in energy production (ENS, 2022b). See figure 2 in the relevant background memorandum.
[16] Consumption of wood for energy production also affects forest biodiversity. This has not been addressed in GR23, but see, for example, (JRC, 2021).

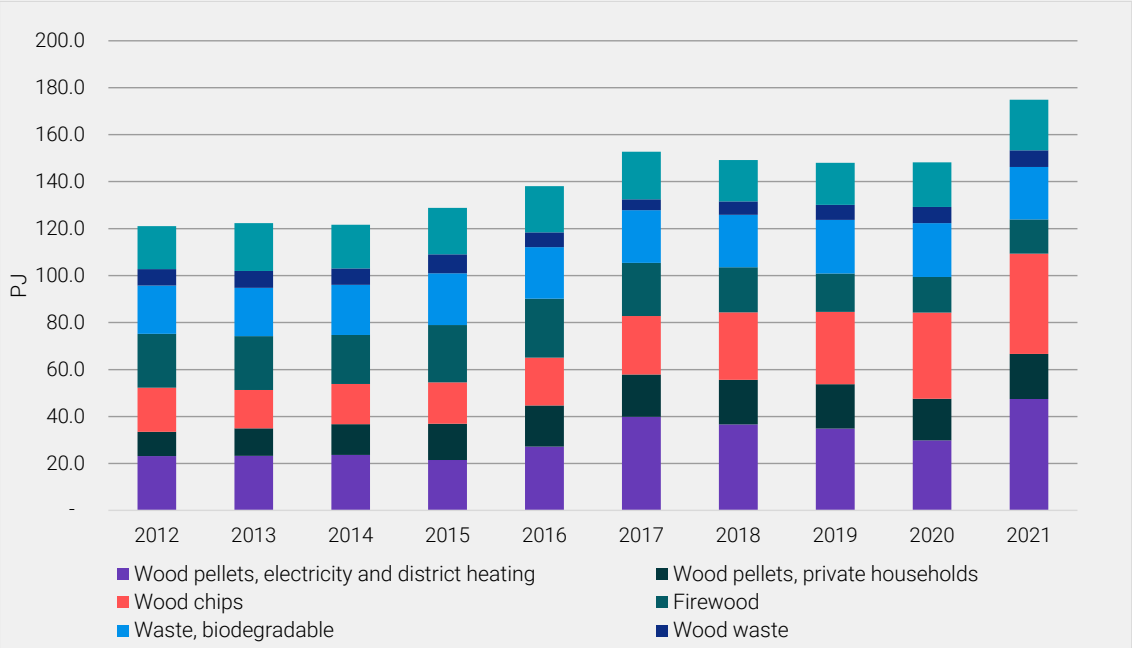
10.1 Main results

10.1.1 Wood pellets and wood chips dominate consumption of solid biomass fuels

Figure 20 shows that total Danish consumption of solid biomass fuels for production of electricity and heating in the period 2012-2021 rose from 121 PJ to 175 PJ. Consumption increased by 37 PJ from 2020 to 2021. The increase was primarily due to high electricity and natural gas prices during the second half of 2021, which led to increased biomass-based production of electricity, in particular. Consumption of solid biomass fuels by households, etc. (wood pellets and firewood) came to 41 PJ in 2021, i.e. almost 23% of the total consumption figure.

Wood pellets and wood chips together accounted for the largest share of total consumption of solid biomass fuels in 2021 (63%), with 81% being used in the production of electricity and district heating. This corresponds to consumption of 88 PJ. The following describes the emissions related to this use of wood pellets and wood chips in electricity and district heating production, as wood pellets and wood chips account for most of the consumption, have the best available data basis and are mostly imported to Denmark from other countries.

Figure 20: Danish consumption of solid biomass fuels for electricity and heating 2012-2021



Source:(ENS, 2022). 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%.

10.1.2 Net emissions from a single year's consumption of wood pellets and wood chips for electricity and district heating decrease over time

In the production of energy from woody biomass, wood is 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. For all these alternatives, except in-situ burning without energy recovery, 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 pellets and wood chips for electricity and district heating fall to zero 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 re-established and the trees would have been felled anyway, even if there was no demand for bioenergy, see box 8. As global warming is continuous, the temporary displacement of the carbon pool from forests to the atmosphere has an impact on the climate.

Box 8: Net emissions from consumption of woody biomass

The results of net emissions associated with Danish consumption of wood fuels for the production of electricity and district heating are based on an analysis from the Department of Geosciences and Natural Resource Management at the University of Copenhagen, as well as on recalculation of the main results from said analysis on the basis of data on consumption in 2021.[17] The net emissions are the increased content of CO_2 in the atmosphere caused by consumption of the biomass fuels. The calculation of total net emissions from consumption of wood fuels includes observed emissions from energy production, process emissions and emissions from indirect impacts. Total net emissions take account of the alternative fate of the wood, in that the alternative emissions that would have occurred over time as the wood rots 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, including emissions from felling trees that would otherwise not have been felled and emissions embedded in wood-use change resulting from the use of wood fuels in energy production.[18]

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

Seen in isolation, Danish consumption of wood pellets and wood chips for electricity and district heating in 2021 led to emissions of 10.6 million tonnes CO_2 in the year of consumption, of which the emissions linked to the use of fossil fuels from production

[17] *"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 2021 input data"*. Anders Tærø Nielsen, 2023.

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

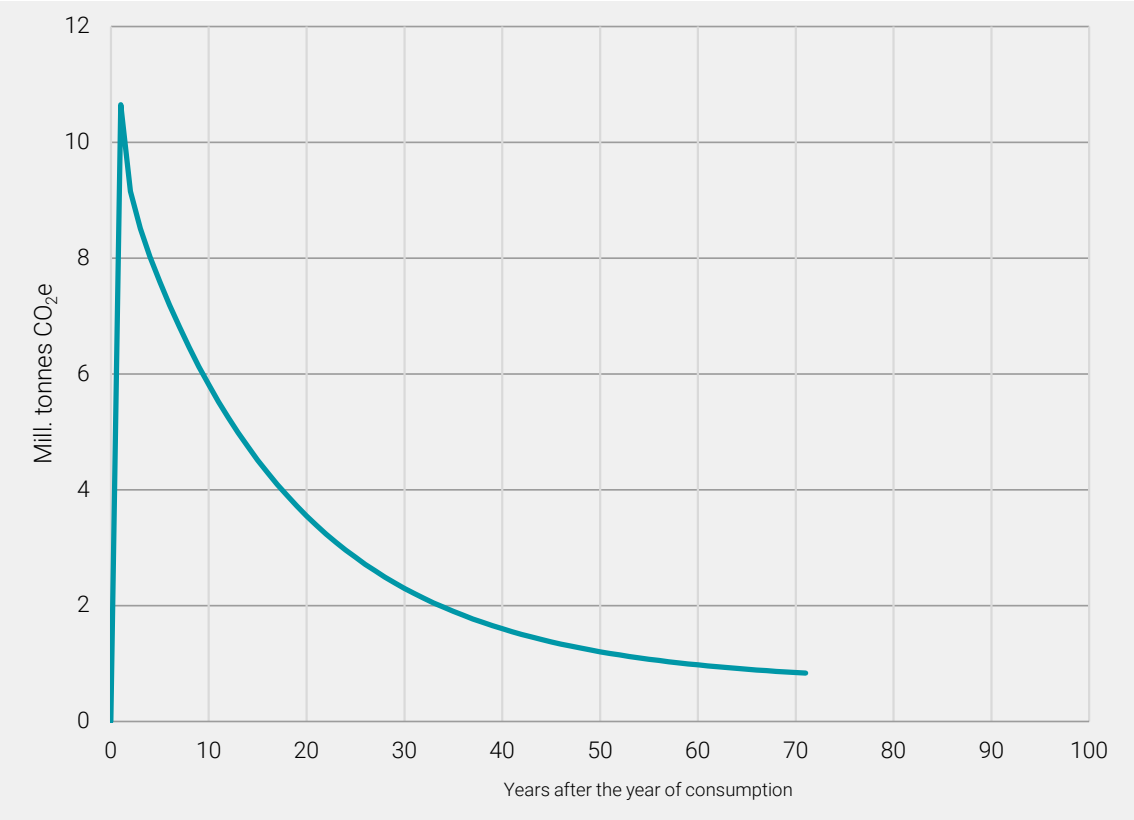
and transport, etc. amounted to 0.5 million tonnes CO_2. The biogenic emissions of 10.1 million tonnes CO_2 correspond to the carbon content in the wood burned for energy production. Figure 21 illustrates the drop in overall net emissions over 100 years following 2021; the year of consumption. The reason for the drop is that the emissions that would otherwise have occurred over this period due to the wood rotting, for example, do not materialise because the wood has already been 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 2021 will be 5.8 million tonnes (a drop of 45%), after 20 years 3.5 million tonnes (a drop of 67%), and 30 years after consumption year 2021, net emissions will have dropped to 2.3 million tonnes (a drop of 78%).

Emissions in the year of consumption have been estimated to have increased by 3 million tonnes CO_2 from 2020 to 2021. This is primarily due to a corresponding increase in consumption from 2020 to 2021. The entire emissions curve is therefore at a higher level than in GR22. The amount of additional CO_2 in the atmosphere is also affected by the type of biomass input, see section 10.1.3.

The results are based on data on consumption of wood fuels and on various assumptions pertaining to forest management, the market for wood products, etc. Based on the best available knowledge, it has been assumed that almost the entire Danish consumption of wood pellets and wood chips for Danish electricity and district heating production comes from trees felled for purposes other than energy production (at least 95%) (IGN, 2022). The trees are felled because the most valuable parts of the tree can be sold for building materials, paper and other wood products. The woody biomass used for energy production primarily consists of branches, tops and poor-quality parts of the stems, as well as 'industrial residues'. . Furthermore, it is assumed that additional felling only for energy production accounts for no more than 5% of consumption, and this is the share of the consumption of the biomass types 'trunks' and 'wood residues from the timber industry' that is allocated to emissions linked to land-use change, see box 8. See also section 10.1.3. Furthermore, it is assumed that the forest stand is restored after felling, so that new trees grow, which otherwise would have increased the net emissions (IGN, 2022).[19]

[19] 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 wood fuels for the production of electricity and heating (Executive Order no. 1419, 2022).

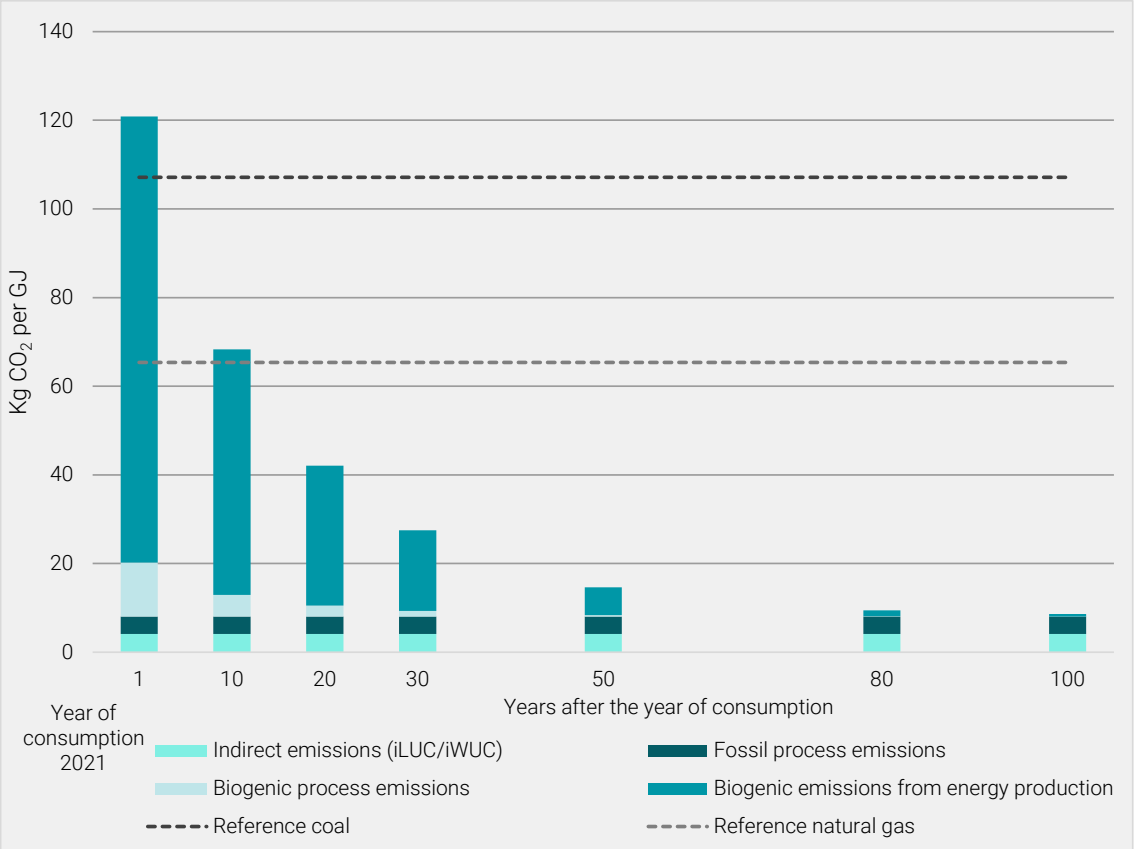
Figure 21: Total net emissions over time from consumption in 2021 of 88 PJ wood pellets and wood chips for electricity and district heating production



Source: (Nielsen, 2023) Note: The figure illustrates net emissions from the quantities and consumption mix of wood pellets and wood chips used specifically to produce electricity and district heating in consumption year 2021.

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 22. In the consumption year, 2021, the total net emissions factor has been estimated at 121 kg CO_2 per GJ, which is more or less the same as the year before. After 10 years, net emissions from consumption of wood fuels in 2021 measured per unit of energy come to 68 kg CO_2 per GJ, which is on par with emissions from fossil natural gas. After 70-80 years, total remaining net emissions (i.e. the additional content of CO_2 in the atmosphere from consumption in 2021) consist almost exclusively of the emissions linked to the use of fossil fuels from production and transport, for example, as well as emissions from permanent indirect land-use change, which are not reduced over time.

Figure 22: Net emissions per unit of energy in solid biomass fuels (emissions factor) over time from consumption in 2021 of 88 PJ wood pellets and wood chips for electricity and district heating production



Source: (Nielsen, 2023). Note: The figure illustrates net emissions from the consumption mix of wood pellets and wood chips used to produce electricity and district heating in 2021.

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

Net emissions associated with consumption of solid biomass fuels are 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 decreases quicker than amounts from stems, for example. This is because the alternative emissions from rotting happen faster for branches than for stems.

