

Fossil free freight transport in the Nordics

A SWOT analysis - Short Version

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Summary

The Nordic countries are similar in many ways; all are small countries on the northern outskirts of Europe, largely dependent on each other, and with extensive trade between them. This leads to many cross-border transports and a need for cooperation. In the autumn of 2023, Triple F held a conference with a Nordic theme where differences and similarities in measures and approaches towards a fossil-free freight transport sector were discussed. The concluding remarks were that sharing knowledge and experiences would benefit the acceleration of the transition. Therefore, Triple F has proceeded with Nordic cooperation, organizing a workshop on how the Nordic countries can lead and collaborate to accelerate the transition to a fossil-free freight transport system. The purpose of the workshop is to prioritize a number of issues (within research, innovation, implementation) where the Nordic countries should cooperate to accelerate the transition to a fossil-free freight transport system. As a basis for the workshop, this SWOT analysis has been conducted.

The purpose of the report is to provide an overview of the current state of fossil-free freight transport in the Nordic region by describing strengths, weaknesses, opportunities, and threats. In summary, it can be stated that the Nordic countries have good conditions for a fossil-free freight transport sector, given that all countries have strong stated goals and an energy sector that is largely already fossil-free. Finland has the most ambitious climate goal within the EU, with a target of carbon neutrality by 2035 across all sectors – with a complete phase-out of coal by 2029, and Iceland has the highest share of energy supply from renewable energy sources in the world, at about 85%, while Sweden has the highest share of renewable energy in the transport sector.

Additionally, the Nordic countries are at the forefront of both technological development and the implementation of fossil-free technology. For example, Norway has advanced the furthest in electrification both on land and at sea, and Denmark is at the forefront regarding offshore wind power and CCS technology in shipping, while Sweden has world-leading actors in the automotive industry. However, in many areas, it is still in the early stages where high costs and limited access to infrastructure for alternative fuels and charging hinder development. This is true for all Nordic countries.

In the transition, uncertainty and market acceptance of new technologies, as well as competition from conventional fossil fuels, are factors that can affect the pace of transition. Therefore, there is a need for long-term policies and financing that support development. The Nordic countries have a strong tradition and position in research and development and are ranked amongst the most innovative countries in the world. Digitalization can support development and contribute to efficiency in logistics and transport and is seen as necessary in an energy sector that is increasingly fragmented and dependent on intermittent sources. Cooperation (between countries and between different roles), demonstrations, and pilots generate new knowledge that strengthens and speeds up implementation. What can hinder development is the economic and geopolitical situation. Recession, inflation, and high interest rates, along with tensions, wars, and crises around the world, can affect companies' willingness to invest and take risks. It can also affect the availability of many of the critical metals needed in, for example, batteries, not only because they are limited in quantity but also because many sources are located in troubled areas.



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Introduction

Stopping global warming and climate change becomes more pressing with the passing of time. The last nine years (2015 to 2023) have been the warmest on record with 2023 breaking the all-time high (WMO, 2024). According to World Meteorological Organization's (WMO) predictions there's an 80 % chance that the yearly average global temperature will temporarily rise above 1.5°C from pre-industrial levels at least once in the upcoming five years. The forecast for the global average near-surface temperature for each year from 2024 to 2028 is a rise of 1.1°C to 1.9°C compared to the baseline period of 1850-1900. The WMO report also indicates an 86% likelihood that at least one of these years will establish a new temperature record. Hence, making it increasingly urgent to cut greenhouse gas emissions. The transition to a fossil free energy and transport sector is pivotal in reducing greenhouse gas emissions.

Triple F is the Swedish Transport Administration's research and innovation initiative, hosted by Lindholmen Science Park in collaboration with VTI and RISE. The program was launched in 2018 and will run until 2030 at the latest and the purpose is to help cut the CO2 emissions produced by freight transport in Sweden. The research program focuses on three challenges. If we tackle them, we will have the opportunity to switch to a fossil-free freight transport system. The first challenge is “A more transport-efficient society”, addressing solutions which reduce the need for freight transport and measures which will reduce the actual distance that goods need to be transported. The second challenge is “Switching to energy-efficient, fossil-free vehicles” addressing measures aimed at switching goods to more energy-efficient modes of transport, but also at using more energy-efficient vehicles and ships within a mode of transport. The last challenge is “Shift to renewable fuels” addressing solutions to facilitate a fossil-free energy supply. The solutions may involve using policies to facilitate a shift, but also looking at solutions where renewable fuels can be introduced in the freight transport system.

Triple F is arranging a Nordic Workshop and as an introductory document for the workshop a SWOT- analysis with the aim to present an overview of the current state of fossil free freight transport in the Nordics by describing the strengths, weaknesses, opportunities and threats was carried out as desk top research using AI-tools such as Chat GPT, Copilot and Scopus AI in order to generate the different factors within each respective category. The results from the three AI tools were then compared, merged and sorted according to Figure 1. To describe each factor, a literature and web search has been accomplished. This report is a short version of that report. For full information and references please check full version.



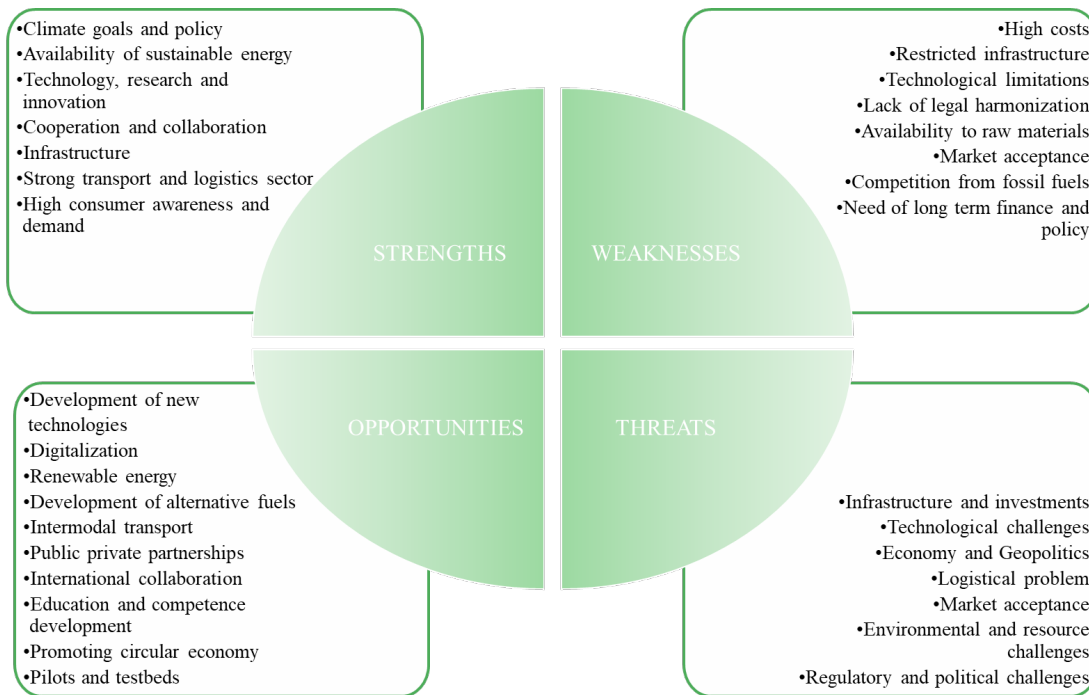


Figure 1 Schematic picture over Strengths, Weaknesses, Opportunities and Threats for fossil free freight transportation in the Nordics.

