Nordic Council of Ministers

Can Economic Instruments Transform Behaviour?

Evaluating the impact of Nordic environmental policy

Contents

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Preface

This report has been commissioned by the Nordic Working Group for Environment and Economics (NME). The report has been prepared by a consortium led by Norion Consult in cooperation with Anthesis AB, Demos Helsinki and Menon Economics.

NME has in several earlier projects engaged in analysing different aspects of using economic instruments in environmental policy. This project could be seen as a follow-up of earlier work done in this field. The time is ripe to make an assessment of what has been achieved with economic instruments in the environmental policy field. The report presents the findings of the impact of selected green taxes and charges in the Nordic countries — Denmark, Finland, Norway, and Sweden. The analysis focuses on whether the charge has had the desired effect on market behavior and the reasons behind it. The analysis highlights that green charges often fall short of optimal levels needed to fully internalise environmental costs.

The report concludes with a set of recommendations. The research consortium behind the report recommends an extended use of economic instruments, based on a careful design of the individual taxes or charges. More impact assessments of the effectiveness of the instruments are also needed to mention some of the recommendations.

Members of the Nordic Working Group for Environment and Economy have provided comments and inputs to the report during the work. The authors of the report are responsible for the content as well as the assessments and recommendations, which do not necessarily reflect the views and the positions of the governments in the Nordic countries. The report constitutes an important contribution to the debate on economic instruments in environmental policy in a time when these instruments phase growing resistance from politicians and decision-makers.

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Chair of the Nordic Working Group for Environment and Economics

Executive Summary

Environmental economic taxes encounter more political resistance today than just two decades ago. At the same time, the green transition is more acute than ever, as a response to environmental degradation and climate warming. The Nordic countries have used green charges for more than three decades and have, therefore long experience and are often perceived as frontrunners in the green transition. However, this image does not fully live up to its reputation anymore. This report presents the findings of the impact of selected green taxes and charges in the Nordic countries—Denmark, Finland, Norway, and Sweden. The analysis for each charge respectively focuses on whether the charge has had or not had the desired effect on market behaviour and the reasons behind it. The analysis discusses the likely reasons for the variations in the effects of the instruments and internal and external parameters that have been successful for the outcome on the market. To mention a few of the parameters are charge level, precision of the charge, political alignment and synergies with other market instruments, and to what extent these parameters have had a positive or negative effect on the desired environmental effect. The study examines eight specific charges—two from each country which are Denmark's tax on pesticides and tax on residential electricity consumption, Finland's carbon tax and beverage packaging tax (deposit refund system), Norway's NO_X fund and waste incineration tax, and Sweden's aviation and plastic bag taxes.

The analysis highlights that green charges often fall short of optimal levels needed to fully internalise environmental costs and that the precision of their design has a greater influence on outcomes than the charge level itself. Policies with strong public and industry acceptance tend to be more stable and effective, with acceptance often tied to equity considerations and synergies with other national objectives. However, a significant challenge lies in balancing the need for high charge levels to address externalities while achieving political and social acceptability. Export-oriented sectors face additional complexities in reconciling competitiveness with environmental objectives. Moreover, while many green charges align positively with broader policy goals, a lack of coherent scientific evaluations hinders the ability to design and implement policies based on robust evidence.

Based on policy impact studies, interviews and workshop discussions with field experts, we offer the following eight recommendations, primarily for guiding policymakers and authorities, in designing effective environmental policies in the green transition.

1. **Continue/expand the use of green charges:** Green charges, aligned with the polluter pays principle, are recommended when bans or EU policies like the EU ETS do not address negative externalities.
2. **Set taxes and incentives close to the externality:** Identify the negative externalities in consumption and production value chains and target policies as close to the negative externalities as possible.
3. **Encourage studies assessing policy impact:** ex-ante and ex-post studies, supported by redirected funding or agency procurements, to evaluate policy impacts and design variations, with Nordic comparisons offer valuable insights.
4. **Prioritise evidence-based policy and policy-based evidence:** Countries should prioritise evidence-based policy by using robust methods, encouraging experimentation with control groups, and tailoring designs through ex-ante assessments to ensure scalability and practical application.
5. **Be aware of potential unintended consequences:** Consider potential unintended consequences, such as crowding out intrinsic motivation, substitution effects, or mental accounting, and carefully design and study policy instruments to address these risks effectively.
6. **Combine charges with a comprehensive policy mix:** Green charges should be combined with a comprehensive policy mix, including redistributive measures and investments in green technology, to enhance effectiveness, prevent backlashes, and increase public acceptance.
7. **Harmonise long-term policy goals and industry signals**: Countries should harmonise long-term policy goals with industry signals to foster confidence, encourage long-term investments, and proactively address the fiscal impacts of green transitions.
8. **Harmonise policy development across countries:** The Nordic countries would benefit from a harmonised reginal policy development to reduce leakage, maximise impacts, and pave the way for broader continental and global agreements.

Resumé

Grønne afgifter møder mere politisk modstand i dag end for blot to årtier siden. Samtidig er den grønne omstilling mere presserende end nogensinde som en reaktion på miljøforringelse og global opvarmning. De nordiske lande har anvendt grønne afgifter i over tre årtier og har dermed omfattende erfaring. De betragtes ofte som frontløbere inden for den grønne omstilling. Dette billede lever dog ikke længere helt op til dets ry. Denne rapport præsenterer resultaterne af effekten af udvalgte grønne skatter og afgifter i de nordiske lande – Danmark, Finland, Norge og Sverige. Analysen af hver afgift fokuserer på, om afgiften har haft den ønskede effekt på adfærden på markedet samt årsagerne bag dens effektivitet eller mangel på samme. Analysen undersøger de sandsynlige årsager til variationerne i effekten af de grønne afgifter og vurderer både interne og eksterne parametre, der har påvirket resultatet på markedet. Blandt de parametre, der fremhæves, er afgiftsniveauet, afgiftens præcision, politisk tilpasning, synergier med andre virkemidler samt graden af positiv eller negativ påvirkning på den ønskede miljøeffekt. Undersøgelsen omfatter otte specifikke afgifter – to fra hvert land: Danmarks skat på pesticider og elforbrug i husstande, Finlands CO_2-afgift og refusionssystem for drikkevarepant, Norges NO_x-fond og affaldsforbrændingsafgift samt Sveriges fly- og plastikposeskat.

Analysen fremhæver, at grønne afgifter ofte ikke når de optimale niveauer, der er nødvendige for fuldt ud at internalisere miljøomkostningerne. Samtidig påpeges det, at præcisionen i deres design har større betydning for resultaterne end selve afgiftsniveauet. Politikker, der nyder stærk offentlig og industriel accept, har en tendens til at være mere stabile og effektive. Denne accept er ofte forbundet med hensyn til retfærdighed og synergier med andre nationale mål. En væsentlig udfordring er at balancere behovet for høje afgiftsniveauer, der effektivt adresserer eksternaliteter, med kravet om politisk og social accept. Eksportorienterede sektorer står over for en yderligere kompleksitet i at forene konkurrencedygtighed med miljømål. Derudover, selvom mange grønne afgifter harmonerer positivt med bredere politiske målsætninger, begrænser manglen på sammenhængende videnskabelige evalueringer muligheden for at designe og implementere politikker baseret på solid evidens.

Baseret på politiske konsekvensundersøgelser, interviews og workshopdiskussioner med eksperter i feltet, præsenterer vi følgende otte anbefalinger. Disse anbefalinger er primært rettet mod at vejlede politiske beslutningstagere og myndigheder i udformningen af effektive miljøpolitikker som led i den grønne omstilling.

1. **Fortsæt og udvid brugen af grønne afgifter:** Grønne afgifter baseret på "forureneren betaler"-princippet bør anvendes, hvor forbud eller EU-initiativer som EU ETS ikke fuldt ud adresserer negative eksternaliteter.
2. **Placér skatter og incitamenter tæt på eksternaliteten:** Identificér negative eksternaliteter i forbrugs- og produktionsværdikæder og målrettede politikker, der præcist adresserer disse.
3. **Tilskynd til politiske effektstudier:** Fremtidige (ex-ante) og efterfølgende (ex-post) undersøgelser, finansieret gennem omdirigerede midler eller offentlige udbud, for at analysere politiske effekter og variationer i design, med fokus på nordiske sammenligninger for værdifulde indsigter.
4. **Prioriter evidensbaseret politik og politikbaseret evidens:** Lande bør prioritere evidensbaseret politik ved at anvende robuste metoder, tilskynde til eksperimenter med kontrolgrupper og skræddersy design gennem forhåndsvurderinger for at sikre skalerbarhed og praktisk anvendelse.
5. **Vær opmærksom på potentielle utilsigtede konsekvenser:** Vurder potentielle utilsigtede konsekvenser, såsom reducere indre motivation (intrinsic motivation), substitutionseffekter eller "mental accounting". Udform og analyser politiske virkemidler grundigt for at håndtere disse risici effektivt.
6. **Kombiner afgifter med et omfattende policy-mix**: Grønne afgifter bør kombineres med et omfattende policy-mix, herunder omfordelingsforanstaltninger og investeringer i grøn teknologi, for at øge effektiviteten, forhindre tilbageslag og styrke offentlighedens accept.
7. **Harmoniser langsigtede politiske mål og industrisignaler**: Lande bør afstemme deres langsigtede politiske mål med signaler fra industri for at opbygge tillid, tilskynde til langsigtede investeringer og aktivt håndtere de skattemæssige konsekvenser af den grønne omstilling.
8. **Harmoniser politikudvikling på tværs af lande**: De nordiske lande vil drage fordel af en harmoniseret regional politikudvikling for at reducere lækage, maksimere effekterne og bane vejen for bredere kontinentale og globale aftaler.

1. Introduction

In the past decades, the world has seen substantial changes in policy practices and multilateral agreements shifting towards building resilient, sustainable societies. This has led to an increased global understanding of the impact and importance of utilising policy instruments for the environment in taxation practices.[1][2] These are referred to in terms of *Green taxation, Carbon taxes, Environmental taxes* or *Green Charges* and have gained traction as a governance tool for meeting countries' commitments to reducing emissions levels globally.[3] The common definitions cover any governmental fiscal attempt to influence behaviour with price manipulation to protect the environment.

No market is perfect, as economic activities create externalities that are not reflected in the market price (shadow prices). These externalities are considered *market failures.* Governments use economic instruments, such as fees and charges, to correct for negative externalities and to change market actors' behaviour.[4] Theoretically, the additional price added by the economic instrument should be equal to the negative impact society incurs by said externality, as illustrated in Figure 1. An increase in the price will decrease the quantity of goods demanded $k^0 \to k^*$ to achieve a social optimum, thus internalising the externality of the good.

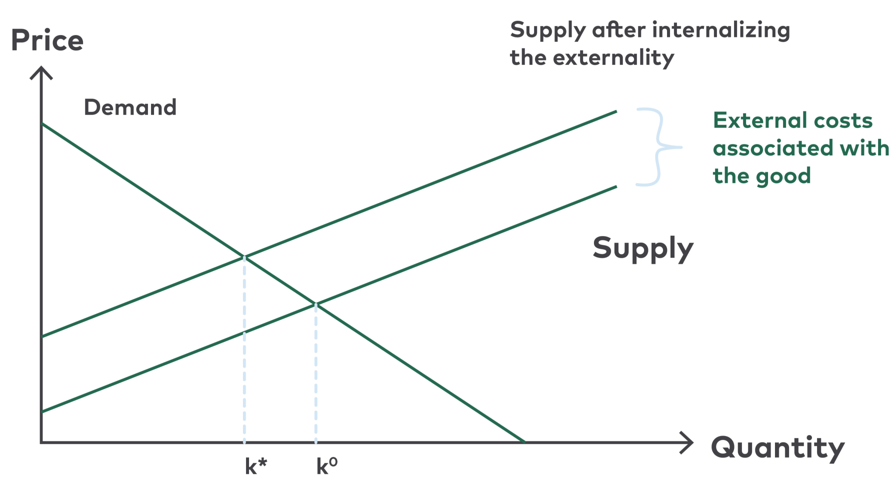

Figure 1: Effect on price and quantity when internalising externalities.

1. European Environment Agency (2020). *The sustainability transition in Europe in an age of demographic and technological change - An exploration of implications for fiscal and financial strategies*
2. OECD (n.d). *Tax and the environment*
3. United Nations, Department of Economic and Social affairs (n.d). *Environmental Taxation*
4. Perman et al (2011). *Natural Resource and Environmental Economics*

Examples of green charges are energy taxes, waste taxes, and taxes on polluting substances, such as chemicals and particle matter. These taxes aim to internalise negative externalities, e.g., by integrating the *polluters-pay principle,* incentivising consumers to buy other products, and shifting consumer and/or producer behaviour. Collectively, green taxation aids in integrating economic practices and environmental protection.

The polluters-pay-principle and green charges have been an integral part of global environmental policy for decades as a part of the UNEP[5] and as core elements of the OECD[6] and EU[7] environmental policies since the 1980s. It continues to be influential - In fact, the polluters-pay-principle is underlying the policy framework for environmental policy in the Treaty of the Functioning of the European Union (TFEU)[8] and plays a role in political agreements such as the European Green Deal.[9] The principle states that the polluter is responsible for paying the price of the externality they induce, herein increasing the product price and resulting in downshifting consumer demand or towards products with lower prices.[10] It is the main pillar of environmental taxation.

Despite the popularity of the principle within the EU, a study conducted by the European Commission shows that the external, societal costs of pollution within the EU are still, to a large extent, not being paid by polluters.[11] Even though environmental taxes play an important role for the green transition, the share of revenues from environmental taxes of total tax revenues has decreased by almost a fifth since 2010 in the EU. Almost 80% of the environmental taxes constitute energy taxes, around 20% are taxes on transportation, and the rest are pollution and resource taxes. The case is the same in the Nordic countries, where there has been a decline in all countries, Sweden being at the bottom, where the share of environmental taxes of total tax revenue has gone from more than 6% in 2010 to only 3% in 2022.[12] This trend across the whole union is noteworthy, especially as fossil fuels consist a big part of energy taxation today and as CO_2 emissions are mitigated, the tax base will decrease. To prevent a big gap in tax revenue in the future, ensure that fossil free technology solutions are favoured and continue follow the polluters pay principle, environmental taxation is essential.

Implementing environmental taxes can be complicated, especially in the integration of other policies and coordination across policies.[13] Environmental problems cover many sectors, and the implementation of environmental taxes must be carefully

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5. UNEP (1994). *Economic instruments for Environmental Management and Sustainable Development*
6. Khan (2015). *Polluters-Pays-Principle: The Cardinal Instrument for Addressing Climate Change*
7. Mottershead et al (2021), *Green Taxation and other economic instruments – internalising environmental costs to make the polluters pay.*
8. TFEU Article 191(2) of the 2007 Treaty of the Functioning of the European Union
9. European Environment Agency (2022). *The role of (environmental) taxation in supporting sustainability transitions*
10. European Court of Auditors (2021). *The Polluters Pays Principle: Inconsistent application across EU envrionmental policies and actions*
11. Mottershead et al (2021), *Green Taxation and other economic instruments – internalising environmental costs to make the polluters pay*
12. European Environment Agency (2024b). *Share of environmental taxes in total tax revenues in Europe*
13. Milne & Andersen (2012). *Handbook of Research on Environmental taxation*

designed to have the intended effect. Issues of lobbyism, economic losses, competition and distributional effects can also affect the lack of political traction for the implementation of environmental taxes. This highlights the need for ex-post policy analysis of existing environmental taxes to provide policymakers with a broader understanding of the effect of different tax designs and the benefits and challenges of imposing green taxes.

Why use green charges in environmental policy?

Green charges can be effective governance tools in achieving environmental goals. Green charges often require less administration than prescriptive regulations, and therefore more economically effective. Since governments cannot know the cost of pollution units of every firm, green charges encourage each polluter to abate in the most cost-efficient way. Green charges also generate government revenue that can be earmarked towards environmental policy measures or towards subsidies and compensation, thereby aiding in the progression of environmental policies. They can also inspire technological innovation by means of encouraging cost-effective practices and thus creating a demand for green technology. The European Environment Agency summarises the reasons for using environmental taxes in five categories: internalisation of externalities, incentivising behavioural change, minimisation of pollution control costs, incentivising innovation and raising revenue. [14]

- Bringing externalities into prices: When a cost, such as pollution, is not reflected in the price of said good, it's an externality. Environmental taxes can incorporate the cost of the environmental damage in the price of the good, thus internalising the externality and reinforcing the Polluter Pays Principle.
- Incentive structure: environmental taxes incentivise both producer and consumer to generate or use less of the taxed good or service.
- Minimising pollution control costs: Because pollution abatement cost varies across producers, policy tools such as prescriptive regulations cannot differentiate between differences in pollution abatement costs. Economic tools do not have to, however, since they will encourage the polluters with the lowest cost of pollution reduction to abate, while for those producers with higher abatement costs, it will be cheaper to pay the tax. This ensures that the cost of archiving a given pollution reduction is lower than with regulation.
- Encourages ongoing innovation: while regulatory policies leave no incentive for companies to reduce their pollution below the given threshold, economic tools such as green charges encourage ongoing innovation because the companies will be continuously incentivised to reduce pollution.

14. European Environment Agency (1996). *Environmental taxes: Implementation and environmental effectiveness*

- Raising revenue: economic tools such as taxes, tradable permits or quotas raise government revenue that can be earmarked towards environmental policy measures or subsidies and compensation measures, also called the double dividend effect.

The impact of an environmental fee depends on the price elasticities of both demand and supply. The price elasticity of demand refers to how much consumers (or producers acquiring inputs) will change their demand following a price increase or decrease. In contrast, the price elasticity of supply refers to how much producers are willing to supply at different price levels. Together, they determine the combined effect of an environmental fee. The amount of the fee transmitted to consumers is the tax incidence, which is only, in special cases, the full amount of the fee. Environmental fees often concern "necessity goods", characterised by a low degree of elasticity of demand, as these types of goods will be consumed on the market even with substantial changes in product prices. Examples include water, petrol and electricity. If the goods have a low degree of price elasticity, the effect of taxation is less than that of regular goods and should, in theory, be higher to be impactful.[15]

An example is the tax on petrol – as petrol is considered a fairly inelastic good, because the price change has little effect on short-term consumption levels. Yet, the long-term elasticity is still more elastic, as consumers and the market adopt over time. This can for example be seen from the market shift to electric vehicles, which offers an equivalent substitute to the gasoline engine. However, setting the tax "as high as possible" has shown to have regressive social effects and therefore distortive market outcomes, posing a heavy burden on low-income groups.[16] Being aware of both economic market effects and social consequences is crucial when evaluating the effects of economic instruments, as this will strengthen the analysis of causality in the scope of market volume.

Part of the explanation of why price elasticities vary among product types lies in the type of product, whether they are considered necessity goods, luxury goods, or inferior goods (demand drops with higher income). However, the consumer responses (and resulting price elasticities) are also influenced by various biases or cognitive processes that limit (or enhance) the possible effects of taxes. For example, many individuals inhibit cumulative cost neglect, which results in low behavioural impact from incremental price changes, even though they may have a significant budget impact over time. Charges may also interact with other motivations, particularly for consumers, potentially resulting in "crowding-in" or "crowding-out" effects.

15. Ramsey (1927), *A contribution to the theory of taxation*
16. Høst et al. (2020), *A socially sustainable green transition in the Nordic region*

1.1 Economic instruments in Nordic environmental policy

The Nordic countries have a long history of implementing economic policy instruments to protect the environment.[17][18] Already in the 1980s-90s, it was shown that green charges were environmentally effective.[19] Mentionable examples include the first CO_2 fees in 1990–1992,[20] the comprehensive bottle deposit-refund systems,[21][22] and the NOx fees in 1990.[23]

Effective environmental policies are key to achieving the climate goals and the Nordic 2030 vision of becoming the world's most sustainable and integrated region.[24] Governments use economic instruments to come closer to fulfilling the polluters-pay principle and regulate externalities on the market. Economic instruments can effectively change producer- and consumer behaviours and protect the environment through direct price changes on certain products in the market. However, evaluating the causality between environmental economic instruments and their impacts is essential to ensure efficient environmental regulation. This has been raised by the Nordic Working Group for Environment and Economy (NME) under the Nordic Council of Ministers, which has initiated this assessment of different green taxes and charges (referred to as charges only going forward) across the Nordics. This assessment focuses on two different charges in Denmark, Finland, Norway and Sweden, respectively, and whether the intended effect seems to have been achieved or not. The aim is to get a broader understanding of what type of regulation has been successful or not to better steer regulation going forward in favour of the green transition across the Nordics. The consortium will establish a firm picture of the causes of positive and negative (or non-significant) effects of green charges in the Nordics, informing future decisions in applying economic instruments in environmental regulation. The study has been led by Norion Consult, Bjørn Bauer, Linda Stafsing, Sofie Kjøller Jørgensen, Amalie Børglum Ploug Olsen, Laura Schou Bagh, Agnes Plesner Skårup. The collaboration has been together with Erik Gråd from Anthesis, Emilia Ståhlhammar, Theo Cox, Vera Saavalainen from Demos Helsinki and Øyvind Nystad Handberg from Menon Economics.

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17. Pedersen & Dengsøe *(2000), Vurderinger af de grønne afgifters effekter i de nordiske lande*
18. Svenningsen et al. (2018), *Policy Brief: The use of economic instruments in Nordic environmental policy 1990-2017*
19. European Environment Agency (1996). *Environmental Taxes: Implementation and Environmental Effectiveness*
20. Dengsøe & Pedersen (2000), *Vurderinger af de grønne afgifters effekter i de nordiske lande*
21. Dansk Retur System (2022), *20 år med producentansvar på tværs af Brancher*
22. European Commission (2021), *Deposit Refund Schemes*
23. Sveriges Riksdag (1990), *Lag (1990:613) om miljöavgift på utsläpp av kväveoxider vid energiproduktion*
24. Nordic Council of Ministers (2020), *The Nordic Region – towards being the most sustainable and integrated region in the world – Action Plan for 2021 to 2024.*

2. Methodology and scope

The countries covered in the analysis are Denmark, Finland, Norway, and Sweden. Two environmental economic instruments (focus on taxes and charges) have been analysed for each country. The instruments chosen should both be considered to have had the "desired effect" and not. By desired effect, it means the intended outcome in market behavioural change.

2.1 Literature review

The research has primarily taken the point of departure in the latest publication of environmental economic policy instruments in the Nordics *Use of Economic Instruments in Nordic Environmental Policy 2018-2020,* from 2023. The report outlines the environmental economic instruments between 2018-2021 in all the Nordic countries. From this report, a literature review of the instruments was created to map the instruments by looking at parameters such as sector targeted, target group, use of revenue, motivation behind the implementation, and intended effect. Apart from instruments covered by the report, updated research on instruments implemented after 2021 has also been conducted. However, for a better assessment foundation and available policy analysis, there has been a restriction that the instrument should at least be implemented for 2–3 years on the market to be able to analyse any effect on the market.

From the long list, a short list per country was chosen, looking at a minimum of three instruments that seem to have had the desired effect and at least three that do not seem to have had the desired effect. Different sectors and target groups (consumer/producer) were taken into consideration, to ensure a broad coverage. Another criterion was that the economic instruments should be relevant to support the green transition in the Nordic region. At least some of the instruments should be present in more than one country (FI, DK, NO, SE). Based on the introductory literature review, the availability of peer-reviewed and governmental policy analysis for the instruments was also screened, which played a significant role in the final choices.

