MINISTÈRE DE L'ÉCONOMIE, DES FINANCES ET DE LA RELANCE
Liberté Égalité Fraternité

Tresor-Economics

No. 285 • May 2021

Direction générale du Trésor

Climate Strategies in the Nordic Countries

Julien Grosjean, Éric Duédal

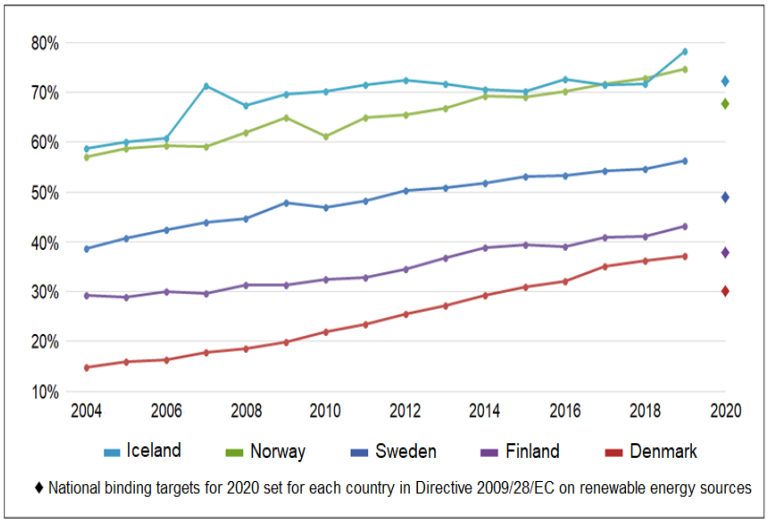
- The Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) are witnessing climate change first-hand, having recorded an increase of 10°C since the preindustrial period in the average annual temperature of some areas, due to the phenomenon known as polar amplification. The increase is more than five times higher than the Paris Agreement goal of limiting global warming to well below 2°C.

- In response to the climate crisis, the Nordic countries have developed carbon-cutting strategies that are both innovative and effective, as evidenced by the net decline in the share of fossil fuels in the region's energy mix over the past 15 years. The primary indicators show that since 2005, the Nordic countries have made significantly more progress in their energy transition than most European Union (EU) Member States, and have done so more quickly. Renewables now account for the majority of final energy consumption in the Nordic region.

- These positive results stem from the decision of governments, in liaison with economic stakeholders, to introduce much more ambitious climate targets than those set by the EU, and to do so very early on. Carbon neutrality was adopted by some Nordic countries more than a decade before the EU. The economic tools introduced to achieve these targets (record high carbon taxes, innovative bioenergy incentives) and the accompanying support measures put in place to ensure a just transition (income tax cuts for low-income households, targeted subsidies) are central to the Nordic model for a green transition. Green finance is another tool used by the Nordic countries (ending fossil fuel export subsidies, record share of green bonds in the bond market). They have also introduced new export-oriented industrial strategies that leverage the strengths of domestic renewable energy sources. These public policies have transformed the Nordic countries into "laboratories" operating at the technological frontier. No other country in the world has more wind power in its electricity mix than Denmark, more electric vehicles than Norway in terms of market share or more extensive use of bioenergy than Sweden.

- These excellent results are tempered by a few things: the lack of a correlation between energy transition and carbon footprint in Iceland and Norway (where the rise in renewable energy has not led to a decrease in emissions), a worrying development of carbon-intensive imports, the environmental impacts of bioenergy (palm oil) and Norway's plans for further oil exploration.

Share of renewables in final energy consumption



Source: Eurostat (2020).

1. One of the world's fastest and most extensive energy transitions

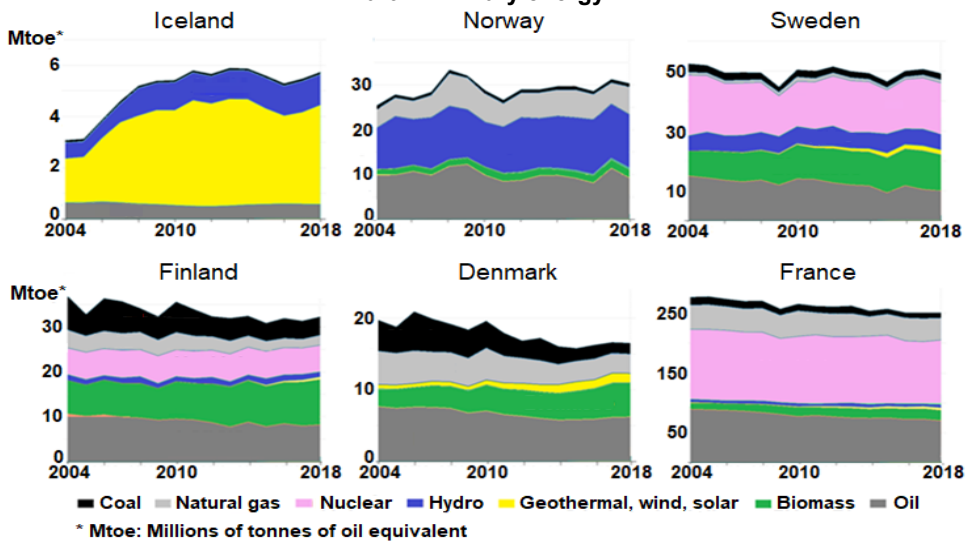
1.1 The Nordic countries have been quick to introduce fossil fuel substitutes into their energy mixes

Among European countries, Iceland, Norway, Sweden and Finland are the furthest along in their energy transitions, with renewable sources accounting for 78%, 75%, 56% and 43%,[1] respectively, of final energy consumption in 2019, compared to an EU average of 19%. The pace of these transitions has been fast compared to the rest of Europe: between 2004 and 2019, the share of renewables increased by 22 percentage points in Denmark, 19 in Iceland and 18 in Sweden and Norway, versus an average of 10 across the EU.