Overall, net emissions from wood fuels for energy production are determined by quantities, alternative fates for the wood, the type of woody biomass, local growth conditions and transport distances.[20]

[20] See tables 3 and 4 in the background memorandum on solid biomass fuels for a review of the conditions affecting net emissions from biomass fuels, including the various types of biomass, their origins and their alternative fates as well as indirect impacts. See also figure 6 and section 4.1 in the background memorandum for a description of the current distribution between different types of biomass and their respective estimated climate impact.

11 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 climate-neutral according to the UN IPCC guidelines. However, there are greenhouse gas emissions embedded in the production and transport of the biofuels used. These emissions occur in the countries where the biofuels are produced, as well as 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[21] estimate of emissions from biofuels for transport consumed in Denmark.

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

11.1 Main results

11.1.1 Biofuel consumption on the rise

In 2020, the Danish blending mandate on biofuels for road and rail transport fuels increased from 5.75% to 7.6%, which resulted in higher biofuel consumption in Denmark in 2020 and 2021 relative to the preceding years, see table 3.

Table 3: Consumption of biofuels (in TJ)

	2018	2019	2020	2021
First generation biofuels	8,166	8,016	9,106	9,179
Advanced biofuels	219	217	709	800
Other second-generation biofuels	825	700	1,093	1,313
Total	**9,210**	**8,933**	**10,929**	**11,292**

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.

Use of bioethanol in particular increased significantly from 2019 to 2020, as the increased biofuel blending mandate caused the sector to change from E5 petrol to E10 petrol. Specifically, this means that the incorporation rate increased from 5% to 10%.[22] Consumption of biofuels has been increasing (see table 3), even though consumption of fuel for transport has generally fallen, reflecting a higher biofuel incorporation rate.

[21] Cradle-to-grave emissions comprise emissions associated with the production (growing and processing), transport and use of biofuels.
[22] By volume (by energy content, the incorporation rates are significantly lower, as the energy content of bioethanol is significantly lower than the energy content of petrol).

11.1.2 Increased biofuel consumption has led to a small increase in emissions

The increased use of biofuels is therefore the most important reason for the marginal increase in cradle-to-grave emissions of CO_2e from biofuels from around 0.29 million tonnes in 2019 to around 0.31 million tonnes in 2021, see table 4.

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

	2018	2019	2020	2021
Biofuels	0.32	0.29	0.31	0.31

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

Despite increased consumption of biofuels, and the associated increased greenhouse gas emissions from biofuels, biofuels have gradually become less climate-impacting over time in terms of grams of CO_2e/MJ. However, this is not the case for bioethanol. Since 2019, there has been an increase in emissions associated with bioethanol, which is likely due to increased demand within the EU, and this has made it difficult to procure sustainable bioethanol; i.e. bioethanol with low emissions of CO_2e g/MJ.

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

The production of biofuels can entail deforestation if existing forest is felled to make space for crop production for use in the production of biofuels. These emissions linked to deforestation are called iLUC[23] emissions. The scope of iLUC emissions embedded in Danish consumption of biofuels in 2021 has been estimated to be more or less unchanged relative to both 2019 and 2020 (regardless of the set of iLUC values used). See the background memorandum on fuels for transport including biofuels for a more detailed description.

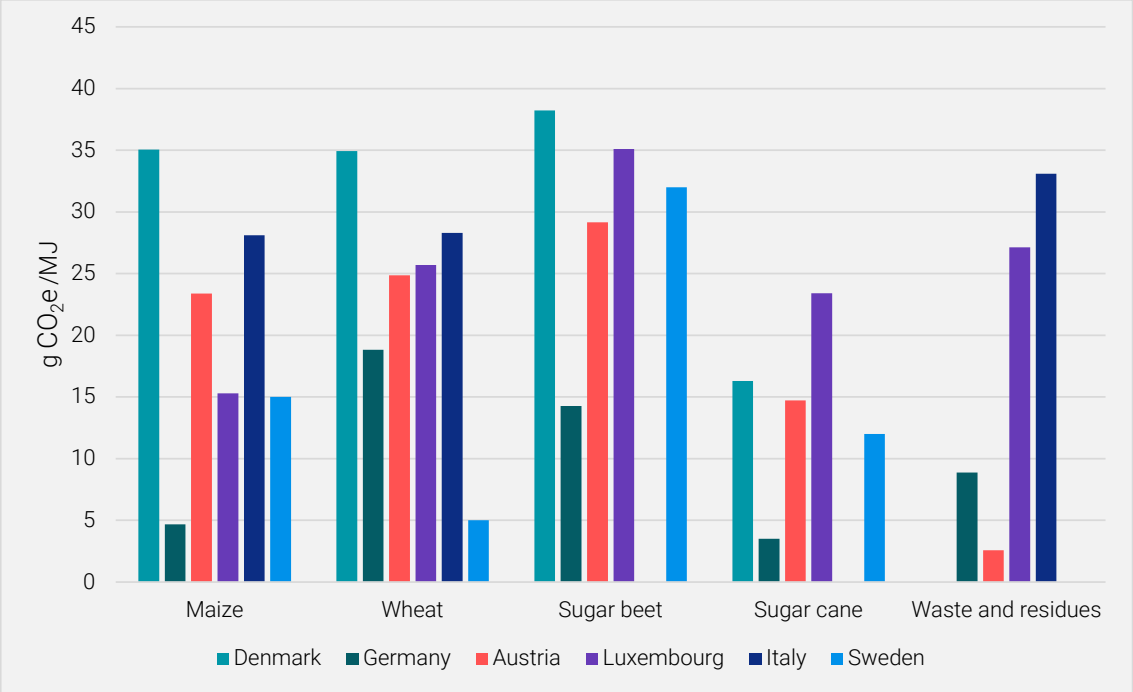
If iLUC impacts are included in the estimate, emissions from biofuel consumption are more than double than if iLUC impacts are not included.

11.1.4 Emissions embedded in the consumption of bioethanol have increased

From 2019 to 2021, emissions from bioethanol measured in g/MJ increased, while they fell or remained at a significantly lower level in other countries. According to figures from Germany reported on the basis of the certificates of bioethanol producers, German emissions are significantly lower per MJ than Danish emissions, see figure 23. Because maize-based bioethanol in the German as well as the Danish mix comes largely from Ukraine, the reason for the different emission levels cannot readily be identified.

[23] iLUC emissions: Indirect Land Use Change.

Figure 23: Emissions linked to bioethanol by type of raw material and place of consumption

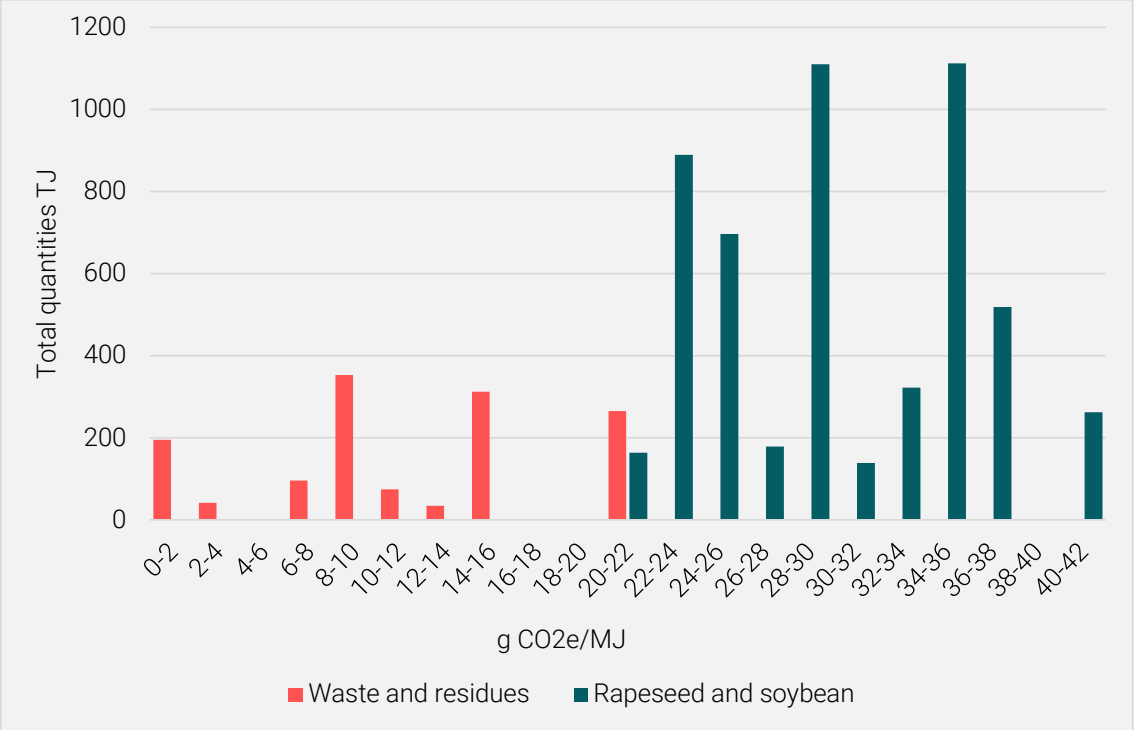


Source: The Danish Energy Agency based on data from reporting for 2021.

11.1.5 Biodiesel used in Denmark based predominantly on rapeseed

Around 80% of the biodiesel used in Denmark in 2021 was based on rapeseed. Average emissions from biodiesel were 25.5 g CO_2e/MJ. However, the underlying figures vary, see figure 24.

Figure 24: Biodiesel use in Denmark in 2021 by cradle-to-grave emissions, g CO_2e/MJ



Source: Data from reporting for 2021. The X-axis shows grouping of fuels by emissions in g CO_2e/MJ. The Y-axis shows the total quantity of biodiesel within the individual intervals.

11.1.6 In a cradle-to-grave analysis, biofuels displaced around 1 million tonnes CO_2e in 2021 relative to a scenario with no replacement of fossil fuels with biofuels

Fossil fuels blended with biofuels have resulted in emissions of around 15 million tonnes CO_2e in 2021 if cradle-to-grave and direct emissions are included in the estimate. Had regular fossil fuels been used instead, the resulting climate footprint would have been around 16 million tonnes CO_2e. According to the estimate, the use of biofuels therefore replaced what corresponds to around 1 million tonnes CO_2e in 2021.

12 International transport

This chapter looks at emissions from international aviation and shipping. Global aviation and global shipping each accounted for 2-3% of global CO_2 emissions from energy consumption in 2021 (IEA, 2022a; IEA, 2022b). Recent years' activity level in the aviation sector has been affected considerably by the Covid-19 pandemic, resulting in fewer emissions. Shipping has been less affected by the pandemic but the growth in emissions from the sector has slowed due to reduced freight activity. From 2021, however, international aviation and shipping emissions figures reveal that both sectors are again in growth (IEA, 2022a; IEA, 2022b). [24]

Emissions from international aviation and shipping 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. Nor are reduction targets for international aviation and shipping included in the national targets of individual countries under the Paris Agreement. However, emissions of CO_2 from aviation internally in the EU are covered by the EU ETS Directive, and these emissions are therefore reported as being part of the EU reduction target under the Paris Agreement, (see the EU's so-called Nationally Determined Contributions, NDCs). The UN IPCC includes emissions from global aviation and shipping in climate estimates and reports.

The results presented in this chapter depend on the definition applied as to what part of aviation and shipping *can be attributed to Denmark*, and they depend on whether there are any data registers available to specify the activity and, thus, emissions related to the fleet.

12.1 Main results - International aviation

12.1.1 Emissions from aviation again on the rise

This section estimates the climate impact attributable to bunkering abroad by Danish air carriers as well as to flights of Danish and foreign air carriers to and from Denmark.

Box 9: Regulation of greenhouse gas emissions from international aviation

International aviation and shipping are primarily regulated through international agreements. Regulation of greenhouse gas emissions from aviation at the global level is through the CORSIA mechanism under the ICAO, in the form of a compensation model to ensure that the aviation sector compensates for any emissions exceeding a fixed level. At EU level, regulation is through the EU Emissions Trading System (EU ETS). In 2021, the European Commission presented its 'Fit for 55' package, which includes a series of proposals for increased regulation of the sector's emissions. The proposals include a reform of the EU ETS (now agreed), proposals still under negotiation for a tax on aviation fuels, and a blending mandate for sustainable aviation fuels (SAF). Furthermore, the European Commission and EASA (European Union Aviation Safety Agency) are planning to introduce new regulation of air traffic management that incorporates climate considerations, as well as new requirements pertaining to infrastructure and airports.

[24] However, the post-Covid-19 pandemic growth in emissions from global shipping is not reflected in the figures for emissions from Danish activities in global shipping.

Figure 25 shows an estimate of emissions from international flights to and from Denmark and emissions from bunkering abroad by Danish-operated aircrafts. As most bunkering abroad by Danish-operated aircrafts is in connection with 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. The figure only shows CO_2 emissions from fuel combustion. However, it is internationally recognised that aviation also has a considerable additional climate impact related to the combustion of fuel at high altitudes, referred to as non-CO_2 effects. These effects are difficult to calculate accurately, see the background memorandum on international transport.

The past ten years have seen a steady increase in greenhouse gas emissions associated with air travel to and from Denmark. This increase in emissions reflects a general international increase in the demand for 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 2021, emissions increased to around 3 million tonnes CO_2e in step with the easing of Covid-19 restrictions and reopening after the Covid-19 lockdown.

Emissions of greenhouse gases from Danish-operated aircraft bunkering abroad increased overall up to 2016. Emissions then followed a downward trend and fell further as a consequence of the Covid-19 pandemic in 2020. Changes in emissions by Danish-operated aircraft are attributable to changes in global demand for air travel, but also to changes in Danish market shares in the global market.

The estimate includes 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. The emissions cannot be linked specifically to the nationality of the passengers on the flight or to the country of production/end consumption of the freighted goods.