The eight charges decided upon for analysis are:

1. Electricity tax on households (DK)
2. Pesticide charge (DK)
3. Tax on fossil fuels (FI)
4. Beverage deposit refund (FI)
5. NO_X fund (NO)
6. CO_2 tax on mixed waste (NO)
7. Aviation tax (SE)
8. Plastic bag charge (SE)

2.2 Interviews

To support the analysis for each charge, dedicated in-depth, semi-qualitative interviews have been conducted, with researchers specialised in the specific tax/charge from each country respectively. The interviews have been important for the validation of findings as well as a deeper understanding of the effect of the instrument and causality.

2.3 Workshop

To ensure the cross-Nordic perspective, a workshop with invited researchers from all four Nordic countries was held. In total, eight researchers participated to discuss uncertainties in findings and similarities and differences across the countries for a more nuanced and up-to-date understanding of Nordic policymaking.

Based on the findings from the workshop, the comparative analysis discusses the success of the different policy instruments, looking at a set of chosen criteria. The criteria were selected to reflect both the design of the charge and external factors that significantly influence market outcomes.

The parameters chosen for the comparative analysis are:

- Charge level
- Precision of charge
- Degree of avoiding leakages
- Equity
- Price elasticity of demand
- Acceptance
- Synergies with other instruments
- Incentivising technology development
- Political alignment

3. Analysis Green charges

This chapter examines the impacts of the selected environmental charges implemented across the Nordic countries. Through an analysis of these measures, the following sections will describe the historical background and historical changes in the charge, assess other changes in the market throughout the years that could have affected market behaviour, and evaluate the intended effect and whether there seems to be a causal relationship. By evaluating the outcomes associated with these fiscal instruments, the chapter aims to provide insights into their efficacy and contribution to improved environmental status and increased sustainability. The two charges are listed per country in the following order: Denmark, Finland, Norway and Sweden.

3.1 Tax on pesticides

Denmark is among the most intensively farmed nations in the European Union, with approximately 62% of the land area consisting of agricultural land (2018). In the mid-1980s, aiming at protecting the groundwater, the regulatory regime started focusing on the impacts of agriculture, introducing several environmentally oriented regulatory measures such as pesticide regulation.[25] Pesticides have been a concern since the first pesticide action plan was introduced in 1986[26] with regulation of the types and amounts of pesticides used.[27] The following section will assess the Danish pesticide charge, focusing on intended effects, changes in consumption, and external factors influencing the efficiency of the policy measure.

25. Pedersen et al. (2019). *Are independent agricultural advisors more oriented towards recommending reduced pesticide use than supplier-affiliated advisors?*
26. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
27. Pedersen et al. (2019). *Are independent agricultural advisors more oriented towards recommending reduced pesticide use than supplier-affiliated advisors?*

1986	First pesticide action plan
1990	3% wholesale tax introduced
1993	Prescriptive regulations implemented
1994	
1995	Pesticide charge implemented
1996	Ad valorem tax introduced
1997	8% pesticide decrease achieved
1998	Pesticide charge increased tenfold
2003	Tax adjusted to counteract pesticide retailers' internalization of costs
2005	
2009	Implementation of EU directive 128/2009EC
2013	Redesign of pesticide charge, differentiated tax
2016	First review of differentiated tax
2023	Redesign of differentiated tax

Figure 2: Historical Development of the Danish Pesticide Tax

In 1986, the Danish government initiated its first pesticide action plan to protect consumers and land workers against health risks (e.g., from ingestion through food and drinking water) and protect the environment.[28] The action plan was motivated by a significant increase in pesticide use and a noticeable decline in farmland wildlife at the beginning of the 1980s. The goals of a 25% reduction of pesticide use by 1992 and a 50% reduction before 1997 were to be achieved through advisory activities for farmers and research on options to reduce pesticide use.[29] The Action Plan achievements were to be measured with the Treatment Frequency Index (TFI), calculated by dividing the total amount of active ingredient used on each crop by the standard doses assigned to each use of the active ingredient.[30] In 1990, an

28. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
29. Nielsen (2005). *Danish Pesticide Use Reduction Programme – to Benefit the Environment and the Health*
30. Kudsk et al. (2018). *Pesticide Load – A new Danish pesticide risk indicator with multiple applications*

added value tax of 3% was introduced for the wholesale turnover of pesticides. A further objective of the Action Plan was to develop an indicator that could change the taxation system from a tax linked to the costs of a pesticide to a tax linked to the risks associated with the pesticide.[31]

The 25% reduction target for 1992 was not achieved. Quite the opposite, pesticide use increased by 2%. Therefore, new initiatives were introduced, including requirements for commercial pesticide users to hold spraying certificates (1993), farmers cultivating more than 10 hectares to keep spraying logbooks (1994), and spraying equipment to be subject to spot checks (1994). An ad valorem tax was implemented in 1996, replacing the 3% fee for the wholesale turnover of pesticides.

In 1997, the Danish Environmental Protection Agency (DEPA) published a progress report based on the Bichel Committee's assessment of phasing out pesticides. The progress report showed that efforts to tighten pesticide approval had been successful and that the goal to halve the pesticide consumption (measured by kilograms of active ingredient sold) had been achieved. As only an 8% decrease in the TFI was reached (against the projected 50%), the pesticide charge was increased from 37% to 54% in 1998,[32] with a prediction that the amended charge would further decrease the use of pesticides with 18–20%.[33] However, pesticide retailers reduced their prices by 6% for farmers' insecticides from 1997 to 2003 to counteract the tax. In 2005, 13% of the tax revenue was used to finance DEPA and research activities, 3.5% financed the pesticide reduction plan, and 83.5% was returned to farmers through funds.[34]

Benefits and challenges with the tax design

The pesticide tax design between 1986 and 2005 was criticised for being a tax on value, as newer, more expensive, but less hazardous pesticides were taxed higher than older, cheaper, and more hazardous pesticides.

31. Kudsk et al. (2018). *Pesticide Load – A new Danish pesticide risk indicator with multiple applications*
32. Nielsen (2005). *Danish Pesticide Use Reduction Programme – to Benefit the Environment and the Health*
33. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
34. Nielsen (2005). *Danish Pesticide Use Reduction Programme – to Benefit the Environment and the Health*

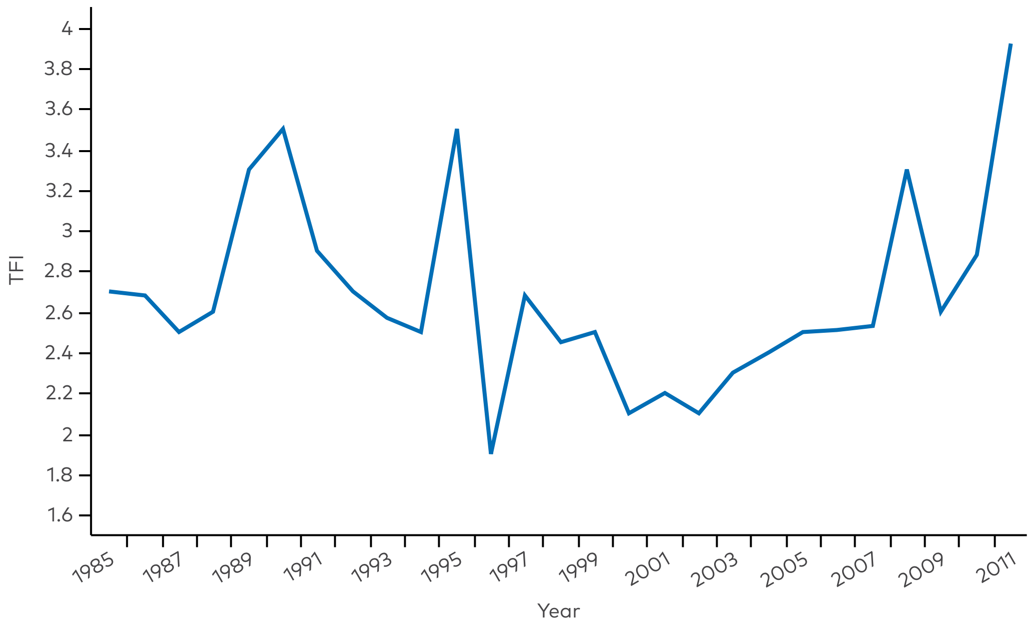

Figure 3: Treatment Frequency Index on Danish agricultural land (Pedersen et al. (2015).

In 2003, it was projected that the TFI could be reduced to 1.4 without significant economic losses to farmers or society. These projections were based on the TFI reduction between 1990–2001 from 3.1 to 2.1. This was never achieved, as seen in Figure 3, which is explained by fluctuating grain prices, decreases in pesticide prices, changes in crop composition, stockpiling, and warmer winters.

Stockpiling is particularly important when examining the TFI statistics, as changes in the political landscape affect stockpiling behaviour. This is illustrated by the spike in the TFI around 2009 when the EU Parliament and Council introduced Directive 2009/128/EC on the sustainable use of pesticides.[35][36]

35. Nielsen (2005). *Danish Pesticide Use Reduction Programme – to Benefit the Environment and the Health*
36. The EU Parliament & Council (2009). *Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009: establishing a framework for Community action to achieve the sustainable use of pesticides*

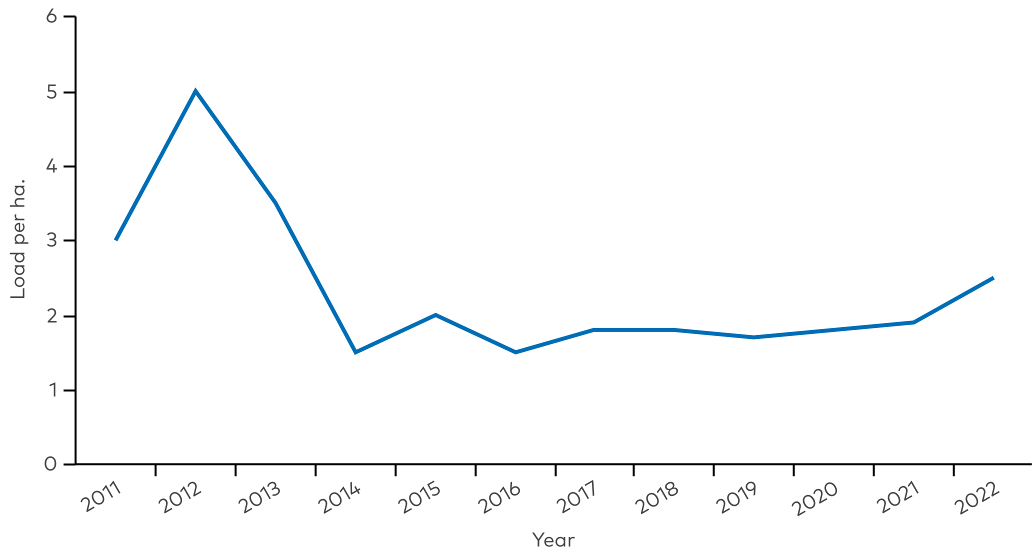

Figure 4: Development of Pesticide Load from 2011–2022, based on pesticide sale (The Danish Ministry of the Environment and Gender Equality, n.d.).

In 2009, the EU Directive launched the Directive on sustainable use of pesticides (128/2009EC).[37] As part of the implementation of this directive, the Danish pesticide tax was redesigned in 2013, changing the indicator from a frequency-based indicator (TFI) to a toxicity load-based indicator (Pesticide Load (PL)) with the sub-indicators *Human health, Ecotoxicology* and *Environmental fate.*[38] The redesigned tax introduced a 40% reduction target in PL by 2015 compared to 2011, equivalent to a PL of 1.96.[39]

By 2016, the first review of the redesign showed that the PL *based on sales* was equivalent to 1.40[40] (the *actual use* of pesticides was higher, which was made possible by stockpiling before the tax implementation in 2013).[41] Later reviews and statistics show an 18% reduction in PL between 2011 and 2017 and a 46% reduction in PL based on sales from 2011 to 2021.[42]

In March 2023, a goal to further reduce the use of pesticides by 27% and PL to 1,46 was established, resulting in a reduced basic charge on pesticides at DKK 20/kg and an increase in PL tax to DKK 140 to further incentivise a redirection towards pesticides with a lower toxicity load. In the sales statistics from 2022,[43] a stock-piling effect before the change is evident (similar to the 2013 situation).

37. European Commission (2009). *Directive 2009/128/EC of the European Parliament and the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides*
38. Kudsk et al. (2018). *Pesticide Load – A new Danish pesticide risk indicator with multiple applications*
39. Regeringen (2013). *Beskyt vand, natur og sundhed – sprøjtemiddelstrategi 2013-2015*
40. Miljøstyrelsen (2018). *Evaluering af den differentierede pesticidafgift*
41. Ørum et al. (2018). *Analyser til brug for evaluering af pesticidafgiften*
42. Miljøstyrelsen (2023). *Bekæmpelsesmiddelstatistik 2021*
43. Miljøstyrelsen (2024). *Bekæmpelsesmiddelstatistik 2022*

Benefits and challenges with the tax design: homogenous pesticide use

The OECD considers the Danish pesticide tax among the world's most sophisticated pesticide tax schemes.[44] Using PL as an indicator addresses the often-seen lack of good indicators for economic instruments, and the tax design includes a nudging approach to direct consumption towards less harmful pesticides.

A concern with the nudging approach has been the risk of farmers primarily using the cheapest pesticides, causing a risk of developing resistance in weeds, fungi and insects to specific active pesticide components.[45] An enlarged price difference may lead to increased and homogenous use of the cheapest products if *Integrated Pest Management* (IPM) strategies are not introduced.[46] The DEPA 2013 evaluation of the charge[47] presumed that the pesticide charge would promote the IPM strategies, and a 2020 DEPA evaluation showed that the charge had increased some farmers' focus on IPM strategies.[48]

Evidence shows that the sale of some harmful pesticides has not changed since 2011, indicating that the charge may not effectively have promoted the switch to less harmful agricultural approaches.[49]

Price elasticity and market effects of the pesticide charge

The Danish pesticide tax is notably higher than those in other Nordic countries.[50] The initial value-based pesticide charge did not achieve the goal of minimising pesticide use, demonstrating a low-price elasticity of pesticides due to farmers' need for crop protection and mitigation of pesticide resistance.[51][52]

This observation corresponds to a meta-analysis of the elasticity demand for pesticides,[53] which shows that pesticides are fairly inelastic but not entirely inelastic. The analysis finds that differentiated pesticide tax schemes with sufficiently high taxes can lead to product substitution, as has, to some degree, been the case with the Danish and Norwegian pesticide taxes. The meta-analysis shows that elasticity differs between groups of pesticides: fungicides and insecticides are more inelastic than herbicides.

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44. OECD (2017). *Environmental Fiscal Reform – Progress, Prospects and Pitfalls*
45. Kristensen (2023). *Pesticidresistens*
46. Kudsk et al (2018). *Pesticide Load – A new Danish pesticide risk indicator with multiple applications*
47. Miljøstyrelsen (2018). *Evaluering af den differentierede pesticidafgift*
48. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
49. Ørum et al (2018). *Analyse til brug for evaluering af pesticidafgiften - En beskrivelse af ændringer i pesticidernes priser, salg, forbrug of belastning*
50. Böcker & Finger (2016). *European Pesticide Tax Schemes in Comparison: An analysis of Experiences and Developments*
51. Skevas et al. (2012). *Can economic incentives encourage actual reductions in pesticide use and environmental spillovers?*
52. Böcker & Finger (2016). *European Pesticide Tax Schemes in Comparison: An analysis of Experiences and Developments*
53. Böcker & Finger (2017). *A meta-analysis on the elasticity of demand for pesticides*

Use of revenue of the tax

Part of the tax design for the pesticide tax is the reimbursement of the tax revenue back to the agricultural sector.[54] With the introduction of the tax doubling in 1998, the revenue was earmarked as compensation for farmers, channelling back 60% to the agricultural sector in the form of subsidy schemes, such as organic farming practices, as well as some administrative costs.[55] Reimbursing the pesticide tax revenue is an integral part of the tax design, and the tax does not serve any fiscal purposes.[56]

With the current version of the tax, it was estimated that the tax increase, and thereby the increase in the price of pesticides, would mean a DKK 150 million increase in expenditures for farmers (after a shift in consumer behaviour).[57] This additional tax revenue is earmarked to finance a tax relief on land taxes for farm owners as compensation to ensure that the sector does not decrease competition ability.[58] Ensuring competitiveness carries a potential risk of leakage. However, there is no evidence in the literature to suggest that the pesticide tax specifically contributes to leakage risk in the industry. Nonetheless, it does add to the overall tax burden on the Danish agricultural sector, which has expressed concerns about the risk of agricultural practices relocating elsewhere due to rising costs for farmers under the current regulatory framework of Danish agricultural policy.[59][60]

Even though the tax is being reimbursed back to the agricultural sector, which aims to limit competitive distortion, it is still challenging to mitigate distributional effects. The tax load is not homogenous across all farmers – some practitioners use substantially more pesticides than others, but they will not necessarily gain the same compensation from the relief in land-use taxes.[61]

Synergies and external effects

While the pesticide tax has been evaluated to have (nearly) the intended effects, Denmark's agricultural fields are heavily regulated and affected by other external factors. Overlapping policy frameworks, policy measures, and economic incentives to change agricultural practices have most likely had synergetic effects on the pesticide tax's efficiency.

54. Retsinformation (2011). *2011/1 LSF 171. Forslag til lov om ændring af lov om afgift til bekæmpelsesmidler*
55. Schou & Streibig (1999). *Pesticide taxes in Scandinavia*
56. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
57. Nielsen et al. (2020). *Evaluering af den omlagte pesticidafgift*
58. Pedersen et al. (2015). *The Danish pesticide tax.*
59. De Økonomiske Råd (2021). *Dansk klimapolitik frem mod 2030*
60. Landbrug & Fødevarer (2022). *Alvorlige konsekvenser af ensartet CO2e-afgift på landbruget*
61. Nielsen et al. (2023). *Ex-post evaluation of the Danish pesticide tax: A novel and effective tax design*

No analysis of the collected effects of, e.g. the Water Framework Directive,[62] the Habitats Directive,[63] the Biodiversity Strategy,[64] and the Nitrates Directive[65] on the development of the Danish pesticide tax have been identified during this assessment. However, the EU Policy measures on pesticide usage and organic agriculture[66] likely have achieved some degree of policy synergy, as goals to protect the environment, human health, and availability of clean groundwater are present in both policy measures. The means to achieve these goals are also intertwined, as organic farming practices are characterised by a (reduced) use of pesticides. The first Danish Organic Farming Act was introduced in the same period that the first pesticide tax was introduced, and the amendments of these two policy measures have occurred relatively simultaneously.[67]

Since 2013, the same year the differentiated pesticide charge was introduced, the agricultural area of organic farming increased from 165,000 hectares to 277,179 hectares in 2023.[68] In a consumer survey conducted by Norstat in 2022, it was uncovered that most consumers are motivated to buy organic food due to less pesticide residue (55%) and reduced negative impact on the environment and drinking water (groundwater) (34%).[69] This motivation and convictions amongst consumers align with communications from the Danish Veterinary and Food Administration, which highlights the protection of nature and groundwater as a key benefit of organic products.[70] This development of organic agricultural practices is, however, also coincident with the European Commission's action plan for the future of organic production in the EU.[71] Therefore, no definite conclusions can be made on policy synergies between the Danish pesticide tax and other efforts working towards similar goals.

3.1.1 Cross Nordic outlook

Pesticide tax schemes have been implemented in all the Nordic countries examined in this study. Among these, the Danish and Norwegian pesticide taxes have attracted significant international interest. The following section provides a brief overview of the approaches to designing pesticide taxes, with a specific emphasis on the Norwegian tax scheme.

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62. The EU Parliament & Council (2000). *Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 - establishing a framework for Community action in the field of water policy*
63. The EU Council (1992). *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*
64. European Commission (2020). *EU Biodiversity Strategy for 2030 - Bringing Nature Back Into Our Lives*, COM/2020/380 final
65. The EU Council (1991). *Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)*
66. The EU Parliament & the Council (2018). *Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council regulation (EC) No 834/2007*
67. Daugbjerg & Schvartzman (2022). *Organic Food and Farming Policy in Denmark: Promoting a Transition to Green Growth*
68. Statistics Denmark (n.d.). *Production and accounts of organic farming and horticulture*
69. Landbrug & Fødevarer (n.d.). *Det økologiske markedet*
70. Fødevarestyrelsen (n.d.). *Økologi*
71. European Commission (2021). *Action Plan for the Development of Organic Production*, COM/2021/141 final/2

Norwegian pesticide tax

The first Norwegian pesticide tax was introduced in 1998, corresponding to 15.5% of the retail price of pesticides. In 1999, the average tax rate doubled, and the first format of a pesticide risk indicator was introduced to supplement the base tax. The tax scheme differentiates between the use of pesticides for commercial and private purposes.[72]

Today, Norway utilises the pesticide risk indicator (NERI), which was developed partly to enable the risks of pesticide use and partly as a method for taxing pesticides. NERI functions as a rating system where products' effects on human health are categorised into four risk classes (low, medium, high, and very high risk). The risk class of a pesticide is based on the labelling of the product. Based on the same data, NERI further determines the risk to human health by assessing the operator exposure when preparing and applying the pesticides. Environmental risks are assessed based on effects on earthworms, bees, birds, aquatic organisms, mobility and leaching potential, persistence, and bioaccumulation. Based on accumulated risk scores, NERI classifies the pesticide products into three environmental risk classes. The combination of risks to human health and the environment results in a classification of pesticide products, grouped into seven pesticide tax classes.[73] Norwegian consumers are then taxed based on the pesticide tax class and Pesticide Load (PL).[74]

The Norwegian pesticide tax has been compared with the redesign of the Danish pesticide tax (the introduction of a differentiated tax in 2013). The Norwegian tax has been deemed as a successful tax design compared to the simple added-value tax (as the Danish pesticide tax before the redesign), especially when looking at the substitution of high-impact products with lower-impact products.[75] However, the Norwegian tax design faces some of the same challenges with unintended effects as the Danish tax design. An example of this is that the pesticide *sulfonylurea herbicides* became cheaper than other herbicides as a consequence of the NERI rating. *Sulfonylurea herbicides* became widely used to treat broadleaved weed species, leading to a pronounced problem with *sulfonylurea resistance.*[76] The case of *sulfonylurea* resistance has been a focus in the discussion of issues related to homogeneous pesticide use. However, very little documentation is available on the extent of the resistance and how widespread the effects of the resistance are.

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72. Shou & Streibig (2005). *Pesticide Taxes in Scandinavia*
73. Kudsk et al. (2018). *Pesticide Load – A New Danish pesticide risk indicator with multiple applications*
74. Nielsen et al. (2023). *Ex-post evaluation of the Danish pesticide tax: A novel and effective tax design*
75. Nielsen et al. (2023). *Ex-post evaluation of the Danish pesticide tax: A novel and effective tax design*
76. Kudsk et al. (2018). *Pesticide Load – A New Danish pesticide risk indicator with multiple applications*

Swedish pesticide tax

Sweden was the first country in Europe to introduce a pesticide tax in 1984, aimed to reduce pesticide use and side effects hereof. The Swedish pesticide tax is based on the amount of active ingredients in the tax. Initially, the tax amounted to €0.48 per kg of active ingredients. The tax was doubled in 1988. In 1994, the tax was again increased to €2.3 per kg of active ingredients, creating revenue of approximately €3.65 million. In this period, there was no link between the revenue generated with the tax and spending on R&D or subsidies. Farmers were subject to paying the tax in advance, based on the expected annual use of pesticides.[77] The Swedish pesticide tax has been raised a total of three times, the latest one being in 2015.[78]

Finnish pesticide tax

The tax on pesticides in Finland is based on the Pesticide Act (327/69) and the Pesticide Decree (792/95).[79] The tax was introduced for fiscal purposes, and a uniform flat-rate VAT on all pesticides was designed at 3.5%, with no expectations of significant changes in the consumption pattern. In 1997, total tax revenue was determined to be €1.63 million, which was used to fund the costs of pesticide registration and maintenance of a pesticide register. Furthermore, a registration fee of €863.42 is charged for all new pesticides.[80] The system to levy registration and administration costs was active in Finland until 2007.[81] It has not been possible to confirm whether the pesticide tax in Finland is still in place, as very little information on the tax is publicly available.