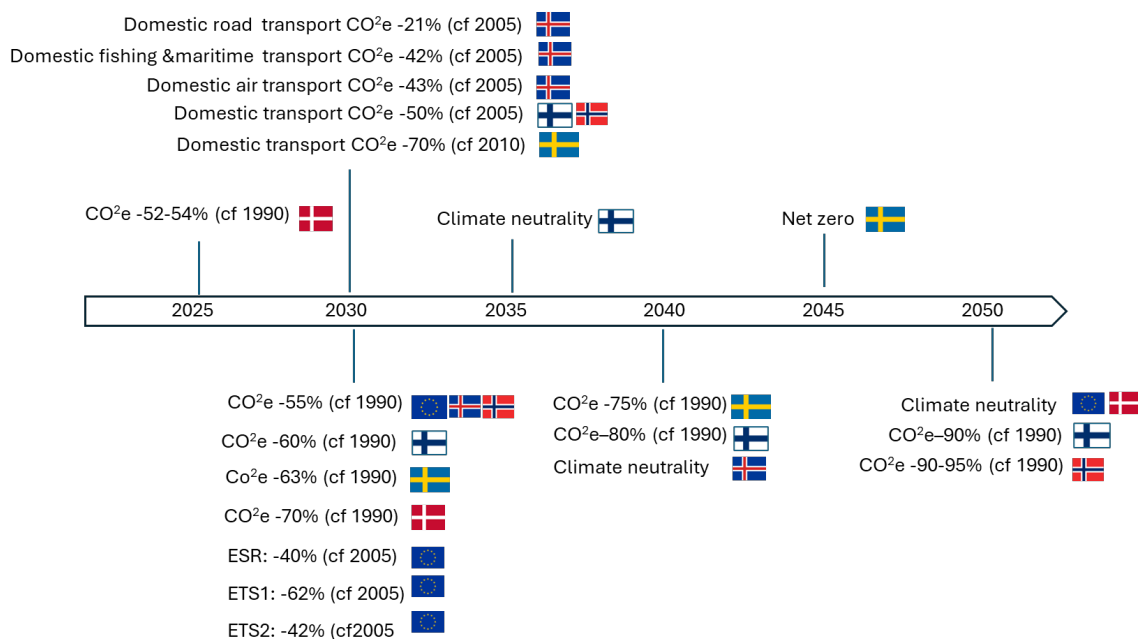


Figure 2 Time-line climate goals in EU and the Nordic countries. Source: Own illustration



Strengths

Climate Goals and Policy

The Paris Agreement, adopted by 194 countries and the EU, aims to limit global warming to 1.5°C, with a maximum threshold of 2°C to prevent catastrophic climate consequences. The EU has set common climate reduction goals, with Nordic countries (Denmark, Sweden, Norway, Finland, and Iceland) leading in ambition and action. However, achieving these goals requires robust policies and effective transition management, balancing long-term sustainability with short-term experimentation.

- **Denmark** focuses on reducing greenhouse gas emissions from road transport, with significant incentives for electric vehicles (EVs) and investment in alternative fuels, though challenges remain in rail electrification.
- **Sweden** has traditionally been a climate leader but faces uncertainty in meeting its goals due to recent policy changes affecting the transport sector, particularly concerning fuel taxes and biofuel blending.
- **Norway** aims for all new cars to be zero-emission by 2025 and has invested in extensive EV infrastructure and incentives, including reduced taxes and VAT exemptions for electric vehicles.
- **Finland** has the most ambitious EU climate target, aiming for carbon neutrality by 2035. However, the current economic situation poses challenges, necessitating further measures to support fossil-free transport and electrification.
- **Iceland** targets a 50-75% reduction in greenhouse gas emissions by 2050, focusing on renewable energy and innovative technologies. The country offers significant tax benefits and subsidies for EVs and charging infrastructure.

Each country has developed specific policies and incentives to support the transition to sustainable transport and reduce reliance on fossil fuels, although further efforts are required to meet their ambitious climate goals.

Availability of Sustainable Energy

The Nordic countries have favorable conditions for achieving fossil-free energy, with renewable energy use generally higher than the EU average. Their electricity mix is notably clean, except for Finland, where renewables account for just over half of the energy. Sweden leads in renewable energy in the transport sector, with a 30% share compared to the EU27's 10%.

- **Denmark** is a leader in decarbonization, with 81% of its power mix coming from renewables like wind, solar, and bioenergy. Denmark has made significant strides in reducing reliance on fossil fuels, lowering its share from 75% in 2011 to 53% in 2022, well below the IEA average. Denmark aims to reach 100% biomethane in heating by 2030 and plans to end fossil fuel production by 2050.
- **Sweden** is at the forefront of the low-carbon transition, targeting 100% renewable electricity by 2040. Sweden's electricity system, powered by nuclear, hydro, and wind energy, is nearly fossil-free. However, the potential phase-out of nuclear power introduces uncertainty, and the transport sector remains a challenge for emission reductions.
- **Norway** has near-zero emissions in electricity generation, thanks to its extensive use of hydropower. The country aims to reduce greenhouse gas emissions by 90-95% from



1990 levels by 2050. Norway is poised to lead in modern decarbonization technologies like electric vehicles, carbon capture and storage, and hydrogen, given the right policies.

- **Finland** aims for carbon neutrality by 2035 and has made progress with new nuclear power and expanding wind energy. Finland has the second-lowest share of fossil fuels in its energy supply among IEA members but still faces challenges in sectors like transport and industry, which remain dependent on fossil fuels.
- **Iceland** boasts the highest share of renewable energy globally, with around 85% of its energy supply from renewables, primarily geothermal and hydropower. Almost all electricity and heating are renewable, but sectors like industry, transport, and agriculture remain major sources of emissions.

Each Nordic country has unique strengths in renewable energy but also faces specific challenges in achieving full sustainability, particularly in sectors like transport and industry.

Technology, Research, and Innovation

The Nordic region is known for its high level of innovation, particularly in renewable energy and green technology, such as electric vehicles, biofuels, and hydrogen. All five Nordic countries rank among the top 20 in the Global Innovation Index 2023, with Sweden leading at second place, followed by Finland (6th), Denmark (9th), Norway (19th), and Iceland (20th).

Sweden is a global leader in vehicle manufacturing, which is crucial to its economy, contributing 15% of export value and 20% of business R&D expenses. The Swedish vehicle industry aims to have 50% of new registrations be electric and 15% biogas trucks.

Universities and research institutes in the Nordic region are pivotal in driving innovations for fossil-free transport through extensive research and education.

