MINISTRY OF FINANCE

Kingdom of Denmark Green Bond Impact Report 2022

July 2025

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Green Bond Impact Report
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Denmark

Photos: Colourbox and iStock.

ISBN: 978-87-94088-97-8 (digital version)

The publication is available for download at fm.dk

Green bonds issued by: Danmarks Nationalbank on behalf of the Danish Ministry of Finance (LEI: 549300PTO6LS1PTM6607)

Name of bonds assigned by the issuer: DGB 0.00'2031 G, DGB 2.25'2033 G

ISIN: DK0009924375, DK0009924615

The Kingdom of Denmark applies a portfolio-based approach, reporting on impact on an aggregated level where most relevant and in correspondence with the Green Bond Framework, published on December 8, 2021.

The content of this document is not subject to any approval or endorsement from ESMA or any other competent authority. No external reviewer has assessed the content of this report.

Summary

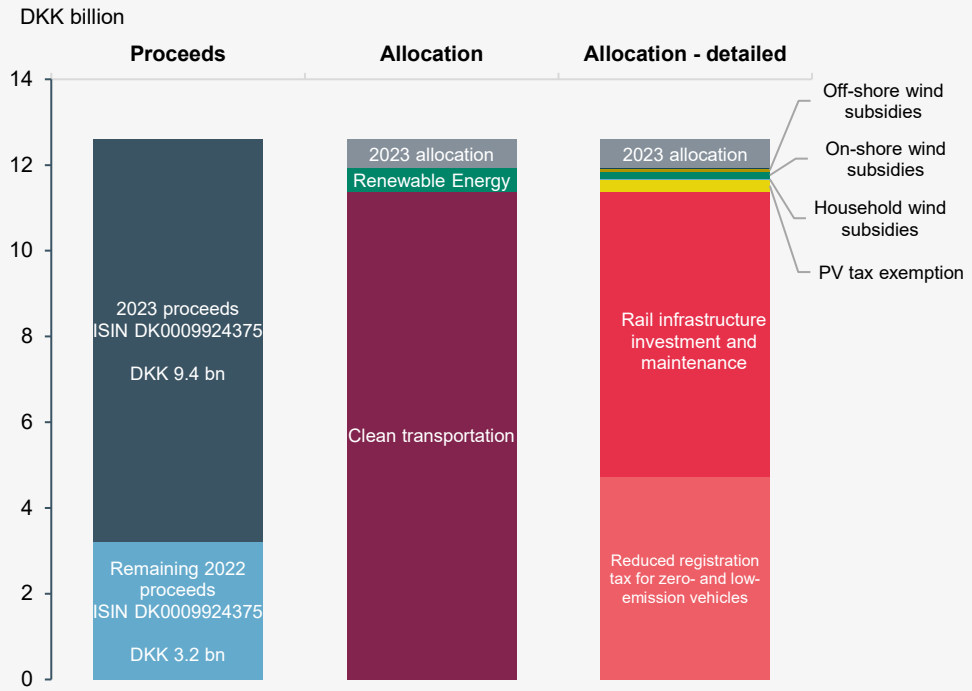
This is the second annual Green Bond Impact Report issued in accordance with the Kingdom of Denmark Green Bond Framework. Between the inaugural issuance of green bonds on 19 January 2022 and the end of 2024, The Kingdom of Denmark has issued a total volume of DKK 32.0 billion of green bonds at market value.

Of the DKK 32 billion proceeds DKK 11.9 billion have been allocated to finance eligible green expenditures in 2022. This report accounts for the climate impact of these. About DKK 0.5 billion or 4.5 per cent have been allocated to projects related to renewable energy, and about DKK 11.4 billion or 95.5 per cent have been allocated to projects related to clean transportation. For a detailed overview of the allocation of the proceeds, *see figure S.1*.

By significantly contributing to reduce Danish CO_2e emissions, the eligible green expenditures in 2022 have contributed to mitigate climate change.

Figure S.1

Detailed overview of proceeds allocated to 2022 eligible green expenditures



Source: Danmarks Nationalbank and National Financial Annual Report 2022.

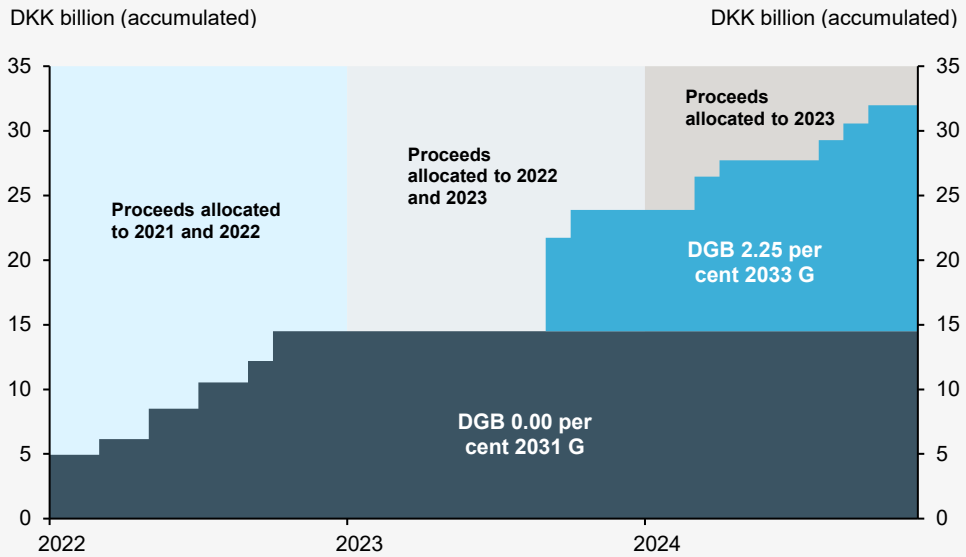
1. Introduction

To support the transition to a sustainable economy and the development of green capital markets dedicated to financing this transition, the Kingdom of Denmark has been issuing sovereign green bonds since the beginning of 2022.

The inaugural issuance of green bonds took place on 19 January 2022. The opening was a great success with the highest amount of bids for Danish government bonds for more than ten years. As planned, DKK 5 billion were sold at the opening auction and a total of DKK 9.5 billion were sold at subsequent auctions in 2022, *see figure 1.1.*

On 26 September 2023, the Danish government issued a green bond maturing on 15 November 2033 via syndication. The issuance was more than two times oversubscribed, showing that investor demand remains high. As planned, DKK 7.2 billion were sold at the syndication and a total of DKK 2.2 billion were sold on subsequent auctions in 2023. In 2024, a total of DKK 8.1 billion have been issued via auction resulting in total proceeds of 32.0 billion being raised under the Danish Government's Green Bond Framework per ultimo 2024, *see figure 1.1.*