3.2 Tax on residential electricity consumption

Household energy consumption accounts for approximately 30% of Denmark's total energy use (2022). Over 80% of household energy is used for heating and hot water, sourced from district heating, electricity, or burning natural gas, oil, or wood. The remaining 20% (household domestic electricity consumption) powers electrical appliances like fridges, washing machines, and lighting.[82] The tax on domestic electricity in Denmark is the highest in Europe, and there is increasing awareness and discussions on whether the electricity tax on household consumption still fulfils its original purpose or hinders the green transition in the energy sector. The following chapter will examine the development, impact, and effect of the tax on household electricity consumption in the Danish market.

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77. Shou & Streibig (2005). *Pesticide Taxes in Scandinavia*
78. Pedersen (2015). *Introducing a Differentiated Tax on Pesticides in Sweden – Substitution Effects and Possibilities for Load and Use Reductions*
79. Kristoffersen et al. (2008). *A review of pesticide policies and regulations for urban amenity areas in seven European countries*
80. Shou & Streibig (2005). *Pesticide Taxes in Scandinavia*
81. Böcker & Finger (2016). *European Pesticide Tax Schemes in Comparison: An Analysis of Experiences and Developments*
82. Gram-Hanssen, K. (2024). *Energiforbrug (husholdninger)*. Den Store Danske

	1973	1st energy crisis
	1977	1st tax on electricity
	1978–80	2nd energy crisis, Tax on coal and oil
	1988–90	3rd energy crises, Tax on gas
	1990	Action plan for renewable energy
Renewable energy production 5 %	**1994**	
	1998	Enforcement of PSO
	1999	EU - Liberalisation of the electricity market
	2005	Enforcement of EU Emissions Trading System
	2018	Lowering of electricity taxes
Renewable energy production 46 %	**2022**	Energy crises, help package PSO phased out
	2023	Lowering charge to EU minimum for 6 months

Figure 5: Historical Development of the Danish Tax on Residential Electricity Consumption

Historical overview of the purpose and development of the tax

Danish energy policy has long focused on reducing carbon emissions, decreasing reliance on fossil fuels, and increasing renewable energy (RE) sources, alongside promoting technological advancements and energy efficiency. Energy taxation is also closely interlinked with climate goals and international commitments.

Denmark has one of the world's largest shares of RE in the energy sector, consisting of 45.6% of the total energy consumption in 2022.[83] In contrast, in 1994, only 5% of the total energy production originated from renewable energy sources. On the

83. Shultz (2023). *Danmarks forbrug af biomasse til energi holder historisk højt niveau*

other hand, the share of renewables in electricity supply to Danish households accounted for 81.4% in 2022. Wind power consisted of 53.6%, biomass 18.9%, and solar energy and biogas 8.8%.[84]

There are three different electricity taxes in Denmark, covering electricity used in households, electricity used for domestic heating and electricity used in industrial processes, respectively. This study covers only electricity used in households for electric appliances (not heating). Further on, the "electricity tax" only refers to this tax.

The electricity tax rate is set by the Danish Parliament and adjusted annually through finance law negotiations. The electricity tax on households is the highest in Europe, and there is also a larger gap between household and business electricity tax rates compared to other countries.[85]

The electricity tax was introduced in 1977. When it was implemented, the overarching objective to reduce fossil fuel dependency and energy consumption as an effect of the oil and energy crisis in the 1970s.[86] The energy tax was, at the time, primarily meant to incentivise energy conservation among households. However, this objective has seemed to somewhat change throughout the years, as the tax has come to play a role in renewable energy transition politics as well.[87]

In 1990, the Energy Action Plan *Energi 2000* set a goal to expand wind energy by 100 MW by 1994 and introduced initiatives to promote biomass and solar energy. Subsequent energy policy agreements in the 90s supported this expansion. The 1999 electricity reform aimed for 20% of electricity to come from renewable sources by 2003.[88]

Since the beginning of the 2000s, there have been numerous political initiatives to promote the development of renewable energy and decreased use of fossil fuels. In 2007, the Danish government announced a goal towards 2025:

- To reduce fossil fuel usage by 15% further by 2025
- To achieve at least 30% renewable energy for the total energy sector, including 60% renewable electricity production by 2025. This would be done by doubling wind power capacity.[89]

In 2012, the Danish government, together with the parliament, agreed on the so-called *Energy Agreement* (Energiaftalen). The agreement set a vision and objectives for Danish energy politics between 2012–2020, among other things, to increase the use of renewable energy. As part of the agreement, the different energy charges

84. Danish Energy Agency (2024*). 2022 Data, tables, statistics and maps – Energy Statistics 2022*
85. Eriksson et al. (2023). *Use of Economic Instruments in Nordic Environmental Policy 2018–2021*
86. Skat (n.d). *Historik*
87. Energistyrelsen (2016). *Danmarks energifortider – hovedbegivenheder på energiområdet*
88. Hansen et al. (2005). *Vedvarende energi i Norden - Et sammenlignende studie af de nordiske landes vedvarende energipolitikker og virkemidler*
89. Sovacool et al. (2008). *Is the Danish Wind Energy Model Replicable for Other Countries?*

were investigated to analyse effect and efficiency from a socio-economic perspective to be able to make necessary regulatory changes in line with the objectives. The analysis concluded, among other things, that the tax on electricity is relatively expensive compared to other energy sources and a relatively inefficient instrument to achieve political energy objectives and that the so-called PSO tax is distorting competition in the market.

The PSO tax on domestic electricity consumption was introduced in 1998 to support renewable energy (RE) investments. Around 10% of Danish electricity bills consisted of the PSO tax, which was a separate tax from the electricity tax. The revenue from the tax was earmarked to specifically support emerging RE sources that were not yet mature enough to compete in the energy market. However, the PSO was gradually phased out between 2017–2022[90] due to pressure from the EU Commission and conclusions from an investigation conducted for the government in 2012. The EU Commission deemed it discriminatory, as it applied to all electricity consumption in Denmark but only funded domestic RE projects, excluding foreign producers. Since 2022, state funding into RE investments has been solely decided in the Finance Act instead of being earmarked through electricity bills. This change means that state aid money into RE investments is competing directly with other priorities, such as hospitals and schools, for political attention. The change in the overall electricity taxation was expected to make Denmark's energy supply greener in the long run and accelerate the shift to green energy production even further, as electricity would be less expensive for the end consumer compared to other energy sources. However, in the short term, it may seem less favourable for renewable energy transition since the money that before was earmarked now needs to be negotiated each year by the government, making the support less predictable from politicians.[91]

In 2018, the Danish Government agreed on a new Energy Agreement to ensure cheaper green electricity. The agreement lays the foundation to reduce the electricity tax on households by around 15% between 2019–2025, with the objective to boost green electricity utilisation.[92] The same year, The Danish Ministry of Taxation concluded in an analysis that the electricity tax on household consumption no longer serves the same green objective as before. Their analysis shows that the high tax no longer has the same positive effect on climate and environment as it used to. The electricity tax is expensive and relatively inefficient in achieving political energy objectives. Their analysis furthermore concludes that there are significant socio-economic costs associated with the tax because the high tax is decreasing demand for electricity to such an extent that it is inappropriate from a socio-economic perspective. Most of the electricity is produced from renewable sources, which should be promoted, but the tax is instead signalling to the end consumer that other energy sources are less expensive. The analysis shows that by reducing

90. Skatteministeriet (2020). *Skatteøkonomisk redegørelse 2019*
91. Jerking (2016). *Forstå sagen: Det betyder PSO-aftalen.* Altinget
92. Energi-, Forsynings- og Klimaministeriet (2018). *Energy agreement 2018*

the tax by 50%, at least half of the relaxation would pay for itself thanks to increased demand for electricity instead of other energy sources that are less sustainable. The calculations estimate that a relaxation of just €0,026/kWh would generate a socio-economic profit of around €134 million. [93]

New estimations from the Danish Tax Authority in 2019 showed that the combined changes of both phasing out the PSO tax and relaxing the electricity tax would provide a total socio-economic profit of around €540 million. Abolishing the PSO tax alone was projected to boost the economy by around €340 million, while reductions in the electricity tax were estimated to add another €200 million in profit (2020 level). Since 2022, the PSO tax has been completely phased out. In 2022, there was a new reform package called "Faster at work, a stronger labour market" (*Hurtigere i job, et stærkere arbejdsmarked*), where there were renewed agreements on gradual reductions in the domestic electricity tax between 2022–2030. The electricity tax was reduced by €0.018/kWh from July 1st, 2022, and will be reduced by another €0.022/kWh between 2024 and 2030 (2022 prices).[94]

The price reductions are estimated to provide tax revenue thanks to increased electricity demand. In 2025 and 2030, respectively, it is estimated to be around €160 million after refunds and behavioural changes have been accounted for.[95]

Use of revenues of the tax

In 2022, total revenue from electricity taxes amounted to around €1.28 billion.[96][97] It has not been possible to decipher how big a share of the revenue comes from the household electricity tax, and the Danish Tax Authority has been contacted, but without clarifications.

Over the past 25 years, energy tax revenue as a percentage of GDP rose until 2000, then declined. Since then, revenue from fossil fuel taxes has dropped by about a third, climate and environmental taxes have halved, and electricity tax revenue has remained steady. This decline reflects the growing use of renewable energy, which has reduced the tax base.[98] More than 10% of the electricity tax goes to Energinet, a state-owned company responsible for maintaining the national electricity grid.[99][100] In March 2024, the domestic electricity price in Denmark was €0.34/kWh, significantly higher than its neighbours. Sweden's kWh-rate was notably lower at €0.20, followed by Finland at €0.167. Norway offered the cheapest electricity among the four, with a rate of just €0.15.[101]

93. Skatteministeriet (2018*). Den høje danske elafgift tjener ikke samme grønne formål som tidligere*
94. Skatteministeriet (2022b). *Faktaark: Lempelse af elafgift til minimumssats i seks måneder*
95. Skatteministeriet (2022a). *Afgifter - provenuet af afgifter og moms*
96. Skatteministeriet (2022a). *Afgifter - provenuet af afgifter og moms*
97. Danmarks Statistik (n.d.). *2022 gav pæn vækst i både BNP og beskæftigelse*
98. Skatteministeriet (2019). *Skatteøkonomisk redegørelse 2019*
99. Stockfleth (2024). *Elafgift – Hvad er afgifter på el i Danmark?*, Elberegner.dk
100. Energinet (n.d.). *Aktuelle tariffer*
101. GlobalPetrolPrices.com (2024). *Electricity prices, March 2024*

Electricity consumption, shift in energy sources and reduced CO_2 emissions

The background and historical perspectives of the electricity tax show that the overall aim of the electricity tax can be divided into three main objectives: to reduce dependency on fossil fuels, reduce electricity consumption and fiscal revenue. According to statistics from Skatteministeriet (2019),[102] total energy consumption (both private and corporate) has remained relatively stable since the 1990s. Despite stable energy consumption, Denmark's GDP has grown by around 62% during the same period. This reflects a significant increase in energy efficiency.[103] Statistics from the Danish Energy Agency show both the energy consumption in total and energy consumption by energy source for households per year between 1990–2022. Since the 1990s, electricity consumption has remained relatively stable, showing increased energy efficiency today compared to 1990. The use of fossil fuels has, on the other hand, dropped significantly, replaced by a steady increase in RE sources.[104] Despite these reductions, fossil fuels constitute around 10% of electricity production as of 2023.[105] Figure 6 and Figure 7 below show the development.

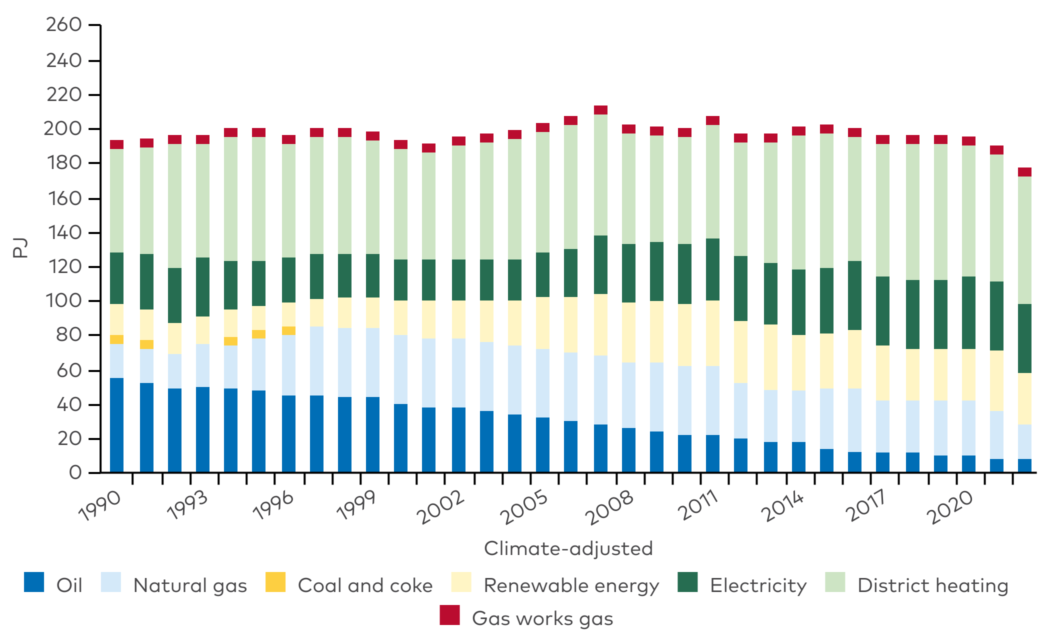

Figure 6: Household energy consumption divided into energy mix (Danish Energy Agency (2023). 2022 Data, tables, statistics and maps – Energy Statistics 2022)

102.Skatteministeriet (2020). *Skatteøkonomisk redegørelse 2019*
103.Skatteministeriet (2020). *Skatteøkonomisk redegørelse 2019*
104.Skatteministeriet (2020). *Skatteøkonomisk redegørelse 2019*
105.Energinet (2024). *Foreløbige gennemsnit af miljødeklarationer 2023*

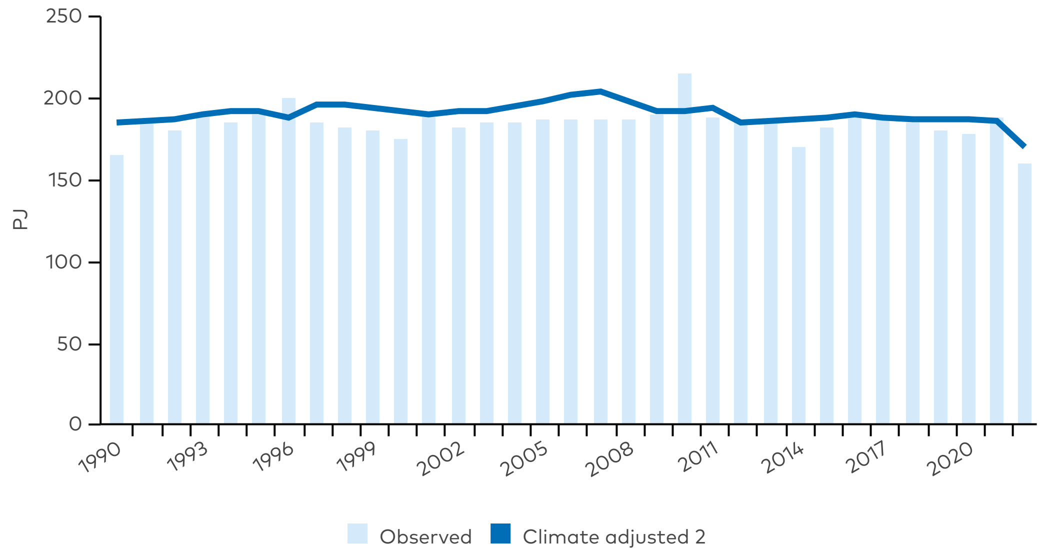

Figure 7: Energy consumption from Danish households between 1990–2022 (Danish Energy Agency (2023). 2022 Data, tables, statistics and maps – Energy Statistics 2022

Thanks to the shift in fuels, there has been a significant reduction in CO_2 emissions from electricity consumption. The amount of CO_2 emitted for each unit of electricity consumed has been reduced by more than 70%, as shown in Figure 8 below.[106]

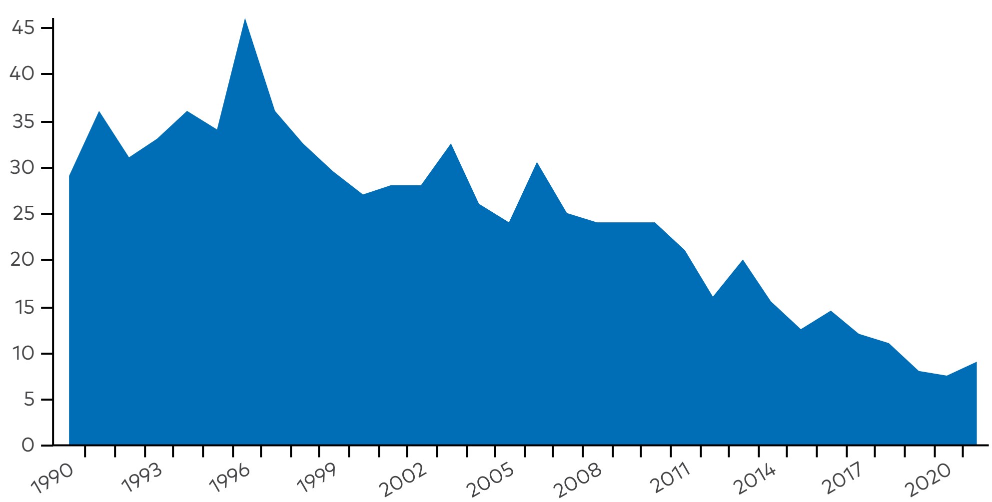

Figure 8: Change in CO_2 emissions (million tons) from the Danish electricity production between 1992–2021 (Energistyrelsen, energy statistics 2022).

106.Danish Energy Agency (2023*). 2022 Data, tables, statistics and maps – Energy Statistics 2022*

Consequently, the presented statistics demonstrate that political will and objectives, together with regulations, raised awareness and economic instruments, have successfully driven significant growth in renewable energy sources and cut CO_2 emissions.

3.2.1 Intended effect of policy instrument

As discussed in previous sections, a combination of regulations, information sharing, and subsidies for research and technology development, along with taxes, have all played a role in driving the green transition in Denmark's energy sector.[107] In an article by Hansen et al. (2005), it is elaborated on how the synergy between these instruments, combined with the political landscape and public sentiment, has shaped market development. This shows the difficulty of isolating the electricity tax from the other instruments to measure the effect. In the article, it is argued that, in addition to electricity taxation, other economic tools that have played a significant role in promoting RE include financial investment support and subsidies for establishing wind and solar power plants, price supplements for RE production (covering wind, biofuels, biogas, and solar), CO_2 quotas, and CO_2 fees. Alongside the economic measures, regulations have been implemented to support infrastructure development for renewable energy, in line with political objectives to increase the share of clean energy. Hansen et al. (2005) also highlight the broad political and public backing for wind energy, which has further been positive for market development, ensuring a relatively stable research and competition market among key stakeholders.[108] In another article by Sovacol et al. (2008) it is also described how political leadership, social attitudes and cultural approaches also have played a big role in supporting the transition towards renewable energy in Denmark and independence on exported energy, compared to the 70s in the energy crisis.[109]

Denmark is often mentioned as a successful example of fostering favourable conditions for wind power. Denmark cannot, as compared to the other Nordic countries, rely on geothermal or hydropower as a renewable energy carrier, which is why wind power has been of extra importance.[110] Since the 1980s, wind power has been a strategic tool integrated into regional planning both on land and offshore, and is still part of the long-term energy policy goal 2050, to achieve independence from fossil fuels by 2050.[111]

107. Nielsen & Pedersen (2013). *Hvordan kan staten fremme innovation, der fører til bæredygtige energisystemer?*
108. Hansen et al. (2005*). Vedvarende energi i Norden - Et sammenlignende studie af de nordiske landes vedvarende energipolitikker og virkemidler*
109. Sovacool et al. (2008). *Is the Danish Wind Energy Model Replicable for Other Countries?*
110. Andersen (2015). *Reflections on the Scandinavian Model: Some Insights into Energy Related Taxes in Denmark and Sweden*
111. Energistyrelsen (n.d.). *Dansk Energipolitik*

There is, however, not a clear causal relationship between the electricity tax and a technology shift in the market to support RE. The effectiveness of the electricity tax in the 2020s is questioned as to whether it hinders the green transition. Due to the high tax rates on electricity in Denmark, electricity is much more expensive than other energy forms like coal, oil, and natural gas. The existing taxation scheme is considered outdated and contradictory, as it distorts consumer behaviour by working against the policy goal of further decarbonisation in electricity production and making electricity more affordable for end users.[112] However, the technological progress of clean energy solutions the government aims at incentivising is considered to be hampered by the high tax.[113] The potential tax deficit that would occur from lowering the tax should be replaced with other taxation. Tax revenues could be earmarked to subsidise clean energy development to support political energy objectives. Using tax revenues to subsidise more sustainable alternatives can also be a strong instrument to increase public acceptance of the tax.[114]

Several stakeholders have in recent years expressed a need for a relaxation of the electricity tax because it is considered to hinder the green transition and incentivise RE. A report from 2017 by business organisation Danish Energy, named Green Power Denmark since 2022, when merged with *Wind Denmark* and *Dansk Solkraft ("Danish Sun Power")*, argues that the household electricity tax is disproportionately higher than the environmental damage from production, because the tax surpasses taxes on other energy sources, even when adjusted for CO_2 emissions.[115] Green Power Denmark also means that the tax structure is outdated and should be reformed to align with the European minimum level.[116] The Danish Council on Climate Change agrees that the tax structure is outdated, recommending a reduction in the tax as electricity production increasingly relies on renewable energy. However, the Council also notes that a modest tax can still be justified if its purpose is to encourage reduced energy consumption, regardless of whether the energy is from renewable or fossil fuel sources.[117] Evaluations from the EU Commission and KPMG highlight that high electricity taxes on the end consumer may discourage them from using electricity instead of other energy sources, negatively affecting household consumption of renewable technologies like solar panels or wind power. The findings suggest that overly burdensome taxation can impede the growth of green energy markets by making them less financially viable for households and businesses.[118] If high taxes lead to reduced electricity supply, this could result in higher prices and disincentivise further investments.[119] The Danish think-tank Concito also argues in a report from 2024 that restructuring

112. Albertsen et al. (2020). *Implementing dynamic electricity taxation in Denmark*
113. Albertsen et al. (2020). *Implementing dynamic electricity taxation in Denmark*
114. Dugstad (2024). *Carbon pricing acceptance – the role of revenue recycling among households and companies in Norway*
115. Lykkegaard & Shultz (2017). *Økonomiske effekter ved at reducere elafgiften*
116. Green Power Denmark (2023). *Finanslov skal sætte en slutdato for elafgiften*
117. Klimarådet (2016). *Nedtrapning af afgift på el*
118. Kosonen & Nicodéme (2009). *The role of fiscal instruments in environmental policy*
119. Hoel-Holt et al. (2023). *Impact assessment of emergency market intervention measures to tackle high energy prices.*

the electricity tax is essential to promote a larger share of renewables like wind and solar and to meet the rising demand for clean energy.[120]

The Danish Ministry of Taxation states, in an analysis of the household electricity tax from 2022, that the tax is very high even though the share of renewable energy is increasing and constitutes a larger share of the total energy supply. Since the share of RE is increasing, it is argued that the tax should be lowered. Apart from being profitable from a climate perspective, it is also estimated to generate socio-economic revenue and increase GDP, as a reduction would increase the demand for electricity in favour of RE production. The analysis from the Ministry of Taxation, therefore, concludes the tax to be both expensive and an inefficient measure to achieve energy political achievements. Furthermore, it is also claimed that a reduction of the tax would be especially beneficial for people with low income.[121] This is because the electricity tax is a regressive tax (as opposed to, e.g. income tax, which is progressive), which means that the tax composes a higher share of the income, the lower the income. Therefore, it is criticised for causing economic inequality and disproportionately affecting households. Electricity is a somewhat inelastic good, meaning that everybody depends on it, and hence, it is argued that the tax is wrongly designed and causes inequality. In a paper by Csereklyei (2020), price elasticity in domestic electricity consumption is compared within the EU between 1996–2016. The author concludes that the long-run price elasticity is estimated between -0.53 and -0.56, indicating a fairly inelastic good.[122] This resonates quite well with the historical data on electricity consumption since it has been relatively stable for the last decades, indicating that changes in the electricity price do not necessarily change the long-term domestic electricity consumption.