Cooperation and Collaboration

Nordic countries have a strong tradition of collaboration, both among themselves and between the public and private sectors. Key areas of cooperation include:

- **Public-Private Partnerships:** All Nordic countries involve businesses in climate initiatives. For example, Sweden's "Fossilfritt Sverige" engages various sectors in developing roadmaps for a fossil-free future. Similar initiatives exist in Finland, Denmark, Norway, and Iceland.
- **Infrastructure and Research Networks:** Nordic infrastructure management organizations collaborate through NIM (Nordic Infrastructure Managers), and research on road systems is coordinated by NordFoU. Nordic Innovation and Nordic Energy Research fund projects aimed at fossil-free transport solutions, while Nordforsk facilitates broader Nordic research cooperation under the Nordic Council of Ministers.
- **Sector-Specific Networks:** NJS (Forum of Nordic Railways Professionals) and NVF (Nordic Road Association) are key networks in the rail and road sectors, promoting knowledge sharing and best practices.
- **Border Committees and Associations:** Border committees, funded by the Nordic Council of Ministers, address cross-border issues and development. The Nordic Logistics Association represents hauliers' interests at the EU level, and the Nordic Transport Workers' Federation serves as a platform for trade unions to share knowledge and experiences.



This extensive collaboration enhances the Nordic region's ability to innovate and implement sustainable solutions, particularly in the transport sector.

Infrastructure for Fossil-Free Transport

The Nordic region is heavily investing in infrastructure to support the transition to fossil-free transport, focusing on charging stations for electric vehicles (EVs) and refueling stations for biogas and hydrogen.

- **Denmark:** As of June 2024, Denmark has significantly expanded its EV charging infrastructure, with approximately 27,000 charging points, a 672% increase since 2020. The majority of these are medium-speed AC chargers. Denmark also has a limited but stable number of hydrogen fueling stations (4) and a growing network of natural gas stations. The country's infrastructure has evolved to meet the rising demand for alternative fuels, with a notable increase in ultra-fast DC chargers.
- **Sweden:** Sweden leads the Nordic region in the number of charging points, with around 44,000 as of June 2024, marking a 205% increase since 2020. Like Denmark, most of these are medium-speed AC chargers. Sweden also has a relatively well-developed network of natural gas and LPG stations, and a small number of hydrogen fueling stations (6). The country has met its Alternative Fuels Infrastructure Regulation (AFIR) targets with more than double the required power output for EV charging.
- **Norway:** Norway, a leader in EV adoption, has around 25,000 charging points as of June 2024. The majority are AC chargers, with a significant portion being ultra-fast DC chargers. Norway has seen a decline in hydrogen fueling points, now down to 2 stations, reflecting the challenges in expanding hydrogen infrastructure. The country also has a robust natural gas fueling network but a decreasing number of LPG stations.
- **Finland:** Finland has rapidly expanded its charging infrastructure, with nearly 13,300 charging points as of June 2024, a 266% increase since 2020. Most chargers are medium-speed AC, and Finland has also increased its natural gas fueling points. However, the country lacks hydrogen fueling stations. Finland has exceeded its AFIR targets, providing nearly three times the required power output for EVs.
- **Iceland:** Iceland has the smallest infrastructure network but has seen significant growth, with 1,792 charging points as of June 2024, a 90% increase from 2022. Most of these are medium-speed AC chargers. Iceland has limited hydrogen and CNG infrastructure, with just one hydrogen fueling station and five CNG stations.

AFIR Compliance: Sweden, Denmark, and Finland have all surpassed the EU's AFIR targets, ensuring that their infrastructure can support the growing number of EVs, with power outputs far exceeding the minimum requirements. Norway and Iceland, while not bound by AFIR, continue to expand their infrastructure to support their transition to fossil-free transport.

Strong Transport and Logistics Sector

The Nordic region boasts a robust transport and logistics sector, with all countries ranked highly in the World Bank's Logistics Performance Index (2023). Finland is ranked second, Denmark third, Sweden eleventh, Norway twenty-third, and Iceland twenty-seventh. The region is known for its prominent logistics companies that are leaders in adopting sustainable solutions.



- **Denmark:** Denmark is a leader in the maritime industry, ranked tenth globally as a seafaring nation. Danish shipping companies are heavily invested in green technologies, including carbon capture and renewable energy integration. Denmark's maritime sector is supported by a strong innovation ecosystem, including initiatives like ShippingLab, which focuses on smart shipping solutions.
- **Sweden:** Sweden's Port of Gothenburg, the largest in the Nordic region, is a critical hub for international trade. The country excels in sustainable transport, with extensive electrification of its railway network and a high rate of electric vehicle adoption. Sweden also invests significantly in modern transport infrastructure, adapting quickly to the growth of e-commerce and smart transport systems.
- **Norway:** Norway is a global leader in electric vehicle adoption, supported by comprehensive charging infrastructure. The country is also investing in low-carbon maritime vessels and modernizing its transport infrastructure as part of the National Transport Plan 2022–2033. Norway's extensive coastline and maritime heritage position it as a key player in sustainable shipping practices.
- **Finland:** Finland is at the forefront of implementing Mobility-as-a-Service (MaaS), promoting sustainable transport by integrating various services into a single platform. The country is also a leader in renewable energy use in transport, with a strong focus on biofuels and LNG infrastructure. Finland's logistics sector is a vital part of its economy, employing around 120,000 people and generating significant revenue.
- **Iceland:** Iceland's strategic location between Europe and North America makes it a crucial link for shipping and aviation. The country is focused on reducing emissions from its maritime and aviation sectors, with significant efforts in place to meet its ambitious climate goals. Keflavik International Airport plays a key role in connecting transatlantic flights, enhancing Iceland's importance in international travel.

High Consumer Awareness and Demand

Consumer awareness and demand for sustainable products are notably high in the Nordic countries, driven by widespread confidence in eco-labels and environmental information. Despite this, there is a discrepancy between perceived climate-consciousness and actual carbon footprints. Nevertheless, the strong demand for sustainable solutions is reflected in the rising adoption of fossil-free transport options across the region.

- **Denmark:** The market for alternative fuel heavy-duty vehicles (HDVs) has expanded significantly, with CNG-fueled HDVs increasing by 1,253% from 2013 to 2023, and BEVs showing a 305% rise from 2022 to 2023. In 2023, 7.76% of new HDV registrations were for alternative fuel vehicles.
- **Sweden:** Sweden saw 3,139 alternative fuel HDVs in 2023, a 134% increase from 2022. CNG-fueled HDVs made up 11.4% of new registrations, while BEVs and PHEVs accounted for 2.67% and 1.39%, respectively.
- **Norway:** Norway's market share for alternative fuel HDVs jumped from 1.11% in 2021 to 17.33% in 2023, with a total of 1,133 vehicles. BEVs made up 66%, PHEVs 31%, and hydrogen vehicles 3% of these new registrations.
- **Finland:** Finland had 421 alternative fuel HDVs in 2023, with 84% being CNG-fueled. Alternative fuel vehicles represented 1.59% of all new HDV registrations, with growth mainly occurring since 2017.
- **Iceland:** In 2023, Iceland had 37 CNG-fueled HDVs and 20 BEVs, which together made up 7.57% of new HDV registrations. There was a notable increase in BEV light-



duty vehicles (LDVs) by 65% from 2022 to 2023, while CNG LDVs slightly decreased.



