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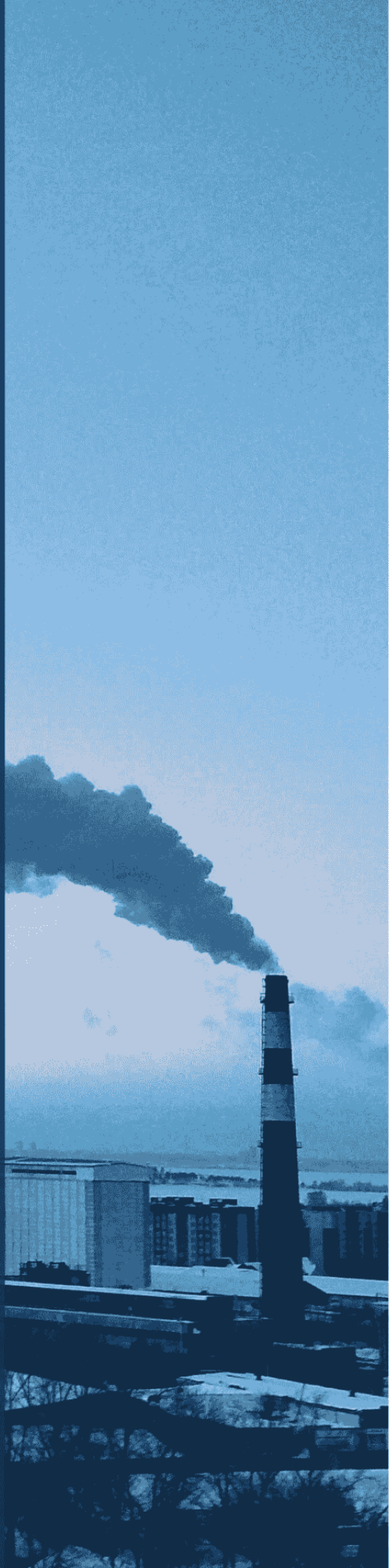
Innovating to Zero Carbon Pollution: Nordic countries and their initiatives to reduce carbon footprint for a Sustainable Future



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INTRODUCTION

Decreasing carbon pollution involves not only reducing carbon emissions but also addressing the broader impacts on society, the environment, and public health. This approach recognizes that lowering emissions alone is insufficient and requires a shift towards renewable energy sources to ensure sustainable, long-term solutions. Additionally, it emphasizes the importance of policy commitments, international agreements, and collective action to create a framework that supports climate resilience, equitable access to clean energy, and the protection of vulnerable communities. By prioritizing these interconnected factors, we not only mitigate environmental pollution but also safeguard ecosystems, promote economic equity, and improve health outcomes, creating a more sustainable and just future for all.

In 2023, global greenhouse gas (GHG) emissions reached a new record high of 53 billion metric tons of carbon dioxide equivalent ($GtCO_2e$). This shows more than 60 percent rise in GHG emissions since 1990.[1] Reducing carbon dioxide (CO2) emissions has become important for countries worldwide due to its critical role in mitigating climate change, improving public health, and supporting sustainable economic growth. CO2, a leading greenhouse gas, significantly contributes to global warming by trapping heat in the atmosphere, which accelerates the onset of extreme weather events, rising sea levels, and environmental degradation[2]. Additionally, burning fossil fuels that generate CO2 emissions also produces harmful air pollutants, negatively impacting human health and ecosystems. Considering these challenges, prioritizing CO2 reduction is essential not only to safeguard the environment but also to create a cleaner, healthier future for generations to come.