Furthermore, a paper from Mikael Skou Andersen shows that when comparing energy content, also called the calorific value of the energy carriers (measured in Giga Joule (GJ)/kWh), the electricity tax is significantly higher than taxes on fossil fuels like oil and gas. Additionally, the tax is an ad valorem tax, taxing the end consumer instead of the polluter, making it an unprecise instrument to steer electricity consumption towards more RE and reduce CO_2 emissions. Therefore, according to Skou Andersen and efficient pricing mechanisms, the tax should be taxing the polluter (in this case, the energy producer), and it should be harmonised across energy sources based on the calorific value GJ/kWh. Skou Andersen further shows that if energy was taxed equally across energy sources (based on GJ/kWh) and paid by the producer instead of the end consumer, it would not be necessary to subsidise renewable energy sources to the same extent as is done in 2024, because RE would compete on more equal terms with other energy sources.[123]

120. CONCITO(2024). *Energiproduktionens betydning for fremtidens arealanvendelse.*
121. Skatteministeriet (2022b) *Faktaark: Lempelse af elafgift til minimumssats i seks måneder*
122. Csereklyei (2020). *Price and income elasticities of residential and industrial electricity demand in the European Union*
123. Andersen (2015). *Reflections on the Scandinavian Model: Some Insights into Energy Related Taxes in Denmark and Sweden*

Taxing the end consumer (on electricity) incentivises reduced consumption and creates more awareness regarding electricity consumption and conservation. On the other hand, is residential electricity consumption estimated to be fairly inelastic, meaning that a causal relationship between the tax and effect on overall electricity consumption is difficult to isolate. The causality between the electricity tax and the shift towards increased RE supply and reduced CO_2 emissions seems, on the other hand, to be weak.

3.3 Carbon Tax

Finland was the first country to introduce carbon-based taxation for energy products in 1990 with a tax of €1.19 per tonne of CO_2.[124] Through a series of reforms in 1997, 2007, 2011 and 2019 the carbon tax rate has been increased and several other reforms have been made to the calculation basis. After 2011, the tax structure was split into two components, a carbon tax and energy content tax. A security of supply levy also operates. The carbon tax operates on the whole life-cycle carbon emissions of fuels and incentivises shifting to lower carbon fuels. The energy content tax aims to promote overall energy and natural resource savings, encourage energy efficiency measures, and prevent market distortions between different energy products. As of 2024 Finland's nominal domestic rates of carbon tax are €77 per tonne of CO_2 for transport fuels and €53 per tonne of CO_2 for heating fuels.[125]

The range of standardized energy taxation covers heating fuels, light and heavy fuel oil, coal, natural gas, and electricity.[126] Peat and pine oil are exempt and subject to a separate tax. Peat is also only taxable when it is used for heat production in power plants or thermal centers exceeding 10,000 MWh in a calendar year. Natural biogas for heating has historically been exempt, but since 2022 has been taxed at the same rate as natural gas. Solid biofuels used in heating are exempt from all energy taxation.[127] A full breakdown of Finland's fuel tax application can be seen in Table 1 below:

124. Eriksson et al. (2023). *Use of Economic Instruments in Nordic Environmental Policy 2018–2021*
125. Grosjean et al. (2024) Carbon Pricing in Nordic Countries
126. Forsström et al. (2022). *Taustaselvitys Suomen energiaverotuksen kehitystyölle*
127. International Energy Agency (2023). F*inland 2023 Energy Policy Review*

Table 1: *Finland's Fuel Tax Application (International Energy Agency (2023). Finland 2023 Energy Policy Review).*

Sector	Fuel/user	Unit	Energy content tax	Carbon tax	Security payment	Total*	EUR/GJ**
Transport	**Diesel**	EUR/litre	0,3457	0,2456	0,0035	0,5948	16,1
	Gasoline	EUR/litre	0,5379	0,2149	0,0068	0,7596	23,0
Heating and mobile machinery	**Heavy fuel oil**	EUR/litre	0,1159	0,1867	0,0028	0,3054	7,9
	Light fuel oil	EUR/litre	0,1033	0,169	0,0035	0,2758	7,1
	Natural gas	EUR/MWh	10,33	12,94	0,084	23,354	6,5
	Coal	EUR/tonne	71,45	147,81	1,18	220,44	8,5
Electricity	**Household**	EUR/MWh	22,4	0	0,13	22,53	6,3
	Industry	EUR/MWh	0,5	0		0,58	0,2

* Excluding value-added tax.
** Estimate based on: fuel oil 0,039 GJ/L, gasoline 0,033 GJ/L, coal 26 GJ/tonne.

While this analysis focuses on the tax's role in reducing CO_2 emissions from fuel use, given the disaggregation of the CO_2 component from the energy content tax only occurred after the tax had been operating for some time, causal inferences for the overall impact of the tax should deal with the tax in aggregate.

Finland's energy taxation aims to reduce emissions by promoting a shift away from fossil fuels and contribute to the national target of carbon neutrality by 2035. However, energy taxes also aim to support central government finances through consistent tax revenue and to align with EU energy and climate directives. The EU Energy Taxation Directive (ETD) of 2003/96/EC went some way to standardising energy taxes within the EU and establishing the main framework for taxation. Until now this includes determining the products subject to tax, setting minimum tax rates, and specifying options for exemptions. However, given the age of the directive it is widely accepted that reform is needed, although finding a compromise position capable of becoming a law has proved difficult.[128]

128. Asquith (2024). *EU Energy Tax Reform Unresolved.*

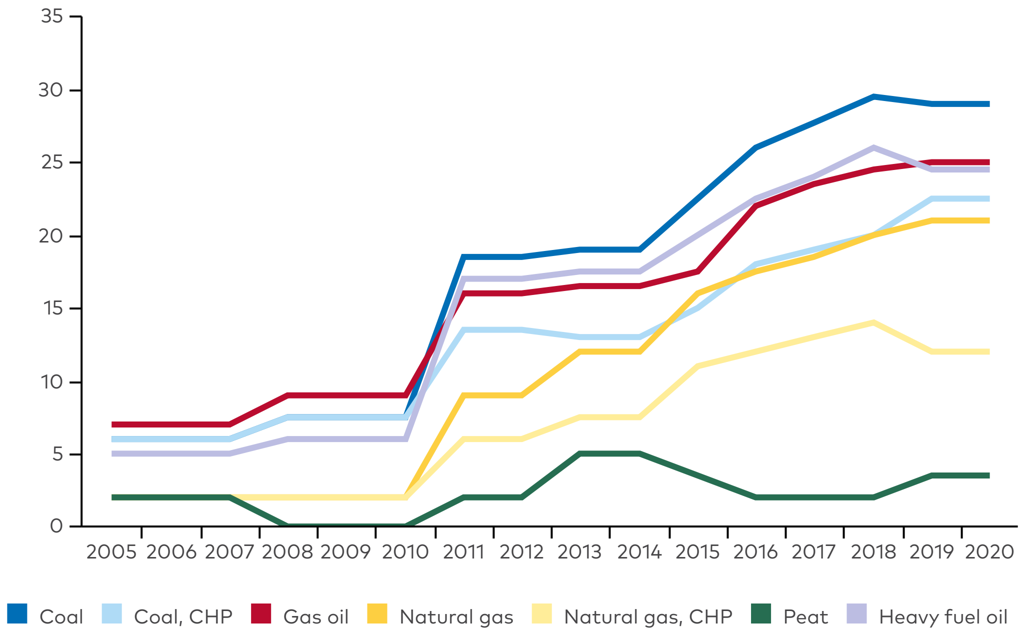

Figure 9: Tax levels for heating fuels (Ministry of Finance. (2021). Report of the working group on energy taxation reform: A proposal for implementing the intentions and goals of the Government Programme and for further development of energy taxation

Since the initial imposition of the Finnish tax, the EU Emissions Trading System (ETS) has also come into effect starting in 2005, targeting different sectors to the Finnish domestic tax.[129] Given the Finnish tax had already been operational for many years before the ETS, and that the ETS was initially far too generous to be impactful, the Finnish fuel tax was the more impactful pricing mechanism to reduce fossil fuel use in Finland for much of its history. However, as the carbon price of the ETS has risen the two now act in a far more complementary manner as part of the wider tax regime; the Finnish tax applies primarily to fossil fuels used in sectors outside the EU ETS, such as transportation, heating, and smaller industrial facilities. It covers emissions not regulated under the EU ETS to ensure comprehensive coverage of greenhouse gas emissions.

Use of revenues

In Finland, energy taxes are excise taxes that target the consumption of energy products. In 2023, the total amount of revenues from energy taxes were €4,238 million, making it the cornerstone of Finland's environmental taxation.[130] Energy taxes increase the central government's tax revenue and are set to have various

129. European Commission (2007). *The EU Emissions Trading System (EU ETS)*
130. Ministry of Finance (2021). *Report of the working group on energy taxation reform: A proposal for implementing the intentions and goals of the Government Programme and for further development of energy taxation.*

environmental, energy and industrial policy objectives.[131] Initially, Finland's carbon tax revenues were used as general government funds, with partial redistribution aimed at reducing income taxes. This "tax-shifting" approach aimed to maintain overall tax neutrality, offering income tax reductions to offset the economic impact of the carbon tax.[132] While Finland has historically held a political commitment to reducing the tax burden on labour, revenues from energy tax are not earmarked for environmental or other purposes but are integrated into the general government budget with a focus on balancing fiscal budgets.[133] This being said, general tax policy is somewhat still leveraged to incentivise sustainability, for example via income tax deductions for households which invest in retrofit and heating improvements, as well as for R&I investments by companies.[134]

Key tax expenditures in energy taxation include tax refunds for energy-intensive companies and agricultural practitioners. Overall, companies eligible for these refunds have received back about 70% of the energy taxes they paid.[135] The refund applies only to amounts exceeding €50,000, so it mainly benefits large firms.[136] These refunds for energy-intensive firms are set to be gradually eliminated between 2021 and 2024.[137] However, the energy tax refunds will still be available for agricultural practitioners. This refund infrastructure can be criticised for undermining the effectiveness of the tax in both reducing carbon emissions at source, but also its ability to generate revenue which can support green state investment on the part of the Finnish government.

Given that Finland has taken a largely tax neutral approach of simply reincorporating tax revenues into the overall budget, Finland's expenditure on fossil fuel subsidies should also be noted. As a proportion of GDP Finland's combined explicit and implicit fossil fuel subsidies are second only to Denmark in the Nordics at 0.88% of GDP, although it should be acknowledged this is on the lower end for Europe as a whole.[138] A 2022 review also found Finland to have the largest spread between fossil fuel and renewable subsidies (in the direction of fossil fuels) in the entire EU.[139] These findings give cause to question Finland's simple reincorporation of tax revenues into the overall budget from an environmental perspective.

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131. Ministry of Finance (2021). *Report of the working group on energy taxation reform: A proposal for implementing the intentions and goals of the Government Programme and for further development of energy taxation.*
132. Vehmas et al. (1999). *Environmental taxes on fuels and electricity: Some experiences from the Nordic countries.*
133. Vehmas (2005). *Energy-related taxation as an environmental policy tool—the Finnish experience 1990–2003.*
134. International Energy Agency (2023). *Finland 2023 Energy Policy Review.*
135. Koljonen et al. (2019). *Energiantuotannon valmisteverotuksen kehittäminen Suomessa*
136. Laukkanen & Maliranta (2019). *Yritystuet ja kilpailukyky, Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja*
137. Ministry of Finance, Finland (n.d.). *Energiaverotus*
138. World Bank (n.d.) *Fossil fuel subsidies (% of GDP)*
139. European Court of Auditors (2022). *Energy taxation, carbon pricing and energy subsidies.*

Evidence and Implications of Price Elasticity

Available research shows that demand for transport and heating fuels in Finland is likely to be fairly price inelastic. One study of the OECD countries using data from 1978–2016 estimates the average own price elasticity of gasoline to be -0.7, and the price elasticity of diesel to be -0.35.[140] Another study using data from 12 OECD countries across 1980–2008 calculated a long run price elasticity of -0.51 for residential natural gas.[141] Relevant elasticity data on light and heavy fuel oils (also covered by the tax) is not available. Heating and transport fuels are attached to costly upfront investments (vehicles, heating systems) which lock in fuel types in a way which renders substitution impossible without significant further outlay on new systems. Further, fuels for heating and transport are regularly identified as essential goods, meaning their continued purchase by consumers is deemed necessary to continue basic living/operations even if other things are reduced.

Interestingly given this logic, a study of UK manufacturing calculated an own price-elasticity -1.08 for gas and -1.38 for coal.[142] In other words, demand is more elastic in industry. A hypothesised explanation may be the greater capacity and willingness of industrial actors to make capital investments which can reduce costs and thus increase profits in the medium-term.

Industry is by far the greatest sectoral consumer of energy in Finland.[143] If Finnish industry follows a similar pattern of elasticity to the UK case, then we would expect that while relatively inelastic transport and domestic fuel use would limit the responsiveness of fossil fuel use to taxation in these sectors, these effects would be counterbalanced by a higher rate of responsiveness in the more energy intensive industrial sector. It should be further noted that Finland has consistently had one of the highest carbon price levels in the world, and as such we would expect to see the tax having tangible impacts even in less responsive sectors.

3.3.1 Intended effect of policy instrument

As noted, energy taxes have a number of objectives, not all of which are environmental. However, the intended environmental impact of the tax is to reduce carbon emissions via incentivising efficiency measures and switching to greener alternatives. Attributing causation and the additionality of tax regarding emissions reductions is difficult for a number of reasons. Most obviously is the potential for carbon leakage beyond the borders of the taxing nation, however given our focus on national impacts we will exclude this concern from the present analysis. Even

140. Liddle & Huntington (2020). *"On the Road Again": A 118 country panel analysis of gasoline and diesel demand.*
141. Bernstein & Madlener (2011). *Residential Natural Gas Demand Elasticities in OECD Countries: An ARDL Bounds Testing Approach.*
142. Steinbuks (2010). *Interfuel substitution and energy use in the UK manufacturing sector*
143. International Energy Agency (2023). *Finland 2023 Energy Policy Review*

domestically, emissions reductions are the result of a complex set of dynamics, not least a policy mix which extends far beyond an individual tax. This is especially true when we examine a nation as a whole, where differing impacts across sectors may interact with one another. Isolating the impacts of individual taxes with confidence is thus difficult and the Finnish case is no different. This is further compounded by the limited post-hoc policy analysis on Finland's energy tax.

However some work does exist analysing the potential impacts of the tax. While on balance this work provides a generally positive picture of its ability to reduce carbon emissions, countervailing evidence exists which casts doubt on the effectiveness of the tax as a standalone mechanism for emissions reductions.

Evidence of positive impact

One of the foundational studies on the tax calculates that the tax reduced overall fuel demand by around 5% by 2012, with demand for coal and heavy oil being reduced by an even greater degree albeit from a lower baseline.[144] Greenhouse gas emissions were in turn calculated to have been reduced by 6% by 2012, with this extra percentage point compared with overall fuel use reductions coming from the higher demand impact on the most polluting fuels. Another paper from 2011 similarly finds a statistically significant negative effect on carbon emissions from the tax, although given the aforementioned complexities regarding the diverse dynamics impacting emissions the utility of the paper's difference-in-difference methodology may be questioned.[145] Another analysis from 2012 concluded that carbon and energy taxation reduced CO_2 emissions in Finland by more than 7% between 1990 and 1998.[146]

A 2020 paper constructing a computable general equilibrium model identifies an expected emissions reduction of around 10% given a carbon price of $80 per tonne which is comparable to the rate Finland uses today.[147] It should however be emphasised that this study models policy scenarios, rather than conducts post-hoc analysis of the policy itself. Finally, a 2024 study focused purely on the transport sector utilising a synthetic control approach identifies emissions in 2005 (the last year of analysis for the author) to be 30% lower than under a tax-free counterfactual scenario.[148]

The introduction of carbon taxes has led some sectors to adopt cleaner technologies to offset higher operational costs and maintain competitiveness.[149]

144. Speck & Jilkova (2009). *Design of Environmental Tax Reforms in Europe: Finland in Carbon-energy taxation: lessons from Europe*
145. Lin & Li (2011). *The effect of carbon tax on per capita CO_2 emissions*
146. Sairinen (2012). *Regulatory reform and development of environmental taxation: The case of carbon taxation and ecological tax reform in Finland. In J. Milne & M. S. Andersen (eds.) Handbook of Research on Environmental Taxation Reform*
147. Khastar et al. (2020). *Evaluation of the carbon tax effects on the structure of Finnish industries: A computable general equilibrium analysis.*
148. Mideksa (2024). *Pricing for a cooler planet: An empirical analysis of the effect of taxing carbon.*
149. Khastar et al. (2020). Evaluation of the carbon tax effects on the structure of Finnish industries: A computable general equilibrium analysis.

Overall, the carbon tax has had mixed success in driving innovation in Finland. While it has spurred energy-efficient technologies in some sectors, exemptions and refunds for energy-intensive industries are seen to weaken its overall impact.[150][151] For example, while energy tax refunds aim to boost the competitiveness of energy-intensive exports, research suggests they undermine CO_2 reduction efforts and show no clear link to productivity or profitability.[152][153] This evidence was supported in a research interview with an expert from the VATT Research Institute. The research team explored the common narrative that carbon taxes impact the competitiveness of firms. The expert shared that their own analysis showed limited economic impacts of the carbon tax for firms, while it did improve environmental outcomes, indicating a perhaps more complex relationship between taxation, competitiveness and clean technology adoption.[154]

Casting doubt on the positive story

One study in particular casts doubt on the positive picture above. Fernando (2019) uses data until 2004 and a synthetic control methodology to conduct a comparative analysis of the environmental impacts of carbon taxes across Finland, Sweden, Norway and Denmark.[155] The author finds that carbon taxation in Finland appeared to have little impact on emissions until 2004 compared with the synthetic control case. The proposed explanation for this result was that the tax rate during that period was too low to create a meaningful disincentive effect around emissions. This interpretation is supported by the authors further findings that Denmark, which also had a very low tax rate, similarly saw limited impacts whereas Sweden and Norway, who both used higher carbon tax rates, saw a marked reduction in territorial emissions.[156]

Fernando's study ends its analysis in 2004 to avoid potential confounding impacts from the EU ETS. Since then both the nominal carbon price used for the tax as well as the effective carbon price when considering the ETS have both increased significantly. In line with Fernando's analysis, we would therefore expect to see the abatement impact of Finland's tax increase in this more recent period, however this will be hard to prove due to the complexities outlined previously. The negative conclusion can be drawn from the analysis thus: during the early years when Finland's carbon tax rate was extremely low it had minimal impact.

150. Laukkanen et al. (2019). *The impact of energy tax refunds on manufacturing firm performance: evidence from Finland's 2011 energy tax reform*
151. Vehmas (2005). En*ergy-related taxation as an environmental policy tool—the Finnish experience 1990–2003.*
152. Laukkanen et al. (2019). *The impact of energy tax refunds on manufacturing firm performance: evidence from Finland's 2011 energy tax reform*
153. Köppl & Schratzenstaller (2021). *Effects of Environmental and Carbon Taxation – A literature review*
154. Vehmas (2005). *Energy-related taxation as an environmental policy tool – the Finnish experience 1990–2003*
155. Fernando (2019). *The Environmental Effectiveness of Carbon Taxes: A comparative Case Study of the Nordic Experience*
156. Ibid.

Nonetheless this conclusion appears contrary to some of the others outlined in this analysis which also focus on a similar time period. This contradiction points to the difficulty in undertaking effective causal analysis of taxation impacts and resolving it in either direction is far too great a task for this piece of research. However it should be noted that the synthetic control methodology used by Fernando is the methodology which allows the messy world of the social sciences to come closest to the scientific 'gold standard' of the randomised control trial (RCT), meaning these results should be taken to hold significant weight and arguably preferred over results from simpler methodologies such as DID as found elsewhere.

Concerning substitution effects

More concerning are the substitution effects which have occurred to produce any apparent carbon reduction which has been observed in Finland. Fossil fuels have primarily been replaced by solid biomass in the Finnish energy supply,[157] which count as renewable energy and are not subject to the carbon tax. Bioenergy and waste made up 34% of the total Finnish energy mix in 2021, with the majority of this coming from solid biomass.[158] This is problematic in a number of ways.

Biomass appears in environmental accounting as carbon neutral based on a model of life-cycle carbon emissions and sequestration; trees and other biomass extract carbon from the atmosphere and so when burned they are only re-releasing carbon which has previously been drawn down. Re-growing forests and similar plantations in theory enables the sector to continue to draw down and re-release the same total stock of carbon, amounting to an overall neutral climate impact while still generating energy.

The first major problem with this logic is described by Haberl et al. (2012, p. 2):

> ***"Plants do absorb carbon, but this line of thought makes a 'baseline' error because it fails to recognize that if bioenergy were not produced, plants not harvested would continue to absorb carbon and help to reduce carbon in the air. Because that carbon reduction would occur anyway and is counted in global projections of atmospheric carbon, counting bioenergy that uses this carbon as carbon-neutral results in double-counting."*** [159]

157. International Energy Agency (2023). *Finland 2023 Energy Policy Review*
158. Ibid.
159. Haberl etl al. (2012). *Correcting a fundamental error in greenhouse gas accounting related to bioenergy*

Furthermore, the re-sequestration of carbon dioxide from burning trees into new plants takes time, meaning burning trees can cause increases in atmospheric CO_2 that can last many years, contributing significantly to the heating of the planet over that time.[160] This is particularly alarming when one observes that solid biomass emits more CO_2 per unit of energy generated than fossil fuels.[161] In the grips of an already severe climate crisis, the world simply cannot afford this 'carbon payback time', as it is known.