Weaknesses

High costs

The development and implementation of new technologies like electric trucks and hydrogen infrastructure come with high initial costs, posing financial challenges for companies and authorities, particularly during early adoption stages. The higher costs of alternative fuels, such as biogas, further hinder their widespread use in freight transport. The logistics sector, being cost-driven, often prioritizes cost reductions, which makes it difficult for many companies, especially smaller ones, to afford the investments needed for innovations. Long depreciation periods of infrastructure also slow adoption. Government incentives or regulations are deemed essential for accelerating technology adoption, as some measures may not be feasible without such support. In the Nordics, the transition to fossil-free freight transport presents both cost-saving opportunities and challenges, with renewable fuel substitution being particularly expensive in short-sea shipping. However, over time, there is potential for significant cost reductions, indicating a cost-efficient transition by 2050.

Restricted infrastructure

The expansion of fueling and charging infrastructure for electric vehicles (EVs) and alternative fuels like hydrogen and biogas faces significant challenges across the Nordic countries. Despite investments, there are gaps in infrastructure, particularly in sparsely populated and rural areas, and along less busy routes. The charging infrastructure for heavy-duty vehicles (HDVs) is still in its early stages, with limited geographical coverage and significant challenges related to high costs, grid capacity, and the need for standardized systems.

In Denmark, while urban areas and major highways are seeing improvements, rural areas still lack adequate coverage, and the electrical grid may require significant upgrades to handle the increased demand. Sweden faces similar issues, with a lack of fast-charging stations hindering long-distance travel and concerns over grid capacity and charging station compatibility. Norway has made progress, but challenges remain in rural areas and the lack of standardized charging systems. Finland's infrastructure is still developing, particularly in the north, with challenges related to grid capacity and a lack of governmental incentives. Iceland's small population and challenging terrain make infrastructure investments less economically viable, with most charging stations concentrated in urban areas.

Cross-Nordic challenges include differences in charging standards and payment systems, complicating cross-border HDV operations, and the high capital investment required for infrastructure development. The electricity grid across the region also faces strain due to increased demand from electrification and the need for significant investments to maintain stability.

Transport infrastructure, particularly railways, also suffers from neglected maintenance across the region, leading to delays, increased costs, and reduced competitiveness for rail freight. These issues collectively highlight the need for continued investment, innovation, and cohesive policies to build a reliable and comprehensive infrastructure network in the Nordics.

Technological limitations

Electric trucks and other fossil-free transport options face technological limitations, particularly in terms of range and capacity compared to traditional diesel-powered vehicles. This restricts their effectiveness for long-distance freight transport and in demanding environments. In the Nordic region, cold winters further impact the efficiency and range of



electric vehicles, necessitating additional technological solutions and infrastructure investments.

A study by Alonso-Villar et al. (2023) in Iceland demonstrated that adverse conditions like low temperatures, headwinds, and varying payloads can reduce the range of electric vehicles by 41–47% compared to optimal conditions. While short-haul routes remain feasible for electrification even under harsh conditions, regional routes may require adjustments and on-route fast-charging to achieve full electrification. The study found that sprinter vans could cover 49% of routes (85% with charging), and trucks could cover 83% (90% with charging), highlighting the critical role of charging infrastructure in enabling the broader adoption of electric vehicles in challenging climates.

Lack legal of harmonization

The lack of legal harmonization across the Nordic countries creates challenges for cross-border transport and the introduction of new technologies. Differences in regulations, such as those for high-capacity transport (HCT), are significant. Finland leads in HCT regulations, followed by Sweden and Denmark, while Norway and Iceland do not yet allow HCT. For example, Finland allows vehicles up to 34.5 meters in length and 76 tons in weight, while Denmark and Sweden have slightly different limits.

Another example is the inconsistent implementation of the EU regulation on weights and dimensions for light-duty vehicles (LDVs). Denmark and Norway adopted the regulation allowing LDVs up to 4.25 tons with a regular B-class license for environmental reasons in 2021, while Sweden adopted it later, leading to complications in cross-border transport.

A study by Pinchasik et al. (2020) suggests that harmonizing policies across the Nordic countries could facilitate modal shifts in transport, particularly in Norway, though the impact on Swedish and Danish freight flows was not analyzed. The study highlights the need for coordinated policy evaluation and sharing of findings across the region to improve future policy design and support seamless cross-border transport.

Availability to raw materials

The production of batteries for electric vehicles (EVs) requires large quantities of raw materials like lithium, cobalt, and nickel, significantly more than traditional diesel vehicles. This shift in material composition is forcing supply chains to rethink procurement strategies, especially given the urgency to transition to electric fleets. However, extracting these materials sustainably and ethically poses significant challenges. Many of these minerals are mined in politically unstable regions, such as the Democratic Republic of Congo, where issues like unethical labor practices, including child labor, and environmental harm have been reported, raising concerns about the overall benefits of EVs.

The sudden increase in demand for batteries, exacerbated by recent global events like the COVID-19 pandemic and the Russian invasion of Ukraine, has led Nordic countries to reassess their ability to become self-sufficient and reduce reliance on external sources of energy and raw materials. The Critical Raw Materials Act (CRMA) in Europe seeks to address these challenges by promoting local extraction and recycling efforts.

Within the Nordic region, countries vary in their approach to raw material sourcing:

- **Denmark** is exploring alternative battery compositions to reduce reliance on lithium-ion and faces challenges in sustainably transporting raw materials from Greenland.
- **Sweden** has set ambitious climate goals but is cautious about opening new mines, focusing instead on research for more efficient battery technologies.



- **Norway** is actively participating in the European Battery Alliance and has significant potential for battery production due to its natural graphite and phosphate deposits. The country also leads in recycling initiatives through projects like Hydrovolt.
- **Finland** is leveraging its raw materials like cobalt, graphite, and lithium, and is advancing in battery recycling through companies like Fortum.
- **Iceland** has access to aluminum, which could support battery production within the region.

The combination of rising demand, geopolitical tensions, and environmental concerns creates potential bottlenecks in the supply chain, highlighting the need for innovation and cooperation across the Nordic countries to ensure a sustainable and secure supply of raw materials for the EV industry.

Market acceptance

Transport companies and logistics operators may resist or be slow to adopt new fossil-free technologies due to uncertainties around reliability, costs, and infrastructure. The transport industry, characterized by low margins, faces significant challenges in acquiring and adapting to new technologies, with these processes often being major obstacles to technology adoption. Smaller firms, in particular, struggle due to a lack of critical resources such as funding, information, and expertise, which hinders their ability to innovate and invest in advanced technologies. This resource gap results in lower innovation rates and missed opportunities. Similar challenges have been observed in other low-margin sectors, like healthcare, where hostile funding environments and regulatory scrutiny further impede technological development.