Thanks to this progress, most Nordic countries were quickly able to achieve their 2020 target for overall share of energy from renewable sources as set out in the renewable energy directive.[2] National targets were set by the EU for each Member State based on GDP per capita and existing share of renewables in the energy mix. In 2012, Sweden exceeded its target of 49% eight years ahead of schedule (followed by Finland and Norway, both six years early; see chart above).

Central to the Nordic countries' transition strategies is the ready availability of wood biomass (Sweden and Finland, along with France, have the largest area of productive forest in the EU),[3] hydroelectricity (Norway), geothermics (Iceland) and wind power (Denmark). These country-specific characteristics can be seen in the wide variety of energy mixes among the Nordic countries (see Chart 1).

Chart 1: Primary energy mix



Source: AIE 2020.

The substitution of biomass for fossil fuels has been a key technological component of the Nordic transition. It has helped to dramatically speed up the decarbonisation[4] of sectors such as heating (via the development of biomass-fuelled district heating networks), transportation and manufacturing. Between 2004 and 2018, the share of bioenergy in the primary energy mix (TPES)[5] grew by 17 percentage points in Denmark and nearly 10 in Finland and Sweden. Thanks to ambitious public policy, with measures such as waiving energy taxes on biofuels and introducing targeted support for motor biofuels, bioenergy now

(1) Eurostat 2020.
(2) Directive 2009/28/EC is incorporated into the Agreement on the European Economic Area (EEA), which includes Norway and Iceland.
(3) Eurostat 2019.
(4) The carbon footprint of biomass-derived bioenergy varies widely between different sources (biodiesel made from waste animal fats, wood from Nordic forests, etc.). Pursuant to Directive (EU) 2008/2001 on renewable energy sources, motor biofuels must reduce greenhouse gas emissions by at least 65% compared to their fossil fuel equivalents (70% for electricity, heating and cooling production from biomass fuels) starting from 1 January 2021.
(5) The primary energy mix (total primary energy supply, or TPES) is the total energy contained in natural resources before being transformed for end-use. It differs substantially from the final energy mix, since 66% of primary nuclear energy and 60% of fossil fuel electricity (excluding cogeneration) is lost, mostly through heat (0% for hydroelectricity and wind power, according to IEA standards).

makes up nearly 30% of Nordic countries' primary energy supply.[6] Strict sustainable forestry regulations (limits on clear cutting, replanting requirements, hardwood tree protection, etc.) have been introduced to prevent harmful impacts on biodiversity and to maintain young-growth forests to maximise carbon absorption.[7] Bioenergy has also been a cost-effective means of speeding up the transition in the region,[8] for example by simply converting boilers to run on biomass instead of fossil fuels.

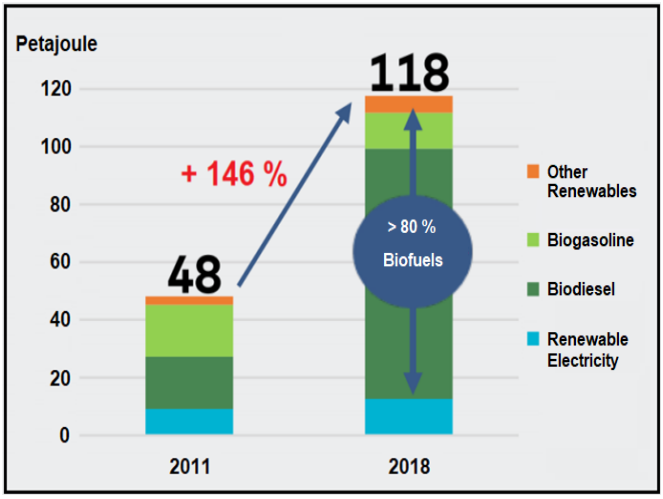
1.2 Progress is relatively even across the energy-consuming sectors

The share of renewable sources in the three energy-consuming sectors (transportation, heating including industrial processes and electricity) has been rising evenly across the region, and there have been no sectors left out of the transition. As in France, transportation is the number-one source of greenhouse gas (GHG) emissions, followed by manufacturing. In light of this, governments took strong, often ground-breaking measures very early on to begin decarbonising the transportation sector.

Over the past 15 years, the Nordic countries have trialled several large-scale transport decarbonisation initiatives, to varying degrees of success (electric vehicles have taken off in Norway whereas use of E85 super-ethanol has declined in Sweden, for example). A potential area of focus is electrified roads that recharge the batteries of vehicles driving on it (Sweden has plans to introduce 2,000 km of such roads by 2030). The international community is closely watching the rollout of these new initiatives to see how feasible they are. Right now, no other country has more electric vehicles than Norway (as a percentage of its automobile fleet) or a higher share of biofuel in total motor fuel sales than Sweden.

Most Nordic countries have largely exceeded the European target of 10% for energy from renewable sources in transport as set out in Directive 2009/28/EC. Sweden and Norway have already achieved three times this figure (30% and 27% respectively in 2019) and Finland two times (21%, which is more than double the EU average).[9] The expansion of biofuels has been a significant factor (see Chart 2), particularly low-blend second-generation HVO biodiesel,[10] which accounts for nearly 70% of biofuels sold in Sweden and Finland by volume.