Furthermore, even this payback calculation assumes that the carbon released will be re-sequestered at all. Since 2021 Finland's land use sector has become a net carbon emitter rather than carbon sink, with a vast reduction in the carbon sequestered by Finland's forests since 1990.[162] This data provides reason to doubt the assumption of effective re-sequestration. Such issues are brought into sharp relief when we compare Finland's progress on emissions reductions with, and without accounting for Land Use, Land Use Change, and Forestry (LULUCF). Excluding LULUCF Finland had in 2022 reduced its emissions by 36% compared to 1990 levels. When LULUCF is included, this number drops to roughly 1%.[163] When we account for the changing role of Finland's land use sector, almost no progress has been made on emissions reductions, even under traditional frameworks which treat biomass as carbon neutral.

Finally, even beyond the litany of concerns which arise from the burning of solid biomass when properly accounted for, the fuel also carries the risk of emissions going missing from carbon accounts altogether. Due to environmental accounting rules, biomass is accounted for in the land-use sector rather than the energy sector. However it has long been noted that for a number of reasons it is likely that in practice biomass emissions in the energy sector are not fully accounted for in land-use accounts.[164]

Against this backdrop, we can see that the true impact of Finland's carbon tax is far more questionable. While the tax does appear to have driven emissions reductions according to orthodox accounting frameworks, over the tax's period of operation Finland has increased its use of biomass for fuel.[165] While it would be reductive to claim the tax has driven a 1-1 replacement of fossil fuel burning with biomass, this trend implies at least some level of substitution effect is in play. The current structure of the tax creates an incentive to use biomass fuel, which may be technically counted as a carbon neutral fuel but is in fact anything but. Looking beneath the accounting, this worrying perverse incentive which significantly hinders

160. Brack (2017). *Woody biomass for power and heat: Impacts on the global climate*
161. Laganière et al. (2017), *Range and uncertainties in estimating delays in greenhouse gas mitigation potential of forest bioenergy sourced from Canadian forests*
162. Natural Resources Institute Finland [Luke] (2023). *Greenhouse gas inventory 2022: No significant changes in the final results for the agriculture and LULUCF sectors compared to the preliminary data published in December 2023*
163. European Commission (2023). *Climate Action Progress Report 2023: Finland Country Profile*
164. Brack (2017). *Woody biomass for power and heat: Impacts on the global climate.*
165. Pelkmans et al. (2021). *Implementation of bioenergy in Finland – 2021 update*

any realistic chance at legitimate climate neutrality (let alone conservation of biodiversity). This is not just a problem for Finland but the world at large and carries lessons around the potential for perverse incentives arising from environmental charges, where potential loopholes such as those around biomass exist. The treatment of biomass in the System of Environmental Economic Accounts (SEEA) must be reformed, and in the Finnish case in the first instance biomass fuel should no longer be exempted from the fuel tax.

3.3.2 Cross Nordic outlook

All Nordic countries now impose some form of domestic carbon tax, however there are differences. The most significant of these is the tax rate used in each country. The table below offers a summary comparison across the Nordic countries, with impact data drawing the comparative analysis by Fernando (2019). The overarching conclusion is that in Norway and Sweden, which have the highest and second highest tax rates in the Nordics respectively, impacts have been more pronounced. However research also demonstrates that Finland's worrying substitution of bioenergy for fossil fuels is also pronounced in Sweden and Denmark, albeit to a lesser extent.[166]

166. Hansen et al. (2021). *Managing sustainability risks of bioenergy in four Nordic countries.*

Country	Date introduced	Tax Structure[167]	Current Nominal Rates (€/ton of CO_2)[168]	Legal commit-ments around revenue use[169]	Impact[170]
Finland	1990	Initially based on carbon content; now includes both CO_2 and energy content. Carbon tax based on whole lifecycle carbon emissions.	€77/tCO_2 for transport, €53/tCO_2 for heating [171]	Returned to the national budget.	Mixed evidence, with a number of studies showing positive impact while another giving a more doubtful view. Reliance on woody biomass significantly negates sustainability impact.
Sweden	1991	Unified based on carbon content of fuel.	€122[172]	Returned to the national budget.	High emissions reductions. Lower reliance on bioenergy than Finland, but still a significant proportion of 'renewables'.
Norway	1991	Unified based on carbon. Also includes GHG emitting fluorocarbons	€90[173]	Returned to the national budget.	Highest emissions reductions (Fernando, 2019). Low reliance on bioenergy.
Denmark	1992	Unified based on carbon. Also includes GHG emitting fluorocarbons	€24 rising to €47 in 2025 [174]	Returned to the national budget.	Difficult to judge significant impacts due to far lower rates (Fernando, 2019). Lower reliance on bioenergy than Finland, but still a significant proportion of 'renewables'.
Iceland	2010	Unified based on carbon. Also includes GHG emitting fluorocarbons	€35[175]	Returned to the national budget.	No analysis available but known low reliance on bioenergy.

167. Grosjean et al. (2024). *Carbon Pricing in Nordic Countries.*
168. Currency figures have been converted to Euros for all countries except Finland, and so should be taken as approximate.
169. Marten & van Dender (2019). *The use of revenues from carbon pricing*
170. Impact analysis from: Fernando (2019). *The Environmental Effectiveness of Carbon Taxes: A comparative Case Study of the Nordic Experience*
171. Impact analysis from: Fernando (2019). *The Environmental Effectiveness of Carbon Taxes: A comparative Case Study of the Nordic Experience*
172. Impact analysis from: Fernando (2019). *The Environmental Effectiveness of Carbon Taxes: A comparative Case Study of the Nordic Experience*
173. Impact analysis from: Fernando (2019). *The Environmental Effectiveness of Carbon Taxes: A comparative Case Study of the Nordic Experience*
174. World Bank (2023). *Carbon Pricing Dashboard: Denmark – Carbon Tax Factsheet.*
175. World Bank (2023a) *Carbon Pricing Dashboard: Iceland – Carbon Tax Factsheet.*

3.4 Beverage packaging tax (deposit refund system)

Finland's beverage packaging tax forms part of a wider packaging reuse and recycling scheme by aligning with Finland's deposit refund system (DRS) for beverage bottles. Importers, producers and beverage packaging companies whose products include soft drinks and alcoholic drinks are liable to pay an excise duty on packaging, however this is waived if they voluntarily participate in the DRS for recyclable and reusable containers.[176] In this way the tax and the DRS operate in tandem to encourage the reuse and recycling of beverage containers.

Background on the DRS and Tax System

The DRS is a system where each beverage bottle or can has an additional charge, or a deposit, that gets returned to the consumer when they deposit the used bottle or can into a machine. This system is done with the intention of motivating consumers to return used beverage packaging, as well as ensuring that the cost for recycling of beverage packaging is paid for by producers. In Finland, the deposit is €0.15 for cans, €0.20 for 0.5l plastic bottles and €0.40 for 1.5l plastic bottles and €0.10 for glass bottles.[177] The deposits are added onto the store price of the beverage, which is then returned to the consumer once the bottles are deposited.

The deposit refund system in Finland started in 1950 with a scheme to recollect, wash and reuse glass bottles. The scheme underwent developments going from the recollection and reuse of glass bottles to the recycling of one-way packaging including both plastic and glass bottles and aluminum cans. The modern scheme began in 1992,and the timeline below shows key developments in **Figure 10**.

176. Finnish Tax Administration (n.d). *Excise Duty on Beverage Containers*
177. Palpa (n.d.). *Millaisia Pakkauksia Voi Palauttaa?*

1992	• The government issues the public consulation on the tax on packaging
1994	• Tax on packaging introduced, with lower rates for packaging in DRS
1996	• Beverage industry/retailers established PALPA and a one-way cans DRS • DRS for "unidirectional" containers (PALPA)
2004	• Ekopullo was created to manage reusable (refillable) PET and glass bottles • Packaging tax: the rate for reusable containers is halved.
2007	• Beverage industry/retailers (in PALPA) established a DRS for PET containers.
2008	• DRS for "unidirectional" PET launched (PALPA) • Packaging tax: the rate for reusable containers reduced to ZERO.
2011	• The beverage industry/retailers (in PALPA) have established an SRD for glass containers.
2012	• DRS for reusable glass containers launched (PALPA)

Figure 10: Historical development of Finland's deposit refund system (E-circular. Finland: Deposit system (DRS – deposit refund system))

In the modern day, the largest deposit refund system operator, controlling the majority of the market is Suomen Palautuspakkaus Oy, known as Palpa, a nonprofit company managing and developing the recycling systems in Finland.[178] Originally formed in 1996 for operating a one-way metal beverage can system, and expanded in 2008 to include one-way PET bottles and 2011 to include glass bottles.[179] Palpa is owned by members of the beverage industry and overseen by a public body.[180] Both retail and HoReCa (hotels, restaurants and catering) can register to be packaging return locations for Palpa. Retail stores selling bottles with deposits are obliged to offer the returning of bottles and paying for the deposits at their

178. Palpa (n.d-a). *Front Page*
179. Ettlinger (2016). *Deposit Refund System (and Packaging Tax) in Finland*
180. Palpa (n.d.-b). *Palpa Briefly*

locations.[181] To participate in the Palpa deposit refund system, companies pay a registration fee as well as package specific recycling fees.[182] Around €360 million in deposits run through Palpa every year, and Palpa's turnover was €80 million in 2023.[183]

In Finland, the deposit refund system is voluntary for producers to participate in. However, if they do not participate in the deposit refund system, they have to incur a packaging tax.[184] A packaging tax of €0.51 is levied per litre of packaged beverage, which is significantly higher compared to the deposit charged to consumers.[185][186]

This packaging tax acts as an incentive for producers to participate in the deposit refund system, as being a part of the scheme is both cheaper as well as cultivates a responsible image of the producer who is participating in the scheme. In 2023, the packaging tax revenue in Finland was €13 million, 0.01% of the total tax revenue.[187]

The tax was first introduced in 1994, and at first the only exemptions applied to reusable beverage containers. A lessened tax was placed on recyclable one-way packaging that participated in the deposit refund system at €0.17 per litre of beverage packaging, compared to €0.67 per litre of packaging not in the system. From 2005–2008, the tax on one-way packaging in the deposit refund system was halved, and in 2008 one-way packaging that are participants in the deposit refund system became wholly exempt from the beverage packaging tax.[188] In Finland, tax revenues from the majority of taxes, including the packaging tax, are collected into a common pool of tax revenue, from which the parliamentary budget allocates the revenue. Thus, tax revenue from the deposit refund system is not directly looped back into environmental expenditures or subsidies, as these are based on parliamentary budget allocations.[189]

3.4.1 Intended effect of policy instrument

Instead of primarily being used to collect additional tax revenue, the packaging tax works as an incentive to motivate producers to join the deposit refund system. This can be seen with the small amount of tax revenue collected compared to the large sum in deposits passed through the deposit system yearly (€13M and €360M respectively), showing the scale of producers who choose to opt in to the deposit refund system instead of paying the beverage packaging tax. The packaging tax has been so successful at incentivizing producers into being a part of the deposit

181. Palpa (n.d.-c). *Who Can Register to Palpa?*
182. Palpa (n.d.-d). *Who Pays for the Recycling of Beverage Packages?*
183. Palpa (n.d.-b). *Palpa Briefly*
184. Palpa (n.d.-e). *Deposit Refund System*
185. Palpa (n.d.-e). *Deposit Refund System.*
186. Finnish Tax Administration (n.d.). *Excise Duty on Beverage Packaging*
187. Veronmaksajat (n.d.). *Tax Collection in Finland.*
188. Ettlinger (2016). *Deposit Refund System (and Packaging Tax) in Finland*
189. Interview with Sirje Stén, Ministerial Adviser at Ministry of the Environment of Finland

refund system that Finland is one of the leading countries in the world when it comes to beverage packaging recycling.[190]

The beverage packaging tax thus also does not function like a traditional Pigouvian tax for internalising negative externalities, where the tax 'prices in' the externality and reduces the harmful market activity by raising its cost to reflect the true social cost. In contrast the beverage packaging tax does not act to directly price in the externalities caused by littering and poor waste disposal, but instead incentivises takeup of an alternative system by producers which facilitates externality reducing consumer behaviour. This still has the desired effect however; by creating a system that incentivises consumers to accurately return their beverage packaging, the negative externalities caused by littering and inaccurate waste disposal is reduced significantly.[191]

The deposit return rate is 98% for aluminum cans, 90% for PET plastic bottles and 99% for glass bottles, with an average overall return rate of 97%.[192] This incredibly high rate of return can be taken to show a positive, indirect impact of the packaging tax on market behaviour; the tax incentivises support of the DRS which in turn has significantly shifted market behaviour of consumers. The growth in return rates since the tax and DRS was implemented are shown in Figure 11 below:

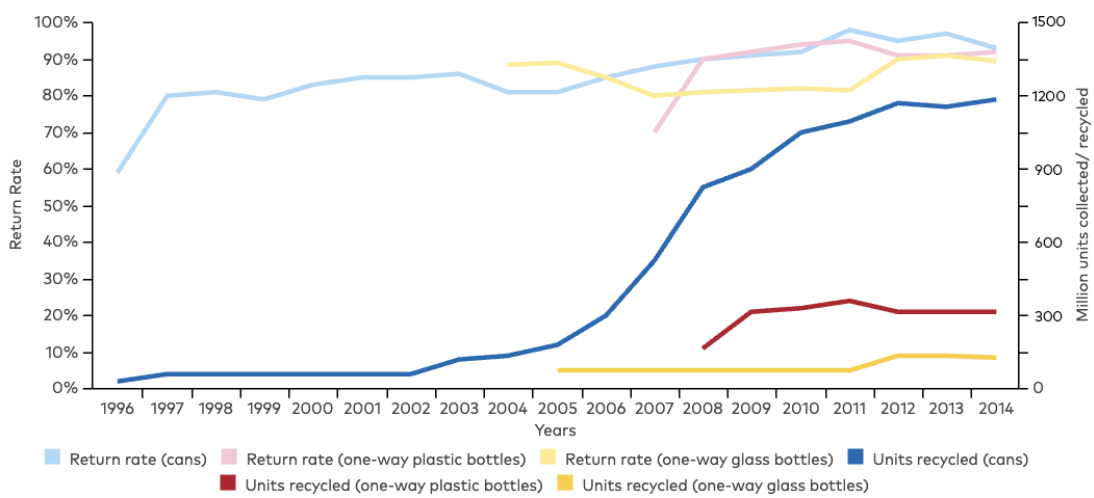

Figure 11: Development of Finnish DRS (Ettlinger, S. (2016). Deposit refund system (and packaging tax) in Finland)

190.Palpa (n.d.-a). *Front page*
191. Eggert et al. (2004). *On the Economics of Bottle Deposits*
192. Palpa (n.d-f). *Return Rates*

This success shows the importance of the tax on producers/retailers being paired with a system which creates economic incentives for consumers also. Interestingly, anecdotal evidence points to some consumers returning disproportionately to the scheme compared with others, by sourcing and returning others' waste containers.[193] It is also common in Finland's bigger cities to observe those who appear visually to be more vulnerable members of society collecting others' containers to return them for their deposits.

While there is no large-scale data validating these accounts, they may point to a potential differential behavioural impact of the deposit charge across the population, with the behaviour of some consumers being far more responsive than others. Given the relatively small sums of money available to be claimed via the return systems, this effect may point to a negative income elasticity in DRS participation. Empirical research into these differential behavioural impacts would prove a valuable area for further study.

Impact on innovation and production choices

The question of whether the packaging tax stimulates innovation in the market was raised in an expert interview with a ministerial adviser to the Finnish Minister of Environment. Their view is that the packaging tax has not led to innovation in the market. Even the contrary can be true, as the extension of the tax exemption to one-way packaging combined with developments in EU policy around plastics has resulted in a significant shift away from reusable packaging and into single-use packaging.[194] This point outlines the key flaw with the system which undermines its effectiveness as an environmental intervention. The majority of packaging captured in the scheme is single-use and recyclable rather than reusable.[195] This is significant because a survey of the Lifecycle Analysis Literature on the environmental impacts of packaging containers,[196] including a standalone study by the EU JRC[197] identifies that on average reusable containers are more sustainable than recyclable ones in most cases. So, while the DRS sees very high rates of return, the sustainability benefits of these returns are diminished. Here the structure of the tax system itself, and in particular the exemption of single-use containers from the tax if they are included in the DRS, has created an incentive structure which undermines the purported sustainability goals of the tax.

193. IS (2018). *Finns have earned large sums just by collecting bottles*
194. Ettlinger (2016). *Deposit Refund System (and Packaging Tax) in Finland*
195. Nurminen (2021). *The Finnish Reuse System for Beverage Packages*
196. Zero Waste Europe, and Reloop (2020). *Reusable vs Single-Use Packaging: A Review of Environmental Impact*
197. Sinkko et al. (2024). *Exploring the environmental performance of alternative food packaging products in the European Union*

3.4.2 Cross Nordic outlook

The deposit refund system for beverage packaging has been implemented in several countries globally, and while following a similar premise, there are differences in implementation. Finland, Sweden, Norway as well as Denmark all have deposit refund systems for beverage packaging. Some have mandatory deposit refund systems while others, such as Finland, have opt-in schemes motivated by taxation.

In Sweden, all beverage packaging is required to be part of an approved recycling scheme to be able to be sold in stores. Exemptions are in the case of dairy products of 50% dairy and above.[198] In addition to the mandatory participation in the deposit refund system, there is an annual enforcement fee calculated based on the amount of beverage packaging sold by the producer. If a producer does not participate in the scheme, they are subject to an environmental penalty fee of SEK 30,000. Similar fees apply to retailers. Ensuring participation is done through unannounced supervisions and checks by the Swedish Environmental Protection Agency.[199]

The Danish deposit return system mandates all beverage and packaging companies to comply with the obligation to accept used beverage containers. The obligation also aims to ensure that 90% of single use beverage packaging is recycled through the Dansk Retursystem.[200] Producers are responsible for paying fees associated with the recycling of their beverage packaging.[201] Some exemptions apply, such as dairy-based products and wine and spirits.[202]

Norway has an environmental tax on top of a base tax on single-use packaging. The environmental tax is lower in products under an approved deposit refund system, dependent on the return rate. For example, products with a 95% or over return rate are exempt from the tax,[203] and the minimum return rate to be eligible for reduced tax is 25%.[204] This is similar to the Finnish deposit refund system in that it is voluntary, however the Finnish exemption from the tax is not reliant on certain return percentages.

In Iceland no packaging tax is in operation and no plans to introduce such a tax. However producers and importers do instead pay a recycling levy. For single use beverage PET packaging, there is advanced fee modulation that takes both recyclability and recycled content into account. However Iceland was the first country in the world to set up a deposit system on a national scale for a wide range of containers, with the DRS being mandatory in the country.[205]

198. Pantamera (n.d.) *Brewery, Producers & Importers*
199. Swedish Environmental Protection Agency (n.d.) *Return Deposit System for Plastic Bottles and Metal Cans*
200. Food Times (n.d.) *Deposit Return Scheme: Danish Excellence in Beverage Packaging Recycling*
201. Dansk Retursystem (n.d) *Expenses in the Returns and Deposit System*
202. Bottle Bill (n.d.-a). *Denmark*
203. Norwegian Tax Administration (n.d). *Beverage Packaging Tax*
204. Bottle Bill (n.d.-b). *Norway*
205. European Environment Agency (2024a). *Early warning assessment related to the 2025 targets for municipal waste and packaging waste: Iceland.*

Country	Mechanism	Overall return rate (2023)
Finland	Beverage packaging tax is used as an incentive to motivate producers to participate in the deposit refund system as participating exempts them from paying the beverage packaging tax.	97%[206]
Norway	Environmental tax reductions used as an incentive to promote the deposit return scheme. There is a reduced environmental tax on producers if they participate in the deposit refund system, dependent on rates of return.	92.3%[207]
Sweden	Mandatory deposit return scheme that producers are obliged to partake in. Noncompliance results in fines.	88.5%[208]
Denmark	Mandatory deposit return scheme, existing for both one-way and refillable beverage containers.	92%[209]
Iceland	No packaging tax. Recycling levy with advanced fee modulation for single use plastics. Mandatory DRS.	85%[210]

3.5 The NO_X fund

NO_X emissions

Nitrogen oxides (NO_X) are the collective term for the nitrogen oxides NO and NO_2, which are significant components of harmful air pollution. NO_X is formed in combustion processes, such as engines, power plants, and boilers, as well as industrial processes with very high temperatures (e.g., in smelters). Locally and regionally, NOx emissions are associated with impaired lung function and worsening of asthma, as well as respiratory diseases (e.g., COPD) and cardiovascular disease, while also ground-level ozone can be harmful to both

206.Palpa (n.d.-f). *Return Rates*
207.Tomra (n.d.) *Norway Deposit Return Scheme*
208.Pantamera (n.d.-a) *Collection and Deposit Statistics*
209.Dansk Retursystem (n.d.) *About Deposits*
210.Endurvinnslan (n.d.). *Home*

humans and vegetation. NOx also contributes to acid rain, which harms ecosystems and vegetation, causes fish mortality, and damages materials and buildings.[211]

In 2022, Norway's total NOx emissions were approximately 135,000 tonnes. The primary sources of these emissions were oil and gas extraction, the maritime industry, and road traffic, which collectively accounted for 68% of the total NO_X emissions.[212] This is illustrated in Figure 12 below.

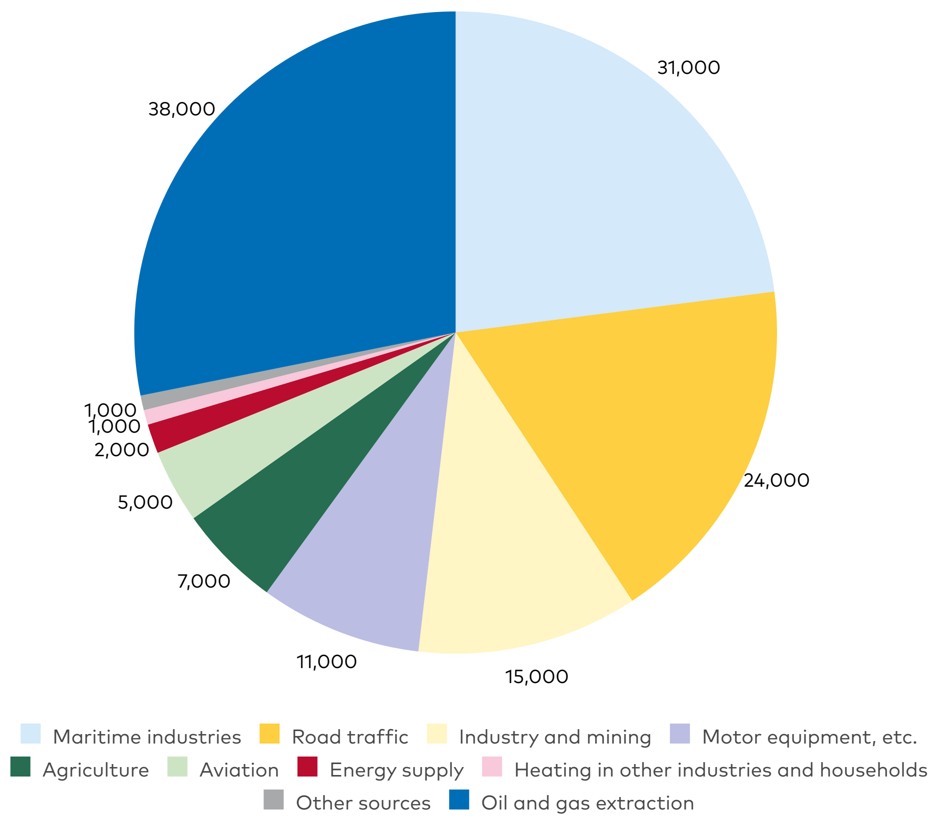

Figure 12: Total NO_x emissions by source in 2022, tonnes of NO_x[213]

The instrument

To fulfil the Gothenburg protocol, Norway has implemented different instruments to reduce NO_X emissions over the last twenty years. These instruments include a charge, an emission cap, and voluntary contributions to a NO_X fund with an accompanying tax exemption.