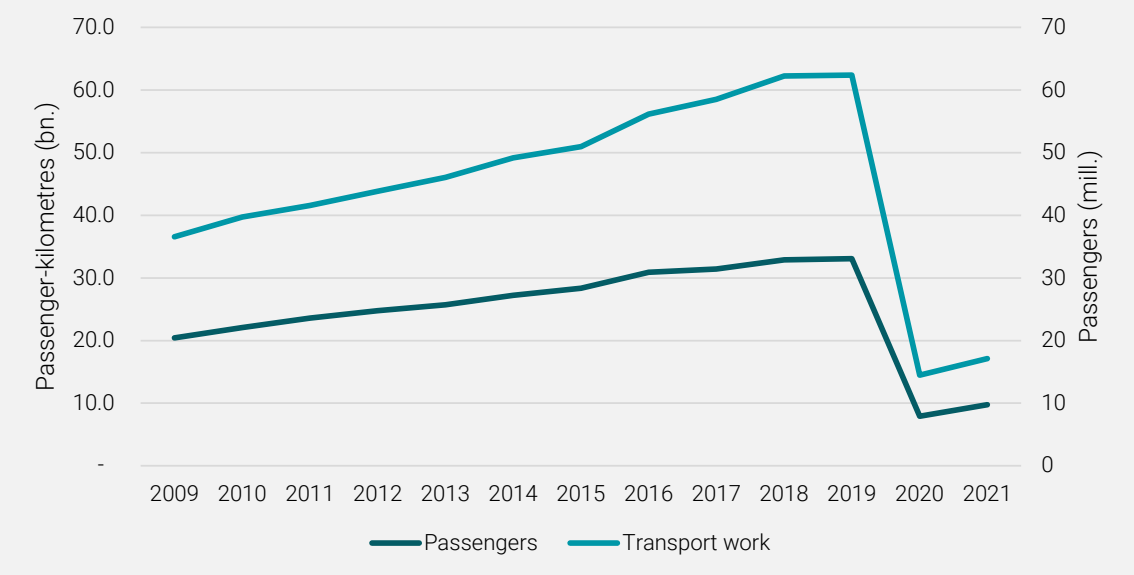
Figure 25: Greenhouse gas emissions associated with international flights to and from Denmark up to 2021 and from bunkering abroad by Danish-operated aircrafts in the period 2009 to 2020 (passenger and cargo flights)

Source: The Danish Energy Agency on the basis of the Danish Civil Aviation and Railway Authority (2022) and Statistics Denmark (2022). 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. The emissions cannot be linked specifically to the nationality of the passengers on the flight or to the country of production/end consumption of the freighted goods. Data from Statistics Denmark includes data up to and including 2020, while energy statistics data includes data up to and including 2021.

12.1.2 Passenger numbers to and from Denmark again on the rise after Covid-19 restrictions lifted

The international growth in demand for air transport is reflected in rising passenger numbers and increased transport.[25] The number of passengers on international flights to and from Denmark increased from around 20 million in 2009 to around 33 million in 2019, while transport increased from around 37 billion passenger-kilometres to around 62 billion passenger-kilometres, see figure 26.[26] The Covid-19 pandemic had a significant effect in 2020, when passenger numbers fell to around 8 million and transport fell to around 14.5 billion passenger-kilometres. In 2021, passenger numbers again increased to around 10 million and transport increased to around 17 billion passenger-kilometres, revealing an emerging increase in activity following the Covid-19 pandemic.

Figure 26: Passenger numbers and transport related to international flights to and from Denmark in the period 2009-2021



Source: Danish Civil Aviation and Railway Authority, 2022. Note: Transport comprises the number of kilometres flown times the number of passengers.

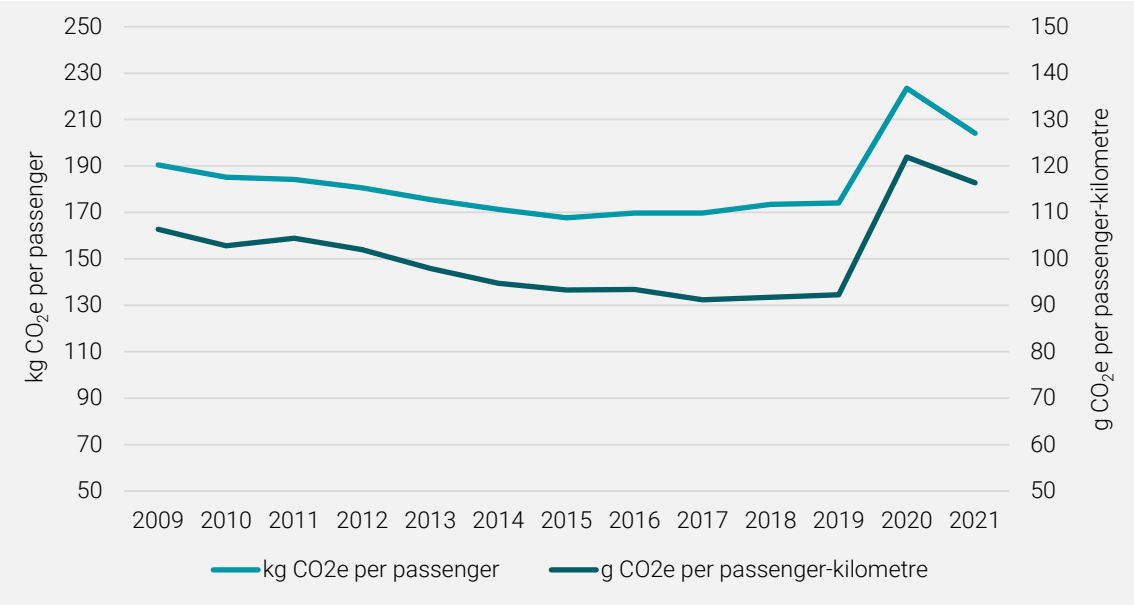
12.1.3 International aviation to and from Denmark has become less greenhouse-gas-intensive

Overall efficiency developments in international aviation to and from Denmark are described through indicators that compare emissions with transport activity, as shown in figure 27.[27] Emissions are affected by technical developments, the size of aircraft, as

[25] Transport is defined as passenger numbers/tonne of cargo relative to the total number of kilometers the passengers/cargo are/is carried.
[26] Statistics Denmark (DST) also publishes data on trends in passenger numbers and transport activity based on data from aviation statistics by the Danish Civil Aviation and Railway Authority. The estimate for transport activity differs from the estimate for transport in this report. See the background memorandum on international transport for details about this.
[27] Read about additional indicators in the background memorandum on international transport.

well as by passenger seat occupancy and travel distance. Emissions per passenger travelling to and from Denmark in the period 2009 to 2019 fell from 189 to 172 kg CO_2e, while emissions per passenger-kilometre fell from 105 g CO_2e in 2009 to 91 g CO_2e in 2019. The increase in emissions per passenger and per passenger-kilometre in 2020 should be considered in light of the Covid-19 pandemic, which led to lower passenger seat occupancy rate. In 2021, the passenger seat occupancy rate was still considerably lower than in the previous 12 years, resulting in a correspondingly lower efficiency.

Figure 27: Developments in indicators of developments in efficiency in international aviation (passenger flights) to and from Denmark in the period 2009-2021.



Source: Danish Civil Aviation and Railway Authority, 2022.

12.2 Main results - international shipping

This section describes developments in emissions associated with bunkering in Denmark as part of international shipping, as well as emissions associated with bunkering abroad by Danish-operated ships. In 2022, Denmark ranked as the 9th largest shipping nation in the world based on the total tonnage of Danish-operated ships. This means that Denmark is responsible for a considerable share of international shipping (Danske Rederier, 2023).

Emissions from shipping that relate to Denmark can be defined in different ways, including:[28]

- Danish-flagged ships: Vessels navigating under Danish supervision (the shipping company must have offices in Denmark).
- Danish-owned vessels: Vessels owned by Danish shipping companies.

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

- 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 10: Regulation of greenhouse gas emissions from international shipping

Greenhouse gas emissions from shipping at global level is regulated through the UN International Maritime Organization, IMO. In 2018, the IMO adopted a strategy to reduce greenhouse gas emissions from shipping, including a goal to reduce transport emissions by 40% by 2030 and CO_2e emissions by 50% by 2050, relative to 2008. In the summer of 2023, the IMO is expected to raise its ambitions and take new steps to follow up on their climate goals. The IMO has established specific mechanisms to estimate the greenhouse gas intensity and energy efficiency of ships and the IMO requires all ships with a gross tonnage of more than 5,000 tonnes to meet certain design and operational criteria. In 2022, in continuation of the 'Fit for 55' package, the EU agreed to phase in shipping in the EU Emissions Trading System (ETS) from 2024. The shipping industry is therefore expected to contribute to reaching EU climate targets in future. Furthermore, March 2023 saw the completion of negotiations on the European Commission's FuelEU Maritime proposal, including:

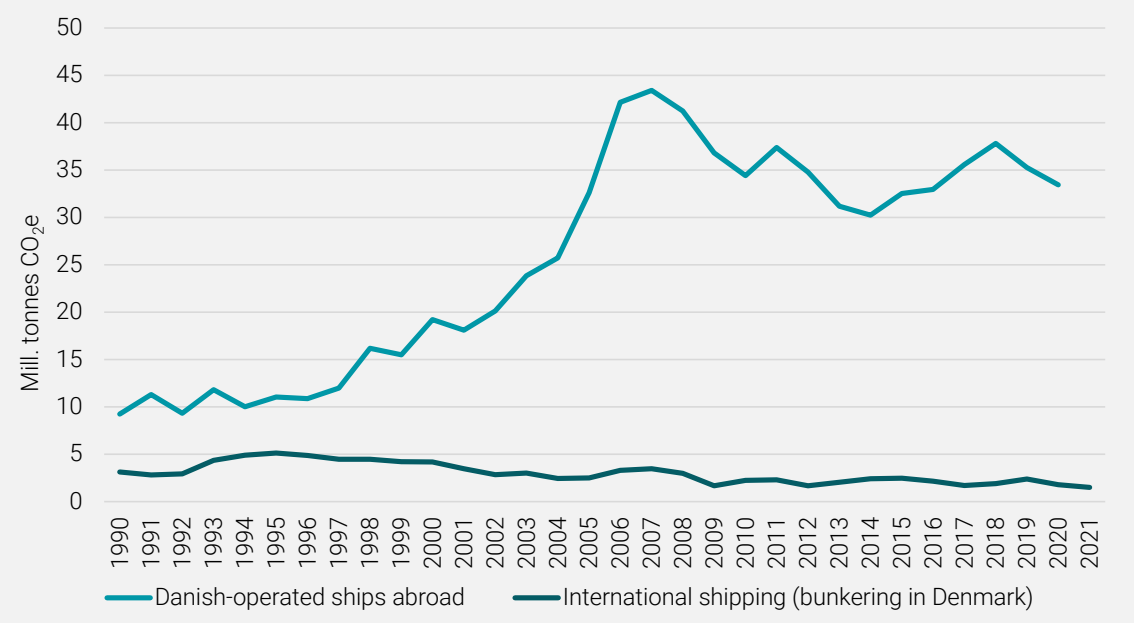
- for ships above a gross tonnage of 5,000, a CO_2 displacement requirement of 2% by 2025, increasing incrementally to 80% by 2050
- for container and passenger ships, a requirement to use the onshore power supply at berths from 2030
- for the fuel mix of ships to contain at least 1% e-fuels (PtX) by 2030 or, alternatively, at least 2% e-fuels (PtX) from 2034.

12.2.1 Emissions from bunkering relating to Denmark

Since 2010, emissions from bunkering in Denmark by Danish and foreign ships in international shipping have been between 1.7 million and 2.5 million tonnes CO_2e, see figure 28.[29] However, emissions associated with bunkering outside Denmark by Danish-operated ships increased considerably in the period 1990 to 2007. This increase can generally be ascribed to global economic growth and increased demand for transport services. After peaking at 42 million tonnes CO_2e in 2007, emissions fell up to 2014 and then increased again to around 39 million tonnes CO_2e in 2019. In 2020, emissions fell to around 33.5 million tonnes CO_2e, likely due to the Covid-19 pandemic and the resulting decline in activity and demand for transport of goods. Note that the changes in emissions from Danish-operated ships are not necessarily due to improved operating efficiency or changes in the global demand for shipping services, but may also be due to changes in the market shares of Danish-operated ships.

[29] In this context, emissions from bunkering only include emissions associated with burning the fuels bunkered. The estimate of emissions by shipping in the chapter on exports includes emissions from the entire value chain for fuels as well as port activities associated with exports.

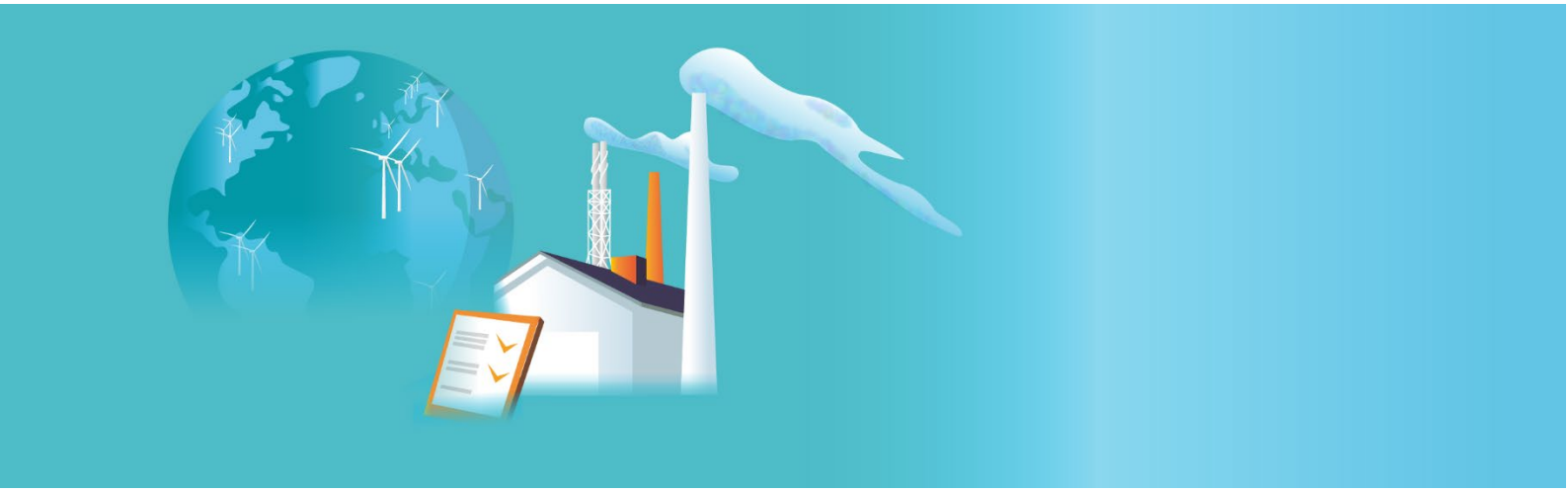
Figure 28: Developments in emissions associated with bunkering Danish-operated ships abroad, as well as emissions associated with bunkering in Denmark by international shipping.



Source: The Danish Energy Agency, 2022, Statistics Denmark, 2022. Note: Data from Statistics Denmark includes data up to and including 2020, while energy statistics data includes data up to and including 2021.

The period 2011-2018 saw a global decoupling of emissions from the continued growth in freight volumes. The increased efficiency is due primarily to better utilisation of ships; optimisation of speed, operations and routes; new designs; as well as larger and more efficient ships.