Chart 2: Final renewable energy consumption in the Nordic transport sector



Source: Nordic Energy Research 2020.

In Norway, the rapid uptake of electric vehicles in combination with hydroelectricity is the reason for the high share of renewables in the transportation sector. In 2020, 83% of new car sales were for electric vehicles of some kind (a world record), with 54% fully electric and 29% hybrid.[11] The evidence from the "Norwegian laboratory" is that, even if the fiscal cost is high (€1.9bn per year in public support), it is technically feasible to adopt electric vehicles on a large scale, without any major issues for the electricity grid to date. Government incentives (exemption from 25% VAT on purchase, discounts of at least 50% on road tolls, parking and ferry fees, etc.) have helped new electric vehicles become more affordable to purchase than equivalent conventional models. The country aims to phase out the sale of new internal-combustion vehicles by 2025. The increase in national electricity consumption associated with a fully electric vehicle fleet would be only 4%.[12] There remains, however, the issue of battery recycling.

(6) IEA (2020), "Data and Statistics on Energy Supply".
(7) Pugh *et al.* (2019) "The Role of Forest Regrowth in Global Carbon Sink Dynamics".
(8) Kriström B. *et al.* (2018), "Are Climate Policies in the Nordic Countries Cost-Effective?".
(9) Eurostat (2021), "Energy from Renewable Sources".
(10) Hydrogenated vegetable oils (HVO), mostly from waste animal and vegetable fats. 92% of HVO biodiesel consumed in Sweden is classified as a second-generation biofuel (derived from non-food sources). It has a chemical structure similar to that of fossil fuel diesel, making it easy to incorporate into low blends.
(11) Reuters (2021), "Electric Cars Rise in Norway".
(12) Statnett (2019), "An Electric Norway – From Fossil to Electricity".

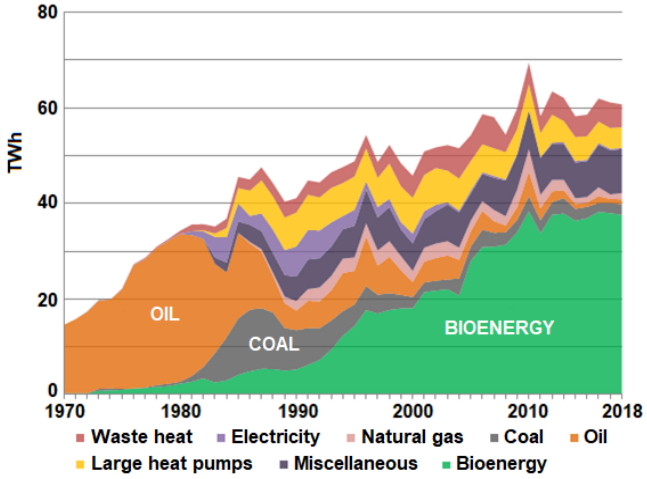
As for heating (buildings, industrial processes, etc.), the second energy sector, the Nordic countries have seen overall positive results, with the share of renewables in 2019 ranging from 80% in Iceland to 36% in Norway, compared to an EU-wide average of 20%. With the exception of Iceland, which has unique geothermal conditions, the strong increase in the share of renewables in heating (up more than 18 percentage points over 15 years across all countries) is due to the development of wood biomass-fuelled cogeneration in district heating networks and the substitution of fossil fuels for bioenergy sources in industrial processes.

In 1980, Sweden's share of fossil fuels in residential heating was comparable to present-day France, standing at 60%. By 2019, the country managed to bring it down to an astonishing 4%, and in 2020 practically achieved its national target of fully eliminating fossil fuels from heating. Nearly all buildings are heated by district heating networks, which are mainly supplied by renewable sources (see Chart 3). In individual homes, there has been strong uptake of heat pumps and district heating systems.

Nuclear energy makes up less than a quarter of the Nordic mix. Like France, Sweden faces the challenge of reducing the share of nuclear energy in its mix.[13] In contrast, Finland is investing in nuclear power to wean itself off fossil fuels and protect its security of supply. It is completing construction of an EPR reactor (Olkiluoto 3), and public perception of nuclear energy, which makes up 35% of Finland's energy mix, is generally positive, including by environmentalists who see it as key to phasing out coal by 2029 and ensuring energy self-sufficiency.

In terms of electricity, the share of renewables improved even though the mix was already low-carbon. Nordic electricity generation was 92% carbon-free in 2019. A feature of the Nordic electricity sector is strong regional integration. Nordic countries began liberalising their electricity markets as early as 1991 in Norway's case. Nearly all power generated is sold on the region's Nord Pool power exchange, now owned by Euronext. For a large part of the year, there is a single market price for electricity across the Nordic countries (excluding Iceland), owing to strong interconnections. Finland imports a quarter of its electricity this way, mainly from Sweden.

Chart 3: Energy sources used in Sweden's district heating network



Source: Swedish Energy Agency (STEM), 2020.

The high degree of regional integration has played a major role in helping renewable energy sources take off. Denmark's world-leading share of wind power (57% of its electricity mix) has been made possible by the flexibility of the cross-border network. According to the International Energy Agency (IEA),[14] interconnections help even out variation in Denmark's wind production 80% of the time. In total, over the period 2004-2019, the share of renewables in final electricity consumption increased by 42 percentage points in Denmark and 20 points in Sweden, driven by wind and biomass power.