Figure 1.1
Proceeds from sale of green bonds in 2022 and 2023



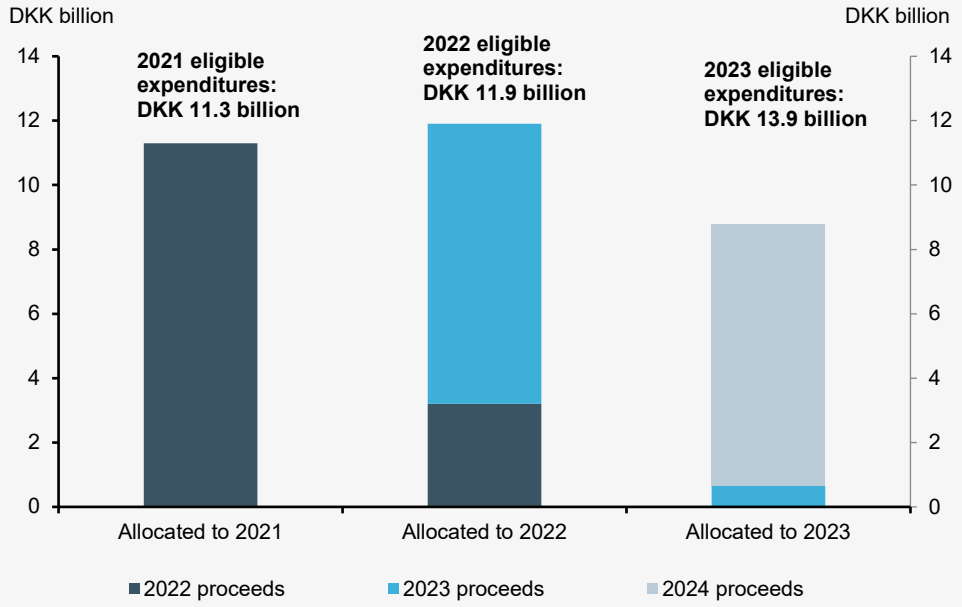
Source: Danmarks Nationalbank.

Total proceeds of DKK 14.5 billion, DKK 9.4 billion and DKK 8.1 billion were issued in 2022, 2023 and 2024, respectively. In accordance with the Green Bond Framework, the proceeds from the issuances can be allocated to either the year

prior to the issuance or the same year as the issuance. Thus, the proceeds from issuances in 2022 can be allocated between 2021 and 2022 and so on.

The DKK 11.3 billion of green expenditures in 2021 were financed entirely by proceeds from issuances in 2022. The DKK 11.9 billion of eligible green expenditures in 2022 have been financed in part by DKK 3.2 billion issued in 2022 and in part by DKK 8.7 billion issued in 2023. The DKK 13.9 billion of eligible green expenditures in 2023 have been financed in part by the remaining DKK 0.7 billion issued in 2023 and in part by DKK 8.1 billion issued in 2024. The eligible green expenditures in 2023 have thus not been fully financed. For an overview, *see figure 1.2*.

Figure 1.2
Allocation of green bond proceeds to eligible green bond expenditures



Source: Danish Ministry of Finance.

With its Green Bond Framework, the Kingdom of Denmark has committed to publish an annual Impact Report that accounts for the positive environmental impact of the eligible expenditures. The present report refers to the financed eligible expenditures from 2022.

The headline targets of the Danish climate strategy and the state of play of their implementation are summarized below. In addition, the overall green bond governance setup and the process for selection of eligible expenditures are recapped. The full description of these can be found in the green bond framework. The rest and main part of the report adds detail to the financed green expenditures and to the estimates of their environmental impact.

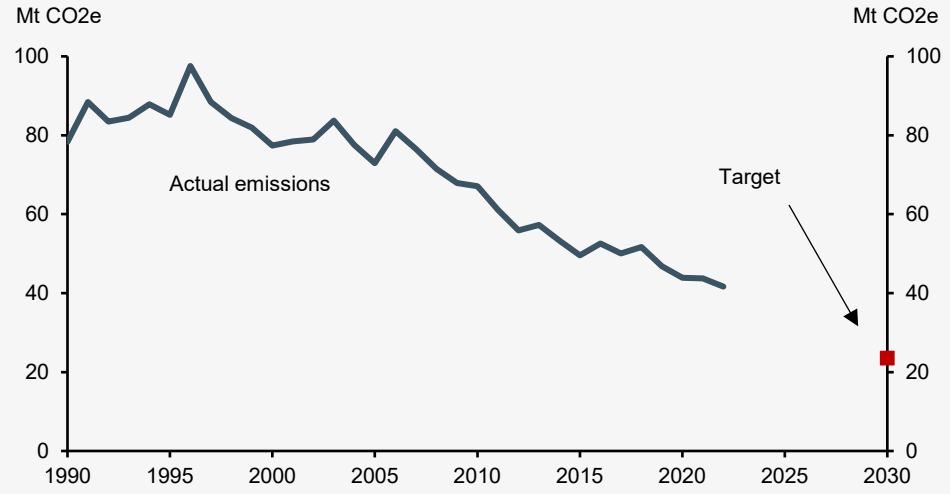
Denmark's climate strategy

Denmark has substantial green ambitions and strives to be a frontrunner, when it comes to mitigating climate change and implementing the necessary transition of our society and economy. At the center of the green ambitions is the Climate Act of 2019, according to which Denmark must reduce its greenhouse gas emissions by 70 per cent by 2030 compared to 1990 levels. In addition, the Climate Act also commits Denmark to achieve climate neutrality by 2050 at the latest, considering the Paris Agreement target of limiting the global temperature rise to 1.5 degrees Celsius.

In its coalition agreement, the new government, in place since 15 December 2022, has committed itself to maintain the ambitious existing climate targets and, in some areas, to take them even further. Most notably, the new government wants to bring forward the target date for climate neutrality from 2050 to 2045 and set a negative emission goal in 2050 by reducing emissions by 110 pct. compared to 1990.

The Climate Act also includes an indicative target that Denmark's emissions should be reduced by 50-54 per cent by 2025 compared to 1990 levels. With Climate Plan 2025 (KF25), total emissions in Denmark are estimated to amount to 33.6 million tonnes of CO_2e in 2025, corresponding to a reduction of approximately 58 per cent compared to 1990, *see figure 1.3*. On 15 March 2025, Denmark submitted the national emissions inventory for 2023 to the EU. The inventory showed that emissions in 2023 had been reduced by 51 per cent compared to 1990 levels. Thus, the lower bound of the 2025 target has been met two years ahead of schedule.

Figure 1.3
Total net CO_2e emissions, Mt, actual 1990-2022 and 2030-target



Note: The target of around 23 Mt CO_2e in 2030 constitutes a 70 per cent reduction in CO_2e emissions compared to the level of emissions in 1990.
Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