The transport work of Danish-flagged container ships made up around 6.5% of the total transport work of the global fleet of container vessels in 2021. This is so even though Danish container ships make up only 2.5% of the world fleet of container ships and 4.5% of emissions from this fleet. Part of the reason for the large share in transport work is that Danish-flagged container ships are among the largest in the world, and this contributes to lowering emissions per tonne of freight. Initiatives to promote technological development, such as optimised ship design and functionalities, new engine technologies and fuels, can potentially have a significant effect on total CO_2e emissions if targeted at Danish container carriers, because they constitute such a large and significant segment of the world fleet.



Climate action by the business sector

This part of GR23 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 2, 5 and 6. 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 13 *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 14 *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.

13 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 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.

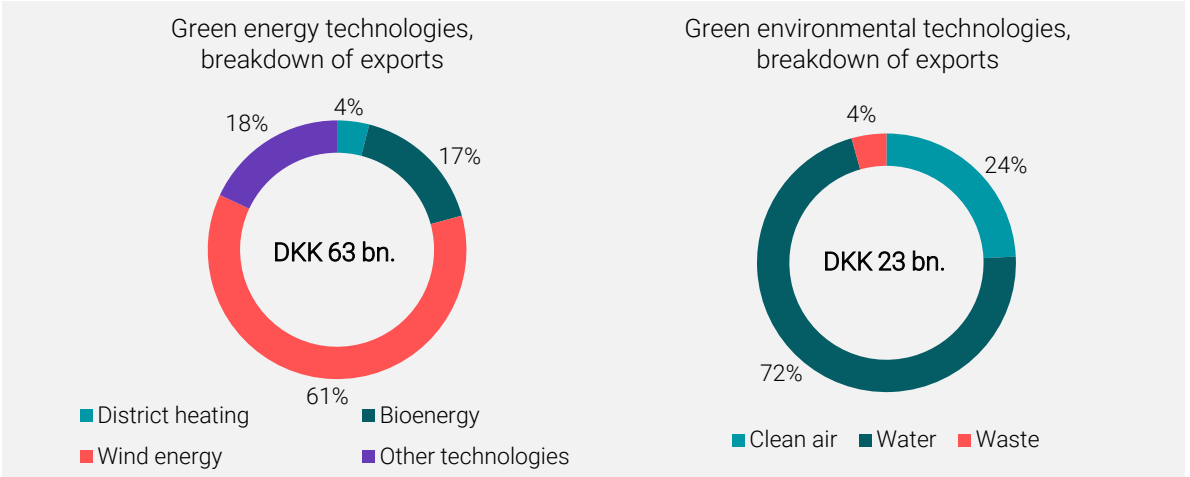
13.1 Main results - the value of Danish green exports

Green exports cover green energy and environmental technologies and related services,[30] i.e. exports that can contribute positively to reductions in global emissions or to environmental and resource savings.

1.1.1 Wind and water technologies dominate Danish green exports

In 2022, Denmark exported green energy technologies worth around DKK 63 billion, and green environmental technologies worth DKK 23 billion, corresponding to around 3% and 6%, respectively, of total Danish goods exports in that year.[31] For green energy technologies, this constitutes a drop of 2%, whereas for green environmental technologies it constitutes an increase of 13%, 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 29 shows the breakdown by type of technology within green energy and environmental technologies in 2022. The figure shows that wind and water technologies dominate Danish green exports.

Figure 29: Exports of green energy technology and green environmental technology in 2022 by type of technology



[30] 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.

[31] 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.

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

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

In 2022, Germany was the largest buyer of Danish green energy technologies, as they bought technology worth a total of DKK 9 billion. This corresponds to 14% of Danish green energy technology exports. Germany was also the largest buyer of Danish green environmental technology, as they bought technology worth DKK 2.7 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 5 billion, and green energy services worth almost DKK 8 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.

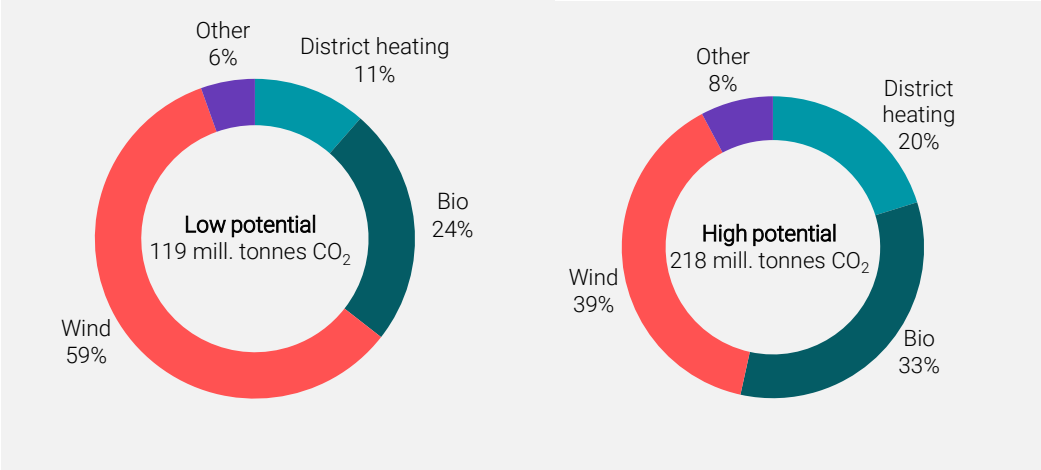
1.2 Main results - CO_2 emissions reductions made possible by Danish green energy technology exports

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 218 million tonnes CO_2 made possible by Danish green energy technology exports in 2022

In a single given year within the lifetime of the exported technologies, Danish green energy technologies exported in 2022 have been estimated to make it possible to reduce global emissions by between 5 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 2022 have been estimated to make it possible to reduce emissions outside Denmark by between 119 and 218 million tonnes CO_2, depending on what technology the exported Danish technology replaces.

Figure 30: 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.

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

Figure 30 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, solid biomass fuels replace coal in combined heat-and-power plants, while in the low range, biogas replaces natural gas.

14 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 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) is expected to make it *mandatory* for large European businesses to report on their greenhouse gas emissions *throughout* the value chain. The ESRS reporting standards under the CSRD are likely to be adopted at the end of June 2023 and will include a large number of 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 be come into effect in the period 2024 to 2028, depending on company size, and the final design of the requirements will be adopted in the summer of 2023.

For this analysis of the climate reporting maturity of large Danish businesses, a survey was conducted to identify 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 setting targets to reduce their climate footprint. The primary focus of this survey was the extent to which businesses are already reporting on the upcoming CSRD reporting requirements.

14.1 Main results

The survey reveals huge differences in the extent to which, and whether at all, Danish businesses are today reporting on their CO_2e emissions. A large number of businesses have already been estimating and reporting their emissions in annual climate accounts for a number of years now, while others have yet to start.

14.1.1 Many businesses are already well underway in climate reporting

Businesses can report on scope 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.

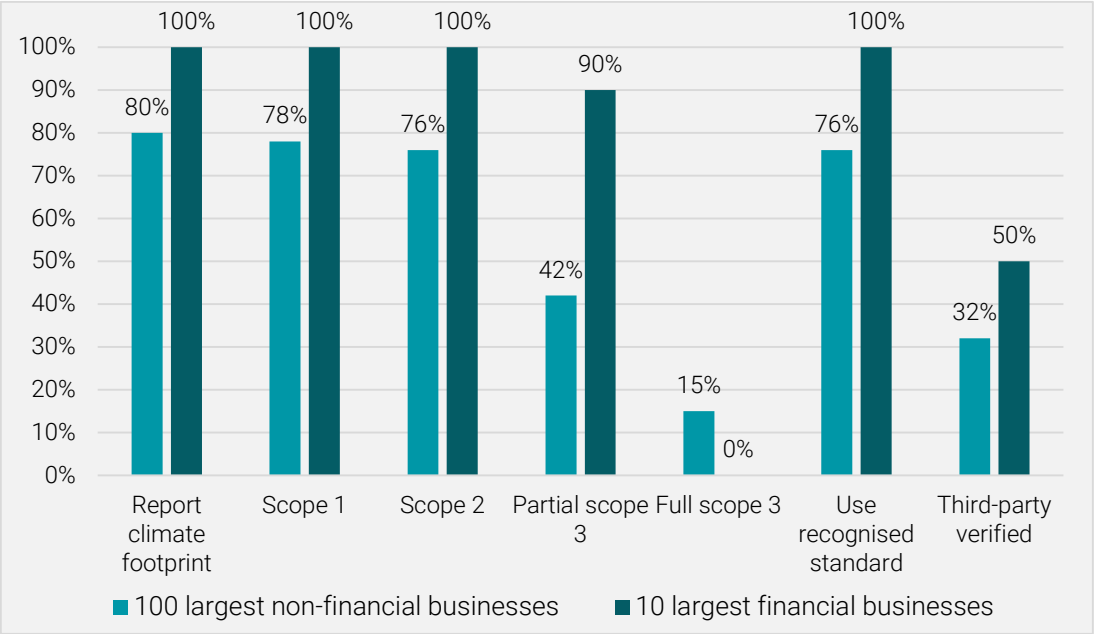
This is reflected in the survey, the main results of which are summarised in figure 32. As many as 77% of non-financial businesses in the survey reported on scope 1 emissions in their most recent annual climate report. For financial businesses, the figure was 100%. The survey reveals more or less the same for scope 2 emissions. As many as 75% of non-financial businesses and all the financial business in the survey reported their scope 2 emissions. For scope 3 emissions, the figures are slightly lower, however. A total of 59% of non-financial businesses also included scope 3 emissions in their most recent annual climate report, while as many as 90% of financial businesses reported on scope 3 emissions in their most recent annual climate report.

14.1.2 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).[32] These are the *de facto* climate accounting norms and are likely to be recommended in upcoming climate reporting standards. A total of 77% of non-financial businesses base their climate accounting on the GHG Protocol or an equivalent standard, according to their annual climate accounts. All ten financial businesses in the survey base their climate accounting on the GHG Protocol.

[32] 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.

Figure 31: Climate accounting by large Danish businesses, the most recent financial year



Source: The Danish Energy Agency and SADERO.

14.1.3 A small share of businesses have their climate reporting verified

According to the CSRD, businesses are required to have their sustainability report verified by an independent third party.[33] The survey reveals that one-third of non-financial businesses in the survey had their most recent climate accounts endorsed by a third party. One-half of financial businesses had obtained such endorsement.

14.1.4 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 59% of the 100 non-financial businesses and 90% of the financial businesses have reported scope 3 emissions at some level or other. Of these, 15% have prepared complete scope 3 emissions accounts (full scope 3 reporting) and have therefore reported on their emissions from all 15 scope 3 categories (or have provided reasons for not reporting).

14.1.5 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

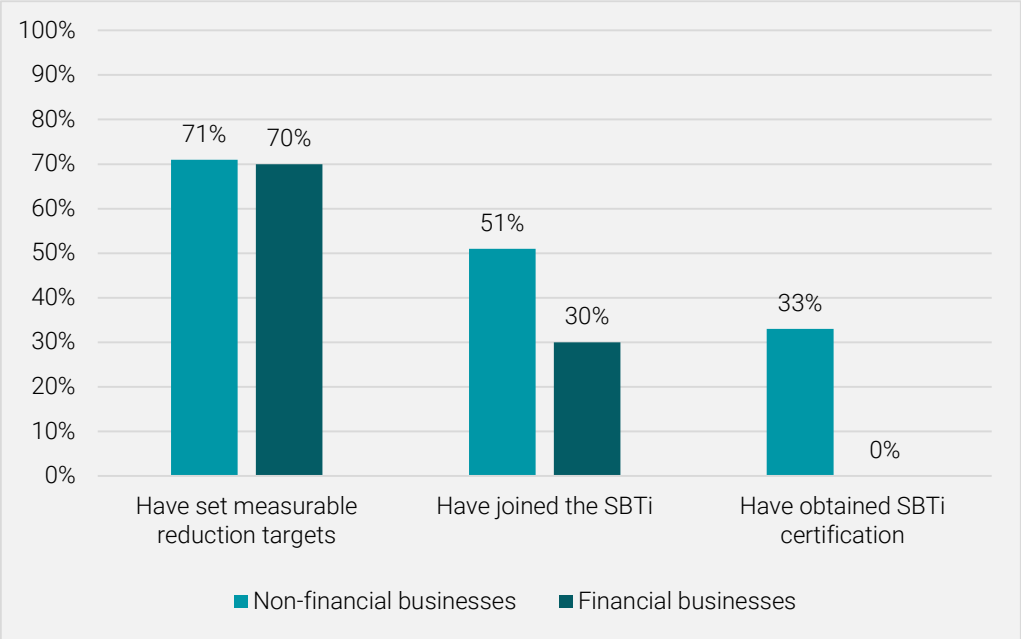
[33] *This entails having an independent third party review the information in the climate accounts and assure the quality of the accounts.*

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.

The survey reveals that 70 of the 100 largest non-financial businesses surveyed have set measurable reduction targets in their most recent annual climate reporting. Of these, by far the majority (49 businesses) have joined the SBTi. A total of 33 businesses have set specific SBTi reduction targets and have obtained SBTi certification, while 18 businesses are still in the process of establishing SBTi reduction targets.

Furthermore, seven out of the ten financial businesses in the survey have set measurable reduction targets and three financial businesses have joined the SBTi, of which none have yet obtained SBTi certification for their reduction target.

Figure 32: Reduction targets and SBTi membership



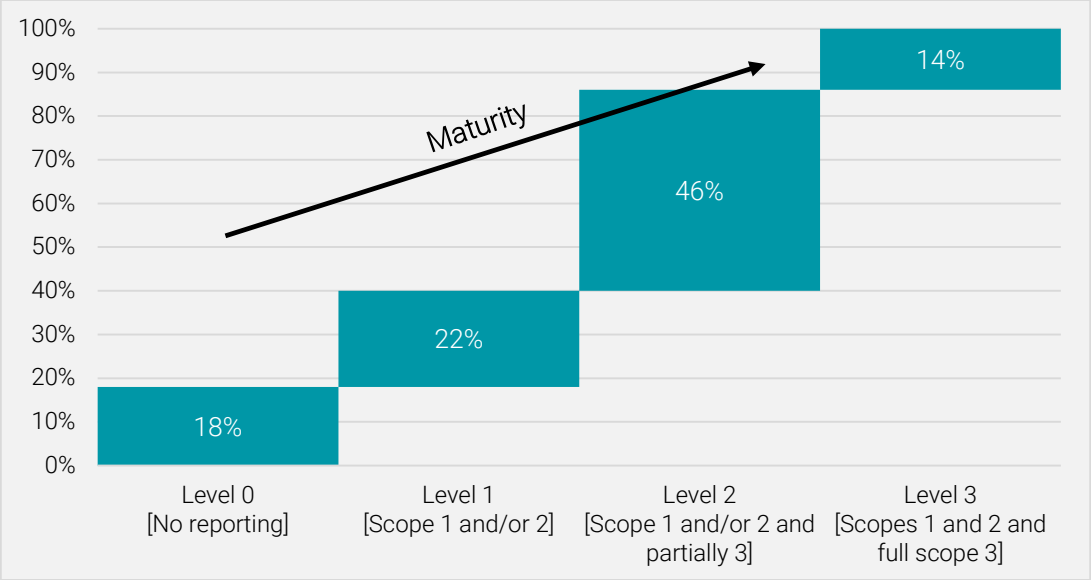
Source: The Danish Energy Agency, SADERO and the Science Based Target initiative.
Note: The figures on SBTi membership and certification are based on data from the SBTi on the 100 largest Danish non-financial businesses and the ten largest Danish financial businesses. The data was extracted from the SBTi database at the end of 2022. Any changes in membership and certifications after this date 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 survey, 18% place at level 0; 22% place at level 1; 46% at level 2; and 14% at level 3. See figure 33 below.