211. What is NO_X? Available at: https://www.noxfondet.no/en/articles/what-is-nox/. (Accessed: 19 September 2024).
212. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.
213. Statistics Norway, table 08941

Norway introduced a tax on NO_X emissions in 2007 with the purpose of contributing to cost-effective reductions in the emissions. The Norwegian Parliament sets the NO_X tax. In 2023, the tax was NOK 24.46 (€2) per kg of NO_X. The rate has roughly grown with the Consumer Price Index (CPI) since its introduction in 2007. The tax applies to:[214]

- Propulsion of machinery with a total installed engine effect of more than 750 kW.
- Engines, boilers, and turbines with a total heating effect exceeding 10 MW.
- Flaring at offshore and onshore installations.

During the initial consideration of the NO_X tax in the Norwegian Parliament, compensatory arrangements were proposed due to pressure from affected business organizations. Consequently, a voluntary agreement was introduced, with the possibility of tax exemption. Negotiations with the authorities in 2008 led to the NO_X Fund. Business entities within the agreement pay a rate per kg of NO_X emissions to the NO_X Fund and are exempt from the NO_X tax. The rate to the NO_X fund is typically lower than the NO_X tax. The income from the NO_X Fund is used for emission-reducing measures at affiliated companies, which means that the members can apply for support from the fund to implement measures (Menon 2024). With typically lower rates and the possibility to pay for measures to reduce emissions (and thus payment to the fund), the NO_X fund should thus be preferred by the businesses.

The development in emissions of NO_X, different environmental agreements (NO_X instruments) and the Gothenburg Protocol targets are illustrated in Figure 13. The environmental agreements are described in detail in Menon (2024).[215]

214. Nordic Council of Ministers. (2023). The use of economic instruments in the Nordic countries 2018–2021. The tax applies for both the Norwegian mainland and the continental shelf. Exemptions are made for vessels travelling between Norwegian and foreign ports, vessels used for fishing and caching in distant waters, aircrafts travelling between Norwegian airports and foreign airports plus mission units covered by and environmental agreement signed with the Norwegian government for initiating measures to reduce NO_X that are implemented in accordance with established national environmental goals.
215. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NO_X. Menon-publikasjon nr. 34/2024.

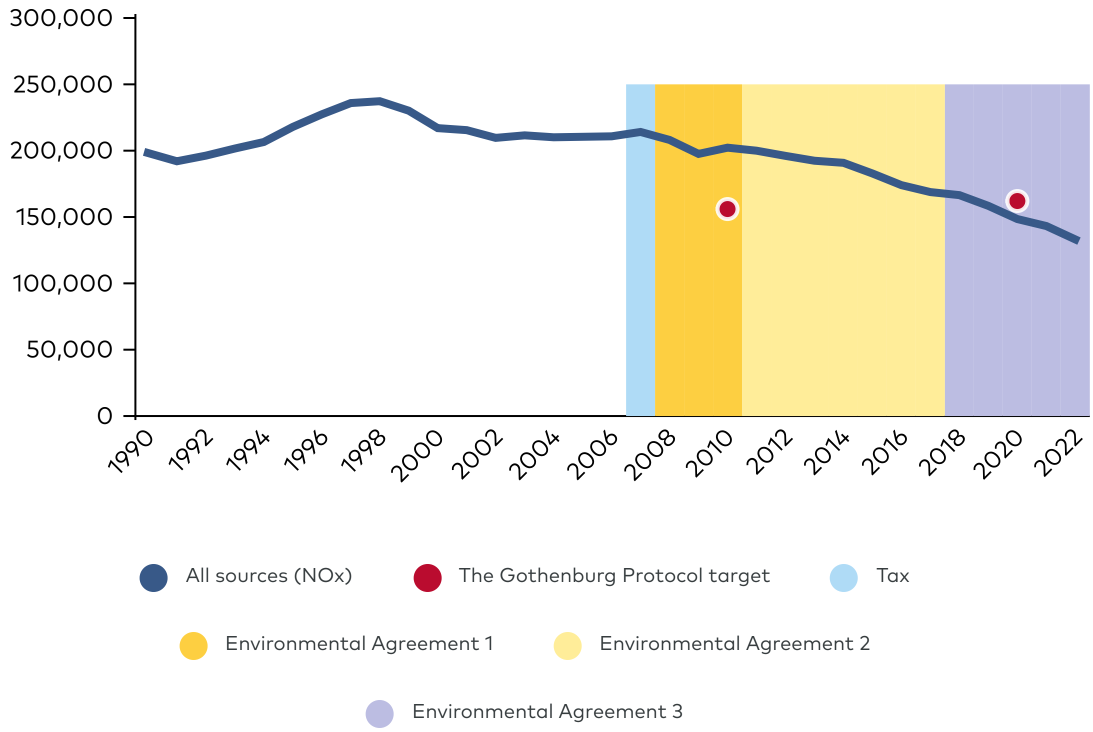

Figure 13: Emissions of NO_x, Environmental agreements and the Gothenburg Protocol targets (orange dots), tonnes of NO_x.[216]

The board of the NO_X Fund sets the rates paid into the fund to achieve the environmental goal in the agreement. These are differentiated with a high rate for entities involved in oil and gas extraction and a lower rate for other businesses (including fishing vessels, shipping, land-based industry, aviation, district heating, etc.). The gap between the rates has narrowed during the agreement period according to the agreement's structure. In 2023, the rates were NOK 17 and 11 (€1.45 and 0.94) per kg of NO_X, respectively, for members of the environmental agreement. The agreement has been renegotiated twice since 2008.[217]

The Textbox below briefly compares the instrument to corresponding instrument in Sweden. An important difference is that in Sweden the income to the system, is (neutrally) returned to the businesses, whereas in Norway the income is targeted for measures to reduce measures.

216. Statistics Norway, table 08941.
217. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NO_X. Menon-publikasjon nr. 34/2024. The Environmental Agency conducts compliance checks in accordance with the agreement (every two years) and assesses whether companies affiliated with the agreement have met the emission requirements. Companies are sanctioned if the environmental goals are not met, but this has not yet happened.

Textbox 1: Information about the NO_X tax in Sweden.[218]

Emissions from the transport sector, the paper and pulp industry, as well as the electricity and district heating sectors, account for most of the NO_x emissions in Sweden.

In 1992, Sweden introduced a NO_x tax that today covers all operations producing more than 25 GWh of electricity, district heating, and process heat (useful energy) per year. When the tax was introduced, it was set at SEK 40 per kg of NO_x emissions and included facilities producing more than 50 GWh of useful energy. The tax is SEK 50 per kg of NO_x, and emissions are measured and reported continuously.

The revenues from the tax are paid back to the industry based on how much energy each establishment generates. This means that all actors within a collective pay a tax per kilogram of emissions, and the tax is then refunded to the emitters based on the distribution key. The net recipients, the winners in the system, are those who produce the lowest NO_x emissions per unit of useful energy produced.

Since the introduction of the tax, soda recovery boilers and the paper and pulp industry were exempt from the tax. Recently, the Swedish government proposed to expand the NO_X tax to also include soda- and black liquor boilers in a sperate permanent fee group with full reimbursement to further reduce NO_X emissions. Emissions from such boilers account for a substantial share of the NO_X emissions.

Possible responses

The current system involves a choice between paying the NO_x tax or the contribution rate to the NO_x Fund. In both alternatives, the companies face higher costs compared to the option without NO_x tax and without an environmental agreement, which can lead to different responses (Menon, 2024):

- **Reallocation of capital:** Businesses can shift capital from activities that cause NO_x emissions to other activities. This will be at a cost for businesses, and lead to reduced NO_x emissions.

218. Anthesis (2024). Analys av stödsystem för NOX-åtgärder inom industri- och energisektorerna. Anthesis rap-port 24/1. The Swedish Government (2024). Utgiftsområde 20: Klimat, miljö och natur.

- **Investments in low-emission technologies:** Increased costs for emissions will provide an incentive to invest in low-emission technologies. With the possibility of fancial support for measures, businesses within the agreement will have a stronger incentive to do this than businesses that pay the NO_x tax.
- **Reducing emissions from existing operations:** When operating costs increase, it may be profitable to produce less. In addition to reduced emissions, this leads to lower value creation in the businesses.
- **Raising market prices:** If the competitive situation in the market allows it, a company can pass part of the cost to others in the value chain. In such cases, market prices increase, which contributes to reduced demand for the product. Many of the NO_x emitters are competitive businesses in an international market and have limited ability to set higher prices than their competitors.

3.5.1 Intended effect of the NO_x fund

Effects on NO_X emissions

Menon (2024)[219] recently evaluated the Norwegian NO_X Fund and other relevant NO_X instruments in Norway. The study claims that the environmental agreements have contributed to significant reductions in NO_x emissions. From 2007 to 2022, the NO_x emissions from taxable businesses have been reduced from approximately 160,000 tonnes to approximately 90,000 tonnes NO_X. This is largely attributed to the measures introduced through the environmental agreements, see Figure 14. The emission reduction has been greatest in shipping, followed by fishing and trapping. The effects are estimated relative to a business-as-usual scenario, but the estimates involve significant uncertainties.

219. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.

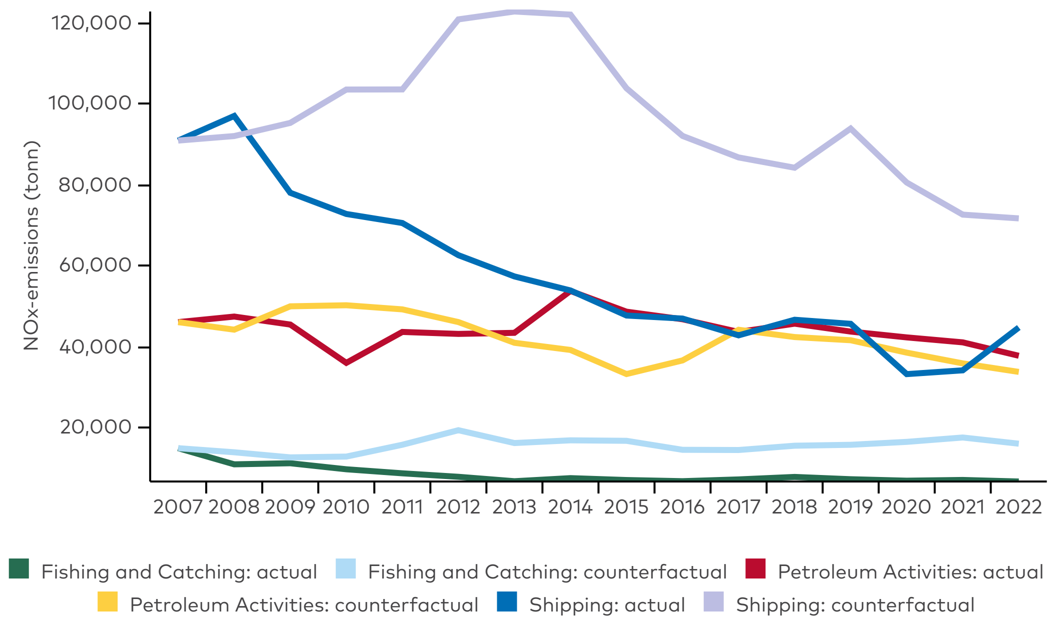

Figure 14: Actual and counterfactual emissions for fishing and hunting, petroleum activities, and shipping, tons of NO_x.[220]

Today's environmental agreement is considered to provide the greatest emission reduction and is the most cost-efficient.[221] The study concludes that a pure NO_x tax is the most cost-effective option and considers it the optimal instrument compared to the current scheme, based on research and economic theory.

Other effects

Menon (2024)[222] found that the NO_X Fund has functioned as financial support for companies to implement emission-reducing measures, which has contributed to technology change. The study also found that the fund has contributed to the spread of knowledge about available technology and support schemes, which has probably contributed to speeding up technology change and restructuring.

Measures that reduce the use of fossil fuels also reduce CO_2 emissions. This is especially true for measures that affect energy efficiency or transition away from combustion engines (electrification). If a measure reduces fossil energy use for a company by 10%, both NO_x emissions and CO_2 emissions from energy use decrease by 10%. Measures to reduce emissions of NO_X will also lead to reductions in health

220. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NO_X. Menon-publikasjon nr. 34/2024.
221. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.
222. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.

costs, and damages to the environment (acidification, eutrophication), materials, and crops.[223]

Relative to the NO_X tax, the NO_X Fund implies a loss of government revenue, see Figure 15. the instrument has a distributional effect, transferring benefits from other sectors in Norway primarily to the shipping and fisheries sectors. Menon (2024)[224] estimates the resulting loss of government revenue to be approximately NOK 2 billion (€170 million) annually.

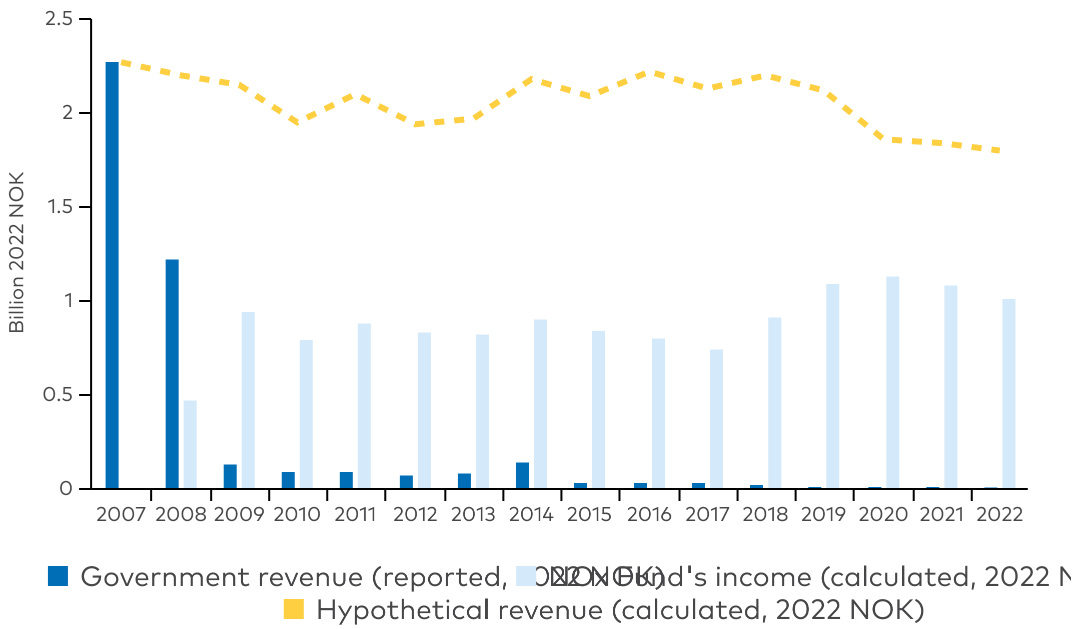

Figure 15: *NO_x tax and payments to the NOx fund, and hypothetical revenue to the state.*[225]

Economic instruments to reduce NO_X-emissions have been thoroughly covered and analysed in the Nordic, e.g., see Coria et al. (2023), Hagem, Holtsmark & Sterner (2013), Sterner (2023), and Sterner & Fredriksson (2004).[226]

223. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.
224. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.
225. Menon Economics (2024). Evaluering av fritak for betaling av avgift på utslipp av NOX. Menon-publikasjon nr. 34/2024.
226. Coria, J., Dupoux, M., Faucheux, L. & Slunge, D. (2023). What drives the substitution of hazardous flame retardants in electronic appliances in Sweden? Cleaner Waste Systems Vol. 6. Hagen, C., Holtsmark, B. & Sterner, T. (2013). Om den norske politikken for reduksjon av utslipp av NOX. Samfunnsøkonomen nr. 2 2014. Sterner, T. (2003). Instruments for Environmental Policy. The Swedish International Development Coopera-tion Agency. Sterner, T. & Fredriksson, P. G. (2004). The Political Economy of Refunded Emissions Payment Programs. Working Papers in Economics, nr 147.

3.6 The waste Incineration tax

CO_2 emissions

Waste incineration involves burning waste in a furnace to recover energy. In Norway about 33% of the waste was incinerated in 2022, see Figure 16. Emissions from waste incineration has been increasing in Norway and was in 2022 almost 1 million tCO_2e (about 2% of total GHG emissions).

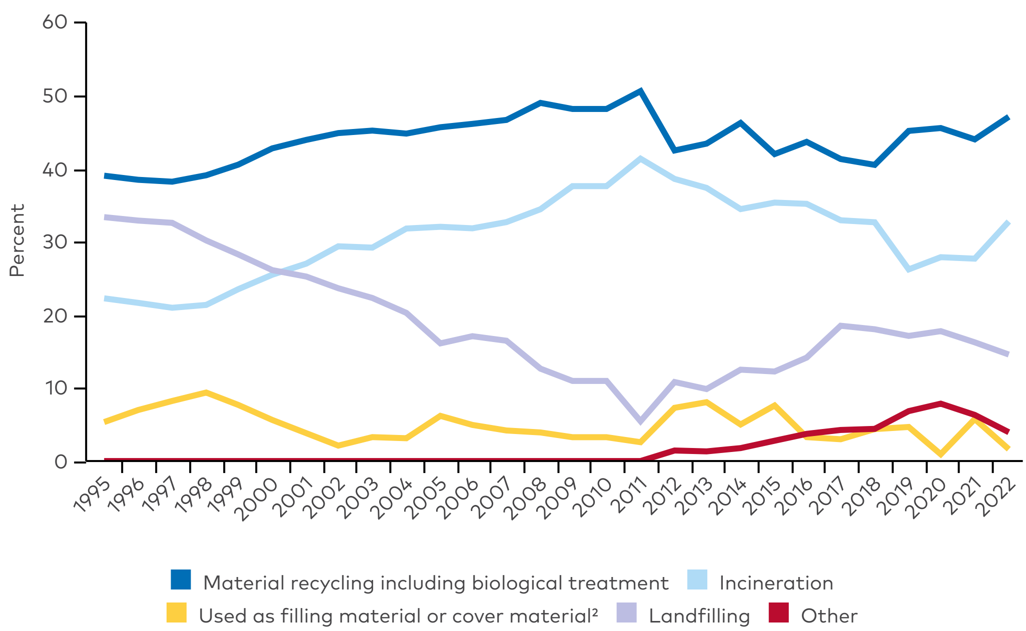

Figure 16: Ordinary waste after treatment (in %). Exported waste is recorded under the treatment method used abroad. Imported waste is not included in the statistics. Contaminated materials that are landfilled or used as cover material are not included.[227]

The instrument

The Norwegian population generates more waste per person than the European average, reaching 726 kg per capita in 2020.[228] The energy from the incineration is used either as district heating or directly to industries in the form of local heating or steam. Many district heating plants in Norway are integrated facilities where a

227. Statistics Norway (2023). Økning i avfallsmengden i 2022. Available at: https://www.ssb.no/natur-og-miljo/avfall/statistikk/avfallsregnskapet/artikler/okning-i-avfallsmengden-i-2022. (Accessed: 19 September 2024).
228. The Nordic Council of Ministers (2024a). Waste incineration in the Nordic countries: A status assessment with regard to emissions and recycling. TemaNord 2024:524.

single company manages both heat production and distribution. These companies are either dedicated district heating companies or energy companies that provide district heating and other energy products. Waste was used as an energy source for 42% of district heating production in 2023.[229]

Emissions from waste incineration in Norway are included in the EU ETS if they result from the combustion of fuels in installations with a total rated thermal input exceeding 20 MW. This does not apply to installations for the incineration of hazardous or municipal waste.[230] All but three Norwegian incineration plants are exempt from the EU ETS.

Emissions from Norwegian municipal waste incinerators outside the EU ETS fall within the scope of the Effort Sharing Regulation (ESR), which establishes emissions reduction targets for non-ETS sectors. Under the climate agreement with the EU, Norway has agreed to cut its non-ETS emissions by 40% by 2030 compared to the 2005 level. Concerning non-ETS emissions from waste incineration, the main strategy is to achieve emission reductions through taxation and the implementation of Carbon Capture and Storage (CCS).[231]

The waste incineration tax was introduced in 2022. The tax applies to waste delivered for incineration in Norway. The purpose of the tax is to contribute to cost-effective reductions in greenhouse gas emissions. The tax is also intended to reduce other environmental damages from waste, including hazardous waste. Additionally, the tax generates revenue for the state treasury. To provide incentives for incineration plants to reduce emissions through waste sorting, these plants can apply to the Norwegian Environment Agency to use a plant-specific emission factor when calculating the tax. CO_2 emissions that are captured and stored (CCS) are exempt from the tax.[232] The rates as of 2024 are summarized in the textbox below.

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229. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS). Available at: https://www.regjeringen.no/contentassets/aa5e7ba7a4154aecbed44df60c214f35/no/pdfs/prp202420250001ls0dddpdfs.pdf.
230. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS). Available at: https://www.regjeringen.no/contentassets/aa5e7ba7a4154aecbed44df60c214f35/no/pdfs/prp202420250001ls0dddpdfs.pdf.
231. The Nordic Council of Ministers (2024a). Waste incineration in the Nordic countries: A status assessment with regard to emissions and recycling. TemaNord 2024:524.
232. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS). Available at: https://www.regjeringen.no/contentassets/aa5e7ba7a4154aecbed44df60c214f35/no/pdfs/prp202420250001ls0dddpdfs.pdf.

Textbox 2: Rates for the waste incineration tax for 2024.[233]

Waste that generates greenhouse gas emission allowances pursuant to the Greenhouse Gas Emission Trading Act: NOK 176 (€15) per ton CO_2.

Other waste: NOK 882 (€75) per ton CO_2.

The excise duty is calculated by multiplying the amount of waste delivered, measured in ton by a factor of 0.5498 ton fossil CO_2 per ton of waste. It is, as mentioned, possible to apply to the Norwegian Environment Agency for an assessment of a facility-specific factor.

The rate of the waste incineration tax was NOK 238 (€20) per ton of CO_2 in 2023, NOK 192 (€16) per ton CO_2 in 2022, and NOK 149 (€13) per ton in 2021.

The Norwegian Government has expressed plans to gradually increase the tax rate for waste incineration along with the standard tax rate for non-ETS emissions to about NOK 2000 (€171) per ton of CO_2eq in 2030. While the three waste incineration plants currently covered under the EU ETS are also covered by the waste incineration tax, the Norwegian government also plans to consider rises in carbon tax rates in conjunction with the price of emission allowances in the EU ETS.[234]

The textbox below gives a brief overview of waste incineration and relevant instruments in other Nordic countries.

233. The Norwegian Ministry of Finance (2020). Skatter, avgifter og toll 2020 (Prop. 1 LS).
The Norwegian Tax Administration (n.d.). Waste incineration tax. Available at: https://www.skatteetaten.no/en/business-and-organisation/vat-and-duties/excise-duties/about-the-excise-duties/avfallsforbrenning/. (Accessed: 19 September 2024).
234. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS). Available at: https://www.regjeringen.no/contentassets/aa5e7ba7a4154aecbed44df60c214f35/no/pdfs/prp202420250001ls0dddpdfs.pdf.