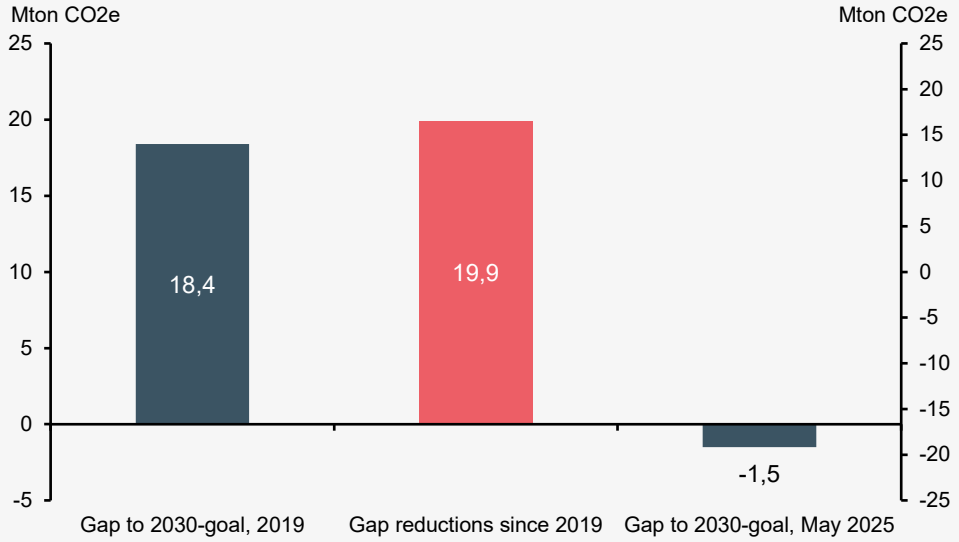
Since the Climate law agreement in 2019 significant political agreements have been reached with the goal of achieving the climate targets, generally with a broad backing in the Danish Parliament. For example, in 2022 a green tax reform that notably introduces a tax on firms' CO_2e emissions was agreed. In November 2024, the government made an agreement on implementation of the green tripartite that, among other things, proposes a tax on CO_2e emissions in the agricultural sector.

In addition, and recognizing that all sectors must contribute to the green transition, agreements on climate initiatives in all major emission sectors have been made. As part of the agreements, reviews are planned for the sectors to ensure implementation, take account of technological developments and evaluate the need for new initiatives. Among the sectors covered are the energy and utilities sector and the transport sector, which are the focus of the green bond expenditures.

Investments in renewable energy have helped transform the power and heating sector from being the most emitting sector in Denmark to having zero emissions in a few years from now. The transport sector, along with the agricultural sector, are the two sectors estimated to account for the largest share of emissions in 2030. Thus, initiatives to ensure e.g. clean transportation play an important part in the green transition of the Danish society and economy.

By the latest estimates, Denmark's total yearly greenhouse gas emissions will by 2030 be reduced by approximately 72 per cent compared to 1990. As a result, the 2030 reduction target is expected to be met with a margin of around 1.5 million tonnes of CO_2e (when taking into account the partially estimated reduction effects of political agreements since the climate projection), *see figure 1.3*.

Figure 1.3
Estimates for the emission reduction gap to achieving the target of 70 pct. reduction in 2030



Note: 'Gap' indicates the estimated emissions in 2030 minus the targeted emissions level (around 23 Mt). Gap reductions includes political agreements, technological developments, model improvements etc. since 2019.
Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

Governance and green bond expenditures

The proceeds from the sale of the green bonds finance a set of eligible green expenditures, that have been identified, assessed and approved by an Inter-Ministerial Working Group (IMWG)[1]. The IMWG has done this in accordance with the criteria in the green bond framework.

The chosen expenditures can be classified into two categories: Renewable Energy and Clean Transportation. The expenditures in the renewable energy category support the production and development of renewable energy, thereby contributing to climate change mitigation. The expenditures related to clean transportation support sustainable modes of personal and mass public transportation and the development and maintenance of infrastructure required for these.

The eligible green expenditures have been evaluated according to, and to the extent possible, aligned with the criteria in the EU classification system for sustainable economic activities (the "EU Taxonomy"). A detailed taxonomy assessment of the eligible green expenditures can be found on the Ministry of Finance's webpage. Further, it is intended that all the eligible green expenditures adhere to minimum social safeguards.

[1] The IMWG consists of the Ministry of Finance, Ministry of Transport, Ministry of Climate, Energy and Utilities, Ministry of Taxation and has The Debt Management Office at Danmarks Nationalbank as observer.

In this selection and evaluation process, a range of potential expenditures have been excluded from the list of eligible green expenditures. Economic activities that was not covered by the EU Taxonomy when the Green Bond Framework was created have thus been excluded, as well as expenditures related to e.g., weapons, gambling, alcohol and tobacco.

Following market standards, the firm Cicero Shades of Green was engaged to provide a second party opinion on the Green Bond Framework. The framework was rated Dark Green and the governance structure was rated as Excellent. Deloitte audited the allocation report for 2021, 2022 and 2023. The second party opinion and the allocation reports can both be found on the Ministry of Finance's webpage.

On behalf of the IMWG, The Ministry of Finance hopes you enjoy reading this second impact report related to green bonds issued by the Kingdom of Denmark, and welcomes any feedback.

2. Impact Table

Table 2.1 below gives an overview of the impact of the eligible green expenditures incurred in 2022 in accordance with the Kingdom of Denmark's Green Bond Framework. The table presents the impact in terms of avoided CO_2e for each of the expenditures. In addition to impact metrics, *table 2.1* also provides an overview of other relevant outcome indicators for the expenditures. In section 3 and 4 the methodology used for each of the expenditure types is presented in more detail.

An Excel sheet with further details, notably a breakdown of expenditures into the shares allocated to the different programs and categories can be found on the Ministry of Finance's webpage dedicated to green bonds.

Table 2.1 Detailed overview of impact metrics for eligible green expenditures in 2022
All expenditures have the Primary EU Environmental Objective of *Climate Change Mitigation*

Category	Description	Expenditure Category	Impact metric avoided CO_2e	Result Indicators	Impact metric other	Amount allocated[1] (million DKK)
	Ministry of Climate, Energy and Utilities					
Renewable Energy	Subsidies for renewable energy (PV systems and other small WE systems)	Renewable energy related subsidies	0.1 Mt	787 MW subsidized production capacity	746 GWh production of renewable energy	1.3
	Subsidies for renewable energy (Off-shore wind)	Renewable energy related subsidies	1.3 Mt	1,439 MW subsidized production capacity	6,222 GWh production of renewable energy	93.2[3]
	Subsidies for renewable energy (On-shore wind)	Renewable energy related subsidies	0.7 Mt	1,044 MW subsidized production capacity	3,015 GWh production of renewable energy	139.3
	Subsidies for renewable energy (Household wind systems)	Renewable energy related subsidies	0.01 Mt	19 MW subsidized production capacity	44 GWh production of renewable energy	42.9
	Ministry of Taxation					
	Taxation of electricity (Exemption of PV-cells)	Tax expenditures[2]	0.1 Mt	108,000 PV-systems	550 GWh of production of renewable energy	275.0
Clean Transportation	**Ministry of Transport**					
	Rail infrastructure – replacing the railway signalling system and other rail infrastructure investment projects	Railroad investment projects, renovation and maintenance	0.4 Mt	1,962 km railway track maintained 802 km electrified railway[4]		6,668.0
	Ministry of Taxation					
	Registration tax (Tax expenditure for zero- and low-emission vehicles' reduced registration tax))	Tax expenditures[2]	1.6 Mt	55,400 newly registered zero- or low-emission cars in 2022		4,688.9
	In total:					**11,908.6**