2. Public policy innovations accelerating the transition

2.1 Ambitious climate targets were introduced very early on to ensure full stakeholder engagement

One of the key tools for ensuring stakeholder engagement and preparing for the transition was the early adoption of ambitious and clearly defined climate targets. Some Nordic countries adopted carbon neutrality as an objective very early on (2008 in Norway and 2009 in Sweden), followed by gradually raising climate targets.

Under the Paris Agreement, Finland is aiming for carbon neutrality by 2035 and Iceland by 2040 (defined, as in France, by subtracting emissions absorbed by carbon sinks[15] from domestic emissions), Sweden by

(13) Nuclear energy accounted for 40% (Sweden) and 71% (France) of electricity generation in 2019.
(14) IEA (2017), "Energy Policies of IEA Countries: Denmark 2017 Review".

2045 (without subtracting pre-existing carbon sinks since the country is already practically carbon-neutral as a result of its forests) and Norway by 2030 (including carbon sinks and international flexibility mechanisms).[16]

These targets are broken down into sub-targets, most of which also exceed those set by the EU. Sweden is aiming for a 59% reduction in non-ETS[17] emissions by 2030 compared to 2005 levels, whereas the effort-sharing target set for the country in Regulation (EU) 2018/842 – the highest target assigned to a Member State – is just 40%.

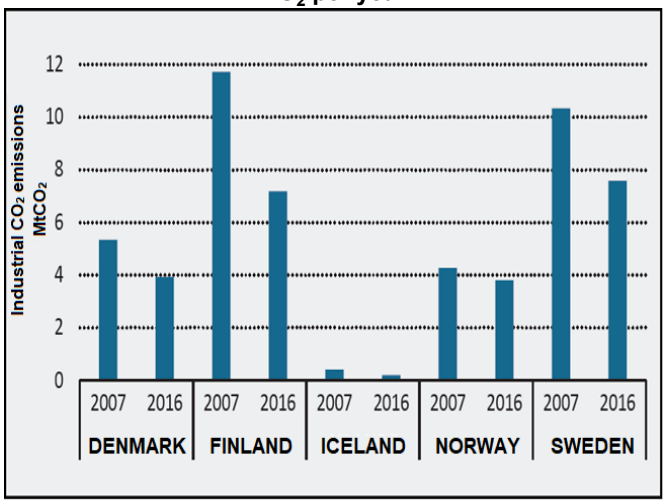
2.2 High carbon taxation with controlled redistribution

Carbon taxes have been the most effective cross-cutting instrument for reducing emissions in the region[18]. It has enabled the societal cost of GHG emissions to be integrated into the choices of economic agents, redirecting them to less carbon-intense and less costly solutions. The Nordic countries pioneered the introduction of a carbon tax in the early 1990s, which today stands at €114 per tonne of CO_2 in Sweden. Although the Nordic region has some of the highest effective carbon tax rates in the OECD,[19] raising them remains central to the Nordic strategy. In early 2021, Norway decided to triple its nominal carbon tax rate, raising it from €57 to €192 per tonne of CO_2 by 2030.

Carbon taxes have a regressive effect in the region:[20] low-income households spend a larger share of their annual resources on taxes than wealthy households (Sterner *et al.*). To mitigate the redistributive effects of a carbon tax increase between household categories, the Nordic countries introduced measures to protect the purchasing power of low-income households, such as an increase to the basic income tax allowance in Sweden (see Box 1) and an income-tested tax credit in Denmark. These support measures are not tied to energy use and are in line with the Nordic decision to allocate green tax income to the general budget instead of earmarking it for environmental initiatives (Skygedberg *et al.*). Generally speaking, when the carbon tax was introduced there was little discussion about its redistributive effects,[21] as the Nordic countries are among the most equal in terms of income, boasting a much lower Gini coefficient[22] than the EU average.

In addition to the polluter pays principle, high carbon taxation has been effective in promoting green energy, which is largely exempt (bioenergy in particular, and soon electrofuels like green hydrogen).[23] It has made it affordable to substitute fossil fuels with bioenergy sources in production assets, helping to cut the share of fossil fuels in Finland's industrial energy supply in half since 1990[24] (see Chart 4). Some heat-generating industries are subject to double carbon pricing (ETS and a national carbon tax). In Sweden, fossil fuels now account for 19% of industrial energy consumption, versus 55% in 1975. In Finland and Sweden, bioenergy now makes up more than 40% of industrial energy consumption.

Chart 4: Industrial CO_2 emissions, millions of tonnes of CO_2 per year



Source: Nordic Energy Research (2020).

(15) Land-Use, Land-Use Change and Forestry (LUCLUCF).
(16) By purchasing international carbon credits.
(17) EU Emissions Trading System.
(18) Nordic Council (2014), "A Case Study on Efficient Policy Measures".
(19) OECD (2019), "Taxing Energy Use".
(20) Skygedberg *et al.* (2020), "Distributional Impacts of Environmental and Energy Taxes".
(21) Andersson J. *et al.* (2020) "The Distributional Effects of a Carbon Tax".
(22) The Gini coefficient measures inequality of income. When the carbon tax was introduced, the Nordic countries had an index of 22, one of the lowest in the world (the EU average was 30.7 in 2019).
(23) Åkerfedlt S. *et al.* (2011) "CO_2 Taxation in Sweden".
(24) IEA (2018), "Energy Policies of IEA Countries: Finland 2018 Review".