Competition from fossil fuels

Despite tax incentives and subsidies promoting fossil-free alternatives, traditional fuels and vehicles remain strong competitors due to their lower costs. In Sweden, recent tax reductions on petrol and diesel have impacted the total cost of ownership (TCO) for battery electric vehicles (BEVs), making internal combustion engine (ICE) vehicles more competitive, especially given the higher purchase price of BEVs. The TCO parity varies by country depending on national taxes and policies, with some countries seeing decreasing costs for ICE vehicles, thereby challenging the adoption of BEVs.

Fossil fuel prices, although volatile, have decreased since their peak in 2022 and are expected to remain unstable due to geopolitical tensions and economic factors like inflation and global economic growth. As the world transitions to renewable energy, fossil fuel demand is expected to decrease, potentially leading to lower prices in the long term. The International Energy Agency (IEA) predicts that fossil fuel demand may peak before 2030, driven by efforts to limit global warming to 2°C.

Need of long-term finance and policy

The private sector often emphasizes the need for stable and long-term finance and policy frameworks to ensure the successful implementation of fossil-free technologies. Long-term finance is crucial for enabling the significant socio-technical changes required for sustainable transitions. However, short-termism, focusing on immediate gains, can hinder sustainable development and long-term investments.

Effective policies that integrate environmental, social, and corporate governance (ESG) factors into business models are vital for promoting sustainability. The financial system plays an essential role in supporting these transitions, and further government intervention may be



necessary to accelerate progress due to the cautious approach of the finance sector toward risks.

Political instability or shifts in policy priorities can also disrupt progress. Historical examples in Sweden, such as the rise and fall of ethanol as a climate-friendly fuel and the abrupt end of BEV subsidies, illustrate how inconsistent policies can lead to market instability and hinder the adoption of sustainable technologies.



Opportunities

Development of new technologies

Continued investments in research and development are crucial for advancing fossil-free freight technologies like battery technology, hydrogen fuel cells, and wind propulsion. These innovations have the potential to create more effective and cost-efficient solutions, but they require significant resources, including public funding and industry support.

Battery Technology: Europe, particularly the Nordic countries, is emerging as a key player in battery production, with significant new factories being built in Sweden, Norway, and Finland. The Battery Atlas, produced by RWTH Aachen University, highlights Europe's transition into a "hot spot" for battery innovation, with efforts to close the gap with Asia in module and pack manufacturing.

Hydrogen: Hydrogen Internal Combustion Engines (H2ICE) offer a promising solution for transitioning to carbon-free mobility. H2ICE leverages existing ICE technology and infrastructure, making it a cost-effective and reliable option, particularly for heavy-duty vehicles. It requires fewer scarce materials than electric vehicles, providing a sustainable option for both near-term and long-term use. Sweden, with its strong aerospace sector, is also exploring hydrogen propulsion for aviation and maritime applications.

Wind Propulsion: New wind propulsion technologies are being developed to decarbonize maritime transport. The Pyxis Ocean, retrofitted with EU-funded WindWings technology, recently began its maiden voyage to test the effectiveness of large wing sails in reducing fuel consumption. If successful, this technology could significantly lower the carbon footprint of shipping, with predictions that by 2025, wind propulsion could be widely adopted in new ship orders.

These developments demonstrate the importance of continued innovation and collaboration in creating sustainable and cost-effective solutions for the transport sector.

Digitalization

Digitalization plays a crucial role in enhancing sustainable and intelligent mobility and transportation. It introduces a variety of tools and technologies that can significantly improve the efficiency and sustainability of logistics and energy systems.

Key Benefits of Digitalization:

- **Improved Efficiency:** Digital tools like route optimization and real-time tracking reduce fuel consumption and emissions by identifying efficient routes and minimizing idle times.
- **Enhanced Visibility:** Digitalization enhances supply chain visibility, leading to better demand forecasting and inventory management, which reduces waste and overproduction.
- **Automation:** Automated systems in logistics operations streamline processes, reduce energy consumption, and improve overall efficiency.
- **Data-Driven Decision Making:** Big data analytics provides insights into logistics operations, helping companies identify areas for improvement and implement sustainable practices.
- **Collaboration and Integration:** Digital platforms facilitate better coordination among stakeholders in the supply chain, leading to more efficient logistics operations.
- **Reduction of Paperwork:** Digital documentation reduces the need for paper, contributing to environmental sustainability and speeding up processes.



- **Electric and Autonomous Vehicles:** Digitalization supports the integration of electric and autonomous vehicles, significantly reducing carbon emissions and improving energy efficiency.
- **Energy Efficiency:** Digitalization enhances energy efficiency through mechanisms such as data collection and analysis, automation and control, predictive maintenance, and the integration of renewable energy. These technologies help in optimizing energy usage, reducing waste, and ensuring the efficient use of renewable energy sources.

Challenges and Opportunities: While digitalization offers significant benefits, it requires robust and interconnected systems to address potential safety and security risks. The Nordic nations are at the forefront of this shift, particularly in renewable energy, and are set to lead the transformation of the North Sea’s renewable energy infrastructure. Digitalization also facilitates the wider adoption of electric and hydrogen vehicles and introduces autonomous systems, which represent a paradigm shift in transport management across various sectors. By leveraging these digital tools and technologies, the logistics sector and energy systems can move towards more sustainable practices, reducing environmental impact while improving efficiency and cost-effectiveness.

Renewable energy

The Nordic region has strong potential for renewable energy, with promising growth in several areas. Sweden has the highest potential for bioenergy, with forecasts ranging from 1.2 to 40 TWh/yr, while Denmark's potential is also expected to grow. Norway's potential is limited due to restricted agricultural land. Biomass, particularly biogas from agricultural residues and manure, is underutilized, with potential production estimated to be six times the current level, potentially replacing 48% of natural gas consumption.

Onshore wind energy has significant potential in uninhabited areas, and offshore wind parks are being developed in the North Sea and Baltic Sea. Solar energy is gaining importance, with both small- and large-scale projects expanding. Nuclear power is also part of the fossil-free energy mix, with Finland ramping up production and Sweden preparing new facilities.

The costs of solar and wind energy fell by around 13% from 2020 to 2021, making them more competitive than fossil fuels. As renewable energy becomes cheaper, it reduces the need for regulatory intervention. Additionally, the region is well-positioned to use renewable energy for green hydrogen production, which could play a key role in decarbonizing industry and supporting sustainable transport. The Nordic region's rich renewable resources offer opportunities to reduce dependence on fossil fuels and transition to greener energy.

Development of alternative fuels

The development of advanced biofuels from local resources like forest waste and agricultural products offers a sustainable alternative to fossil fuels for freight transport. Between 2004 and 2018, biofuel use in transport increased from 1.5% to 8.3%, with biodiesel comprising the majority. Advanced biofuels, such as Fatty Acid Methyl Ester (FAME) from waste fats and oils, are critical to achieving 2030 greenhouse gas (GHG) reduction targets in the transport sector. However, current policies are inadequate, and immediate interventions are needed to increase market uptake and improve industry performance. Collaboration with agriculture and forestry sectors is essential for biomass mobilization, and financial support for conversion innovations is crucial.