Nordic countries are at the forefront of efforts to reduce CO2 emissions due to their strong environmental policies, commitment to renewable energy, and a deep-rooted emphasis on sustainability. Nations like Sweden, Denmark, Finland, Iceland, and Norway have set ambitious targets for carbon neutrality and have enacted comprehensive climate legislation, such as carbon taxes and incentives for renewable energy adoption. Norway, for instance, generates 98% of its electricity from hydropower[3], while Denmark leads in wind energy technology. These countries also heavily invest in innovative green technologies, like carbon capture and storage (CCS), and actively support global climate agreements. In 2023, greenhouse gas emissions in the Nordics dipped below 200 million metric tons of CO_2 equivalent ($MtCO_2e$), the lowest value in at least three decades[4]. Their leadership in reducing carbon emissions stems from a combination of environmental values, robust governmental support, and a proactive approach to transitioning away from fossil fuels, positioning them as models for global carbon reduction efforts.

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[1] https://www.statista.com/statistics/1285502/annual-global-greenhouse-gas-emissions/
[2] https://climate.nasa.gov/vital-signs/carbon-dioxide/?intent=121
[3] https://lowcarbonpower.org/region/Norway
[4] https://www.statista.com/topics/11146/climate-change-in-the-nordics/

This paper explores the efforts practiced by Nordic countries to reduce their carbon emissions and highlights the urgent need for countries to focus on reducing carbon emissions and the strategic benefits of such efforts on a global scale.

METHODOLOGY OF THE STUDY

- Priority indicators

There are several parameters to consider for the decrease in carbon pollution. The use of renewable energy, adoption of policies, aims to achieve carbon neutrality, use of carbon taxation, and yearly emissions of GHG are some of them. These parameters showcase an overall picture of a Nordic country and where it stands to reduce carbon pollution.

- Data compilation

The data for Nordic countries was collected based on set parameters like the number of years since the first policy was introduced to decrease carbon pollution, the year the country targets to achieve carbon neutrality, policies introduced and practiced for reducing CO2 emissions, innovations for reducing carbon emission, GHG emissions from 2020 to 2023, the percentage decrease in GHG emissions in 4 yrs, percentage of renewable energy used, and the applicable tax rate for GHG emission. First, a list of Nordic countries was created followed by data collection according to the parameters. The data compilation followed both qualitative and quantitative approaches.

- Rank Assessment

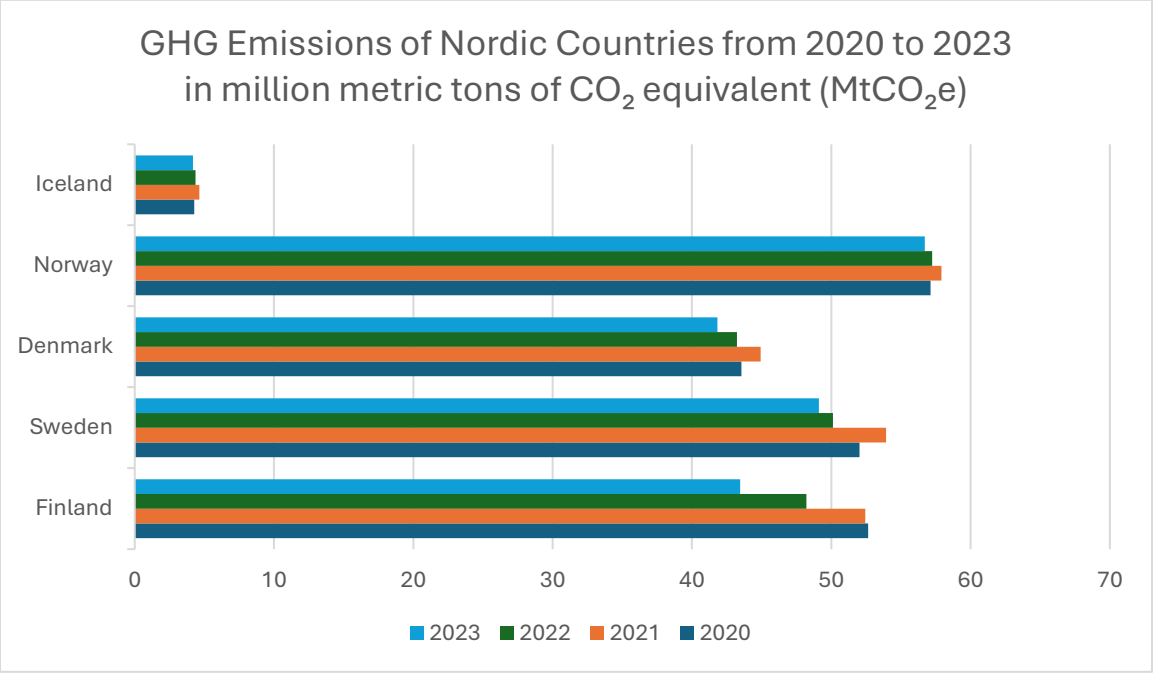
The rank assessment was done by calculating the index scores based on weighted averages and a comparison of the ranking among the countries.