Box 1: Sweden's green tax shift

In the 2000s, Sweden's Social Democrat government undertook a large-scale environmental tax reform, or a "green tax shift". It increased environmental taxes by 0.7 percentage points of GDP between 2001 and 2006, while also paying the same amount back to households and firms, primarily in the form of income and corporate tax cuts.[a] The carbon tax rate grew from €40 to €90 per tonne of CO_2 between 2000 and 2004. To ensure a just transition,[b] Sweden accompanied the increase with measures to limit the impact on the end-price of fuel (the reduction in energy tax almost completely offset the increase in price)[c] and, more generally, used tax breaks to limit the impact on the most vulnerable consumers[d] (*cf.* Table 1). The basic income tax allowance was raised, ensuring additional purchasing power for lower-income households. The reform was a success in terms of public reception, since the redistributive effects between household categories and between urban/rural areas were largely neutralised.[e] It also succeeded in reducing fossil fuel consumption.

The increase in carbon taxation sent a strong price signal to energy suppliers (sellers of fuels, heating, etc.), incentivising them to replace fossil fuels with bioenergy sources, which had become more competitive with the tax exemptions[f]. Consumers saw practically no change in prices, since the increase in energy taxes for producers was largely neutralised by a decrease in general consumption taxes. Even though Sweden's carbon tax rate is three times as high as France's, the total tax charged on motor fuels per litre is similar in both countries. It has proven to be an effective measure that has been credited for the record share of renewable energy in Sweden's transportation mix. In early 2019, the government introduced another reform: new green tax revenues, equivalent to 0.3% of GDP, are to be created during the 2018-2022 mandate and fully paid back to households and firms. The country is forging ahead with its green tax strategy in other areas, introducing more new taxes (fees on plane tickets, plastic bags, chemical products, electronic devices, etc.).

Table 1: The green tax shift between 2001 and 2003

Year	Tax reform measure	Impact of measure	Net impact (in €m)
2001	Increase in basic income tax allowance	€120	280
	Decrease in employer contributions	0.10%	49
	Carbon tax increase (25%), energy tax decrease (8%)	Neutral	0
	Additional carbon tax increase	€7/tonne of CO_2	99
	Energy tax increase on electricity	€1.8/MWh	205
	Tax increase on diesel	€0.1/litre	26
	Total transferred		330
2002	Increase in basic income tax allowance	€90	200
	Carbon tax increase	€8/tonne of CO_2	93
	Energy tax increase on electricity	€1.2/MWh	91
	Tax increase on waste	€3.8/tonne of waste	16
	Total transferred		200
2003	Increase in basic income tax allowance	Varies based on income	300
	Carbon tax increase	€12/tonne ofCO_2	88
	Energy tax increase on electricity	€2.5/MWh	173
	Tax increase on waste	€8.2/tonne of waste	28
	Tax increase on natural gravel mining	€0.5/tonne of favel	9
	Total transferred		300
	Total transferred for the period 2001-2003		**830**

Source: Swedish budget bill (2004).

a. Grosjean J. and T. Sterner (2017), «Une fiscalité verte efficace pour le climat : retour sur l'expérience suédoise», *Annales des mines*.
b. As noted by France's High Council for Climate Action (2020 report), wealthy households have a far greater carbon footprint than low-income households, but the share of the budget they devote to the green transition, particularly through taxation, is much smaller.
c. There has not been a significant increase in the effective carbon tax rate of motor fuels in Sweden. At national level, the rate varies between fuel types, sectors and economic stakeholders. The Nordic rate is only slightly above the OECD average for motor fuels, but among the highest for other sectors (OECD "Taxing Energy Use 2019").
d. In addition to a loss of purchasing power, the government considered the loss of well-being: green tax increases lead low-income households to make certain choices (lowering their heating, carpooling, taking public transit, choosing smaller and more remote housing, etc.) to a greater degree than wealthy households.
e. OECD (2014), "OECD Environnemental Performance Reviews: Sweden 2014".
f. The introduction of mandatory carbon footprint reductions for fuels led to the lifting of tax exemptions for low-blend biofuels in July 2018.

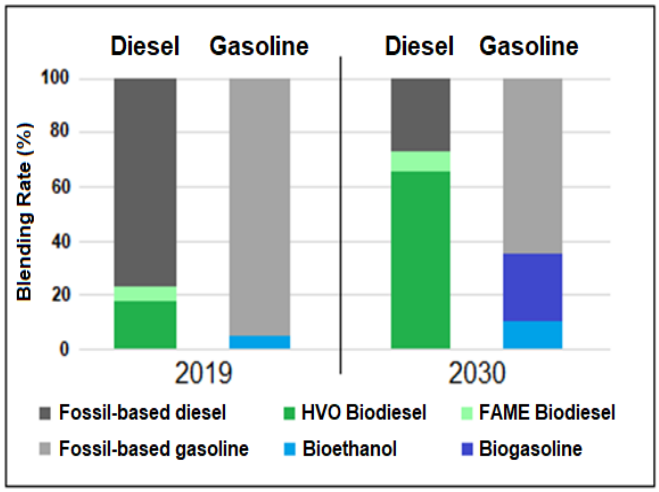
2.3 Innovative policies targeting strategic sectors and green finance

The Nordic countries have also introduced innovative sector-specific measures in their efforts toward a green transition. Looking to tap its vast wind power potential of 100 TWh to decarbonise its energy mix and support its industrial champions (Vestas, Ørsted), Denmark announced a major "energy island" project for offshore wind farms, which will include a 2-gigawatt site on Bornholm by 2030 and a 3-gigawatt site on an artificial island in the North Sea by 2033 (with the government contributing a third of the €28bn investment). As in France but unlike other Scandinavian countries, which opted for an extra-budgetary mechanism[25] (green certificates), Denmark offers variable feed-in tariffs for wind-generated electricity depending on the site.