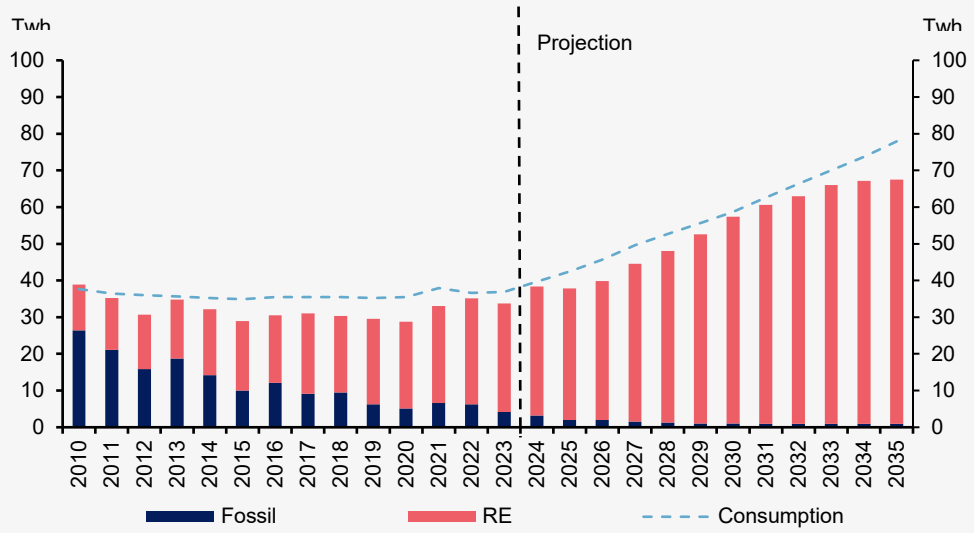
Note: All expenditures are in million DKK.
1) For more descriptions on the allocation of bond proceeds, see the Kingdom of Denmark Allocation Report, published in December 2023.
2) The two tax expenditures are calculated separately from the Budget Act and the Governments Annual Financial Report and are based on estimates from the Ministry of Taxation.
3) For this budget item, the expenses are a corrected version of the expenses in the National Financial Annual Report for 2022 (Statsregnskabet), where an error in the treatment of certain payments has been identified.
4) For more a detailed description of the progress on the electrification of the danish railway, *see table 4.1.*
Source: Danish Ministry of Finance.

3. Renewable energy

Denmark is transforming its energy infrastructure to further increase the production of renewable energy, thereby contributing to climate change mitigation. The Green Bond Framework includes three subsidy schemes and one tax exemption scheme to incentivize this transformation, notably by providing long-term economic security for operators of renewable energy generation plants.

As a result of past decisions, renewable energy (RE) today already constitutes a very high share of Danish electricity production and consumption. Since 2022 electricity production by renewable energies have constituted above 80 per cent of electricity consumption, and this share is expected to increase in the coming years, *see figure 3.1.*

Figure 3.1
Danish electricity production and consumption, Twh

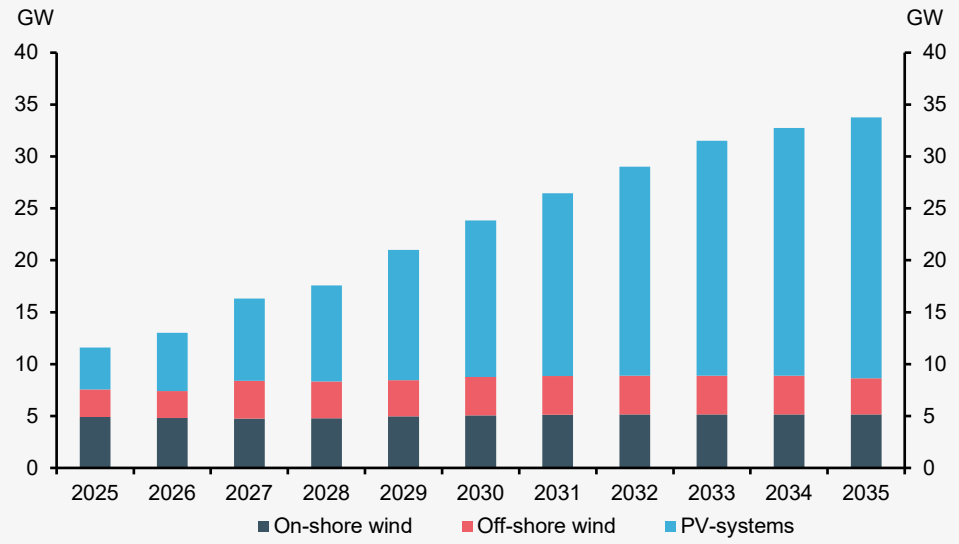


Note: RE-production was around 81 per cent of electricity consumption in 2022, and is expected to be of around 94 per cent of both electricity consumption and production in 2025. Electricity imports account for the difference between production and consumption.
Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

In terms of capacity, PV, on-shore wind and off-shore wind represented 2.8 GW, 5.0 GW and 2.3 GW respectively in Denmark in 2022. A broad majority of the Danish parliament has in recent years agreed to expand the production of renewable energy towards 2030. Production capacity is expected to increase from 10 GW in 2022 to 31 GW by 2030. The main drivers for these ambitious projections are

the expected increase in capacity from off-shore and on-shore wind systems and solar (photo-voltaic/PV) energy, *see figure 3.2*.

Figure 3.2
Projection of sustainable energy capacity, by production technology



Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

3.1 Subsidies for renewable energy

Subsidies have played an important role in the development of renewable energy production
The very high share of renewable electricity in Denmark can, to a great extent, be attributed to the subsidies for producers of renewable electricity introduced in 1992. The aim was to increase the competitiveness of renewable energy sources compared to fossil fuel-based sources, and thereby to promote renewable energy production.

The subsidies for renewable energy were transformed to a tariff programme for utility bills, more precisely the PSO-tariff (Public Service Obligation). Utility users would pay a PSO-tariff, based on their power consumption, which was used to finance renewable energy subsidies (wind, solar, biomass, biogas), as well as R&D for environmentally friendly energy technologies and subsidies for decentralized cogeneration (small-scale combined heat and power (CHP)).

In 2016, the Danish parliament (Folketinget) decided to gradually phase out the PSO as a tariff on the consumer's bill. Therefore, subsidies were partly financed by the PSO-tariff and partly financed by the state budget from 2017-2021, with the share of the state budget increasing gradually. By 2022, the tariff has been fully phased out, and the subsidies for renewable energy are financed entirely from the state budget.

According to the Danish Climate Council (Klimarådet), the subsidy has been a key driver of the green transition, and the large share of renewable energy in Denmark.

Renewable energy subsidies in the Green Bond Framework
The Green Bond Framework only includes wind and solar energy related subsidies. However, subsidies are also given to other types of renewable energy. The share of installed capacity that has been subsidized, and thus provides the basis for the impact metric, is listed in *table 2.1*.

The three renewable energy subsidies are estimated to have mitigated climate change by avoiding 2.1-2.2 million tonnes of CO_2e emissions in 2022, by producing fossil free energy.

There is some overlap in the impact estimate, as some smaller non-commercial PV systems can in principle both receive direct subsidies and the tax exemption for own consumption described below. 2.1 million tonnes is thus a lower bound estimate.

Avoided CO_2e emissions are calculated on the basis of the expected production from the included subsidized electricity production as reported in *table 2.1*. The applied emission factor is derived from a combined build margin and operating margin for the Nordic electricity market, as suggested by the Nordic Public Sector Issuers (NPSI) in 2024[2]. The baseline emission factor for electricity suggested by NPSI is 191 g CO_2e/kWh.