ANALYSIS

Climate conferences and agreements like the Kyoto Protocol and Paris Agreement are held time and again around the world to adopt policies for reducing carbon pollution and to hold nations and governments accountable to the environment and people while conducting any kind of developmental effort. Nordic Countries have actively been a part of environmental protection efforts by not just signing agreements but also adopting policies to meet their goal of reducing the carbon footprint. Greenhouse gas (GHG) emissions in the Nordic countries have significantly dropped in recent years due to the adopted policies and practices like carbon taxation, subsidizing electronic vehicles, and increasing the use of renewable energy like hydropower and wind energy to reduce carbon pollution from as early as the 1990s.

Finland and Denmark were the first countries around the world to start their carbon-neutral policies and efforts in 1990[5]. Similarly, Finland also has an ambitious goal of becoming a carbon-neutral country by 2035, which will be one of the first countries around the world to do so[6]. Along with these initiatives to reduce their carbon pollution, Nordic countries have also increased their use of renewable energy. Denmark uses an exemplary, 81.4% of renewable energy[7], followed by Iceland with 78.6% of its energy being renewable. These efforts have significantly helped the Nordic countries to reduce their GHG emissions and be on track to meet their goal of being a carbon-neutral country.

The graph below shows a reduction in GHG emissions from all five Nordic countries over the last four years.



Source: Frost and Sullivan Institute

Policies Introduced in 2020 in Nordic Countries

In December 2020, the EU enhanced its target for 2030 under the Paris Agreement. The new target is to reduce emissions by at least 55 % below 1990 levels by 2030.[8]

In 2019, the Finnish National Air Pollution Control Program (NAPCP) which comprises actions to implement the emissions reduction commitments of Finland under the National Emissions Ceilings Directive (2016/2284/EU), as well as other actions to improve air quality was introduced.

[5] Carbon Removal Policy in Denmark
[6] https://www.weforum.org/stories/2023/06/finland-carbon-neutral-2035-goals/
[7] https://denmark.dk/innovation-and-design/clean-energy
[8] https://www.regjeringen.no/en/dokumenter/meld.-st.-13-20202021/id2827405/?ch=1

Similarly, in 2020, Finland allocated €5.5 million for the points. In 2020, the Rural Development Program for Mainland Finland provided support for local biogas plants which contributed to a reduction in methane emissions from manure.

In Sweden, from 2017-2020, the Swedish Environmental Protection Agency funded the research Swedish Clean Air & Climate Research Program (SCAC2), which has helped strengthen the scientific basis for action on short-lived climate pollutants[9].

In Denmark, The Climate Act, approved by the Danish Parliament in June 2020, sets legally binding targets of a 70% reduction in GHG emissions by 2030 (compared with 1990) and climate neutrality by 2050[10].

In Norway in the year 2020, about NOK 4.5 billion was allocated to a green restructuring package, including funding for research, innovation, and green restructuring in the business sector and at the local government level[11].