Sweden has introduced innovative measures to "automate" progress toward its target of reducing transport-related GHG emissions by 70% between 2010 and 2030 – the world's most ambitious target. The government introduced rates for lowering the carbon footprint of fuel sold in the country in order to make the automobile fleet greener through biofuels being blended into diesel and petrol. In 2021, operators can only sell diesel whose GHG emissions are 26% lower than fossil fuel diesel. As a result, the diesel sold in Sweden contains approximately 30% biodiesel. Every year, the rates are raised for both diesel and petrol in order to achieve the national target for 2030 (see Chart 5). It is a pioneering initiative that provides investors with long-term visibility, and it has been extended to the airline sector.[26] The issue of palm oil has arisen (see Section 3.3).

Public finance is another tool the Nordic countries have used to support the green transition (see Box 2 for Norway). Sweden was the first country to prohibit government export support for any kind of fossil fuel exploration or drilling projects by 2022, and the government required Swedfund, the country's development finance institution, to end all fossil fuel financing, including indirect financing provided through financial intermediaries. Directive 2014/95/EU, known as the Non-Financial Reporting Directive (NFRD), requires firms with more than 500 employees to publish an annual sustainability report; all of the Nordic countries have extended the scope of this requirement to firms with at least 250 employees (50 in Norway). Sweden plans to introduce a green savings scheme for individuals who invest in government-certified green products, with a tax credit worth 1% of their investment.

Chart 5: Sweden's programme to reduce the GHG emissions of motor fuels



Source: Swedish Energy Agency (STEM), 2020.

On the bond markets, the Nordic countries are the world's leading issuers (per capita) of green bonds. The largest market, worth over €9bn, is in Sweden. As a whole, the Nordic region had issued a total of €15.8bn in green bonds at the start of 2020, which is two-thirds the volumes of France and China. In 2019, green bonds made up 15% of new bond issuances in Sweden, compared to 7% in France and 1% worldwide. Norway is also home to the world's leading green bond rating agency, Cicero Shades of Green, which covers a quarter of the global market.

(25) The green electricity certificate system introduced in Sweden in 2003 and extended to Norway in 2012 will be shut down on 31 December 2021, 10 years earlier than planned, as the governments consider it to have achieved its objectives. It was fully extra-budgetary in Sweden from 2003 to 2020 and incorporated into the national accounts at the end of 2020.

(26) 0.8% decrease in the carbon footprint of kerosene for 2021 (27% by 2030).

Box 2: Should Norway's sovereign wealth fund be seen as a model for sustainable management?

Among the Nordic countries, Norway has a strong influence in the global green finance arena through how it invests the assets of its oil fund (the world's second largest sovereign wealth fund). Renamed Government Pension Fund Global (GPFG) in 2005, the fund had €1,074bn in assets under management at 3 February 2021, invested 69% in equity and 28% in fixed income. The fund controls 1.4% of global market capitalisation and is invested in some 9,200 companies across 73 countries. Big tech stocks are the fund's biggest holdings. In 2016 the fund, which has had an ethics committee since 2004, decided to sell stakes in companies that derive more than 30% of their income from coal (a total of 52 companies including 16 in the US, 13 in India and 3 in China).

In 2019, Norway's parliament required the fund to divest from oil and gas producers that have not begun the transition to renewable energy. The fund can no longer invest in pure-play oil companies (134 companies on the FTSE Russell), but it can remain invested in companies with any degree of diversification, no matter how small (at the start of 2020, the fund held a 2.55% stake in Shell, 2.33% in Total and 2.34% in BP). Parliament prohibited the fund from investing in companies that produce more than 20 million tonnes of coal annually or generate more than 10 gigawatts of power from coal. This decision is expected to force the fund to sell its holdings in companies like Glencore, BHP Billiton, RWE, Enel, etc. The decision was based on financial criteria, in light of the growing risk to the value of fossil fuel assets in the medium term. Parliament has allowed investment in non-listed companies associated with renewable energy projects, even though the fund is generally not allowed to invest in private equity.

These measures will help the fund improve its environmental performance. In 2020, the carbon footprint of the fund's equity portfolio – accounting for direct emissions (scope 1) and indirect emissions associated with the purchase of electricity and heat (scope 2) – stood at 133 tonnes of CO_{2eq} per million USD in turnover, [a] which is 17%[b] less than in 2019 and 20% less than the benchmark index (FTSE All Cap). In France, the pension reserve fund's 2019 footprint stood at 233 tonnes of CO_{2eq} per million euros in turnover.[c]

However, Norway's fund emitted the equivalent of 92 million tonnes of CO_{2eq}. in 2020,[d] which is double the country's national emissions. Including indirect emissions (scope 3) would put this figure even higher.

a. The carbon footprint is measured as the weighted sum of the carbon intensities of the companies invested in by the fund. Carbon intensity is calculated by dividing a company's annual GHG emissions by its annual turnover.
b. Norska Bank (2021), "Responsible Investments 2020 - Government Pension Fund Global".
c. FRR (2020), "Rapport annuel 2019".
d. Scope 1 and 2 emissions calculated based on the percentage held by the fund in each company.