Figure 33: Assessment of the maturity of the 110 businesses in the survey



Source: The Danish Energy Agency and SADERO. Note: The assessment is based on data in the most recent 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,[34] reflecting Denmark's various targets: 1) Increase global climate ambition; 2) Reduce global greenhouse gas emissions; 3) Strengthen focus on adaptation and sustainable development; 4) Shift financial flows to green; and 5) Cooperate with the private sector 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 GR23, which provides a status report on a selection of international climate actions by the authorities, focussing on initiatives realised in 2022.

Chapter 15: *Global climate ambitions* investigates examples of Danish climate diplomacy initiatives to raise global climate ambitions.

Chapter 16: *Global reductions* investigates examples of Danish initiatives under the auspices of Danish climate assistance, as well as bilateral cooperation aimed at reducing CO_2 emissions globally.

Chapter 17: *Global climate change adaptation action* investigates examples of initiatives under the auspices of Danish climate assistance that aim to support climate change adaptation in particularly vulnerable countries.

Chapter 18: *Climate assistance and climate finance* provides a quantitative account of Danish climate assistance and mobilised climate finance.

Chapter 19: *The climate footprint of public and private investments abroad* describes the climate footprint of Danish public co-financing of green projects internationally, for example wind and solar farm projects, and provides examples of the climate footprint of private investments.

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

Chapter 20: *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.

14.2 Difficulty in quantifying 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 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.

15 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 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 2022.

15.1 Main results

15.1.1 Host for the May Ministerial Meeting on Implementation

Prior to COP27, in partnership with the Chairs of COP26 and COP27, Denmark hosted the May Ministerial Meeting on Implementation, which counted almost 50 participating countries and focussed on enhanced ambitions and implementation. The meeting was the first since COP26 and served as an important step to follow up on results from COP26 and to create momentum up to COP27. Acting as the host stressed Denmark's prominent role in helping to push the global climate agenda and it created the basis for Denmark's continued importance in preparations for COP27.

15.1.2 Denmark leading the way with a climate loss and damage fund of DKK 100 million

In 2022, the government entered an agreement with five of the parties in the Danish Parliament (the Folketing) on an additional pool of DKK 100 million earmarked for loss and damage initiatives in relation to climate change adaptation. The financing package includes funds that Danish civil society organisations can apply for to conduct projects in the climate vulnerable Sahel region in Africa. Through these funds, Denmark is involved in the Global Shield against Climate Risks initiative[35] launched by Germany during its G7 presidency in collaboration with the Vulnerable Twenty (V20) Group of Ministers of Finance of the Climate Vulnerable Forum.

The launch of the DKK 100-million package at minister level during the High-Level Week of the UN General Assembly in September 2022 drew international attention and placed Denmark at the forefront of the international loss and damage agenda. The launch of the financing package also meant that Denmark came to play an important role in urging the EU to take a constructive stance on loss and damage up to and during COP27.

15.1.3 Denmark negotiated a long-term work programme for increased reductions

During COP27, Denmark had special focus on negotiations about the work programme for increased reductions before 2030 (Mitigation Work Programme). At the conference, Denmark and South Africa were appointed as the facilitator of negotiations on the work programme. The work programme was the central decision item in relation to mitigation at COP27 and therefore carried great political weight for the results of COP27. With the

[35] The Global Shield initiative aims to enhance financial protection, including insurance schemes, against climate-related disasters in vulnerable societies and regions.

role of facilitator on such an important subject Denmark confirmed its key role in global climate negotiations about mitigation.

An agreement was reached on a work programme that will run up to 2026, at the minimum, and that will include discussions and cooperation on how the participating countries can increase their climate contributions and achieve the goals within different sectors and focus areas. It was also decided that the world's leaders will look at specific ways to reduce greenhouse gas emissions up to 2030 as a permanent part of political discussions. This is the first time in a UN context that a frame of reference has been set for how countries can discuss ways to meet their climate targets.

15.1.4 The launch of a 'Group of Friends' for ambitious EU climate diplomacy

In October 2022, in cooperation with Germany, Denmark launched a 'Group of Friends' to raise ambitions for EU climate diplomacy work. The group comprises foreign ministers from 12 EU Member States and it advocates an ambitious EU approach to global climate diplomacy work through anchoring climate diplomacy at the core of EU foreign and security policy. For example, the group wants to create a stronger connection between the climate and security areas in EU foreign and security policy and ensure coordination among countries about climate action across all areas of EU foreign and security policy. Furthermore, the group aims to accelerate the global energy transition and phase-out of fossil fuels, for example by striking partnerships with countries outside EU on energy transition.

15.1.5 Alliance to phase out coal 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. COP27 bore testimony to growing international recognition and support for the ambition to phase out *all* fossil fuels, not just coal. Chile, Fiji and Washington State, US, joined BOGA, and Kenya and Tuvalu expressed their wish to join in the near future.

15.1.6 New global offshore wind alliance

At COP27, Denmark launched the Global Offshore Wind Alliance (GOWA) in collaboration with the International Renewable Energy Agency (IRENA) and the Global Wind Energy Council (GWEC). The initiative gathers both public and private players and aims to raise ambitions considerably for the deployment of offshore wind energy, and to share experience on developing the best policy framework, projects and value chains.

The ambition of the alliance is to help deploy at least 380 GW offshore wind capacity by 2030, followed by an annual deployment of 70 GW until a total of 2,000 GW have been deployed by 2050. According to IRENA, this is needed to realise the goal of holding the global temperature rise to 1.5 degrees Celsius. In the first phase, GOWA will focus on launching a number of activities to raise the ambitions of governments and public and private stakeholders as well as create regional and international fora for knowledge and experience sharing on developing the best policy framework and value chains. A total of 14 countries have formally joined the alliance.

15.1.7 Socially fair energy transition in selected growth economies

Denmark's involvement in Just Energy Transition Partnerships (JETPs) is another example of Danish climate diplomacy. The objective of these partnerships is to help growth economies move away from dependence on coal and towards accelerating the transition to more climate-friendly solutions, including addressing the socio-economic effects of the transition, including reskilling coal workers and creating new jobs for them. Norway and Denmark are the only countries outside the G7 involved in JETPs, and Denmark has been invited to join the JETP International Partners Group (IPG) for Indonesia and Vietnam. Denmark has been invited to join these partnerships by virtue of its strong climate profile and its long-standing bilateral cooperation on energy, giving Denmark a unique platform for this type of work. Finally, there is ongoing dialogue about possible Danish participation in the IPG for South Africa, of which Denmark is yet to be a formal member.

16 Global reductions

Denmark advocates for a green transition that focuses on ensuring that the world's largest emitters reduce their emissions and that developing countries follow sustainable development paths. Danish efforts are multilateral, primarily through financial support to multilateral funds and energy associations. There are also 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 provides examples of the above, with focus on initiatives in 2022.

16.1 Main results

16.1.1 Danish climate assistance supports 'zero emissions by 2050'

As in previous years, in 2022 the guiding principle behind realisation of climate assistance was to support realisation of zero emissions by 2050 in countries that Denmark supports. The year 2022 saw work on four topics (see table 5) based on Denmark's development cooperation strategy and long-term strategy for global climate action, as well as on Sustainable Development Goal 7 (SDG7) on sustainable energy and Sustainable Development Goal 13 (SDG13) on climate action.

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.	**Support for the NDC Partnership** Denmark has contributed DKK 35 million to the NDC Partnership in the period 2020-2023 (the grant was extended by one year in 2022). The Partnership has provided support to 80 developing countries in their efforts to improve their NDCs. Up to 2022, a total of 62 NDCs have been updated. In addition to this, the NDC Partnership supports six onshore facilitators and 90 advisors that provide consultancy on how to incorporate climate in planning, budgeting and investment processes. **Support for the green transition through international initiatives** Support for the green transition through international initiatives such as the International Renewable Energy Agency (IRENA), Just Energy Transition Partnerships (JETPs) and the Climate Investment Fund's Accelerating Coal Transition (CIF-ACT).

Topic	Examples of results
Access to clean energy at national and household levels Danish climate assistance has contributed to supporting access to clean energy in some of the least developed countries in Africa and elsewhere.	**Transitioning away from the use of firewood and coal in household cooking** Through the allocation of funds, Denmark supports efforts to help the poorest families in Africa to replace firewood and coal with cleaner cookers and cleaner fuels. **Support for the green energy transition in Africa** Denmark has contributed DKK 100 million for the period 2021-2030 to the Sustainable Energy Fund for Africa (SEFA) 2.0. Through realisation of these funds, Denmark is supporting SEFA's work to help African countries make the most of new opportunities, including within green energy. In the period 2020-2022, SEFA financed 19 projects with a total of DKK 132.5 million. In 2022, for example, this included financing for biogas in Ghana, geothermal energy in Ethiopia and solar PV in Tunisia. **Innovative green startups** In 2022, Denmark contributed DKK 50 million to the Energy and Environment Partnership Africa Trust Fund (EEP Africa) under the Nordic Development Fund (NDF). The EEP supports small local startups that deploy mini-grids for households and for small-scale cooling systems, for example for fish and produce, electrical water pumps, or at schools and healthcare centres. The electricity can also be used to run electric taxi scooters, contributing to reducing noise pollution in big cities in Africa.
Sustainable energy for climate change adaptation plays a central role in climate change adaptation in developing countries, where efforts in this area help to ensure access to weather information, water and cooling.	**Energy-efficient cooling in 100 cities in India** Denmark has contributed a strategic grant to efforts by the Cool Coalition to ensure improved energy-efficient cooling in 100 cities in India. The Cool Coalition consists of a wide circle of public and private players under the UN Environment Programme (UNEP).

Topic	Examples of results
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.[36]	**Promotion of international dialogue on the 2050 agenda regarding zero emissions** Denmark is advocating adoption of an ambitious strategy for climate-neutral shipping in 2050 by the UN International Maritime Organization (IMO). Denmark, together with the rest of the EU, is also pushing for the International Civil Aviation Organisation (ICAO) to set ambitious long-term climate targets. In 2022, ICAO adopted a goal of climate neutrality for international aviation by 2050. Furthermore, Denmark has worked actively for an ambitious agreement on stronger CO_2 emissions reduction requirements for new light-duty vehicles in the EU. In October 2022, the Council and the European Parliament agreed on a ban on the sale of new diesel and petrol cars in the EU from 2035. Denmark supports the transition to sustainable corporate global value chains. Partnering with UN Global Compact Denmark, the government is helping Danish businesses raise their climate ambitions and reduce their CO_2 emissions, for example. Together with Ethical Trade Denmark, efforts are being made to establish alliances on deforestation-intensive value chains for food products, such as coffee, soy and palm oil. In 2022, the Ministry of Foreign Affairs of Denmark launched a new partnership with the World Wildlife Fund (WWF) for sustainable production of soy in Brazil.

Source: The Ministry of Foreign Affairs of Denmark

Box 11: Danish cooperation with South Africa illustrates the scope, reach and holistic approach of Danish global climate initiatives

Danish cooperation with South Africa on climate, the environment and the green transition is primarily through Danish strategic sector cooperation (SSC) on energy, water and sustainable towns and cities. Cooperation initiatives are implemented within the framework of a green strategic partnership established in February 2022 between the prime minister of Denmark and the president of South Africa.

Because South Africa is a middle-income country with an economy in rapid transition and highly dependent on coal, Danish climate action can make a huge difference with regard to reducing emissions. Furthermore, South Africa is also particularly vulnerable to climate change, and cooperation in the water sector and within the area of sustainable towns and cities will help strengthen South Africa's adaptive capacity.

Cooperation included a large number of initiatives and results in 2022, for example:

- Help for ESKOM (South African public electricity supply) to meet needs of a liberalised energy sector with electricity production from privately owned wind farms and solar farms.
- Support for South African authorities to improve public tendering for renewable energy through focus on better technical descriptions, digitalisation and economic development.

[36] 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 and concrete, shipping/maritime transport, artificial fertilisers, and promotion of green value chains in general.

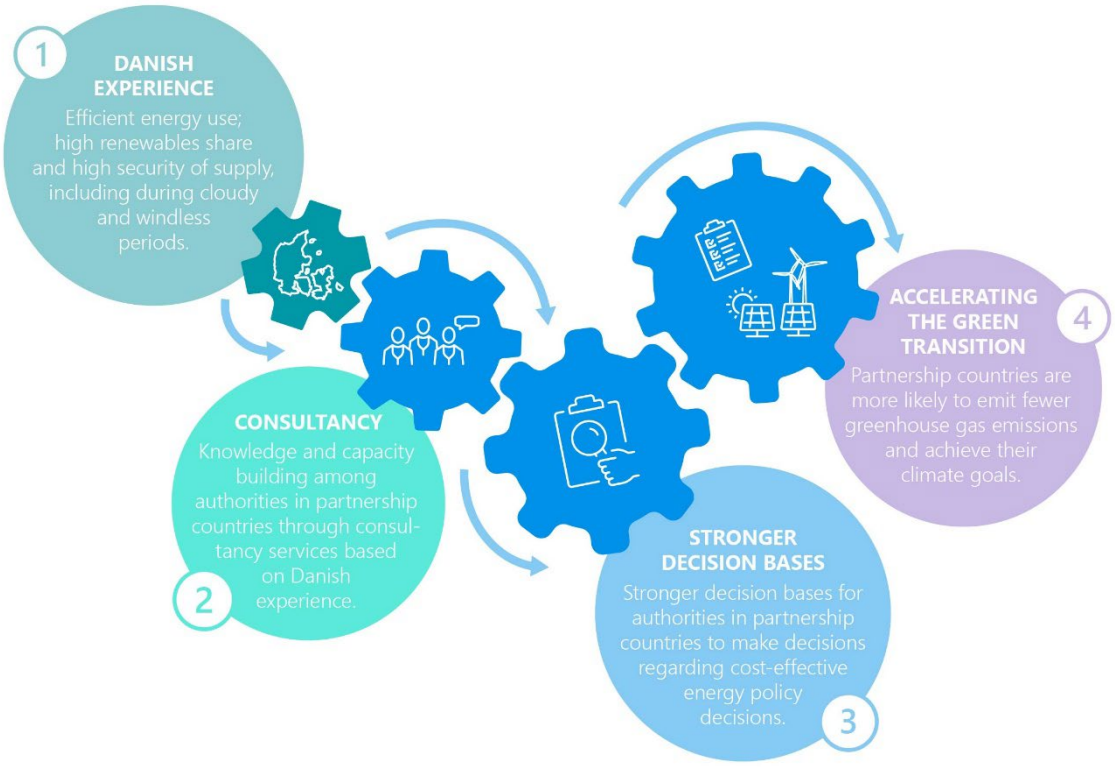
- Work in the Mpumalanga region to identify mining rights and opportunities for use of alternative sources of energy to supply electricity to underserved local communities.
- Optimisation of the wastewater treatment plant and drinking water supply for the City of Tshwane in cooperation with the Municipality of Aarhus and Aarhus University in Denmark.