Due to the surge of energy prices in 2022, the allocated subsidies diminished significantly and only accounted for approximately DKK 0.28 billion in 2022.

As technology has evolved, production costs have fallen, and as learning has taken place on the regulatory and planning side, renewable energy is increasingly being generated under market conditions, without the need for subsidies. In fact, most of the newly installed onshore wind- and solar energy capacity, as well as offshore wind capacity currently under construction, in Denmark is not subsidized. And the total amount paid out in wind- and solar related subsidies is generally expected to decrease in the long term. However, it should be noted that recent market changes, including interest rates changes and supply chain constraints and uncertainty on the demand side, have challenged the offshore wind sector, and it is therefore expected that there is a need for subsidies for offshore wind in the current market.

The gradual phasing out of subsidies for renewable energy technologies that can function under market conditions contributes to an efficient energy system and frees up resources for other uses, notably to promote the green transition.

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[2] https://www.kuntarahoitus.fi/wp-content/uploads/2024/05/NPSI_Position_Paper_2024.pdf

An energy system well equipped to face geopolitical and climate risks

Russia's invasion of Ukraine and the resulting reduction of energy supply from Russia has underlined the strong connections between energy and security policy, and further improved the case for increasing renewable energy production and making Europe independent from Russian energy.

The geopolitical instability led to increased uncertainty regarding Europe's energy supply. Due to Denmark's energy infrastructure, including extensive district heating, its diversity of energy sources such as bioenergy, wind and solar energy, as well as continuously updated contingency plans, Denmark is well prepared to face market instability. For example, district heating is the main heating form for more than fifty per cent of residential buildings, *see figure 3.3*. The electricity- and district heating sector functions largely on renewable energy sources, as attested by its very low CO_2e emissions, *see figure 3.4*.

Figure 3.3
Energy sources in final heat consumption in households, 2023 (PJ)

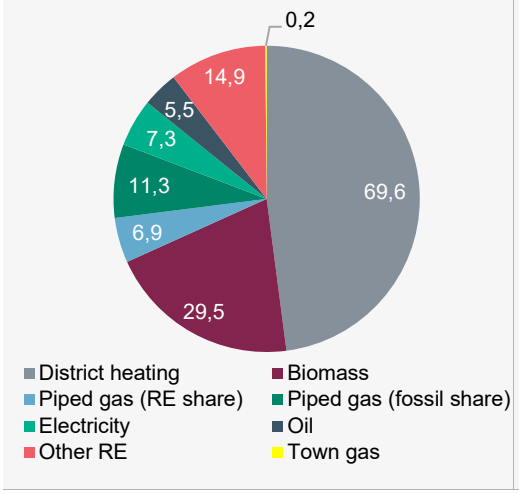
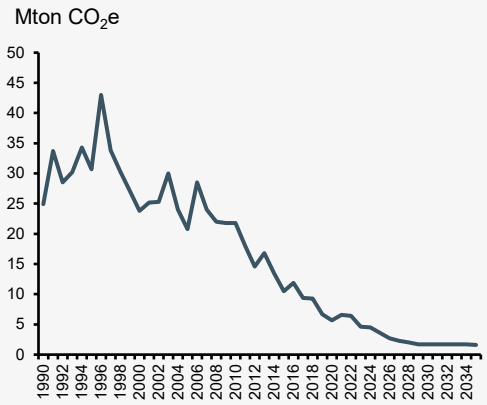


Figure 3.4
CO_2e emissions from the electricity- and district heating sector incl. waste incineration



Note: Left: Primary heating form of residential buildings. Right: 2023-2035 are projections.
Source: Minestry of Climate, Energy and Utilities' Climate Projection 2025.

Another risk is climate change leading to more extreme weather, e.g. stronger wind and changing precipitation (hail/ice/snow). The Danish energy sector and infrastructure is generally considered well equipped for such changing climatic conditions, even though there may be a need to secure some facilities even further.

The consequences of more extreme weather are generally assessed to be limited for PV-panels and wind turbines in Denmark. Specifically, the wind turbines are already secured against high wind speeds. In case of storm and high wind speeds, the wind turbines are designed to shut down, and electricity production ceases. The vulnerable power supply network is largely made up of underground cables, that are mostly unaffected by more extreme weather.

Important efforts to ensure that renewables do not significantly harm other environmental goals
Denmark makes important efforts to ensure that renewable power installations etc. do not significantly harm other environmental goals. For example, all Danish wind farms require an Environmental Impact Assessment (EIA).[3] During the tendering process of a wind farm in Denmark, an exhaustive EIA of the designated area, the export cable route, and the grid connection is completed by the Danish Transmission System Operator (TSO), Energinet, and fully consented before the bidding date.[4]

In terms of recycling, wind turbines are generally highly recyclable and easy to dismantle, with exception of the blades. There are unfortunately still only limited recycling and refurbishing options for the composite materials that make up a large part of the wind turbine blades. The blades are therefore either incinerated, co-incinerated in a cement kiln, or more likely buried in landfills.

The European wind turbine industry is committed to end the landfilling of wind turbine blades and to reuse, recycle, or incinerate all the blades from 2030. The industry is currently developing and commercializing technologies to make wind turbine blades recyclable in the future, which will make wind power an even more sustainable source of green energy.

The underlying conditions for recycling PV installations are good, as these generally use equipment and components that are recyclable. About 56 per cent of waste from electrical and electronic equipment (WEEE) was separately collected in Denmark in 2019, and the WEEE Directive[5] requires that a minimum of 80 per cent of separately collected waste from PV panels shall be prepared for re-use and be recycled. In general, Denmark is still a relatively new market for PV installations, and end-of-life panels and the corresponding PV waste is therefore still very limited.[6]

[3] And the EU EIA-directive (Directive 2014/52/EU) is implemented in Denmark.
[4] https://ens.dk/media/5673/download
[5] Waste from Electric and Electronic Equipment 2019/290/EU
[6] https://mim.dk/media/223007/handlingsplan-for-cirkulaer-oekonomi.pdf

3.2 Taxation of electricity (Exemption for own consumption of electricity from solar energy)

Danish solar power capacity is expected to increase significantly in the coming years, from about 3.1 GW in 2022, to 18.2 GW in 2030, as can be seen in *figure 3.2*. While much of this increase in capacity is expected to come from solar panels installed in fields, the capacity from solar panels on rooftops is also expected to increase significantly.

To promote the acquisition of solar panels and use of renewable energy sources, typically smaller non-commercial solar panel installations (typically on rooftops etc.) receive indirect public support, as electricity consumed by the owner of solar panels (who can be households, firms, municipalities etc.) is exempt from taxation. This is one amongst other benefits of self-consumption from solar panels.

The Ministry of Taxation estimates and reports on the tax expenditure based on estimates using data regarding the capacity of privately-owned solar panels from the Danish Energy Agency. This approach is necessary because self-consumed electricity production is not directly recorded.

There are different owner categories of solar panels and for each, the Danish Energy Agency have standard assumptions about production and the share of self-consumed production along with assumptions about source of heating in the related building. The assumptions rely on estimates from 2014, and thus the resulting estimate is uncertain.