3. Some green strategies have a mixed environmental record

3.1 An increase in Icelandic and Norwegian emissions is dragging down the Nordic carbon balance

Thanks to renewable energy, the Nordic region reduced its overall GHG emissions by 20% between 1990 and 2018, despite an increase in emissions in Iceland and Norway (see Chart 6). This is below the EU average (–25%) despite strong performances from Denmark (–30%) and Sweden (–27%), which now boast the lowest GHG emissions per capita in the EU15 (5 tonnes of $CO_{2eq.}$). Seemingly paradoxically, the increased adoption of renewable energy in Iceland and Norway has not led to a decrease in GHG emissions. The share of renewables in the primary energy mix grew by 18 percentage points in Iceland, but the island saw a 30% increase[27] in emissions between 1990 and 2018. In Norway, emissions have risen slightly since the early 1990s, even though the share of renewable energy sources has gone up. In Iceland, this disconnect is due to the growth of power-intensive industries, such as aluminium production, which have been improving the environmental impact of their production by shifting to competitive green energy sources (hydro,

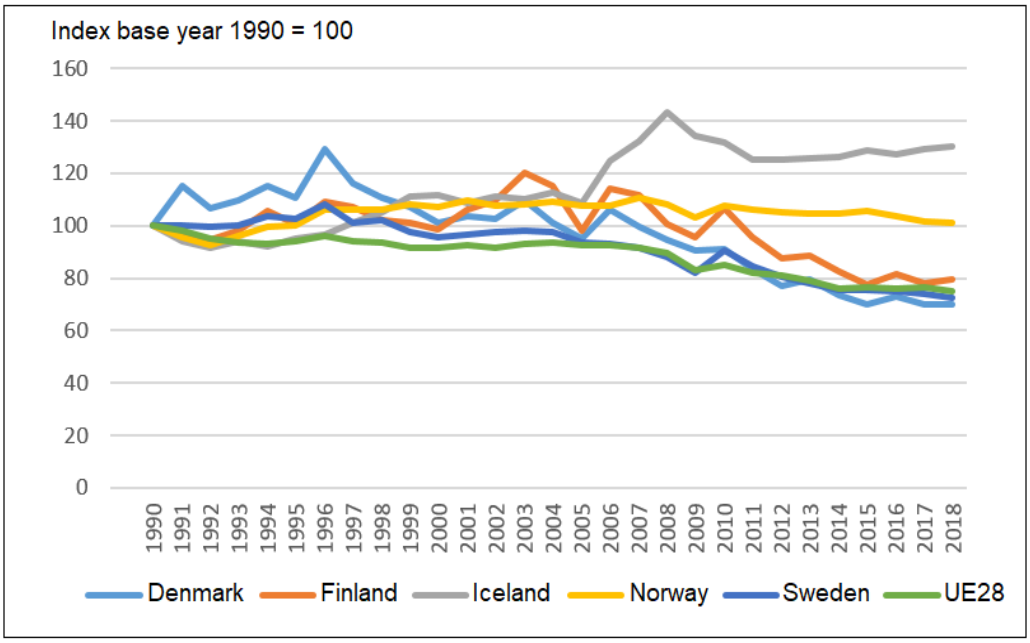
(27) EEA (2021), "Trend and Projections in Europe".

geothermal) but emit large quantities of CO_2 from the use of carbon anodes in the electrolysis process. Overall, the increase in Iceland's emissions[28] is chiefly attributable to its industrial emissions.

In Norway, the disconnect is due to the country's oil platforms, which account for a quarter of its emissions (primarily from gas turbines installed on the platforms). Alongside increased production, their emissions grew by 110%[29] between 1990 and 2018, despite a targeted carbon tax.[30] The energy used to power pumps and supply electricity to the platforms has traditionally come from gas turbines, but a move has been made toward electrification.[31] Norway's oil exports are also the source of more than 1.5% of worldwide CO_2 emissions from fossil fuel burning activities.

Norway is continuing to pursue oil exploration activities, in contrast to other Scandinavian countries which, like France, have introduced bans.[32] Denmark, which is the EU's leading oil producer, plans to cease production by 2050. In December 2020, Norway's supreme court rejected an appeal by Greenpeace to stop Norwegian oil exploration projects in the Arctic. Norway's new 2030 climate targets include few new initiatives and are much less ambitious than those of its Scandinavian neighbours. The country has also not made any major decisions against government support for oil exports, in contrast to Sweden.

Chart 6: GHG emissions of Nordic countries



Source: OECD.

3.2 Nordic imports remain relatively carbon intensive

High carbon pricing levels in the Nordic region raise the issue of potential carbon leakage,[33] which is when ambitious climate policies in a given region cause emissions to increase elsewhere in the world.[34]