Source: The Ministry of Foreign Affairs of Denmark

16.1.2 Denmark cooperates with other countries to support sustainable transition

Denmark is involved in a number of bilateral cooperation efforts to support the green transition in partnership countries. Denmark shares its knowledge and experience in energy, environment and food and thereby contributes to building capacity in partnership countries within these areas. By helping to build national authorities' knowledge and capacity in partnership countries, Denmark guides policymakers to make decisions that take climate change into account.

Figure 34: Denmark is the green cog that sets the global transition in motion - for example in the form of bilateral energy cooperation.



Source: The Danish Energy Agency. Note: Denmark contributes to accelerating the green energy transition globally through cooperation with the authorities in partnership countries. Denmark has unique experience with energy transition, including with ensuring a high level of security of supply, a high share of renewables, as well as energy efficiency. Through sharing experience with partnership countries, Denmark supports them in their efforts to create the best framework for a green transition. Bilateral 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.

16.1.3 Bilateral cooperation on energy

Denmark is considered one of the world's leading countries on green energy transition.[37] Due to many years of experience with 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 with energy transition contribute to the reduction of global emissions through Denmark's involvement in bilateral cooperation. To meet international demand for Danish green energy transition knowhow and experience, in 2022 Denmark established additional bilateral cooperation on energy with five new countries: Brazil, Colombia, Estonia, Latvia and Lithuania. In Estonia, Latvia and Lithuania, Denmark will contribute with knowledge about framework conditions for offshore wind energy.

[37] For example, Denmark ranks at the top of the Climate Change Performance Index (CCPI) and ranks third in the World Energy Council's Trilemma Index.

On behalf of Denmark, the Danish Energy Agency is therefore cooperates with central, regional and local governments in a total of 24 countries, which, together, emit around 70% of the world's CO_2.

Although emissions overall remain coupled with economic growth in the countries Denmark cooperates with, the renewables share in these countries' electricity production increased by 79% from 2012 to 2020. Increased use of renewables has therefore displaced emissions from fossil energy in these cooperation countries.

16.1.4 Bilateral cooperation on environment

Denmark has more than 35 years of experience with regulation and enforcement of regulation within management of sustainable water resources, waste and pollution abatement. Denmark has knowledge on a large number of very relevant technologies and solutions within these areas that can be shared bilateral cooperation across the globe. Bilateral cooperation on the topic of environment primarily contributes to reducing greenhouse gas emissions globally through support for reductions in energy consumption linked to water resources management, and through support for increased recycling and reduced resource consumption through sustainable waste management initiatives.

The Danish Environmental Protection Agency is currently involved in long-term agreements on water and the environment with five developing countries. Denmark has 'water agreements' with India, China and South Africa, and 'waste and circular economy agreements' with Indonesia and Kenya. Furthermore, in 2022, Denmark established new cooperation agreements on water with Ethiopia and Morocco. Finally, under a new framework agreement, Denmark has established two new cooperation agreements with Kenya (water) and Thailand (circular economy).

16.1.5 Bilateral cooperation on the food sector

The Danish agrifood 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, Mexico, Nigeria, Indonesia, Vietnam, South Africa and Bangladesh.

It was decided in 2022, that, from 2023, authority cooperation by the Danish Veterinary and Food Administration will focus on sustainable and reduced climate-impacting food production through focus on food waste, food losses and resource-efficient food production, for example.

Box 12: Danish-Kenyan cooperation reduces food losses and improves efficiency in the agriculture 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 sector. Furthermore, cooperation efforts focus on building resilience to climate change by ensuring appropriate framework conditions for food security.

Source: The Danish Veterinary and Food Administration

17 Global climate change adaptation measures

Denmark is working to inspire and encourage climate resilience and adaptation to climate change initiatives globally through cooperation and export promotion. GR23 focuses on Denmark's contribution to climate change adaptation, supported through bilateral and multilateral channels as part of Danish climate assistance in 2022. The following describes important results of Danish climate change adaptation action in 2022.[38]

17.1 Main results

Danish climate assistance for climate change adaptation initiatives[39] is realised according to the climate change adaptation targets in Denmark's new development cooperation strategy (*The world we share*) and the former government's long-term strategy for global climate action. Danish climate assistance for climate change adaptation can be grouped under four topics specifying the targets.

Three of these topics are described in this chapter, see table 6, while the fourth topic, export promotion, is described in the chapter 20.

[38] This chapter is based on the background memorandum on climate change adaptation action supported through Danish climate assistance and export promotion.
[39] Climate change adaptation is a process for adapting to current and expected climate change and the consequences of climate change. Climate change adaptation is therefore about preventing and mitigating the consequences of climate change. Resilience is a concept closely related to climate change adaptation. In this context resilience refers to the capacity of people or systems to adapt to, or undergo transformation in response to, risks arising from, or amplified because of, climate change. These definitions have been developed by the IPCC.

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

Topic	Examples of results
Increased resilience to climate change among the most vulnerable people and groups in the least developed countries: Poor and marginalised populations in the least developed countries are hit harder by climate change and environmental degradation (IPCC, 2019). Denmark therefore has a clear ambition to strengthen efforts to promote climate change adaptation and resilience to the benefit of these groups, in particular. This is done through contributions to a number of funds that integrate climate considerations with consideration for the most vulnerable groups.	**Support for the Local Climate Adaptive Living (LoCAL) Facility designed by the UN Capital Development Fund** Denmark's contribution of DKK 50 million, out of a total expected commitment of DKK 100 million to LoCAL has been earmarked for activities in Africa. LoCAL supports local governments to gain better access to climate finance and to build capacity and technical knowhow, so as to enhance local resilience to climate change. Through a combination of results-based grants for local governments that focus specifically on inclusive processes, aimed women for example, as well as capacity building and technical advice, LoCAL aims to adapt infrastructures to climate change and increase the resilience of vulnerable communities in a number of countries in Africa. **Support for efforts to address climate-induced loss and damage** Climate-induced loss and damage include serious effects of climate change that cannot be prevented through emissions reductions or mitigated through climate change adaptation locally. In 2022, Denmark announced that extra climate assistance of DKK 100 million would be earmarked in the 2022 Finance Act for climate change adaptation efforts, including climate-induced loss and damage, for the world's poorest countries. The extra climate assistance will be allocated to promote strategic partnerships between the Ministry of Foreign Affairs of Denmark and existing civil society activities related to climate-induced loss and damage; to increase contributions to CISU - Civil Society in Development; and to support Global Shield work to improve the resilience of vulnerable countries through insurance schemes to cover risk, loss and damage related to climate-related disasters.

Topic	Examples of results
Climate change adaptation, conflict and food security	Case: Support for a regional programme on climate, conflict, displacement and irregular migration in the Sahel Climate change exacerbates the already enormous challenges in the Sahel, affects ongoing conflicts in the region and adds to forced displacement and irregular migration. Helping the poorest people, smallholders for example, adopt to a changing climate has historically been challenging. Often only a minor share of climate funds reaches the vulnerable people in the most at-risk countries. A new green displacement initiative in Sahel was therefore launched in 2021. The objective of the initiative is to improve resilience to climate change in this fragile region. The programme was approved in 2022 and involves an expected total commitment of DKK 800 million over four years from 2021 to 2024. So far, four main partners are taking part in the programme: the World Bank, the UN International Fund for Agricultural Development (UNIFAD), the Dutch development organisation SNV, and the United Nations Development Programme (UNDP). Through the Enhanced Adaptation for Smallholder Agriculture Programme (ASAP+), UNIFAD helps to improve the resilience of particularly vulnerable communities in the face of climate-driven food insecurity. The programme develops climate-smart agricultural solutions for vulnerable smallholders, focussing on greenhouse gas emissions reduction, for example. The programme cooperates with a wide range of partners, from agricultural ministries and organisations to minor civil society organisations. The programme also includes agreements with the Dutch development organisation SNV to improve food security and income among agro-pastoral households in the border regions of Burkina Faso, Mali and Niger. The Pro-ARIDES programme helps drive transition to more climate-adapted agriculture and food production.

Topic	Examples of results
Promotion of initiatives that incorporate climate, the environment and biodiversity concerns. Through support for multilateral development banks and civil society organisations, Denmark is seeking to promote nature-based solutions[40] to address development challenges such as poverty, food insecurity, access to clean water, climate change, natural disasters, and loss of biodiversity through vital ecosystem conservation and restoration. There is already widespread hunger and poverty today which the world's existing food systems are unable to address. At the same time, there is a huge pressure on the planet's resources. And with an ever-growing world population, the situation is only getting worse.	**Support for UN Decade on Ecosystem Restoration** In 2022, Denmark became a key supporter in the Multi-Partner Trust Fund for the UN Decade on Ecosystem Restoration. The objective of the fund is to establish a global movement for restoration of ecosystems through a number of flagship projects aiming to create concrete results to serve as inspiration for others. The first flagship projects are: 1) Small Island Developing States – SIDS, 2) Central American Dry Corridor, and 3) The Great Green Wall for Ecosystem Restoration and Peace. Denmark is providing DKK 70 million in funding for 2022-2025. **Support for the Global Environmental Facility (GEF)** The Global Environmental Facility (GEF) is the largest and oldest multilateral fund dedicated to environmental protection. The GEF supports developing countries' work to address pressing environmental issues and to meet their commitments under multilateral environmental agreements. Denmark is providing DKK 800 million in funding for the GEF for the period 2022-2026 (GEF-8); twice the previous amount. **Cooperation with Danish civil society organisations** The Green Partnership established in 2021 collaboratively between the Ministry of Foreign Affairs of Denmark and various Danish civil society organisations, continued its work in 2022. The objective of the Green Partnership is to help implement the 'green track' in Denmark's current development policy strategy through encouraging cooperation on policy development, capacity building and knowledge-sharing. Furthermore, the ambition of the partnership is to propose innovative and sustainable green solutions to help meet climate, nature and environmental targets while also considering poverty reduction, human rights, indigenous peoples' rights, equality and the needs of local communities. In 2022, activities included public events on topics within climate, nature, the environment and development. The partnership also contributed to stronger dialogue between civil society organisations and specialist departments of the Ministry of Foreign Affairs of Denmark. An expert group on nature-based solutions was set up under the Green Partnership to strengthen knowledge-sharing and experience-sharing between civil society organisations and the Ministry of Foreign Affairs of Denmark. The Ministry of Foreign Affairs of Denmark has 18 Strategic Partnerships (SPAs) for 2022-2025 with Danish civil society organisations. These partnerships take a cross-cutting approach to green topics, as well as climate and green solutions. Through the Civil Society Fund administered by CISU - Civil Society in Development, small civil society organisations can apply for funding for projects on climate change adaptation, nature and the environment. Funding for climate change adaptation projects is also available through the Climate Change Adaptation Modality (CCAM); a separate fund expected to launch under the Civil Society Fund in 2023.

[40] Initiatives to protect, sustainably manage and restore natural or modified ecosystems; to handle societal challenges efficiently and at the same time adaptively; and to provide benefits for people and biodiversity (IUCN).

Box 13: Improved access to water and clean energy in Kenya

Since 2012, Denmark has supported the Northern Rangeland Trust (NRT) in Kenya. This is a membership-based umbrella organisation aimed at **supporting local communities in 43 protected natural areas (community conservancies)** in Kenya. Denmark is a key supporter of the NRT, providing around 9% of NRT's total funds.[41]

The projects are primarily in the northern parts of Kenya, which are currently experiencing the most severe drought in 40 years. The projects cover 63,000 km^2 in the northern and coastal parts of Kenya, with a population of around half a million people, most of whom are livestock breeders. The targeted areas are heavily affected by climate change, and by drought, in particular, which means that access to natural resources such as water, firewood and grass is under pressure. The livelihood of the people living in these areas is under threat, and, historically, this means increased risk of violent conflict between different groups of the population.

The NRT focusses on climate change adaptation activities to **improve access to water and sustainable energy** in some of the most vulnerable regions of Kenya, for example. In these areas, water shortages are being exacerbated by climate change and are causing unpredictable precipitation patterns, higher temperatures, and more frequent and longer droughts. Activities to address the lack of access to water aim at establishing dams, restoring boreholes and optimising rainwater collection. Activities for clean energy focus on the need to protect nature and use natural resources sustainably by introducing biogas plants and other climate-smart energy solutions.

Source: The Ministry of Foreign Affairs of Denmark

Box 14: Access to clean and secure drinking supply in Bangladesh

In January 2022, through its embassy in Dhaka, and in partnership with the development organisation BRAC in Mongla Upazila, Denmark launched a project entitled "Enhancing Safe Drinking Water Security and Climate Resilience through Rainwater Harvesting". Mongla is one of the most climate-vulnerable regions in the southwestern coastal region of Bangladesh. The region suffers from a serious lack of access to clean drinking water. The project is developing climate change adaptation technologies for clean drinking water by establishing rainwater collection stations at household and institutional levels. The project employs a local- and community-based approach to increasing the climate-change resilience of these vulnerable population groups. The project is running from January 2022 to December 2024 and has a total budget of DKK 29 million. The budget for 2022 was DKK 6.5 million and 2022 saw the establishment at household level of 1,200 rainwater collection systems (2,000 litres), for example. Furthermore, 90 bricklayers were trained in installing rainwater collection systems, and 66 steering committee members were trained in use and maintenance of the water installations. See descriptions of other results in the background

[41] Based on 2020 data. The embassy does not have up-to-date figures for 2022 and Denmark contributed an extra donation of DKK 35 million to the NRT in 2022.

memoranda on climate change adaptation action supported through Danish climate assistance.