Based on these assumptions, it is estimated that in 2022 self-consumed production from solar panels was approximately 580 GWh distributed on 108,000 PV systems. The production and number of solar cells is expected to increase towards 2030, where self-consumed production is expected to be approximately 600 GWh.

The level of the tax expenditure is estimated using the relevant levels of taxation for electricity, electricity used for heating and electricity tax on businesses. The electricity tax as of 2022 is 0.72 DKK per kWh, albeit it has been politically agreed to reduce the tax over the coming years. In 2022 the heating tax was set at 0.008 DKK per kWh, and the electricity tax on businesses was 0.004 DKK per kWh.

Of the estimated DKK 241 million in tax exemption for 2022, the electricity tax contributed with close to 100 per cent, while the heating tax contributed minimally, and the electricity tax on businesses even less.

The estimates are subject to uncertainty, as the produced GWh cannot be fully attributed to the subsidy. First, it is to be expected that some individuals would install solar power without the exemption, which is not accounted for in the estimates. In addition, there is some overlap in the impact estimate, as some smaller non-commercial PV systems both receive direct subsidies for electricity produced to the grid and the tax exemption for own consumption.

4. Clean Transportation

Making the Danish transportation network more sustainable is a key objective as this sector is central in the green transition and the main source of eligible green expenditures in the Kingdom of Denmark's Green Bond Framework. The framework includes operating and capital expenditures for the rail network infrastructure and a tax expenditure to incentivize consumers to buy zero- and low-emission vehicles.

4.1 Developing and managing the Danish railways

The Kingdom of Denmark's railway infrastructure manager, Banedanmark, is building new attractive railway networks for modern and climate-friendly electric trains, while simultaneously maintaining and renewing the existing infrastructure.

Maintaining a green mode of transport

Even today, with a combination of electrified trains and diesel trains in operation, the operation of the Danish railway system is far more climate friendly than the average Danish fleet of cars and trucks. Maintaining and improving the railway network will improve the performance and attractiveness of this mode of transportation as well as operation.

Of all railway renewal and maintenance costs included in the Green Bond Framework, approximately 70 per cent are estimated to benefit railway lines that will be electrified before 2030, while 30 per cent of costs are estimated to benefit lines that will be operated by battery trains by 2030.

Investing in full electrification by 2030

By 2030, 100 per cent of the Danish state's railway trackside infrastructure and associated subsystems are planned (and financed) to be either electrified or readied for battery train operation, with electrified line tracks taking up approximately 80 per cent of the state network length, and battery-operated line tracks taking up the remaining 20 per cent.

Benefits from electrification include:

1. Reduced CO_2e emissions and particle pollution
2. Reduced travel time, as electric trains can travel at higher speeds (160-250 km/h) and accelerate and brake faster
3. Reduced operation and maintenance costs, thereby improving the business-case of investing in green transportation
4. Increased stability of the overall train service operations, thereby improving the performance and attractiveness of this mode of transportation

Investing in full implementation of digital signals by 2033
The targets of the European Green Deal require a significant increase in rail transport capacity, both for cargo and passenger, which cannot be obtained without a large-scale acceleration of the roll-out of the European Rail Traffic Management System (ERTMS) throughout the European Union. Denmark is the first European country replacing existing signalling systems on the entire railway network. The new signalling system, which is planned for full implementation in 2033, will provide a digital foundation for better centralized traffic control, energy optimization, and real-time passenger information.

Benefits from a digital signalling system include:
1. Higher speeds and much fewer delays
2. Improved headway (i.e., shorter distance between trains measured in time)
3. Improved energy optimization
4. The creation of a digital European railway area that is better at competing with other modes of transport

The digital signalling system thus improves the attractiveness of railway transport for cargo and passenger transport. The investments in the system also pave the way for other EU-countries and the transition to more sustainable modes of transportation in the EU.

Mitigating climate change and transitioning to a circular economy
Banedanmark is working in accordance with the Climate Act's goal of a climate-neutral society by 2050 and a green transformation of the transport sector. Specifically, the national Climate Act commits Denmark to a 70 per cent reduction in CO_2e emissions in 2030, compared to 1990. Within this framework, Banedanmark will reduce its own CO_2e emissions by 20-30 per cent by 2030, compared to 2019. This reduction will be possible with measures within energy efficiency; materials optimization, selection, and substitution; waste management and recycling. Finally, Banedanmark performs systematic screenings of all procurement with respect to its environmental impact. These initiatives carried out by Banedanmark ensure, that expenditures in the Green Bond Framework are used as sustainably as possible.

The Green Taxonomy's circular economy criteria states that at least 70 per cent of the non-hazardous construction and demolition waste must be prepared for reuse, recycling, or other material recovery. Banedanmark, however, recycles more than 99 per cent of its total waste volumes[7]. Banedanmark uses techniques within optimization, selection, and substitution of materials; resale of surplus goods; waste management, handling of hazardous substances and high-quality recycling by selective removal of materials, using available sorting systems to achieve these results.

[7] In 2022, 99.5 per cent was recycled, 0.1 per cent was incinerated, and 0.4 per cent ended in landfills.

Impact of railway expenditures
The impact of investing in railways is two-fold: On the one hand, investment in the upkeep of the transport mode and on the other hand, investment in making it greener by reducing CO_2e-emissions.

CO_2e-reductions primarily stem from the continued electrification of the railway-services in Denmark. This is due to the fact that electrification of railways leads to them being used by electric trains instead of diesel-driven trains. Thus, it must be underlined that the reduction in CO_2e-emissions comes from the transition from diesel-driven trains to electric trains. The body responsible for the trains is not a state institution, and is therefore not included in the Danish Green Bond Framework. Only expenditures related to the electrification, investments and maintenance in the railways are included. The investments are thus, as described above, a determining factor for the CO_2e-emissions, but not the triggering factor. The CO_2e-emissions caused by a transition into electric trains are described below.

Table 4.1 summarizes the estimated contribution of the 2022 railway expenditures in the green bond program on some selected impact metrics. The expenditures have contributed among other things to the renovation, maintenance and development of almost 2,000 km of railways and to the electrification of 802 km of railways.

Table 4.1 – Clean Transportation Impact Metrics
2022

	Kilometres of railway track	Amount allocated
Expenditure		
Renovation, maintenance, and development (rail infrastructure investment projects; rail infrastructure renovation and maintenance; and rail infrastructure operation)	1,962 km	5,345.8 million DKK
Electrification of the rail infrastructure (rail infrastructure investment projects)	802 km[1)]	1,322.2 million DKK

Note: Electrification, amounting to 1,322.2 million DKK, concerns the lines Køge Nord-Næstved, Aarhus-Lindholm, Fredericia-Aarhus, and Roskilde-Kalundborg as well as a more general modernization of the catenary system. For more descriptions on the allocation of bond proceeds, see the Kingdom of Denmark Allocation Report for 2022.
1) Total length of electrified railway track under Banedanmark primo 2023. Down from 803 km primo 2022 because of decimal rounding. No further electrified railway has been put in commission in 2022 because electrification works are still ongoing. In subsequent years, when the projects are finished, the electrified railway will be put in commission and counted as electrified railway.
Source: Danmarks Statistik, table Bane41, Banedanmark annual report 2022, National Financial Annual Report 2022.

Maintaining and renewing the Danish railway system, while allowing passenger transport and freight capacity is no simple task. Construction projects are complex and have long construction periods in multiple phases.