According to Iceland's Climate Action Plan 2020, climate mitigation measures were allocated an increase in funding of almost 7 billion Icelandic krónur in the period 2019-2023. A general carbon tax, already in place, would gradually increase (it was increased by 50% in the beginning of 2018, by 10% in 2019, and by 10% again in 2020).

NORDIC COUNTRIES AND THEIR INITIATIVES TO REDUCE CARBON POLLUTION OVER THE YEARS

[9] https://www.ccacoalition.org/partners/sweden
[10] https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/679106/EPRS_BRI(2021)679106_EN
[11] https://www.regjeringen.no/en/dokumenter/meld.-st.-13-20202021/id2827405/?ch=1

1. Finland

Finland was one of the first countries worldwide to adopt policies to decrease carbon emissions in 1990 and is considered a pioneer in carbon neutrality due to its ambitious environmental policies, innovative practices, and strong commitment to sustainability. The country aims to achieve carbon neutrality by 2035, one of the most ambitious goals globally. Finland's best practices include investing in renewable energy, such as wind and solar power, which now make up over 40% of its electricity generation[12]. The Finnish government also prioritizes energy efficiency, carbon pricing, and forest management, with forests acting as vital carbon sinks. Key policies include the carbon tax, incentives for clean energy technologies, and the "Climate Roadmap" (i.e. climate action strategy), which guides the nation's path toward carbon neutrality. Finland also emphasizes circular economy principles, reducing waste through recycling and repurposing materials. Additionally, Finland's environmental education programs and community engagement in sustainability efforts strengthen its reputation. In 2020, Finland was ranked first globally in the Environmental Performance Index, reflecting its strong environmental governance, clean air, and commitment to reducing pollution, making it a leader in environmental sustainability[13].

2. Sweden

Sweden is a global leader in sustainability and carbon neutrality, with a comprehensive approach that combines ambitious policies, innovation, and social commitment. The country aims to achieve net-zero emissions by 2045 and has already made significant strides, with 56% of its energy coming from renewable sources such as hydropower, wind, and bioenergy[14]. Sweden's commitment to carbon pricing through a robust carbon tax system has been a key factor in its success, incentivizing businesses to adopt cleaner technologies. Additionally, Sweden has pioneered waste-to-energy systems, with about 50% of household waste being recycled or used to generate energy[15]. Its policies, like the "Climate Act," which legally binds the government to meet carbon neutrality goals, and investments in sustainable transportation, such as electric vehicles (EVs), are central to its efforts. Sweden also leads in promoting green innovation and climate action through programs like "Fossil-Free Sweden," which brings together various industries to transition toward a low-carbon economy[16]. Ranked consistently high in global sustainability indexes, Sweden's commitment to environmental protection, combined with its focus on social equity and public health, has made it one of the world's top countries in terms of environmental performance.

[12] https://kansalaisuuskoe.com/renewable-energy-in-finland-wind-solar-and-bioenergy-initiatives/
[13] https://www.oecd.org/en/publications/oecd-environmental-performance-reviews-finland-2021_d73547b7-en.html
[14] https://www.iea.org/countries/sweden
[15] https://www.blueoceanstrategy.com/blog/turning-waste-energy-sweden-recycling-revolution/
[16] https://pub.norden.org/temanord2024-534/6-sweden.html

3. Denmark

Denmark is a frontrunner in environmental sustainability and carbon neutrality, with a clear focus on renewable energy, climate-friendly policies, and innovation. The country aims to reduce its greenhouse gas emissions by 70% by 2030 compared to 1990 levels and become carbon-neutral by 2050.[17] Denmark's energy sector is highly advanced, with over 50% of its electricity generated from wind power, making it a global leader in wind energy production.[18] The Danish government has introduced policies like a green tax system that incentivizes businesses to reduce emissions and adopt sustainable practices. Denmark also promotes energy efficiency through building regulations and the widespread use of district heating, which serves around 60% of the country's homes[19]. The nation has committed to phasing out coal by 2030 and focuses on integrating sustainable transportation solutions, including electric vehicles and public transit. Denmark's "Climate Agreement" for the green transition, along with its emphasis on circular economy principles, helps the country lead in waste management and resource conservation[20]. With policies that balance environmental goals and social welfare, Denmark has become one of the best examples globally for how to integrate sustainability into both the economy and daily life, ensuring that its green transition is inclusive and just.