Country-Specific Overview:

- **Denmark:** Bioenergy accounts for over two-thirds of renewable energy consumption. Denmark has seen rapid growth in biogas production but faces challenges in meeting



advanced biofuel targets for the transport sector. Efforts to comply with EU regulations continue, with the potential for future advanced biofuels expansion.

- **Sweden:** Biofuels, especially hydrogenated vegetable oil (HVO), dominate Sweden's transport sector, though most biofuels are imported. Sweden is developing domestic production capacity, including a Bioenergy with Carbon Capture and Storage (Bio-CCS) plant and biorefineries to produce biodiesel. Financial support for these initiatives is increasing, but further regulations are needed to boost biofuel production.
- **Norway:** Norway is focusing on biofuels to reduce emissions from internal combustion engine vehicles and has set biofuel quotas for road traffic, off-road diesel, and shipping by 2030. The government aims to use forest residues and agricultural by-products to expand advanced biofuel production.
- **Finland:** With 42% of its energy consumption coming from renewables, Finland aims for 30% renewable fuels by 2030. Finland is investing heavily in biorefineries and biogas facilities, and companies like Neste are global leaders in biofuel production. Advanced biofuels, particularly from forest-based biomass, are a key focus for Finland's green energy transition.

These countries are leveraging their renewable resources to develop biofuels, but further policy and financial support are needed to meet ambitious climate goals and foster the growth of advanced biofuels.

Intermodal transport

Intermodal transport, which integrates various transport modes like rail, shipping, and electric vehicles, offers significant economic and environmental advantages. By optimizing the strengths of each mode, intermodal transport can reduce carbon emissions and improve efficiency. The Nordic region is well-suited for developing such systems due to its established shipping and rail infrastructure, making the shift from truck to rail particularly promising for sustainable freight transport.

Standard IT solutions can enhance the competitiveness and efficiency of rail/sea transport by improving operational coordination and communication between involved parties. This contributes to the creation of sustainable transport corridors. The European Commission supports the promotion of intermodal transport by advocating for technological and organizational improvements, alongside institutional, fiscal, and pricing reforms to balance competition between intermodal and road transport.

However, despite its potential, intermodal transport faces challenges such as inadequate infrastructure, industry complexity, and lack of competitiveness. Growth is hindered by the private sector's fragmented role and inefficient operations, making it difficult to achieve the European Commission's modal shift targets, as the share of intermodal transport has remained stagnant over the past two decades.

Public private partnerships

Strengthened collaborations between the public and private sectors are key drivers of innovation and investment in fossil-free transport solutions. Public investments and policies create incentives for private companies to invest in sustainable transport, with Public-Private Partnerships (PPPs) being particularly effective in promoting sustainability and reducing transport emissions. In the U.S., PPPs have contributed to infrastructure projects improving traffic flow and reducing congestion, especially in trucking and rail sectors. In Sweden, the Arlanda Line, a major PPP project, was developed by A-Train AB and operates under a long-term agreement. Finland's "Whim" app, launched in 2016, exemplifies a PPP in mobility,



involving both public and private stakeholders. Additionally, Green Public Procurement (GPP) can help push markets towards sustainability by promoting zero-emission vehicles and sharing investment costs.

International collaboration

International collaboration in sustainable transport allows Nordic countries to benefit from shared resources, experiences, and technologies, promoting fossil-free transport. Projects such as Horizon Europe support research and innovation in this area. International trade associations and organizations like the EU, World Bank, and UN agencies are pivotal in shaping policies for sustainable transport. Businesses also engage in partnerships, such as Volvo's collaboration with Daimler and Traton to build charging networks, and Maersk's work with Microsoft on digitizing logistics. These collaborations improve sustainability by enhancing vehicle utilization, reducing emissions, and fostering innovation. Overall, international partnerships promote economic and environmental progress, policy development, and knowledge exchange.

Education and competence development

Countries are adapting their workforces to the changing global economy to support the transition to fossil-free transport and society. Nordic countries have implemented various action plans addressing their unique challenges:

- **Denmark** launched a lifelong learning strategy in 2007 to address workforce issues, allowing employees to receive normal salaries while pursuing education.
- **Sweden** emphasized digital competency post-pandemic, with government and business efforts to promote skill development for workers and students.
- **Norway** introduced schemes focused on vocational training, higher education, and research, addressing educational disparities between urban and rural areas.
- **Finland** has a top-rated skill development program, using forecasting models (VATTAGE and MITENNA) to predict labor market needs.
- **Iceland**, after the 2008 financial crisis, prioritized education and vocational training, with the Education Policy 2030 focusing on literacy, digital skills, and vocational training while balancing Icelandic and English language needs.

These strategies enhance workforce readiness and support sustainable development across sectors.

Promoting circular economy

Implementing circular economy principles in the transport sector can reduce waste and optimize resource use by recycling, reusing materials, and extending the lifespan of vehicles and infrastructure. The EU's 2020 Circular Economy Action Plan targets key sectors, including vehicles and batteries, while Nordic countries have tailored their own plans to boost competitiveness and sustainability. Collaborative efforts in the region focus on creating shared markets for materials, aligning standards, and investing in circular infrastructure.

- **Denmark** is 4% circular, with policies focused on sustainable production, waste management, and digitalization. The Green Transition Fund supports circular economy projects.
- **Sweden** has a broad national circular economy strategy focused on sustainable production and consumption, with regions like Östergötland implementing local circular models.



- **Norway**, the least circular at 2.4%, has a strategy for construction, food, energy, and recycling but has yet to take strong actions.
- **Finland** developed a citizen-driven roadmap, focusing on food, forestry, technical loops, and transport, with public support for circular policies.
- **Iceland** focuses on waste reduction and industrial symbiosis, with measurable targets for emissions reduction and resource efficiency.

These efforts support sustainability and competitiveness, with varying levels of progress across the Nordic countries.

Pilots and testbeds

The Nordic region is showcasing fossil-free transport solutions through pilot projects and demonstrations, accelerating the commercialization of innovative technologies. Nordic Research and Technology Organizations (RTOs) play a key role in translating research into practical applications for industry by providing access to testbeds and expertise. However, RTOs face challenges due to increasing technological complexity and small domestic markets, making cross-border collaboration essential. A joint initiative by Nordic RTOs, including GTS, VTT, SINTEF, and RISE, aims to provide companies with access to advanced test facilities across the region.

A study on Nordic testbed collaboration revealed that while cross-border partnerships are crucial, there is hesitancy due to concerns over legal models, sovereignty, and financial liabilities. More informal collaborations are favored but do not significantly enhance access to facilities and expertise. Nordic RTOs emphasize the need for deeper collaboration in key growth sectors like green technology, healthcare, and digitization.