Source: The Ministry of Foreign Affairs of Denmark

18 Climate assistance and investment

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.

18.1 Main results

18.1.1 Danish climate assistance and climate finance mobilised increased overall from 2020 to 2021

In 2021, total Danish climate assistance came to around DKK 2.8 billion, of which around 47% went to climate change adaptation initiatives and around 53% to emissions reduction initiatives, see table 7. In addition to the climate assistance agreed under the annual Finance Act (section 06.3), a total of DKK 372 million in climate assistance through EU's global instruments in 2020 can be attributed to Denmark. Furthermore, Denmark mobilised around DKK 2.1 billion in climate finance for developing countries through IFU, see table 7. There are currently no 2021 figures for climate finance mobilised through the multilateral development banks, but the level is expected to remain as in 2020, i.e. at around DKK 4.5 billion.

Table 7: Total Danish climate assistance and mobilised climate finance 2019-2021

DKK mill.	2019	2020	2021
Climate assistance in total	2,161	2,036	2,871
Climate assistance as a percentage of development assistance[42]	15.1%	13.7%	20.2%
Adaptation as a percentage of climate assistance	41%	56%	47%
Climate finance through the EU's global instruments	362	378	372

[42] Section 06.3. Assistance for developing countries set aside in the Finance Act.

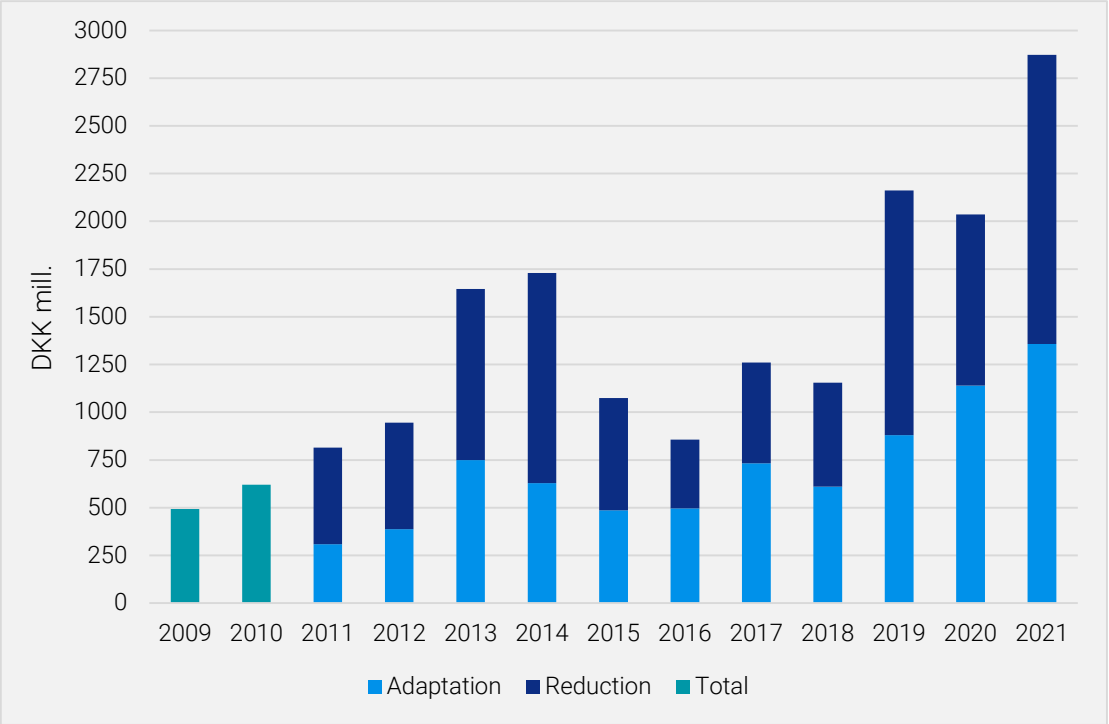
DKK mill.	2019	2020	2021
Climate finance mobilised through IFU	675	1,269	2,149
Climate finance mobilised through multilateral development banks Of which, private-sector mobilisation	4,020 Around 800	4,480 Around 880	-
Total	7,193	8,183	

Source: The Ministry of Foreign Affairs of Denmark

18.1.2 Danish bilateral climate assistance at an all-time peak in 2021

Danish bilateral climate assistance came to DKK 2,871 million in 2021, corresponding to 20.2% of the assistance for developing countries set aside under section 06.3 of the Finance Act; an all-time peak both in absolute figures and as a percentage of total assistance for developing countries.

Figure 35: New pledges for climate projects in developing countries given in the period 2009 to 2021, by climate adaptation and emissions reduction



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

18.1.3 Danish authorities instrumental in increasing private investments in the climate

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 IFU (Investment Fund for Developing Countries), which is owned by the Ministry of Foreign Affairs of Denmark. In 2021, IFU mobilised slightly more than DKK 2 billion in financing for climate projects, see table 7. This is an increase of almost DKK 1 billion relative to 2020 and is due largely to increased co-finance mobilised from private investors.

Box 15: Mobilising private finance for climate projects in developing countries: Solar energy in Nigeria - an example

The national electricity grid in Nigeria only supplies around 20% of the demand for electricity. A considerable share of the electricity demand is therefore met using diesel generators. There is an estimated 5 million or more generators in Nigeria, resulting in an estimated total cost of fuel and maintenance of up to USD 14 billion annually. The diesel generators contribute significantly to CO_2 emissions and to air pollution in general.

Through the Danish SDG Fund, IFU has been heading a consortium of public and private investors who have invested a total of USD 38 million in the Nigerian company Daystar. The company supplies ready-to-use solar energy systems to businesses and factories. Daystar contributes to a stable electricity supply and also to reducing costs and CO_2 emissions.

The investment was to contribute working capital, so that Daystar could develop its organisation and scale up solar energy deployment. Through IFU's active ownership, an attractive company was established and subsequently sold to Shell, which aims to develop Daystar further. The result is a locally based company, which can be a driver in the green transition and create green jobs and growth in Nigeria in the future.

Source: The Ministry of Foreign Affairs of Denmark

18.1.4 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 2020, Denmark was responsible for mobilising finance through development banks of DKK 4.5 billion, see table 7. Of this amount, around DKK 3.5 billion was mobilised through the banks' own gearing of their investments, and around DKK 1 billion was mobilised as co-finance from the private sector. Figures are as yet not available for 2021 but they are expected to be at the same level as for 2020.

19 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 EKF Denmark's Export Credit Agency and IFU Investment Fund for Developing Countries (IFU). Furthermore, for the first time, there is an estimate of the climate footprint of the portfolio of shares and corporate bonds held by Danish insurance and pension companies and investment associations in foreign listed companies. 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 investment. Note that the climate footprints of the portfolios of the individual players cannot be compared with each other because of methodological differences. The estimates for EKF Denmark's Export Credit Agency and IFU include scopes 1, 2 and 3 emissions, while the estimate for private investments only includes scopes 1 and 2.[43] Furthermore, only part of the insurance and pension companies' and the investment funds' total investment portfolios is included in the estimates. The estimates illustrate trends over time for EKF Denmark's Export Credit Agency, IFU and institutional investors, respectively. Note that this chapter does not describe CO_2e reductions abroad that Danish actors have helped realise through significant green investing and financing.

19.1 Main results

19.1.1 First estimate of the climate footprint of total investments by EKF Denmark's Export Credit Agency

EKF Denmark's Export Credit Agency provides finance for exports and internationalisation activities by Danish businesses, so that Danish businesses are better protected against financial and political risks associated with export activities.

Box 16: Export and Investment Fund of Denmark

As of 1 April 2023, EKF Denmark's Export Credit Agency became a 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). The objective of EIFO is to generate the highest possible returns for society through promoting growth and innovation in the Danish business community, paving the way for exports and internationalisation activities for Danish businesses, participating in the global value chain and cultivating new markets, as well as contributing to the sustainability transition.

[43] 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' when categorising a business' greenhouse gas emissions. 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 of the business.

Source: The Ministry of Climate, Energy and Utilities

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 2022, the total climate footprint of EKF Denmark's Export Credit Agency from financing projects internationally was 2.8 million tonnes CO_2e. The estimate includes all the agency's international projects, whether already up and running or being established.[44]

CO_2e emissions in connection with projects on renewable energy make up 27% of total emissions, see table 8. These emissions are largely attributable to the materials (including concrete and steel) used when erecting wind turbines.

The large climate footprint from renewable energy is primarily due to the scope of EKF Denmark's Export Credit Agency's activities within renewable energy. In 2022, the agency had renewable energy activities worth DKK 88 billion. However, this footprint is much smaller relative to the amount financed; i.e. DKK 9 million tonnes CO_2e per DKK million financed. Naturally, fossil energy production is linked to a relatively large footprint per DKK million financed. However, EKF Denmark's Export Credit Agency has a relatively small exposure to these activities: DKK 0.6 billion in 2022. Total emissions from these activities are therefore lower than for renewable energy activities.

Table 8: The total climate footprint of EKF Denmark's Export Credit Agency's international activities in 2022*

	CO_2e footprint, tonnes CO_2e*	Sector share, %	CO_2e footprint, tonne/DKK mill.
Oil and gas**	15,584	1	46
Mining operation	79,705	3	64
Food and agriculture	199,172	7	122
Chemicals	56,781	2	296
Metals and minerals	766,303	27	511
Fossil energy production	469,415	17	726
Renewable energy	771,136	27	9
Wastewater	8,096	0	656
Infrastructure and transport	232,967	8	18
Other	235,580	8	66
Total	2,834,740	100	25***

Source: EKF Denmark's Export Credit Agency **Note:** ***CO_2e** footprint including Scopes 1, 2 and 3 emissions and relative to the agency's share of investments. ****In this context, the oil and gas sector covers financing of projects related to extraction and production of oil and gas. *****Total, CO_2e footprint, tonnes CO_2e/DKK mill. average tonnes CO_2e emitted per DKK million financed by the agency.

[44] For more information on the methodology for calculating CO_2e footprints, see EKF Denmark's Export Credit Agency's 2022 Annual Report (EKF, 2022).

19.1.2 Second time that the climate footprint of IFU's activities has been estimated

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 performed calculations of the climate footprint of its activities for the first time in 2020 prior to Global Report 2022.[45] IFU has now calculated the climate footprint for 2021. IFU's climate footprint was 0.74 million tonnes CO_2e in 2020 and around 0.82 million tonnes CO_2e in 2021, reflecting an increase of 10%.

The increase is primarily due to an increase in the total portfolio, which grew by 23% from 2020 to 2021. Furthermore, the period saw a series of developments giving rise to decreases as well as increases in emissions. Emissions from emission-intensive sectors such as cement and concrete, agriculture with livestock and fertiliser production have fallen. The fall in emissions from the cement and concrete sector is due a decline in production in 2021. The fall in emissions from the fertiliser sector is due primarily to a change in the emission factor for older fertiliser plants.

The footprint from IFU's investment in funds in 2021 increased relative to 2020, which is due to increased investment and increased production in some of the funds. 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 larger in 2021 than in 2020. This increase is due to an increase in renewable-energy plants under construction, i.e. an increase in so-called Scope 3 emissions (emissions in the supply chain). In accordance with the calculation method applied, all emissions from the construction of these plants have been included in the first two years of the investment and emissions will therefore decrease over time.

IFU's climate footprint per DKK million invested fell by 10%, from 143 tonnes of CO_2e/DKK million in 2020 to 129 tonnes of CO_2e/DKK million in 2021, see table 9. Furthermore, IFU's investments in funds, cement/concrete, and renewable energy are accountable for more than 50% of IFU's climate footprint.

In 2022, the board of IFU adopted a new climate policy, including the goal of a climate-neutral investment portfolio by 2040. Furthermore, IFU pledges to continuously report on how it intends to achieve this goal for its portfolio.

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

Table 9: Trends in the climate footprint of IFU's portfolio 2020-2021*

Sector	CO_2e footprint, tonnes CO_2e*	Sector share, %	CO_2e footprint, tonne/DKK mill.	CO_2e footprint, tonnes CO_2e*	Sector share, %	CO_2e footprint, tonne/DKK mill.
	2020	2020	2020	2021	2021	2021
Renewable energy	16,701	2	21	87,885	11	54
Fossil energy	14,610	2	218	32,913	4	141
Fertiliser	77,469	10	1993	63,798	8	602
Cement/concrete	175,473	24	1587	149,535	18	1352
Agriculture (livestock)	77,677	10	185	65,319	8	161
Agriculture (other)	2,659	0	11	6,535	1	22
Hotels, restaurants and property	21,680	3	39	17,700	2	35
Other industries	69,898	9	100	65,214	8	87
Funds (besides those managed by IFU)	114,910	16	140	186,130	23	182
Microfinance funds	96,155	13	340	13,035	2	46
Other financial institutions	73,118	10	85	128,825	16	131
Total	740,348	100	143	816,889	100	129**

Source: IFU. Note: *Climate footprint including scopes 1, 2 and 3 emissions and relative to the IFU's share of investments. **Total, CO_2e footprint, tonne CO_2e/DKK mill., average tonnes CO_2e emitted per DKK million financed by IFU.

19.1.3 The very first estimate of the climate footprint of investments in foreign listed companies by insurance and pension companies and investment funds

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.

This year, this report includes the first ever report on scope 1 emissions and scope 2 emissions stemming from investments in foreign listed companies by Danish private institutional investors. The reporting is based on the first ever calculations, in March 2023, by the Central Bank of Denmark (*Danmarks Nationalbank*), of the climate footprint of investments in the shares and corporate bonds of listed companies by Danish

insurance and pension companies and investment funds.[46] Danmarks Nationalbank expects to incrementally build further on its climate-related indicators and calculations as the quality and availability of data improve.

An extract has been made for GR23 of investments by these investors in shares and corporate bonds in companies that are listed outside Denmark. 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 calculations show that Danish investment funds financed scope 1 and scope 2 emissions totalling around 3.8 million tonnes CO_2e in 2022 through their investments in shares and corporate bonds in foreign listed companies, while insurance and pension companies financed emissions totalling around 6.7 million tonnes CO_2e. The larger footprint of insurance and pension companies is because the insurance and pension companies manage larger assets in listed shares and corporate bonds than the investment funds.