4. Iceland

Iceland stands out as a leader in sustainability and carbon neutrality, primarily due to its abundant renewable energy resources and its commitment to environmental protection. Nearly 100% of Iceland's electricity comes from renewable sources, with geothermal energy and hydropower as the main contributors[21]. The country aims to become carbon neutral by 2040, and it has already made significant progress, with its emissions per capita being among the lowest in Europe[22]. Iceland's use of geothermal energy for both heating and electricity is a hallmark of its environmental strategy, making it one of the most energy-efficient nations in the world. Additionally, Iceland has pioneered carbon capture and storage technologies, such as the "Orca" project, which captures CO2 from the air and stores it underground, reducing atmospheric carbon levels[23]. The country's "Climate Action Plan" focuses on reducing emissions from transport, enhancing energy efficiency, and protecting its natural ecosystems. Iceland also promotes sustainable practices in agriculture, fisheries, and tourism, which are key industries for the nation. With its emphasis on innovation, strong environmental policies, and a unique reliance on clean,

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[17]://efaidnbmnnnibpcajpcglclefindmkaj/https://www.europarl.europa.eu/RegData/etudes/BRIE/2024/767173/EPRS_BRI(2024)767173_EN.pdf

[18] https://denmark.dk/innovation-and-design/clean-energy

[19] https://stateofgreen.com/en/news/danes-embrace-energy-efficiency-with-building-improvements/

[20]://efaidnbmnnnibpcajpcglclefindmkaj/https://unfccc.int/sites/default/files/resource/ClimateProgramme2020-Denmarks-LTS-under-the%20ParisAgreement_December2020_.pdf

[21] https://www.unep.org/news-and-stories/story/iceland-world-leader-clean-energy-supports-africas-push-geothermal-power

[22] https://ec.europa.eu/commission/presscorner/detail/en/ip_24_588

[23] https://www.winssolutions.org/orca-pioneering-large-scale-carbon-capture/

domestic energy, Iceland is a global example of how to transition to a sustainable, low-carbon economy while preserving natural resources.

5. Norway

Norway is a global leader in sustainability and carbon neutrality, with a strong focus on renewable energy, climate action, and environmentally friendly policies. The country aims to achieve carbon neutrality by 2030, and it is already one of the top countries for green energy, with nearly 98% of its electricity generated from renewable sources, primarily hydropower.[24] Norway's commitment to reducing emissions is further supported by its carbon tax, which has been in place since 1991 and helps incentivize businesses to adopt cleaner technologies.[25] The country is also a pioneer in electric vehicles (EVs), with EVs accounting for more than half of all new car sales, making it the highest share in the world. Norway's "Green Tax Reform" and policies like subsidies for electric transportation and sustainable shipping demonstrate its comprehensive approach to tackling climate change[26]. Furthermore, the government is investing in carbon capture and storage (CCS) technology and has allocated funds to preserve its extensive natural landscapes and promote sustainable fisheries. Norway's high level of environmental consciousness, combined with its strong government policies, innovative solutions, and vast natural resources, has made it one of the best models globally for achieving both sustainability and carbon neutrality while ensuring economic growth.