For instance, electrification of the Danish railway is a project that involves multiple construction phases, each of which must be completed before the railway can be put into service. In many cases, preparatory phases can take years to complete and these works are often a prerequisite for the completion of the electrification phase. In 2022, important progress has been made with regards to the preparatory works on the longest sections that are currently planned for electrification.

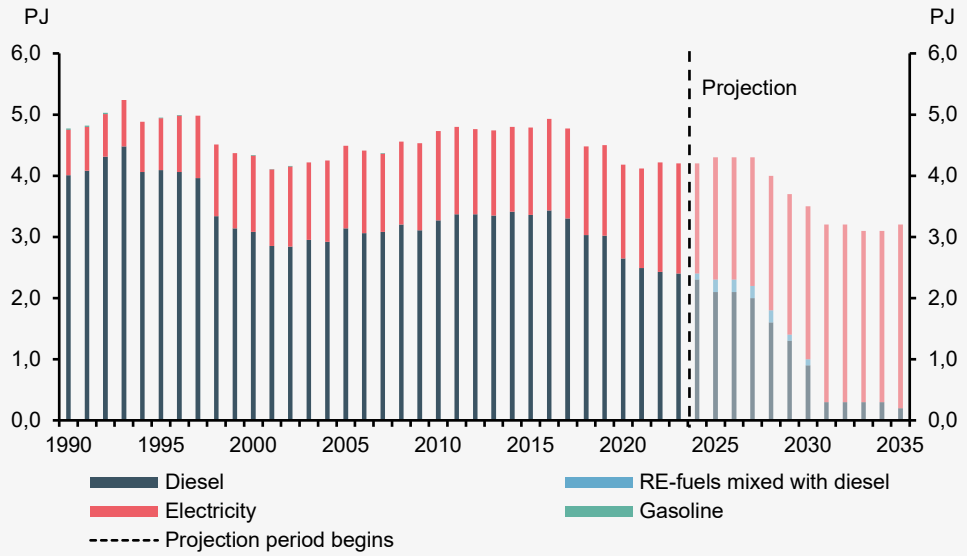
This important preparatory work, that is a precondition to the electrification of the railway infrastructure in order to enable the use of climate friendly electrical trains, is, however, not reflected in data regarding electrified railway km, since data only shows electrified railway km taken into use. The most complex preparatory works include, among others, e.g. reconstruction of bridges, or tracks, to make room for overhead contact wires underneath bridges. In the coming years, further electrified railway sections will be taken into use.

As of primo 2023, almost 40 pct. of the Danish railway is already electrified.

Energy consumption

Even as the amount of transport by rail increases in years to come, the associated energy consumption is expected to decrease, due to electrification. *Figure 4.1* shows energy consumption by fuel source from 1990-2035. In 2030, 71 per cent of the energy consumption is expected to come from electricity, and from 2035 almost all diesel trains will be phased out. By then, only 0.02 PJ will come from RE-fuels mixed with diesel.

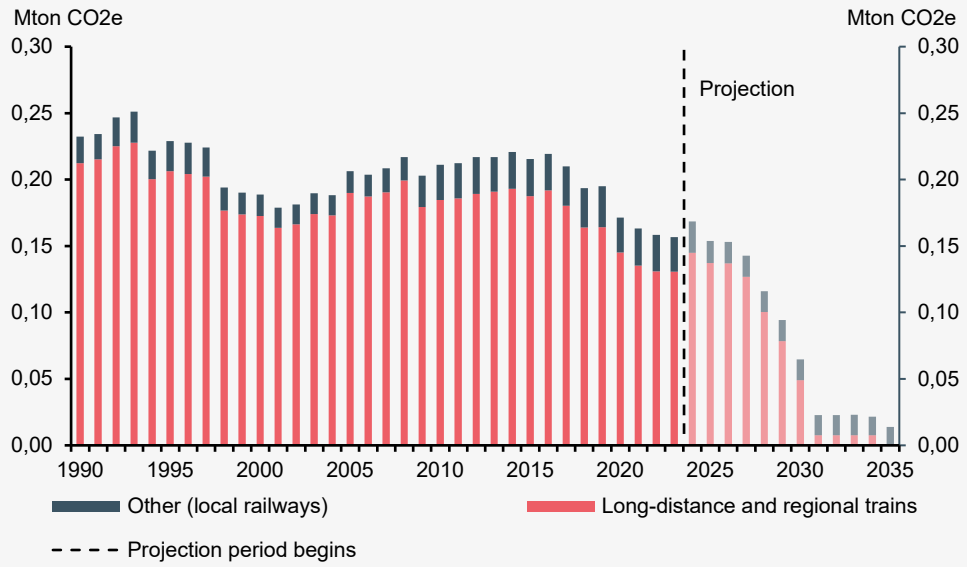
Figure 4.1
Rail transport's energy consumption by fuel source, PJ



Note: The numbers from 2023 and onwards are projections. From 2023 "Diesel" also covers gas.
Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

Emissions
Figure 4.2 shows rail transport's total emissions from 1990-2035 divided into those attributed to long-distance/regional service (red) or local service (grey).

Figure 4.2
Emissions from rail transport sorted by train types (1990-2035)



Note: The numbers from 2023 and onwards are projections.
Source: Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

In 2030, the emissions from the railway are expected to be just 0.06 million tonnes of CO_2e, and by 2035 it is expected that the total emissions from rail will be at just 0.01 million tonnes of CO_2e. Most of these reductions can be attributed to electrification of the Danish railway.

It is expected that electrification of the Danish railway will reduce the yearly emissions from rail transport by approximately 0.193 million tonnes of CO_2e. The total cost of the electrification programme is expected to be approximately DKK 33 billion price level 2022.

DSB and Banedanmark have a close operational relationship within Denmark's railway infrastructure. DSB operates passenger train services on the national rail infrastructure owned and maintained by Banedanmark. This close partnership means that while Banedanmark is responsible for electrifying the tracks, DSB is responsible for running electric trains. As a result, both organizations share responsibility for delivering the environmental benefits of rail electrification, making it a joint commitment to greener transportation in Denmark.

The total reduction is distributed between the Green Bond Framework by the Danish government and the green bond framework by DSB based on their respective

financial contributions and the expected lifetime of the assets. The Danish government finances the electrification of the railway infrastructure, which has an expected lifetime of 50 years. DSB's green bonds finances the electric train sets and associated maintenance facilities, with an expected lifetime of 25 years.[8]

In 2022 DKK 1.322 billion of the proceeds from Danish green bonds were allocated to electrification of the railway. Using the method described above, the impact of these proceeds is estimated to 0.386 million tonnes of CO_2e.

The above assessment of the potential CO_2e reduction is consistent with the observed reduction in emissions in previous years. E.g., from 2020 to 2022, DSB (the largest railway operator on the Danish network) had a reduction of yearly CO_2e-emissions from diesel train operation of 40,169 tonnes. In 2016–2022 the total reduction in yearly CO_2e emissions from diesel train operation was 67,595 tonnes. This was due to the electrification of more lines, delivery of electric locomotives, decommissioning of several types of old diesel trains and change of operator of several lines.