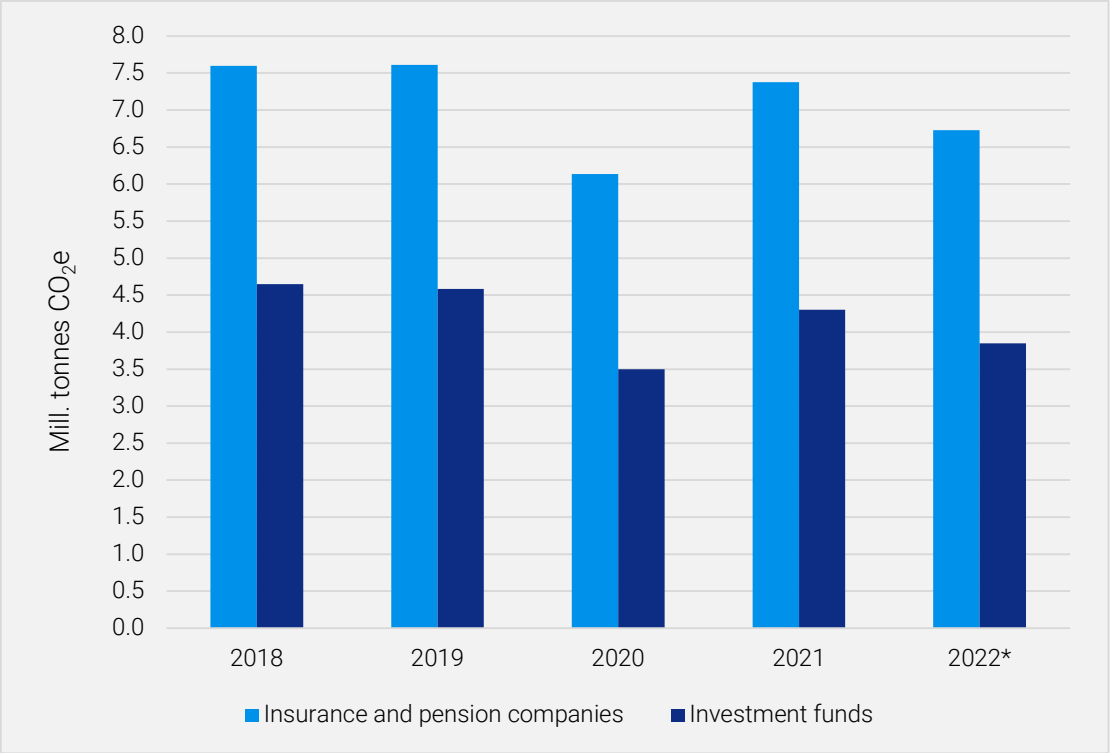
These two groups of actors together financed scope 1 and scope 2 emissions corresponding to around 10.5 million tonnes CO_2e via investments in foreign listed companies in 2022.

Calculations by Danmarks Nationalbank cover the period 2018-2022, showing the trend over time. The trend shows that financed emissions by insurance and pension companies fell by 11% from 2018 to 2022, while they fell by 17% for investment funds, see figure 36.

The fall in financed emissions is largely because insurance and pension companies, as well as investment funds, have reduced their ownership shares in emissions-intensive listed companies. Moreover, emissions of greenhouse gases have levelled out or dropped in many companies since 2018.

[46] The calculations measure the greenhouse gases controlled, directly or indirectly, by the businesses (scope 1 and scope 2 emissions), but do not include other greenhouse gas emissions embedded in the value chain of the businesses (scope 3 emissions). The calculations do not include unlisted shares, mortgage-credit bonds, government bonds, etc. The climate footprint of banks is also not included in the climate footprint. For further information about the new calculations and about sources and methodology, see (Danmarks Nationalbank, 2023a) (Danmarks Nationalbank, 2023b).

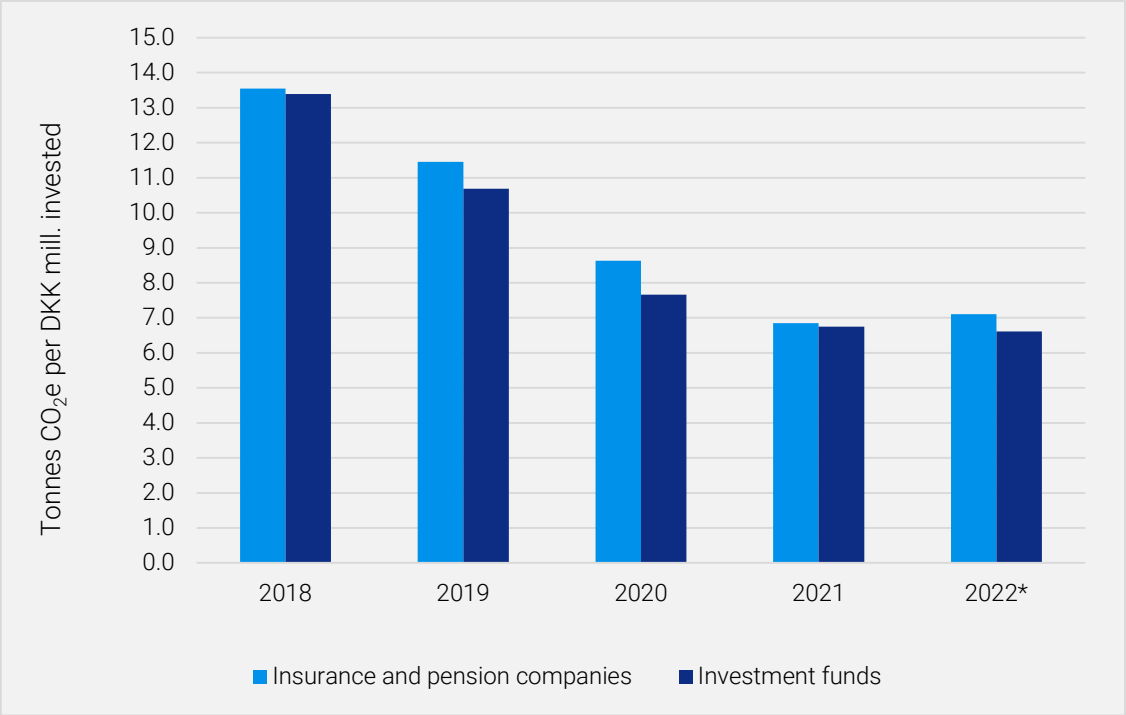
Figure 356: Financed emissions abroad related to investments by Danish insurance and pension companies, as well as investment funds, in shares and corporate bonds in foreign listed companies 2018-2022 (million tonnes CO_2e)



Source: Danmarks Nationalbank, 2023. **Note:** Financed emissions (scopes 1 and 2) attributable to investments in shares and corporate bonds in foreign listed companies. Data for the year are based on averages of quarterly figures. *2022 are provisional figures.

A similar picture is seen for tonnes of greenhouse gases emitted by businesses in the respective portfolios per DKK million invested, see figure 36. In figure 36, the CO_2e footprint has been estimated at around 7.1 tonnes CO_2e per DKK million invested by insurance and pension companies in 2022, and around 6.6 tonnes CO_2e per DKK million invested for investment funds. Over the period 2018-2022, there is a drop of around 50% for both sectors.

Figure 36: The CO_2e footprint of investments by Danish insurance and pension companies and investment funds in shares and corporate bonds in foreign listed companies 2018-2022 (million tonnes CO_2e)



Source: Danmarks Nationalbank, 2023. **Note:** CO_2e footprint (Scopes 1 and 2) attributable to investments in shares and corporate bonds in foreign listed companies. Data for the year are based on averages of quarterly figures. *2022 are provisional figures.

20 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 done 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.[47]

20.1 Main results

20.1.1 Action Plan for Economic Diplomacy to promote focus on sustainability in initiatives supported by the Ministry of Foreign Affairs of Denmark

The Action Plan for Economic Diplomacy 2022-2023 sets a new common direction for overall promotion of Danish exports, innovation and investment. The action plan will guide 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. The action plan contains more than 100 activities aimed at delivering on one or more of the dimensions of performance on *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 of Denmark contribute to the global sustainability transition, with focus on the climate. 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, wastewater initiatives, and greener textile production, with benefits for Danish exports and the climate.

20.1.2 Increased green exports to the US and EU

2022 saw focus on implementing the two action plans for increased green exports to the EU and the US. Many results have been achieved with regard to enhancing Danish green strongholds and exports, such as new strategic collaboration agreements with public authorities and businesses, strategic sector alliances and targeted export promotion activities. In September 2022, the Danish prime minister visited the US with a delegation of more than 50 Danish businesses and industry organisations. The focus of the visit was to promote Danish products and services within energy, water, biosolutions and

[47] This chapter is based on the background memoranda on climate diplomacy; climate change adaptation action supported through Danish climate assistance; and reduction efforts supported through Danish climate assistance.

food security. The visit also marked the announcement of a new partnership to develop a Danish-American Power-to-X hub.

20.1.3 Action plan for food cluster exports

An action plan for Danish food cluster exports 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 on food cluster exports also focusses on strengthening the Danish food cluster's exports and contribution 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 collaborations on biosolutions in the US and Germany, and as targeted authority cooperation and export promotion on relevant markets.

20.1.4 New strategic water alliance and water partnership with the US

In January 2022, the strategic water alliance, Water Technology Advisory (WTA EU) was launched. WTA is a cross-geographical alliance including Germany, Poland, Italy and Spain. In 2021, sector experts were employed with the delegations in Hamburg, Warsaw, Rome and Madrid/Lisbon that cooperate with the Danish Environmental Protection Agency, commercial advisors at the delegations, Danish businesses and organisations. The aim of the WTA alliance is to achieve the goal of the former Danish government to double Danish exports of water technology and water solutions in 2030 (see Denmark's export strategy for water). WTA helps to promote energy efficiency and climate efficiency in the water sectors of cooperation countries. The relevant sector experts ensure ongoing technical dialogue with 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 2023.

2022 also saw the establishment of strategic partnerships with California, Houston and Chicago. These partnerships are being supported by the well-established strategic water alliance, Water Technology Advisory US (WTA US), which includes sector experts with the delegations in Houston, Washington DC, Silicon Valley and Chicago. There is close cooperation with experts from the Danish Environmental Protection Agency, as well as Danish businesses and organisations. In 2022, WTA US entered into a strategic partnership with the US Water Alliance on a climate-neutral and energy-neutral American water sector. The US Water Alliance comprises the largest and most ambitious utilities in the US. The alliance is an influential lobby player at federal level. In 2022, the Ministry of Environment of Denmark established entered into an agreement (Memorandum of Understanding (MoU)) with the California State Water Board, the California Department

of Water Resources, and the US Environmental Protection Agency on concrete cooperation initiatives for an efficient water sector.

20.1.5 Danida Green Business Partnerships

The new Danida Green Business Partnerships (DGBP) programme aims to promote the green transition and private-sector-driven inclusive economic growth through innovative partnerships. The DGBP completed its first application round in 2022. Applications were plenty, with many qualified applications. DKK 100 million were granted to a total of 14 new partnership projects within sustainable agriculture and green technology, in particular. A total of eight Danish partners received grants. The projects are expected to commence during 2023. A new application round is being planned for 2023

20.1.6 More sustainable business value chains

New legislation from the European Commission, such as in the Corporate Sustainability Reporting Directive (CSRD) and in the Corporate Sustainability Due Diligence Directive (CSDDD), introduces stricter requirements for businesses on environmental and social sustainability throughout their value chains. Denmark has been an eager supporter of ongoing efforts because they are an important step in transitioning the European business sector to a sustainable economy. A number of Danish initiatives and partnerships support Danish businesses in their sustainability transition. For example, in 2022, the Ministry of Foreign Affairs of Denmark supported efforts through a partnership with Ethical Trade Denmark and the UN Global Compact Denmark. This partnership helps to promote sustainable and responsible cooperate behaviour through knowledge development, market analyses, networks and consultation. Ethical Trade Denmark encourages responsible global trade and due diligence advice, and manages alliances against deforestation-intensive value chains for food products (soybeans, palm oil, coffee, etc.). The UN Global Compact Denmark strengthens the global responsibility of Danish businesses toward people, nature, and the environment and contributes to raising climate ambitions and to decarbonising value chains.

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Glossary and abbreviations

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.

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, fuel wood, wood chips, wood pellets, wood waste, biodegradable waste, etc. In global impact reports, biofuels are also defined as biomass.

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

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.

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, clearing forest 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.

Emission factor for foreign electricity: Emission 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 connection with the energy sector, e.g. within district heating, bioenergy, wind energy or energy-saving equipment.

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

Solid biomass fuels: Solid biomass fuels 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.

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

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.

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.

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.

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).

Liquid biofuels: Fuels produced from biomass. If the biofuels are produced from crops that could alternatively be used for food or animal feed (rapeseed, 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.

Abbreviations

GDP	Gross domestic product
CO_2e	CO_2 equivalents
DGIF	Danish Green Investment Fund
EKF	EKF Denmark's Export Credit Agency
GR22	Global Report 2022
HVO	Hydrotreated vegetable oil
IFU	Investment Fund for Developing Countries
IRENA	The International Renewable Energy Agency
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

GDP	Gross domestic product
TWh	Terawatt-hours, 1,000,000 MWh.
USD	US dollars
RE	Renewable energy

List of annexes and background material

Annexes:

- Annex 1: Legal basis for global impact reporting

Background memoranda:

- 0. Introduction to material concerning Denmark's Global Climate Impact – Global Report 2023
- 1. Background memorandum – The climate footprint of Danish consumption
- 2. Background memorandum – Projection of Denmark's consumption-based climate footprint
- 3. Background memorandum – Key indicators of consumption
- 4. Background memorandum – The climate footprint of Danish imports
- 5. Background memorandum – The climate footprint of Danish exports
- 6. Background memorandum – The climate footprint of public procurement
- 7. Background memorandum – Textile analysis
- 8. Background memorandum – Fuel balance
- 9. Background memorandum – Electricity trade
- 10. Background memorandum – Solid biomass fuels
- 11. Background memorandum – Transport related fuels – Fossil fuels including biofuels and other renewable fuels
- 12. Background memorandum – International transport
- 13. Background memorandum – Green exports and potential reductions
- 14. Background memorandum – Climate action by large Danish businesses
- Introduction to the background memorandum on global action by authorities
- 15. Background memorandum – Climate diplomacy
- 16. Background memorandum – Reductions through climate assistance
- 17. Background memorandum – Reduction efforts through bilateral energy cooperation
- 18. Background memorandum – Reduction efforts through bilateral environmental cooperation
- 19. Background memorandum – Reduction efforts through bilateral food cooperation
- 20. Background memorandum – Global climate change adaptation action through Danish climate assistance and export promotion
- 21. Background memorandum – Climate finance
- 22. Background memorandum – Finance of international investments

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, GR23 also describes additional areas.

The Climate Act also states that global impact reports are to be submitted for public consultation, so that external actors 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.