Textbox 3: Legislative frameworks for waste incineration in the other Nordic countries.[235]

Waste incineration plays a major role in the Nordic countries, both as a means of decreasing waste volumes while avoiding landfills (which are not used for untreated waste on a large scale anymore in the Nordics) and in terms of energy delivery to industry and households, especially in district heating. The Nordic countries have a higher incineration capacity than is fulfilled from their domestic waste. The gap is filled with imported waste from other countries. With the district heating sector decarbonizing its operation, fossil emissions stemming mainly from the incineration of plastic waste make up a large part of the total fossil CO_2 emissions in district heating.

Common for all Nordic countries is a considerable integration between waste incineration and the district heating sector. Legislation and rules, however, differ between the countries. Examples are national implementation of the ETS trading scheme and taxation (such as in Denmark and Sweden), but also whether changes in capacity are legally specified. Denmark, for example, has an active policy goal to reduce the waste incineration capacity. The other countries in the Nordics, on the other hand, currently do not have any goals to reduce their waste incineration capacity. For Finland in particular, waste incineration plants have been installed more recently, resulting in incentives for the energy companies to continue using the existing infrastructure at least for its technical lifetime. A political goal of reducing the capacity in turn would be counteractive to these incentives.

Ambitious political circular economy goals are in place in all the Nordic countries. Whether they can be reached depends primarily on the future use of plastics, both concerning their amount, composition and sorting rates. Illegal handling of waste is a problem, especially where high gate fees and a lack of legal consequences suggest a high financial return at low risk.

235. The Nordic Council of Ministers (2024a). Waste incineration in the Nordic countries: A status assessment with regard to emissions and recycling. TemaNord 2024:524.

Possible responses

The waste incineration tax can lead to different effects:[236]

- It can **reduce the volume of products that create emissions** during incineration (in this case, fossil waste).
- It can also **incentivise better waste management** (sorting, reuse, or recycling) and **investment in new emissions-reducing technologies**, including carbon capture and storage (CCS).

Incineration plants have several ways to adapt to the tax. They can pass the tax on through higher prices for waste management. Parts of the industry have claimed that there is no room to increase prices for waste management services due to strong competition from Sweden and Denmark. However, The Norwegian Ministry of Finance (2024)[237] is aware of examples where operators have raised prices for such services citing increased tax levels. Higher prices incentivize waste management service buyers to reduce the amount of waste delivered. Incineration plants can also pass the tax on through higher district heating prices (up to the maximum price) for businesses and households.[238]

The waste incineration tax incentivizes incineration plants to reduce emissions through better waste management. They can invest in new systems for sorting the fossil part of the waste and apply for a lower facility-specific emission factor. This results in a lower overall tax cost for plants that sort out a large portion of their fossil waste. CO_2 emissions from waste incineration that are captured and stored (CCS) are exempt from the tax. This exemption gives facilities that implement CCS technology a competitive advantage, as the variable costs represented by the tax will be lower for these facilities than for those that do not invest in CCS technology.[239]

3.6.1 Intended effect of the waste incineration tax

Effects on emissions

Figure 17 shows the CO_2 emissions from waste incineration in Norway over time. The figure indicates some reduction in emissions from 2018 to 2022. It is challenging to estimate any causal effect on emissions by the tax. Generally, the effects tend to be larger over time. This is typically the case when businesses need to invest in new production assets or organize production in new ways to adapt to the tax. Business cycles, tax levels in other countries, and technological developments will also influence the development of emissions in the sector.

236. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
237. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
238. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
239. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).

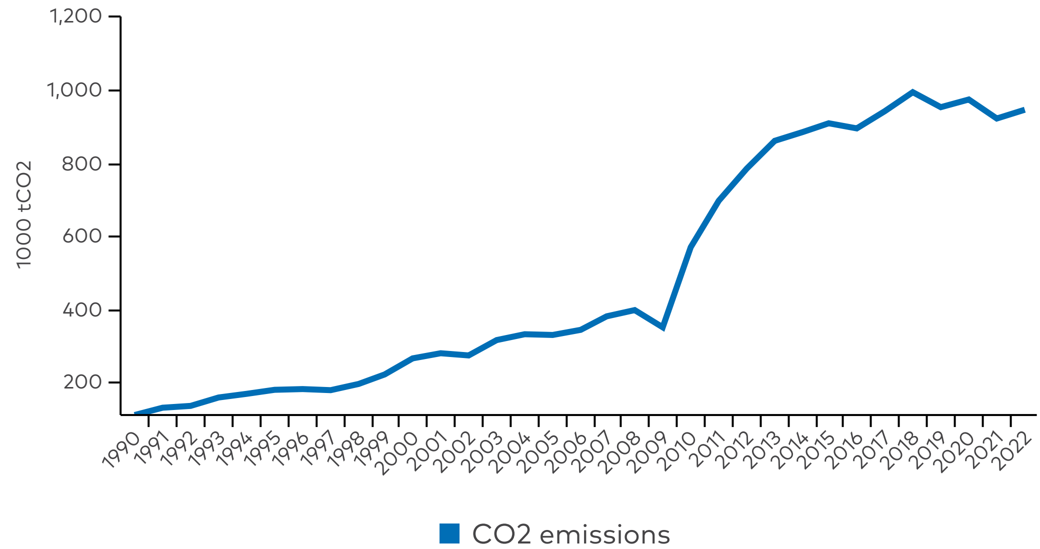

Figure 17: CO_2 emissions from waste incineration in Norway 1990–2022.[240]

Other effects

The Norwegian Ministry of Finance (2024)[241] evaluated the effects of the waste incineration tax on emissions, competitive conditions, Norwegian district heating production, etc. They report:

- that the waste incineration tax provides facilities with incentives to reduce emissions by rewarding facilities that invest in emission-reducing measures and separate the fossil part of the waste,
- further increases in the waste tax level towards 2030 could negatively affect the competitiveness of Norwegian facilities and the profitability of Norwegian district heating production.
- suggestion to keep the waste incineration tax practically unchanged in 2025. The tax will be further increased to the general level in 2026 following the climate plan.

A tax on waste incineration will make district heating production more expensive, either directly by having the district heating producers pay the tax or indirectly by forcing producers to shift towards other, initially more expensive, energy sources. The tax on waste incineration contributes to the transformation of the Norwegian economy, but in isolation, it will reduce the amount of district heating produced in Norway.[242]

240.Statistics Norway, table 08940
241. The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
242.The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).

The Norwegian Ministry of Finance (2024)[243] suggests a price elasticity of -0.42 for the waste sector, implying that a 1% price increase leads to a 0.42% decrease in demand in the long run. Concerns have also been raised that the tax affects the liquidity of incineration companies, hindering investments in CCS technology. An April 2024 study indicated that current incentives are insufficient to drive CCS investments in the short to medium term. The government is considering measures to address barriers in the CO_2 management value chain.

The tax could lead to carbon leakage. In 2022, 68% of waste exported from Norway went to Sweden and 14% to Denmark. Until 2024, Swedish and Danish incineration plants within EU ETS faced higher carbon prices than the Norwegian tax, so the waste tax did not disadvantage Norwegian businesses competitively. However, in most of 2024, the Norwegian tax exceeded the price in EU ETS. Swedish and Danish plants face lower emission prices because their calculations use lower emission factors. Norwegian waste exports decreased between 2017 and 2023. Despite a nearly 25% tax increase from 2022 to 2023, exports to Sweden also declined. The development in the export and import of combustible waste for 2017–2022 is shown in Figure 18. Multiple factors influence export volumes, making it difficult to attribute changes directly to the tax. The government's plan to raise the tax to NOK 2,000 (€171) by 2030 could disadvantage Norwegian businesses. If the tax leads to increased waste exports to the EU, the impact on emissions becomes uncertain, as these emissions would fall under the EU ETS. Waste export could contribute to increased emissions from transport, depending on distance and the transport method.[244]

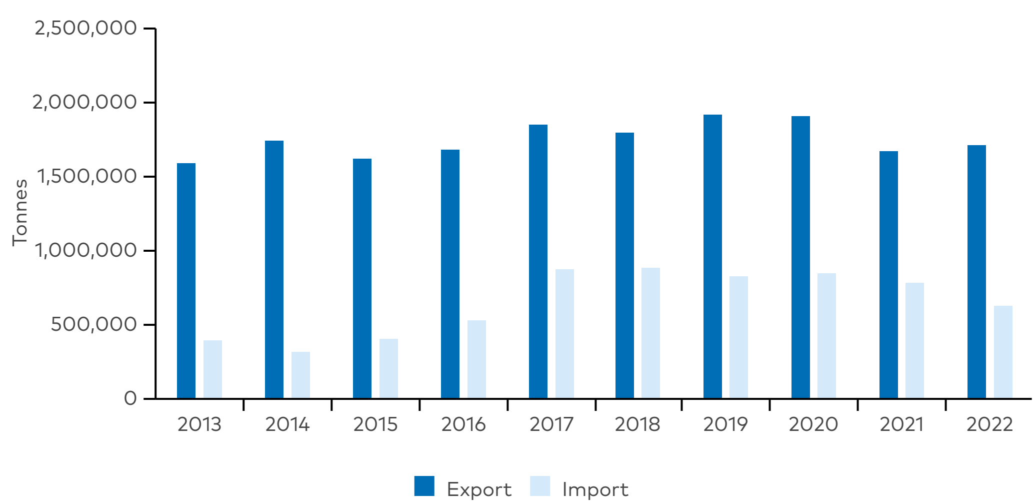

Figure 18: Development in the export and import of combustible waste 2017–2022.[245]

243.The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
244.The Norwegian Ministry of Finance (2024). Skatter og avgifter 2025 (Prop. 1 LS).
245.The Norwegian Environment Agency (2024). Eksport og import av avfall.

Emissions from waste incineration contain harmful substances that can negatively impact health and the environment, including dust, NO_x, acidifying compounds such as HCl, HF, and SO_2, as well as environmental toxins like heavy metals and dioxins. Some waste incineration plants use treatment systems that also result in emissions to water. In addition, new types of waste are generated, such as bottom ash and filter dust, which must be properly managed.[246]

In a circular economy perspective, the tax could translate to increased costs for households and businesses to dispose of waste and thus contribute to more efficient resource use. Norway has one of the highest consumption levels per person in the world, and only 2.4% of all materials used in Norway are recycled back into the economy.[247] This implies that the Norwegian economy has a long way to go in transitioning to become more circular.

Textbox 4 summarises recent studies on the effect of economic instruments within the circular economy. These studies show that economic instruments to promote circularity have been implemented in Norway, other Nordic countries, and the EU in recent years. Additionally, the studies show that economic instruments can be used to both achieve reduced emissions and circularity. It is mentioned that cooperation between countries especially can be useful as both emissions and poor waste management are issues that often span across countries.

Textbox 4: Economic instruments and the circular economy.[248]

Menon et al. (2024) have analyzed literature on effects of different economic instruments on circularity. Waste taxation was one of these instruments. The study found that taxation of landfills in the UK was successful in both generating state revenue, reducing the waste being sent to landfills and increasing the rate of recycling. Similar effects have been found from the introduction of landfill tax in Italy. Other studies that have evaluated landfill taxation and incineration taxation in in Norway found relatively modest effects of the taxes on waste streams. In general, the study by Menon et al. found that effects of other instruments (such as taxes on materials for use in construction etc.) on circularity are often small.

246. The Norwegian Environment Agency (2024). Eksport og import av avfall.
247. SNL (2023). Sirkulær økonomi.
248. SOU (2024: 67). Om economiska styrmedel för en mer cirkulär ekonomi (SOU 2024:67). NILU (2024). Nasjonalt samfunnsoppdrag om sirkulærøkonomi: Forslag til organisering. NILU rapport 2/2024. The Nordic Council of Ministers (2024b). Policy Options for Reducing Consumption-Based Emissions. TemaNord 2024:545. Menon Economics, Cicero, NIBIO, NIVA & Sintef (2024). Litteraturoversikt: effekter av økonomiske virkemidler for å fremme sirkulær økonomi. Notat 1/2024.

In Norway, the Ministry of Climate and Environment is considering a "mission" for the circular economy aimed at the implementation of circular solutions, with a focus on green and digital transformation. NILU is supporting the ministry and has *inter alia* proposed how to organize the mission (NILU 2024). Several workshops have been held to limit the focus for the missions' objectives. The focus for the objectives of the mission have now been limited towards *reduced consumption*, *reuse*, and *sharing economy*. Some of the main take-homes from the workshops are that economic instruments are relevant to make business models viable. Regulations and development of standards are however central.

Recently, a committee appointed by the Swedish government released a report on financial governance to promote the transition to a circular economy (SOU 2024:67). The committee finds that the regulation of the circular economy is becoming increasingly comprehensive and is increasingly occurring within the EU. Waste management was one of the first areas to be regulated within the EU, with a focus on protecting health and the environment, as well as promoting recycling. These fundamental rules for waste management have influenced the formulation of other regulations. The committee also found that economic instruments specifically aimed at developing a more circular economy, are relatively rare. This could be due in part to the difficulty of implementing such instruments at the EU level, as well as the challenges in designing national economic instruments that achieve the desired purpose.

The Nordic Council of Ministers (2024) recently released a report on policy options for reducing consumption-based greenhouse gas emissions and other air pollutants across the Nordic countries, especially focusing on key consumption sectors. The main message of the report is that available consumption-based emissions statistics and trends motivate and support policy action. This action could be further supported by improved statistics, clear policy ambitions and Nordic cooperation. Furthermore, their mapping shows that there is no lack of possible options for policymakers that seek to reduce consumption-based emissions. Further analysis to combine promising policies in actionable and effective packages is recommended. In the report, it was also mentioned that consumption-based emissions often involve multiple countries, and coordinated approaches can be especially effective.

3.7 Aviation tax

The Swedish aviation tax was introduced in 2018[249] and will be removed effectively in July 2025. The tax is based on individual passenger flights originating from Swedish airports, and the tax amount depends on the travel destination distance. The tax amounts have increased each year, and in 2024 flight companies pay either SEK 76, 315 or 504 (equivalent to €6.59, 27.3 & 43.7, 09/12-2024) for each passenger, depending on the destination. Certain passengers are exempt from the tax, such as transit and transfer passengers, children under 2 years, personnel, and travellers who did not reach their target destination due to unforeseen events. The motive for introducing this tax was to correct market failures due to the negative externalities of air transportation. Prior to 2018, aviation was the only mode of transport in Sweden exempt from emission charges. The aviation tax has been subjected to criticism and debate, with SAS threatening to discontinue some of their routes.[250] The current rationale for removing the tax is to enhance the competitiveness of Swedish companies and create a level playing field, as only a few EU countries impose aviation taxes.

3.7.1 Intended effect of policy instrument

To understand the impact of an aviation tax, it is important to be aware of both income elasticities, price elasticities, and other possible behavioural impacts of a tax. Causal claims cannot be inferred from simply comparing flight data before and after a tax was introduced.

Only a few studies have assessed the impact of the Swedish aviation tax. A notable study is a dissertation by Stråle (2022).[251] He investigates both the heterogeneous income elasticity and the effects of the tax on flight prices and quantities of flights. In the first study of the dissertation,[252] he uses a conditional censored quantile regression model[253] and household expenditure data to assess the income elasticities for household consumption of international flights (only leisure flights and not including business travel). With this model, results show income elasticities for a range of households. Instead of estimating an average elasticity, it produces elasticities for each percentile of households based on air travel consumption relative to similar households. As **Figure 19** shows, the income elasticity is much higher for households who travel more seldom (left part of the x-axis) than for those who travel often (right part). Flight travel is a luxury good, especially for

249. Skatteverket (2024). Flygskatt.
250. SVT (2018). *I april införs nya flygskatten – SAS hotar flytta avgångar.*
251. Stråle, J. (2022). *Travel demand and environmental policy.*
252. Stråle, J. (2021). *Household level heterogeneity in the income elasticities of demand for international leisure travel.*
253. With a Conditional Cencored Quantile Regression (CCQR) they compare the income elasticity of each percentile (Quantile) of households with similar characteristics (conditional), not including roughly the half of households with no international air travel in a given year (censored).

consumers flying more seldom. If income increases by 1%, the demand for international travel increases by more than 1%. The average income elasticity is estimated at around 3, considered high. Only about half of households took international flights during the years studied, which is why the x-axis starts at the 50th percentile. These findings have significant policy implications, as distributional impacts are likely substantial. The results also suggest that income elasticity will decrease over time due to rising incomes. Policies aimed at reducing international air travel demand by increasing prices may be less effective, as income growth is expected to outweigh price effects.

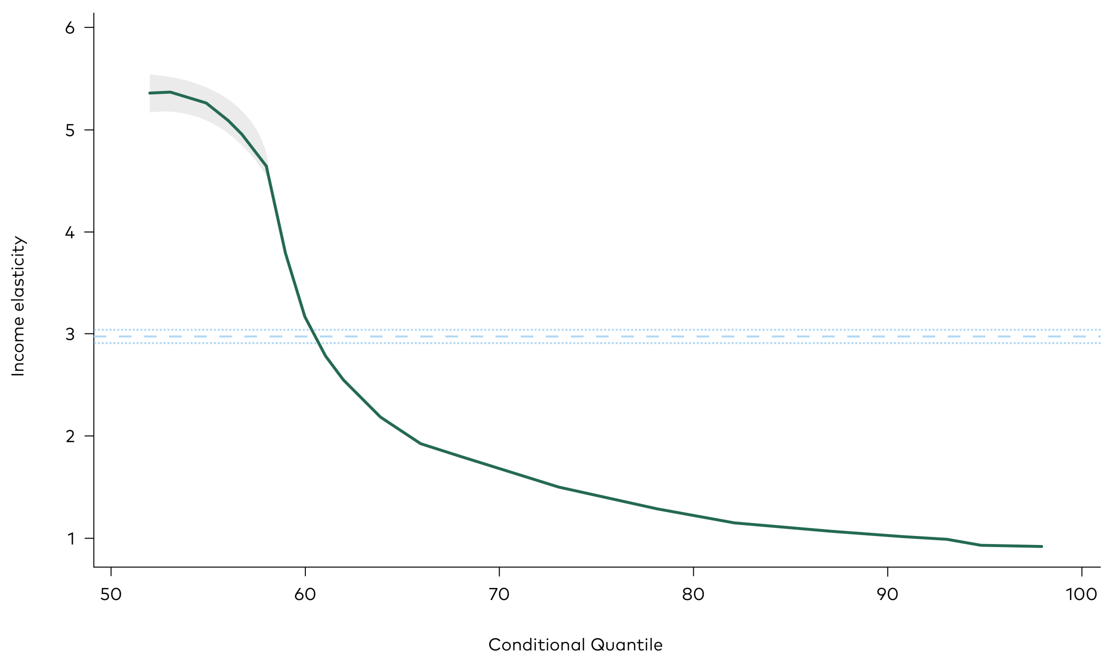

Figure 19: Income elasticity of international air travel in Sweden (Stråle, 2022).

In a second paper, currently a Working Paper, Stråle[254] specifically investigates the impact of the Swedish aviation tax. The main difficulty with assessing the causal effects is that it is difficult to know the counterfactual, what would have happened without the tax. To estimate this, Stråle constructed a synthetic control group and compared the actual outcomes on the Swedish market with this synthetic control. The synthetic control was built using data from countries similar to Sweden that did not implement an aviation tax during the period. Price levels and flight amounts before and after the tax were compared with the same changes in the synthetic control, creating a synthetic difference-in-difference.

254.Stråle, J. (2021). *The Effects of the Swedish Aviation Tax on the Demand and Price of International Air Travel.*

The results show a clear reduction in airfare travel following the aviation tax. Under the first quarter following the introduction of the tax, travel was reduced by 6%. This effect increased over time, reaching 13% in the last quarter of 2019. However, no significant impact is found on prices. This indicates that there is some other effect that drives the reduction in air travel from the introduction of the tax. Stråle explains this as likely being an effect of the media attention that made the negative external effects of flights more salient. It is also not straightforward to conclude that prices were not affected (lack of evidence of an effect is not evidence of no effect). The impact on travel quantities, however, were still larger than the expected impact that could have been explained by the price elasticity and an increase in the price of the same magnitude as the tax. This is verified by estimations of the price elasticity using web-scraping of flight prices and quantities of flights consumed. The estimated price elasticity is -0.76. Regardless of uncertainties regarding the price effects, this study shows that the impact of the aviation tax was significant, with a larger impact than what could be explained only by the price elasticity. Additional behavioural impacts played an important role.

A similar study, using the same methodology, showed that the introduction of the German aviation tax significantly reduced the number of flights in Germany.[255] At the same time, they found evidence that the number of flights at closely located airports in neighbouring countries increased. They also found that while most regional airports saw less traffic, the major hub airports were not as much affected, some even increasing in traffic.

The aviation tax is progressive. High-income groups spend a higher share of their income on air travel compared to low-income groups. As income levels increase over time, flight transportation is likely to increase as well. This increase will be driven mainly by currently infrequent fliers, who have a high-income elasticity. In the long run, any impact of a tax (if not at significantly higher levels) is likely to be dwarfed by income effects.

The aviation tax was set at a rather low level, far below a Pigouvian tax rate that would capture the whole social cost of carbon. Still, the tax has been one step in the direction of internalizing external costs, which can be seen as better than nothing. Mostly, however, it may act as a symbol tax, suggesting that flights are something that the government understands hurts the environment and is something that we should actively try to minimize. The tax design, however, is far from what economists would call "first-best". A first-best aviation tax would put a price on the damaging source rather than the end product. It would tax the fuels (with some modification to also adjust for contrail effects) rather than the number of travellers. Such a tax would not only reduce demand by higher prices, it would also provide incentives for the flight companies to use cleaner alternatives fuelling the flights. In an ideal world, the tax would also be international.

255.Borbely, D. (2019). *A case study on Germany's aviation tax using the synthetic control approach.*

Taxes such as the aviation tax can also be seen as signal taxes, signalling to the industry how the government wants the industry to look in the future. However, for air travelling, the confidence in technical solutions that can effectively replace the currently highly polluting fuels is likely low. These technical solutions are starting to appear but are at no capacity to replace any large share of current fuel use. Once confidence in these types of alternatives rise, governments may want to use policies to signal that the industry needs to transform.

Emissions from international aviation is part of the EU ETS. However, the ETS only covers flights within EU. It also does not account for additional negative externalities from high-altitude effects, which amount to roughly 40% of the total climate impact from aviation.[256] Effectively, the EU ETS thus only covers less than half of the climate impact from international aviation. Additional policies would then be needed to account for the negative externalities.

The acceptance of the policy has been varied. While the aviation industry has argued against the tax, public acceptance has been relatively high. However, when compared with other less stringent policy alternatives, the tax is less popular.[257] Among politicians, there has evidently not been a consensus on whether to keep the policy. To increase the acceptance among the public further, studies show that earmarking revenues for investments in renewable aviation fuels.[258] There are also ongoing studies on how to design an aviation tax that provides incentives for reducing the negative externalities, while also retaining the highest possible acceptance.[259] Suggestions involve taxing and redistributing revenues in a system that provides incentives for reduced negative externalities, while not having too much negative impact on households' economies.

3.7.2 Cross Nordic outlook

Among the Nordic countries, only Sweden and Norway have existing aviation taxes. The tax in Norway is similar to the Swedish design, was introduced in 2016, and has also been subjected to criticism and debate. Denmark will implement a very similar policy in 2025. In Finland, an aviation tax has been proposed and discussed, but never implemented. A study on the potential effectiveness and cost of aviation taxes in Finland compared alternative policy designs.[260] They compared a tax based on tickets and distances (as the Swedish and Norwegian design), a uniform departure tax, and an EU-based fuel tax. They found that these would be beneficial, with various benefits and disadvantages of each design. For example, a fuel tax would provide proper incentives for technological improvements that the other design alternatives would not.