Examples of successful initiatives include the Nordic Way, a cross-Nordic project enhancing traffic safety and reducing CO₂ emissions through cooperative intelligent transport systems (C-ITS). In Sweden, the REEL initiative focuses on electrifying heavy transport by uniting stakeholders to operate and evaluate regional logistics flows, demonstrating the importance of both national and cross-border pilots. These efforts highlight the need for rethinking technological infrastructure and strengthening collaboration to support sustainable transport innovation.



Threats

Infrastructure and investments

The lack of infrastructure for alternative fuels, such as biogas, poses a significant challenge to their adoption in freight transport, exacerbated by financial uncertainties. Investments in transport infrastructure are critical, with Nordic countries planning significant projects. However, cross-border coordination is weak, as infrastructure projects are often assessed individually by each nation.

Nordic Infrastructure Plans:

- **Denmark:** The "Denmark Forward" plan (2021-2035) allocates 160 billion DKK (€21.5 billion) towards reducing congestion, enhancing public transport, and supporting green initiatives.
- **Sweden:** The 2022-2033 plan allocates 799 billion SEK, focusing on sustainable transport, with 437 billion SEK for new investments, including rail and road infrastructure.
- **Norway:** The 2022-2033 National Transport Plan includes 1200 billion NOK for expanding road networks, rail connections, and maritime infrastructure.
- **Finland:** The 2021-2032 plan commits 26.95 billion € to enhancing rail connectivity, road networks, and sustainable transport solutions.
- **Iceland:** The 2020-2034 transport plan focuses on road infrastructure and sustainable transport, with investments in electrifying the public bus fleet and expanding bike lanes.

Cross-border infrastructure projects are essential but have seen slow progress due to fragmented planning.

Charging Infrastructure:

Battery-electric vehicle (BEV) adoption requires a robust network of public chargers. In the Nordic region, private operators manage the expansion of charging infrastructure, but profitability is a concern due to high capital costs and low utilization rates. Norway, a global leader in BEV adoption, faces challenges with fragmented charging networks and underutilization in key locations.

Hydrogen Fueling Infrastructure:

Hydrogen infrastructure development faces significant hurdles due to high costs and technological barriers. The hydrogen supply chain, especially for heavy goods vehicles, is underdeveloped, requiring advancements in production, storage, and distribution technologies to ensure profitability and wider adoption.

Technological challenges

Battery technology plays a crucial role in electrification, but challenges remain. While battery production is increasing in Europe and the Nordic countries, issues such as long delivery times and ramping up production hinder progress. Additionally, battery limitations in terms of range and weight are problematic for heavy long-range transport across various modes. Hydrogen technology faces several technical and economic obstacles, including sustainable production, efficient on-board storage (requiring high pressures or extremely low temperatures), and reliable energy conversion devices. Conventional hydrogen production emits significant greenhouse gases, pushing the need for greener, cost-effective methods. Current electrolysis methods are only 60-80% efficient, with high costs (\$5 per kg), and efforts are underway to improve efficiency and reduce costs below \$2 per kg. Moreover, the



hydrogen supply chain for freight transport lacks sufficient life cycle analysis, revealing a gap in understanding its full technical challenges.

Economy and Geopolitics

The global economy is showing signs of stabilization with falling inflation, leading to potential interest rate cuts and improved economic conditions for households and businesses. Despite economic improvements, geopolitical tensions remain high, including conflicts in Ukraine, Gaza, and between China and Taiwan, which continue to impact global stability. Increased global tensions and the potential for a new economic-political world order focused on strategic independence rather than globalization. Super Election Year, 2024 is a significant election year with major elections in the USA, India, the UK, South Africa, Russia, Indonesia, Bangladesh, and the EU Parliament. These geopolitical risks contribute to global uncertainty and can have both short- and long-term economic effects. Inflation is decreasing, but there is uncertainty about its future trajectory. Central banks may adjust interest rates based on inflation trends.

Denmark

In Denmark the economic situation of the post-pandemic years has shown rapid recovering. Inflation in Denmark peaked in 2022 and then rapidly decrease in 2023. In 2023 Denmark saw an increase in the real GDP of 1,9%, which is expected to continue in 2024 and 2025 with 2,6% and 1,4% respectively. For 2023 the biggest net contributor to the positive growth is the export of Danish goods and services – despite the weak domestic demand and higher interest rates. Furthermore, Denmark has a thriving labor market – with low unemployment rates – although similar to Sweden there are a growing issue connected to skills shortage, which is needed for the green transition within the Danish society. (SEB, 2024)

Sweden

The post-pandemic years have been challenging and in 2023 the Swedish economy shrank by 0,2%, following real GDP growth of 2,7% in 2022. Sweden is experiencing increased economic stability with inflation falling, leading to potential interest rate cuts. Energy prices have stabilized significantly, and extreme price spikes from 2022 are not expected to return. During 2023 one of the main contributors to a positive real GDP growth was the continued export of Swedish goods and services, lessening the impact from a decreased domestic demand and change in inventories. Despite a challenging global environment, Sweden’s GDP growth is projected to be 0.1% in 2024 and 2.8% in 2025. Ongoing global conflicts and geopolitical tensions continue to pose risks to Sweden’s economic outlook. Sweden have one of the highest employment rates in the EU, but unemployment rose during 2023 and is expected to continue doing so in 2024 – unemployment rate of 7,7% in 2023 and 8,4% in 2024 – as a result of the economic situation. Although due to the labor and skill shortage prevalent in many different sectors – going on for years – some employers might hoard labor, making employment more resilient to the economic situation. Sweden’s competitiveness has been high for a long time, to keep its edge there needs to be a higher focus and more investments in increasing the use of renewable energy sources – to reach the climate goals set by the EU. (SEB, 2024)

Norway

Norway’s economy is expected to remain stable with moderate growth. Norges Bank is anticipated to start lowering interest rates gradually, with a slower pace compared to other central banks. Inflation is projected to decrease, supporting household purchasing power and economic stability. The energy sector continues to play a significant role, with stable energy prices contributing to economic predictability. (SEB 2024)

Norway's economy is slowing due to inflation and higher interest rates affecting consumption and investment. The labor market is tight with robust wage growth but also high and rising



labor shortages and job mismatches. The fiscal stance is expansionary but should become contractionary to support monetary policy. Public spending is the highest in the OECD, but oil revenues are declining and ageing costs are rising, which may strain public finances in the future. (OECD, 2024)

Finland

Similarly to the rest of the EU, Finland saw high inflation on domestic demand in the post-pandemic years – leading to a recession in 2023. Domestically, Finland have seen low consumer demands with higher interest rates – this in combination with a decrease in international demand for Finnish goods and services lead to the recession now apparent which have continued into the first half of 2024. Although, the Finnish economy is prognosed to grow in 2025 with expected growth in export and investments. Finland is expected to experience modest economic growth in the coming years. In 2023 the real GDP decreased by 1%, 2024 real GDP change is predicted to land on 0%, and for 2025 the growth is prognosed to 1,4%. Inflation rates are projected to stabilize, contributing to a more predictable economic environment. The central bank may adjust interest rates in response to economic conditions, aiming to support growth and control inflation. Finland saw some increase in unemployment rates during 2023, although at the same time the employment rate increased. This imbalance is mainly due to the skill shortage prevalent in many sectors – the Finnish government have implemented some measures to increase the flexibility of the jobs market with the expected results being increasing employment by 100 000 people by 2027. Finland faces challenges such as global economic uncertainties and geopolitical tensions, which could impact its economic outlook. (SEB, 2024)