4.2 Registration tax (Reduced registration tax for zero- and low-emission vehicles)

Zero- and low-emission vehicles receive a tax advantage in the registration tax compared to conventional vehicles. The tax advantage incentivizes consumers to purchase zero- and low-emission vehicles instead of conventional vehicles.

Box 4.1
Definition of green cars (zero- and low-emission vehicles)
Electric cars emit 0 grams CO_2e per km driven. Thus, they are classified as zero-emission vehicles. Plug-in hybrid vehicles are cars that fuel on electricity as well as either gasoline or diesel. Plug-in hybrid vehicles can be charged using an electric cable as opposed to regular hybrid cars. With the political agreement on the green transition of road transportation from December 2020 (Aftale om grøn omstilling af vejtransport),) low-emission cars are defined as cars with a maximum emission of 50 gram CO_2e per km driven. This definition is also used by the EU Clean Vehicle Directive (EU/2019/1161) and in the EU Taxonomy. However, starting January 1, 2026, only zero-emission vehicles will be classified as "clean vehicles" under the EU Clean Vehicle Directive (EU/2019/1161).

Source: Skatteøkonomisk Redegørelse, 2021 and EU Clean Vehicle Directive (EU/2019/1161).

Kick-starting the green transformation of car ownership

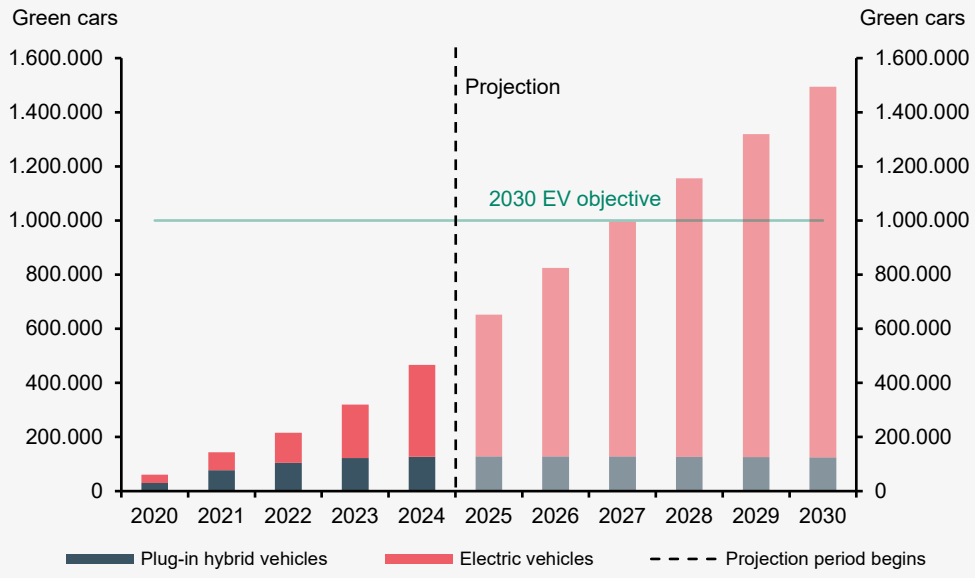
With the political agreement on the green transition of road transport (Aftale om grøn omstilling af vejtransporten) from December 2020, the Danish government put forward an ambition to reach 1,000,000 zero- and low-emission cars on the roads by 2030. An important initiative to reach this target is the reduced registration

[8] The method for estimating the impact of the proceeds allocated to eligible railway expenditures has been changed since the Kingdom of Denmark Green Bond Impact Report 2021 (link). This change has been made to provide a more accurate estimate of the impact of the proceeds allocated to railway expenditures, e.g. by making the estimate more comparable to the impact of the proceeds allocated to reduced registration tax for zero- and low-emission vehicles. Had this method been used in the impact report for 2021, the impact of the proceeds allocated to railway expenditures would have been 0.2 million tonnes of CO_2e.

tax for zero- and low-emission cars. The sale of zero- and low-emission passenger cars in 2022 was around 57,200, and corresponded to 39 per cent of the total sale of new passenger cars in that year.

In the latest climate projection (Klimafremskrivning) from 2025, the Danish Ministry of Climate, Energy and Utilities estimates that by 2030 there will be 1,359,000 electric and 124,000 plug-in hybrid passenger cars on the Danish roads, corresponding to a share of 47 per cent of the total passenger car stock, *see figure 4.3*. Thus, the ambitious target of 1,000,000 zero- and low-emission cars by 2030 is within reach.

Figure 4.3
Projection of electric and plug-in hybrid cars in the danish car stock



Note: The horizontal line displays the Danish Governments' goal for zero- and low-emission cars by 2030. Numbers from 2025 and onwards are projections.
Source: Ministry of Taxation, Ministry of Climate, Energy and Utilities' Climate Status and Outlook 2025.

Measuring the climate impact

It should be noted that the sale of zero- and low-emission vehicles cannot be fully attributed to the tax advantages. However, it is estimated that without the tax advantages the sale of these vehicles in 2022 would have been around 4,600 zero- and low-emission vehicles, indicating a substantial decline.

The sale of zero- and low-emission vehicles contributes to reduce the CO_2e-emissions from the road transport sector to the extent that it represses the sale of conventional vehicles. Based on the Ministry of Taxation's so-called *car-model* that models the changes in the sale of cars based on changes in the taxation of cars, the expected reduction in CO_2e attributed to the tax advantages is estimated at 1.6 million tonnes CO_2e.

The expected reduction in CO_2e is calculated as the accumulated effect over a vehicle's 15-year lifespan in 2022. The calculations are made based on data for the actual sales of vehicles in 2022, including data on CO_2e-emissions of conventional vehicles. It is then assumed that zero- and low-emission vehicles did not receive a tax advantage in 2022 to assess how sales would have been impacted. Further, it is assumed that low-emission vehicles drive 50 per cent of the time on electricity and 50 per cent of the time on gasoline.

The IMWG is aware that other Danish issuers of green bonds include tax advantages on zero- and low-emission vehicles to limited degrees in their green bond program. It is not possible for the IMWG to distinguish potential double counting of possible impact metrics. The potential overlap is deemed to be very limited.

Preventing significant harm from vehicles on other environmental goals
In Denmark, it is a requirement that end-of-life vehicles must be handled by approved auto scrapers. However, it is estimated that the illegal market for car scrapping (including illegal exports etc.) accounts for 20-25 per cent of all scraps in Denmark. Measures are however in place to ensure that end-of-life vehicles are handled by approved auto scrapers. These include a scrapping allowance scheme, where car owners can receive a scrapping allowance, when the scrapped car is handed over to an approved and registered car wrecker.

The reduced registration tax for low-emission and zero-emission vehicles could in theory lead to an increased number of vehicles instead of a more efficient vehicle-stock.

The Ministry of Environment in Denmark does not record data on the reusability, recyclability or recoverability of the subsidised vehicles specifically. However, due to the weight and slightly lower recyclability of batteries, it is likely that these vehicles will be slightly less recyclable than other vehicles. It is likely that the subsidised vehicles will have the same level of recoverability as other vehicles.

A range of European regulations and directives relevant to preventing and controlling vehicle pollution are applicable and implemented in Denmark. Further details on this aspect can be found in the detailed taxonomy assessment of the eligible green expenditures on the Ministry of Finance's webpage.

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