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256. Larsson, J., Elofsson, A., Sterner, T. & Åkerman, J. (2019). *International and national climate policies for aviation: a review.*
257. Larsson, J., Matti, S. & Nässén, J. (2020). *Public support for aviation policy measures in Sweden.*
258. Matti, S., Nässén, J. & Larsson, J. (2022). *Are fee-and-dividend schemes the savior of environmental taxation? Analyses of how different revenue use alternatives affect public support for Sweden's air passenger tax.*
259. Larsson, J. et al. (w.d)
260. Valtioneuvosto, Statsrådet (2022). *Undersökning ger ny information om alternativ för genomförande och effekter av flygskatt i Finland.*

3.8 Plastic bag tax

Sweden introduced a plastic bag tax in May 2020 to comply with EU directives targeting plastic waste reduction. The tax imposes a SEK 3 (equivalent to €0.26, 09/12-2024) levy per plastic bag on manufacturers and importers, raising checkout prices for consumers. It aims to reduce single-use plastic consumption by encouraging the use of alternatives like reusable or paper bags. This measure responds to the EU's broader directive to limit plastic bag consumption to 40 bags per capita by 2025, primarily to combat litter and reduce ecological harm.[261][262] The tax was removed in November 2024 as the government determined it was no longer necessary to achieve the target goal, as plastic bag-consumption has been well below the EU limit for a number of years, at roughly 20 bags per capita and year.[263]

Central to the evaluation of the plastic bag tax is understanding the motive behind its introduction. Although there has been some confusion surrounding the rationale, the primary purpose was to comply with EU directives aimed at reducing plastic bag consumption to minimize litter. The Swedish government's response to this directive was the implementation of the tax. In assessing the tax's success, we can either focus on its specific impact on plastic bag consumption or adopt a more holistic approach, examining how the tax influences various behaviours with broader effects on the environment and climate.

3.8.1 Intended effect of policy instrument

Available evidence reveals a substantial reduction following the tax's introduction. However, most estimates are based solely on comparisons between pre- and post-tax sales figures. While the tax likely influenced demand, several other factors could also have contributed, such as increased media attention, heightened public awareness, and store practices like routinely asking customers if they need a bag. The most comprehensive analysis, to the authors' knowledge, was conducted by Romson et al.[264]

Romson et.al. note a substantial difference in both plastic bags sold, and paper bags sold before and after the tax. However, to better isolate the specific tax impact from other influences, they conduct analyses accounting for potential seasonal trends and shifts related to the COVID-19 pandemic, which may have affected stores in varying ways. For instance, travel patterns likely differ by store location, with some stores more frequently accessed by car, while others see higher

261. Nielsen, T. D., Holmberg, K., & Stripple, J. (2019). *Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect?*
262. Martinho, G., Balaia, N., & Pires, A. (2017). *The Portuguese plastic carrier bag tax: The effects on consumers' behavior.*
263. Regeringskansliet (2023). *Plastpåseskatten ska avskaffas.*
264. Romson, Å., Boberg, N., Erikccon, F.A., Herlaar, S. & Sanctuary, M. (2022). *Försäljningseffekter av skatt på plastpåsar.*

foot traffic or public transport usage. The authors use a difference-in-difference (DiD) regression analysis. This method allowed the authors to compare pre- and post-tax sales data and estimate the tax effect separately from other external influences. Fixed effects were included for each store to account for store-specific effects. Key data was gathered from 43 grocery stores across Sweden, focusing on monthly sales volumes of plastic and paper bags as well as store revenue from January 2020 to September 2022. Results from the analysis revealed an 83% decrease in plastic bag sales per unit of revenue and a 103% increase in paper bag sales, suggesting consumers switched to paper bags as a less expensive option. A survey conducted in February 2022 further supports these findings, showing that nine out of ten consumers frequently bring their bags, with 70% preferring reusable bags like cloth or multi-use options. These findings show that the tax substantially shifted consumer behaviour, reducing reliance on single-use plastics and instead increasing the use of alternatives in Sweden.

We can also not entirely exclude the possibility that the large shift in consumer behaviour was partly an effect of a general attitude shift. Due to the nationwide tax implementation, the study by Romson et al could not include stores unaffected by the tax as a control group. Instead, they rely on the assumption that the tax was the only time-varying change that influenced consumption from a store-level perspective. The authors suggest future research could compare Swedish stores with those in neighbouring countries without the tax. Another factor influencing plastic bag use may be how cashiers ask customers about bags. In Swedish grocery stores, customers typically choose bags themselves, while in other types of stores, cashier behaviour may have a greater impact.

Given the goal of reducing the consumption of plastic bags, the tax must be seen as successful. With a more holistic view of goals and considering the entire negative externalities and paper bag consumption, the success is less clear. To the best of our knowledge, we lack holistic studies that explore both the causal impacts of the tax, combined with LCA of the negative impacts of both alternatives.

3.8.2 Cross Nordic outlook

Denmark introduced a tax on plastic bags in 1994, requiring retailers to pay a levy per bag, which is often passed on to consumers. This approach has significantly reduced plastic bag usage, from 800 million to 400 million bags,[265] which today amounts to roughly 70 bags per person per year. In Norway, an increase in a fee paid to Handelens Miljøfond increased prices from roughly NOK 3 to 4.25 (€0.26–0.36) in the summer of 2023. Estimates indicate a 31% drop in plastic bag sales following the fee increase.[266] However, Norwegian plastic bag sales remain significantly above the EU target of 40 bags per capita, with approximately 130 bags per capita sold in 2022.

265.European Union (2019). *The case for taxing plastic.*
266.Lindin, I.K. (2023). *Kraftig fall i plastposesalget, men hva så?*

4. Cross Nordic comparison

In the following, we summarise the cases described in the previous chapter and make a cross-Nordic comparisons. Table 2 gives a schematic overview of the policies and our assessment of them. The criteria are selected to cover the aspects we found to be most relevant in determining the success of the policies. The criteria are:

- The extent to which the instrument's **charge level** internalises the external costs of the targeted emissions.
- The **precision** of the charge, i.e., how effectively it targets the emitter and the emissions source
- **The price elasticity of demand** and the responses of those affected, highlighting notable differences between short- and long-term effects.
- Whether the policy incentivises **technology development**.
- The extent to which the policy avoids **leakages**, i.e., unintended negative effects.
- **Equity:** The distributional effects of the policy, particularly whether taxes are progressive, regressive, or neutral.
- To what extent the policy **positively interacts** (has synergies) with other policies.
- The level of industry and/or consumer **acceptance** of the policy.
- The policy's **political alignment**.

Note that the summary can only be considered an indication and not a complete review of the charges. In particular, it is not an assessment of whether the charge should be continued or not. Please see the individual charge analysis in Chapter 0 for more details.

Table 2 shows that the **charge levels,** in general, are lower than the optimal level to internalise the external environmental costs. Further, it shows that the **level of precision** is considered relatively higher and more beneficial than the charge level. Less precise charges could require higher levels, but for several of the charges, the levels are considered to not be sufficient even though the precision is relatively strong. The **price elasticity** is particularly challenging to assess, and relevant elasticities only exist for a few of the studies and, to an even lesser extent, differentiate between the short- and long-term. Only the payers of the pesticide tax are relatively responsive to changes in the tax. For others, there is a lack of substitutes (e.g., aviation) or responses require investments in new technologies (e.g., waste incineration). The incentive for **technology development** depends on the charge level, precision, price elasticity, other policy designs and the possible responses of the agents; it is particularly assessed similarly to the elasticity criteria. **Leakage** is only considered to be a substantial problem for the plastic bag tax, where the charge could increase the consumption of paper bags. In other cases, the charges could affect activities in other sectors or countries, but the environmental effect is uncertain. There is a particularly large spread in **equity** (if the policy is regressive or progressive). For the charges addressing consumers, beverage packing and aviation tax is considered progressive, while electricity tax and the plastic bag tax are considered regressive. Most policies are considered to have **positive interactions with other policies** and have synergies with other targets. Lastly, there seems to be a strong correlation between consumer and industry **acceptance** and **political alignment**; policies that are accepted by the public and the relevant industries are likely to have broader political support.

Table 2: Summarizing the assessments of the policies across cases.
Color explanation: Green=high (▶ ▶ ▶), yellow=medium (▶ ▶), red=low (▶), grey=irrelevant/unknown

Charge	Charge level (degree of internalised cost of externality)	Precision of charge (targeting externality)	Price elasticity of demand	Incentivising technology development	Degree of avoiding leakages	Equity (progressive or regressive tax)	Positive interaction/ synergies with other instruments	Acceptance (consumer, industry)	Political alignment
Electricity tax	▶ ▶ [267]	▶ [268]	▶ ▶ [269]	[270]	[271]	▶	▶ ▶		▶ ▶ ▶
Pesticide tax	▶ ▶	▶ ▶	▶ ▶ [272]	▶ ▶ ▶ [273]	▶ ▶ [274]	▶ ▶ ▶	▶ ▶ ▶	▶ ▶ ▶ [275]	▶ ▶ ▶
NO_X fund (NO)	▶ ▶	▶ ▶ ▶	▶ ▶	▶ ▶	▶ ▶	▶ ▶	▶ ▶ ▶	▶ ▶ ▶	▶ ▶ ▶
Waste incineration tax (NO)	▶ ▶	▶ ▶ ▶ [276]	▶ ▶	▶ ▶	▶ ▶ [277]	▶ ▶ ▶	▶ ▶	▶	▶ ▶
Aviation tax (SE)	▶ ▶	▶	▶ ▶	▶ ▶	▶ ▶	▶ ▶ ▶	▶ ▶	▶ ▶	▶
Plastic bag tax (SE)	▶ ▶ ▶	▶ ▶	▶	▶ ▶	▶	▶	▶ ▶ ▶	▶	▶
Carbon tax on fuels (FI)	▶ ▶	▶ [278]	▶ ▶	▶ ▶ [279]	▶ ▶	▶	▶ ▶ ▶	▶ ▶	▶ ▶
Beverage packaging tax (FI)	▶ ▶ ▶	▶ ▶ ▶		▶		▶ ▶ ▶	▶ ▶ ▶	▶ ▶ ▶	▶ ▶ ▶

267. Yellow because the price is high enough to create awareness around consumption, but the environmental externality is not captured by the tax.
268. Taxing end consumer, little effect on environmental impact. Higher effect on consumption, but still limited due to relatively inelastic good.
269. Yellow, because the long term elasticity is fairly inelastic, which also can be seen from electricity consumption over time.
270. End consumer, no effect on innovation
271. End consumer, necessity good.
272. Pesticides have a low degree of elasticity, but the charge has been sufficiently high to have had a shift in consumer behavior.
273. The Introduction of precision application technology has increased following the implementation of the differentiated tax.
274. No leakages of significance have been identified; however, obtaining a full overview of leakages is challenged by the diverse policy mix on the agricultural sector. Positive effects from the charge are identified, as the revenue is earmarked back to the sector.
275. Significant acceptance of the charge in amongst citizens due to societal benefits of groundwater protection. Low industry acceptance in the early configurations of the tax amongst farmers, which later quieted down.
276. Adresses waste and calculated from tonnes of waste; not directly CO_2
277. Risk of leakage to other countries, but not necessary emission effects
278. Exemption of the agriculture sector
279. Medium In the transportation sector, otherwise low

Some of the criteria are supporting each other. Stronger accept among consumers (voters) and the industries increases the likelihood for political alignment and thus decrease political risks (increase stability in policies). Equity and synergies with other policies could also be part in determining acceptability and political alignment. Incentivising technology development and adoption should decrease the risk of leakages since the new, more environmentally friendly technologies reduce the need for moving the activity. More precise charges strengthen the price signal, thereby amplifying the impact through price elasticity.

Other criteria are in conflict. There could be a conflict between setting a charge level that sufficiently internalises the externalities and a charge level and design that is (politically and socially) acceptable. The Norwegian government plans to increase the CO_2 tax on waste incineration to the level of other non-ETS emissions in Norway but receive strong criticism from the industry. On the other hand, the Norwegian NO_X fund (and a similar system in Sweden) is considered successful, in particular due to the industry and political acceptance. The aviation tax in Sweden has also received strong resistance from the industry and will be removed. While the charge level is lower than the externalities, the signal of the charge could be stronger than the actual price increase, which could help explain the low industry (and political) acceptance.

A conflicting goal in increasing relevance is between internalising environmental costs and competitiveness. Industry acceptability could, therefore, be more relevant for green charges affecting export-oriented businesses. In our cases, this is particularly relevant for the NO_X tax (and the NO_X fund), the carbon tax and the electricity tax. Increased focus on competitiveness (e.g., the Draghi report – *The future of European competitiveness*) could increase the relevance of industry acceptance for green charges.

5. Conclusions

Since the 1980s, Nordic policymakers have demonstrated a forward-thinking and comprehensive approach to sustainability by utilising environmental economic instruments. The studies of Denmark, Finland, Norway, and Sweden have shown several insights into each green charge's effectiveness and design. While the charges generally fall short of the optimal levels needed to internalise environmental externalities fully, the precision of the charge often influences policy outcomes more than the charge level itself. This highlights the importance of carefully precisioned charges that strengthen the effectiveness and, hence, the desired behavioural change.

Measuring price elasticities lets us know how much demand shifts due to price changes. This can indicate what impact economic instruments may have on the market. However, we have also seen (such as for the Swedish aviation tax) that the effect of policies may be even higher than what can be explained solely by the price elasticities. This may be attributed to the signalling effects of the policies. However, limited data makes it difficult to assess their price elasticity, hindering the ability to predict behavioural responses.

The comparison shows a strong link between public and industry acceptance and the likelihood of political alignment, which reduces policy instability over time. Policies that share synergies with other national objectives and where equity is more present (progressive rather than regressive) tend to be more publicly acceptable.

The study also highlights a significant gap in the scientific evaluation of green charge policies, limiting evidence-based policy design. Government reluctance to implement policies step-wise, e.g., through control groups, to control for the effect on the market, hinders progress on coherent evaluations. However, research indicates that public acceptance of policy experimentation is often underestimated, suggesting opportunities for more experimentation with policy implementation programs.[280] Scaling up successful small-scale policy experiments would require careful adaptation from control groups to broader contexts to understand and monitor the effects. This approach could ease the evaluation of policies and, with more precision, be able to measure causal relationships.

However, some interests when designing environmental charges are unavoidably conflicting. A notable tension exists between setting charge levels high enough to internalise externalities while ensuring they are politically and socially acceptable.

280.Dur et al. (2024). *Who's Afraid of Policy Experiments?*

The Norwegian government's plan to increase CO_2 taxes on waste incineration illustrates this dilemma, facing industry resistance despite the positive environmental impact. Similarly, Sweden's aviation tax faced significant pushback, leading to its removal, demonstrating the balance needed between sustainability goals and industry acceptance. This challenge is particularly present for export-oriented industries, where competitiveness concerns heavily influence the acceptance and political will of implementing green charges.

This is, as mentioned in the introduction, not only a trend seen in the Nordic countries. Over the past 15 years across the European Union, there has been a noticeable shift away from green charges in favor of subsidies. Subsidies are often used to encourage innovation, support the development of new green technologies, or lower the barriers for adopting sustainable practices. While they can stimulate the green transition, they don't penalise pollution or directly reduce harmful behavior. Instead, they offer financial incentives to guide positive action, such as renewable energy adoption. Green charges on the other hand, serve as tools to internalise the external costs of pollution. As these taxes directly address the "polluter pays" principle, those responsible for environmental damage also contribute to its mitigation. Moving away from green charges risks losing an efficient, market-driven mechanism to address behavior harmful for the climate and environment. Environmental and climate problems are often urgent and systemic, which requires tools that can both fund solutions and incentivise behavioral changes. While subsidies alone may drive innovation, they do not sufficiently discourage existing unsustainable practices, making environmental taxes an essential complement in the green transition strategy.

In conclusion, green charges hold significant potential to address market failures and mitigate environmental harm. However, achieving the desired outcomes demands thorough evidence-based policy design, addressing trade-offs such as environmental effectiveness, equity, and acceptability. All these aspects become increasingly important for every year, as people become more aware of environmental justice and the effects of climate change. This necessitates not only more comprehensive impact assessments but also a willingness to test and refine policy over time. Finally, the analysis clearly shows the importance for the Nordic countries to keep ensuring scientific evaluation of environmental economic instruments, to not fall behind and to dare believe that we can still be a frontrunner in a global context.

6. Recommendations

Based on the studies of policy impact assessments and the workshop discussion with researchers, we have several recommendations for consideration to government agencies and researchers studying policy impacts for improved environmental policymaking with a focus on the effectiveness of green transition.

1. **Continue/expand the use of green charges**
   Green charges typically follow the polluter pays principle. We encourage using green charges, at least when other policies such as bans are not in place, or when negative externalities are not covered by overarching EU policies, such as the EU ETS.
2. **Set taxes and incentives close to the externality**
   Negative externalities arise from emissions of pollutants and habitat destruction, not from the consumption of goods and services themselves.[281] Therefore, we recommend identifying the negative externalities in consumption and production value chains and target policies as close to the negative externalities as possible. This is the first-best policy design. While second-best, consumption-based taxes (such as the aviation tax and the electricity tax) reduce consumption and thereby the negative externalities, the same positive effects can be reached with a more precise tax. The first-best solutions also allow producers to either increase the price of the goods and services (reducing demand) or invest in new technology or production lines with less negative externalities. To the degree possible, exemptions should be avoided, and taxes equalised across sectors and sources of pollutions, to provide consistency and fairness.
3. **Encourage studies assessing policy impact**
   Ex-ante studies can provide a good foundation for policy designs which give the best chance of reaching the intended impacts and goals of policies. Ex-post studies can assess whether or not goals were achieved. We recommend a heightened focus on studies assessing the impacts of policies and variations in policy designs. A redirection of scientific funding would be needed, or direct procurements of policy evaluations from relevant agencies. Comparisons between policy designs across the Nordics also provide a fruitful basis for assessing the impact of varying policy designs.
4. **Prioritise evidence-based policy and policy-based evidence**
   If proper control groups are accessible, difference-in-difference or regression discontinuity approaches often provide good evidence. If not, we encourage

281. Hart & Stråle (2021). *Konsumtionsskatters roll i långsiktig miljöpolitik*

policy experimentation with control and treatment groups that allow comparisons between treated groups and counterfactuals.[282][283] Governmental agencies are often reluctant towards implementation of policy experiments, based on expectations of negative reactance. However, public acceptance for such experimentation is often higher than expected.[284] When policy experimentation is not possible, other methods such as synthetic controls should be used to assess causal effects of policies, rather than simply comparing before-and-after measurements, which run the risk of being confounded by a range of other factors. Furthermore, we recommend a focus not only on evidence-based policy, but also policy-based evidence.[285] The evidence that we produce must be tailored towards how it will be used. Too often, small-scale experiments are used, where adaptations can be made for local circumstances. When scaling up solutions, additional considerations must be made, and the designs may need to change depending on resource availability etc. For a discussion on how ideas and policy designs may fail at scale, as well as solutions to mitigate these issues, see List (2022).[286] We encourage ex-ante assessments to tailor experimental designs as much as possible to circumstances necessary for a large-scale implementation.

5. **Be aware of potential unintended consequences**
   Policies may induce unintended consequences such as extrinsic motivations crowding out intrinsic motivation or mental accounting, when people may feel more at ease with causing negative externalities if they pay for them through taxes.[287] They may also lead to substitution effects and other perverse incentives which undermine sustainability objectives. These considerations must be made when designing policy instruments, and properly studied in separate circumstances.
6. **Combine charges with a comprehensive policy mix**
   Charges may not lead to their full potential in isolation. Public acceptance may be low unless combined with redistributive policies in a wider policy framework. Tax and redistribution combinations provide promising solutions for effective policies that receive public acceptance.[288] A careful consideration of policy mixes may eliminate the threat of perverse incentives or backlashes (e.g., "Gilet Jaunes" effect). Tax revenues can also be earmarked for investments in green technology, to increase public acceptance and further enhancing the effectiveness for a green transformation.

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282. List (2011). *Why Economists Should Conduct Field Experiments and 14 Tips for Pulling One Off*
283. List et al. (2011). *So you want to run an experiment, now what? Some simple rules of thumb for optimal experimental design*
284. Dur et al. (2024). *Who's afraid of policy experiments?*
285. List (2024). *Optimally generate policy-based evidence before scaling*
286. List (2022). *The Voltage Effect: How to Make Good Ideas Great and Great Ideas Scale*
287. Pizzo et al. (2024). *Carbon Taxes Crowd Out Climate Concern: Experimental Evidence From Sustainable Consumer Choices*
288. Matti et al.(2022). *Are fee-and-dividend schemes the savior of environmental taxation? Analyses of how different revenue use alternatives affect public support for Sweden's air passenger tax*

7. **Harmonise long-term policy goals and industry signals**
   Without clear signals and stable policies from governments and agencies, industries lack confidence and incentives for long-term investments. Policies changing back and forth with new election cycles create unpredictable investment environments. To the extent possible, we recommend ensuring stable and clear policies to foster industry confidence and induce long-term investments. Address potential tax revenue deficits from green transitions with proactive fiscal planning.
8. **Harmonise policy development across countries**
   The best possible policies are global implementations. This requires substantial collaborations that are complicated by conflicting goals and targets. The EU has taken important steps in harmonising environmental policies, but there is further potential for strengthening policies and harmonisation across countries. Harmonisation reduces potential leakage effects, and the wider impacts of policy implementations are maximised. While the end goal should be for wider harmonisation, the Nordic countries should increase harmonisation between these neighbouring and relatively similar countries. Agreements in separate regions can act as a first step towards agreements at continental and global scales.
9. **Ensure biomass brought under the energy tax framework**
   If we are to reduce dangerous greenhouse gas emissions, then burning biomass for fuel cannot be treated as carbon neutral by energy tax frameworks. Biomass fuel should be subject to energy and carbon tax just like any other carbon emitting fuel. Ideally this would be coupled with a refactoring of how biomass emissions are treated in more widely in the System of Environmental Economic Accounts, but proper taxation is nonetheless an important first step that is more easily achieved by individual governments.

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8. Appendix

8.1 List of interviewed experts

Name	Position and organization	Case
Jessica Coria	Professor at Aarhus University	The NO_X Fund
Riccardo Boero	Senior Scientist at NILU	The waste incineration tax
Jonathan Stråle	Postdoctoral researcher at the Swedish University of Agricultural Sciences	The aviation tax
Rob Hart	Professor at the Swedish University of Agricultural Sciences	The aviation tax
Åsa Romson	Senior expert and researcher at IVL	The plastic bag charge
Mikael Skou Andersen	Professor at Aarhus University	The electricity charge
Anders Branth Pedersen	Senior researcher at Aarhus University	The pesticide charge
Kimmo Ollikka	Senior researcher at VATT	Carbon tax
Sirje Stén	Ministerial Adviser at Ministry of the Environment of Finland	Packaging tax

8.2 List of experts at workshop

Name	Position and organization
Jonathan Stråle	Postdoctoral researcher at the Swedish University of Agricultural Sciences
Rob Hart	Professor at the Swedish University of Agricultural Sciences
Jörgen Larsson	Senior Researcher at Chalmers University of Technology
Mikael Skou Andersen	Professor at Aarhus University
Jens Erik Ørum	Senior Advisor University of Copenhagen
Henrik Lindhjem	Co-founder, Research Director, Partner. Menon Centre for Environmental and Resource Economics (MERE), Norway
Kimmo Palanne	Researcher in the Environment, energy and climate policy research group at VATT Institute for Economic Research

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