BEST PRACTICES FROM NORDIC COUNTRIES TO REDUCE CARBON POLLUTION

Developing countries can learn valuable lessons from the Nordic countries in terms of sustainability and environmental policies. Here are five best practices and their implications:

1. Investing in Renewable Energy:

   The Nordic countries, particularly Denmark and Iceland, have led the way in using renewable energy. Denmark generates over 50% of its electricity from wind power, and Iceland relies on nearly 100% renewable energy, primarily from geothermal and hydropower. Developing countries can follow this model by investing in renewable energy infrastructure, thus reducing dependence on fossil fuels, improving energy security, and creating green jobs. By focusing on affordable and scalable renewable energy solutions, these countries can reduce emissions while promoting sustainable development.

2. Carbon Pricing and Green Taxes:

[24] https://www.nordicenergy.org/figure/ambitious-climate-targets-and-visions-for-all-nordic-countries/carbon-neutral-as-soon-as-2030/
[25] https://www.iea.org/reports/norway-2022/executive-summary
[26] https://earth.org/country/norway/

Norway and Sweden have successfully implemented carbon pricing mechanisms, such as carbon taxes, to incentivize businesses to reduce emissions. Sweden's carbon tax, introduced in 1991, is one of the highest in the world, at about $126 per ton of CO2[27]. Developing countries can adopt similar mechanisms to encourage businesses to reduce their carbon footprint. The revenue generated can be reinvested into renewable energy projects or used to support vulnerable communities during the transition to a low-carbon economy.

3. Promotion of Electric Vehicles (EVs):

   Norway is a world leader in electric vehicles, with EVs accounting for over 50% of all new car sales in 2020[28]. This success was driven by policies such as tax exemptions, lower registration fees, and the establishment of a comprehensive charging infrastructure. Developing countries can promote EV adoption by offering financial incentives, building EV infrastructure, and fostering public-private partnerships, which would reduce pollution and improve air quality, especially in urban areas.

4. Circular Economy and Waste Management:

   Sweden is a pioneer in the circular economy, with about 50% of its waste being recycled or converted into energy. This includes the implementation of waste-to-energy plants and robust recycling programs. Developing countries can learn from Sweden's example by developing better waste management systems, promoting recycling, and investing in technologies that turn waste into energy, thus reducing landfill waste and generating renewable energy.

5. Integrated Climate Action Plans and Long-term Policy Commitment:

   The Nordic countries have implemented clear, long-term climate action plans, such as Finland's "Climate Roadmap" and Sweden's "Climate Act," which legally bind the government to meet its carbon neutrality targets. Developing countries can take a similar approach by creating comprehensive, legally binding climate action plans that integrate environmental, social, and economic factors. These plans can be tailored to the unique circumstances of developing countries and ensure that climate action is aligned with national development goals, creating a roadmap for sustainable growth.

By incorporating these best practices, developing countries can create more resilient, sustainable economies, reduce their environmental impact, and foster inclusive growth for future generations.

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[27] https://taxfoundation.org/research/all/eu/sweden-carbon-tax-revenue-greenhouse-gas-emissions/

[28] https://www.euronews.com/2021/01/05/norway-becomes-first-country-where-electric-vehicle-sales-exceeded-50-of-car-trade-in-2020

CONCLUSION

The efforts of Nordic countries in reducing carbon emissions provide a powerful model for global climate action. Through the adoption of innovative policies, commitment to renewable energy, and long-term sustainability goals, these countries have made significant strides in curbing greenhouse gas emissions while ensuring economic growth and environmental protection. Their focus on renewable energy sources like wind, hydropower, and geothermal power, alongside carbon pricing mechanisms and sustainable practices, has created a comprehensive framework for climate resilience. As the Nordic nations continue to lead by example, their best practices offer valuable lessons for both developed and developing countries. By investing in renewable energy, implementing effective carbon pricing, promoting electric vehicles, advancing waste management, and committing to long-term climate action plans, nations around the world can reduce their carbon footprint and foster sustainable growth. In doing so, they can contribute to a more equitable, healthier, and sustainable future for all, addressing the urgent challenges of climate change while improving quality of life for current and future generations.

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