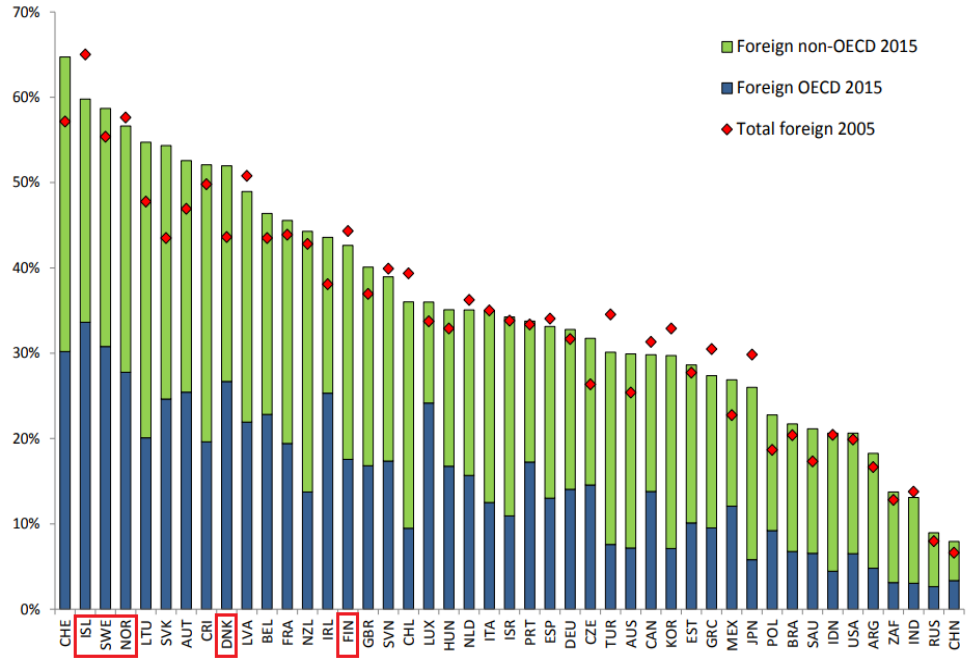
Leakage from the Nordic region seems to have been limited by free carbon quotas awarded under the Emission Trading Scheme (EU ETS) to exposed sectors, green national tax exemptions to companies under the EU ETS and relatively low carbon prices during the initial phases of the ETS. The region also

(28) EEA (2020), "Greenhouse gases – Data Viewer".
(29) EEA (2021), "Trend and Projections in Europe".
(30) Since 1990, the platforms' CO_2 emissions (85% of which are from electric turbines) have been subject to a CO_2 (€53 per tonne of CO_2 in 2021).
(31) 50% of platforms are to be electrified by 2025.
(32) Denmark has prohibited oil exploration and new drilling since 2020 (2022 in Sweden).
(33) Leakage can be "direct" (production moved to countries with less strict environmental rules) or "indirect" (higher fossil fuel consumption in less environmentally ambitious countries due to a downward global price trend associated with lower consumption levels in ambitious regions).
(34) L'Heudé W., M. Chailloux et X. Jardi (2021), "A Carbon Border Adjustment Mechanism for the European Union", *Trésor-Économics* no. 280.

appears to be positioned on the downward slope of the environmental Kuznets curve[35] as evidenced by the relationship between rising GDP and falling total aggregate GHG emissions across the Nordic region.[36]

However, these positive results are tempered by the carbon intensity of the region's gross imports. Levels only contracted by 24% in Denmark and 31% in Sweden between 2005 and 2015, which is below the OECD and EU averages (42% and 35% respectively).[37] The figure is now much higher in Denmark and Finland than in France. This is particularly concerning in that the Nordic countries have very open economies that are dependent on imports (see Chart 7). These high carbon intensity levels appear to mainly be due to an increase in imports of manufactured products from China (Peters *et al.)*.[38]

Chart 7: Share of CO_2 emitted abroad in total CO_2 embodied in domestic final demand



Source: OECD, 2020.

3.3 Debates surrounding bioenergy and geothermal emissions

The Nordic strategy of substituting fossil fuels with wood biomass has been criticised by some NGOs despite the positive climate impacts of sustainable forestry practices (young-growth forests that absorb more carbon, new species better adapted to climate change, increase in albedo[39] after wood harvesting, etc.). The time it will take to absorb emissions produced by felling (carbon dioxide released from the soil, emissions produced by felling equipment, transportation, etc.) and burning trees is estimated to be several decades, which these NGOs consider to be too long given the urgency of the climate crisis. They are also concerned about protecting the biodiversity of forests.

(35) The environmental Kuznets curve is an inverted U curve representing a relationship between pollution and economic development. The theory posits that pollution begins to decline when a country reaches a certain economic threshold..
(36) GHG emissions in the Nordic region fell by 20% between 1990 and 2018, despite increased emissions in Iceland and Norway over the same period.
(37) OECD (2020), "Carbon Dioxide Emissions Embodied in International Trade".
(38) Peters G. *et al.* (2010), "Global carbon footprint – results from the Nordic countries".
(39) The reflectivity of the sun's rays (albedo) is higher in young-growth forests than old-growth forests, which reduces local warming. The deforestation of specific areas of the planet could have a positive effect on the climate (Williams (2021)).

Motor biofuels are also subject to some criticism. In 2019, a third of Sweden's biofuels came from PFAD[40] palm oil residue. This led the government to eliminate tax breaks for PFAD-derived HVO biodiesel in July 2019, which is expected to increase the share of biodiesel from other sources. As of 2022, only palm oil-derived biodiesel that meets the highest sustainability standards will be allowed to be sold. In Iceland, geothermal power plants are criticised for their hydrogen sulphide (H_2S) emissions due to concerns of the impact on human health[41]. In response, since 2010 the government has been imposing penalties on power producers when atmospheric H_2S concentration levels in the capital exceed 0.5 µg/m^3,[42] which has helped to limit spikes in pollution.

(40) Palm fatty acid distillate.
(41) Finnbjornsdottir *et al.* (2019).
(42) OECD (2014), "OECD Environmental Performance Reviews: Iceland 2014".

Publisher:
Ministère de l'Économie, des Finances, et de la Relance
Direction générale du Trésor
139, rue de Bercy
75575 Paris CEDEX 12

Publication manager:
Agnès Bénassy-Quéré

Editor in chief:
Jean-Luc Schneider
(01 44 87 18 51)
tresor-eco@dgtresor.gouv.fr

English translation:
Centre de traduction
des ministères économique
et financier

Layout:
Maryse Dos Santos
ISSN 1962-400X
eISSN 2417-9698

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