Iceland

Iceland's economy is one of the fastest growing in the OECD, driven by foreign tourism and strong domestic demand (OECD, 2023). GDP is expected to grow by 2.5% in 2024, a slowdown from previous years and inflation is projected to decline to 4.9% in 2024, down from higher levels in 2023 (OECD, 2023). The Icelandic Chamber of Commerce (2024) is expecting private consumption and business investment to slow, housing investment to moderate growth and export growth to be driven by increased activity in the tourist sector. Rapid immigration has boosted the working-age population and met labor demands, but challenges in integration, language training, and housing need to be addressed. The labor market is tight with robust wage growth, contributing to a highly egalitarian economy, but inflation is persistent, and barriers to entry remain in many sectors. According to OECD structural reforms could help raise productivity and support disinflation. (Bardal, 2017)

Logistical problem

Long travel distances, particularly in the Nordic region, present a significant challenge for efficient and sustainable transport, as identified by Sovacool et al. (2018). The sparsely populated areas and vast distances complicate the maintenance of reliable charging infrastructure.

Climate change further exacerbates these challenges by disrupting supply chains and transport infrastructure through extreme weather events like hurricanes, floods, and heatwaves, which lead to delays, cost increases, and infrastructure damage (Yun & Ülku, 2023; Hirsch & Kunstman, 2014). Northern Norway's Saltfjellet pass, for example, experiences reduced traffic during severe weather (Wicki, 2023). Recent incidents in Norway and Sweden have highlighted the destructive effects of climate-induced events, with bridges and railways being severely damaged (DN, 2023, 2024).

Seaports are especially vulnerable due to their coastal locations, and climate change could necessitate costly infrastructure repairs (Dickson et al., 2010). Additionally, climate uncertainty impacts trade credit and financial resilience, stressing the need for improved risk



management (Cao et al., 2024). Unfortunately, there is limited research on climate change's effect on marine cargo insurance and green logistics measures (Jarašūnienė & Išoraitė, 2024). Geopolitical crises, such as the Russia-Ukraine war, can severely disrupt logistics by increasing costs, causing delays, and affecting international shipment and transport infrastructure. Geopolitical risks, including regulatory disharmony, negatively affect air, sea, and road freight, with sea freight being particularly susceptible (Liu & Fu, 2024).

Market acceptance

Market acceptance of fossil-free freight transportation is shaped by customer demand, stakeholder influence, cost, regulations, and sustainability concerns. While corporate stakeholders and internal initiatives primarily drive the development of green logistics services, public regulation has minimal influence (Osman et al., 2023). A meta-analysis by Wicki et al. (2023) found limited knowledge and evidence regarding consumer attitudes and uptake of battery electric vehicles (BEVs), which hinders adoption.

The acceptance of new technologies is critical for transport innovations, but challenges such as high initial costs, infrastructure needs, and uncertainties about charging infrastructure, safety, and maintenance complicate the transition to electrified transport (Stelling & Brunner, 2023). Additionally, the market uptake of alternative fuels, like ethanol in heavy-duty transport, has not met expectations due to insufficient acceptance (Trafikanalys, 2022). Incentives through policy instruments and regulatory changes may be required to encourage the logistics sector to adopt emission reduction options. However, balancing environmental sustainability with economic efficiency is challenging, as the sector focuses on cost reduction and may not fully implement available emission reduction measures (Neaogoe, 2024; Wanniarachchi et al., 2023).

Environmental and resource challenges

The Nordic region faces shared challenges in transitioning to a more sustainable and resource-efficient future. Despite access to natural resources, the region depends on imports and is vulnerable to climate-related impacts like melting ice and land degradation, which affect native species.

Country-Specific Challenges:

- **Denmark:** Urbanization around Copenhagen and Aarhus increases pressure on infrastructure, resources, and the environment, concentrating carbon emissions in these areas. The split of its environmental and food production ministries may complicate coherent regulation.
- **Sweden:** Digitalization and demographic changes challenge sustainability efforts. Large-scale projects like wind farms and mining disrupt ecosystems, including traditional Sámi lands, while the textile industry pushes for circular economy practices.
- **Norway:** Climate change, including melting glaciers and rising sea levels, threatens habitats in Svalbard and species like the Arctic fox. The Norwegian government focuses on oceans, green transitions, health, and digitalization as strategic priorities.
- **Finland:** Climate change affects society through rising temperatures and changing rainfall patterns. The OECD recommends improvements in air, waste, water, and biodiversity management, along with climate change mitigation and green recovery initiatives.
- **Iceland:** Tourism boosts Iceland's economy but strains infrastructure and threatens the environment. Iceland relies heavily on imports, contributing to a large carbon



footprint. Migration is critical for population growth, and the country must enhance education and skills to sustain development.

Each country is navigating complex environmental, economic, and social challenges to achieve sustainability.

Regulatory and political challenges

Creating harmonized laws and regulations for fossil-free transport across the Nordic countries is challenging due to differing political landscapes. Long-term investments in green transport require stable political will, but political changes can disrupt progress. Achieving fossil-free freight transport in the Nordics requires coordinated efforts from governments, industries, and society.

Political and legal uncertainties at micro, meso, and macro levels hinder the adoption of electric freight vehicles (EFVs). Denmark, Sweden, and Finland, as EU members, follow EU transport regulations, while Norway and Iceland, outside the EU but part of the EEA, cooperate economically with the EU. The Nordic Council has advocated for coordinated infrastructure efforts, but formal cooperation remains limited, with Sweden being the most hesitant to advance this coordination despite recent improvements in collaboration, particularly following Sweden and Finland's NATO membership.



Conclusion

To conclude, the Nordic countries have favorable conditions for a fossil-free freight transport sector, given that all countries have strong climate goals and an energy sector that is largely already fossil-free. The Nordic countries are at the forefront of both the development and implementation of fossil-free technology and consumer awareness. Additionally, digitalization has been identified as an important tool in the energy transition, and the Nordic countries are among the most digitalized societies in the world.

However, initial high costs, limited access to charging and refueling infrastructure, and disruptions in the supply chain for critical raw materials can hinder development. Therefore, there is a need for long-term policies and financing to consolidate the transition even during geopolitical and economic uncertainty.

There are good opportunities to, through increased cooperation between Nordic actors, strengthen and spread the existing strengths, both common and specific, and accelerate the transition to fossil-free transport. At the same time, increased cooperation and common strategies can lead to better capacity to handle the identified threats.





Triple F stands for **Fossil Free Freight**, which alludes to the programme's purpose – to help cut the CO₂ emissions produced by freight transport in Sweden. Triple F is the Swedish Transport Administration's research and innovation initiative, which is hosted by Lindholmen Science Park in collaboration with VTI and RISE. The programme was launched in 2018 and will run until 2030 at the latest.