

Scandinavia's maintenance debt

The road to reduced
CO₂-emissions from asphalt

Short version



Foreword

The Scandinavian road network is crucial for the functionality of our society, built over several generations through hard work and investments.

Roads create transportation connectivity, making it easier to travel for work, education, healthcare, and leisure. Good connectivity encourages people to explore new opportunities, leading to a better quality of life. Roads are essential for enabling people to live and work across all parts of the Scandinavian countries, bridging gaps between cities and rural areas.

Despite the importance of the road system, the Scandinavian countries have allowed their infrastructure to deteriorate over many years. The maintenance debt in our road system is substantial and continues to grow.

NCC has long played a significant role in designing, constructing, and maintaining the Scandinavian road system. We have collaborated closely with many municipalities, regions and road authorities in Scandinavia. Through this work, we have witnessed the challenges society faces in building durable road systems.

We consider it our duty to share our knowledge and expertise with decision-makers and customers, thereby contributing to addressing the substantial maintenance debt in our road systems and helping Scandinavia achieve its climate goals.

In the pursuit of an emission-free world, various measures must be adopted, and everyone must do their part. To address both the maintenance debt and the climate crisis, it is evident to us that we need to produce more asphalt with a lower climate impact.

If the Scandinavian societies undertake the right measures, we together can reduce the climate impact of maintaining the road system by up to 50 percent by 2045.

This report aims to clearly and concisely outline the direction of action needed. It highlights the importance of building and maintaining our road system in a sustainable manner in order to achieve established climate goals and outlines the conditions required for Scandinavia to reduce the maintenance debt in its road network.

Grete Aspelund, Head of NCC Industry



Summary

In order to maintain the functionality of the Scandinavian road system and at the same time reach the Scandinavian countries' vision of achieving complete carbon neutrality by 2045–2050, the Scandinavian societies must not only advocate for fossil-free transportation, but also devote greater resources to maintenance and focus their efforts on how we can mitigate the climate impact of designing, constructing, and maintaining the Scandinavian road system.

This report identifies long-standing challenges in maintaining the road infrastructure in Scandinavia. In 2023, the accumulated maintenance debt in Scandinavia amounted to approximately €7.8 billion, with forecasts suggesting that this figure could double to €15.6 billion by 2045 if nothing is done.

In Scandinavian national plans, the budget for road maintenance is insufficient, resulting in a growing maintenance debt. Increased government funding is crucial not only to maintain current road conditions, but also to significantly reduce this mounting debt. Failing to address this issue will lead to higher costs and an unsustainable future.

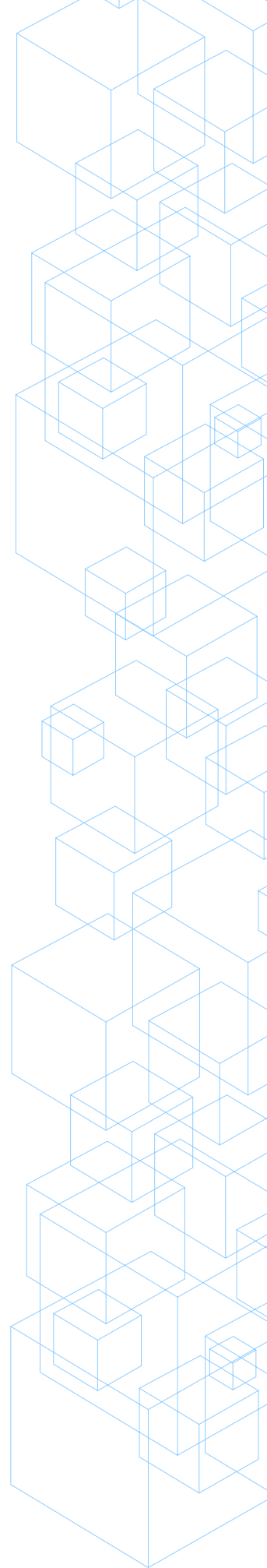
In order to significantly reduce Scandinavia's maintenance debt over the next decade, the yearly use of asphalt for maintenance must increase from the current rate. Achieving a substantial reduction in this debt will therefore require an intensification of asphalt production. This, in turn, will result in higher emissions.

Current asphalt production levels generate 980,000 tons of CO₂e emissions annually. With higher production levels, emissions could rise to as much as 1,100,000 tons of CO₂e by 2045. The Scandinavian countries, driven by their ambitious climate goals, must find a balance between increasing asphalt production and minimizing asphalt-related emissions. Maintaining this balance is critical for the Scandinavian countries if they are to restore the functionality of the road system and at the same time reach their climate objectives.

If the Scandinavian societies undertake adequate measures, the report shows that there is a possibility to reduce the climate impact of maintaining the road system by up to 50 percent by 2045.

Public procurement can serve as a pathway for tackling these environmental concerns in the road sector. By integrating stringent environmental criteria into the tendering process, the Scandinavian governments and municipalities have the potential to promote the adoption of sustainable materials, energy-efficient technologies, and innovative methods.

The report recommends eight policies designed to address the growing maintenance debt in the road sector. These policies encompass achieving a balance between increasing asphalt production and minimizing asphalt-related emissions.





“We have been involved in building and maintaining our road system for many years, working closely and in collaboration with many of Scandinavia’s municipalities, so we have seen the challenges that society faces when it comes to building durable road systems.”

Grete Aspelund, Head of NCC Industry

The Scandinavian road system

Sweden is home to the longest road network in Scandinavia, followed by Norway and Denmark. The countries vary not only in terms of the length of their road systems but also in terms of road management. In Sweden, most roads are under state control, while in Norway, county authorities oversee a significant portion, and in Denmark, the majority falls under municipal jurisdiction.

The road network in the Scandinavian countries has been developed over a long time and has now aged. A significant portion of this road infrastructure was constructed prior to 1970 and was designed to accommodate the traffic and loads of that era. As a result, an increasing number of roads in the Scandinavian countries are approaching the end of their intended technical lifespan.

Denmark

In Denmark, roads are categorized into state roads, municipal roads, and private roads. The country boasts a total of 74,897 km of public roads, supplemented by an additional 25,000 km of private roads.

Norway

Norway's road infrastructure is divided into national roads, county roads overseen and municipal roads. The state roads cover a distance of 10,700 kilometers. County roads form the majority of the road network, spanning 41,200 kilometers, municipal roads constitute 29,500 kilometers and private roads 100,000 kilometers.

Sweden

Sweden's road infrastructure is categorized into three distinct classes: State roads; municipal roads, and private roads. State roads play a substantial role in the country's road network, spanning approximately 98,500 kilometers, municipal roads cover a distance of around 43,000 kilometers and private roads total 480,000 kilometers.

The state of Scandinavian roads

Road conditions in Denmark

A 2017 nationwide analysis by the Danish Road Directorate (Vejdirektoratet, 2017) offers a detailed view of road conditions at the municipal level, Figure 2. With 72 out of 98 municipalities participating, the analysis revealed that nearly 20 percent of all roads have a lifespan of less than 30 percent, which is below an acceptable condition.

The analysis by the Danish Road Directorate shed light on the conditions of Denmark's municipal roads (Vejdirektoratet, 2017). The findings indicated a marked difference in the remaining lifespan of roads across the country, with many rural municipalities dealing with a particularly short projected lifespan for their roads.

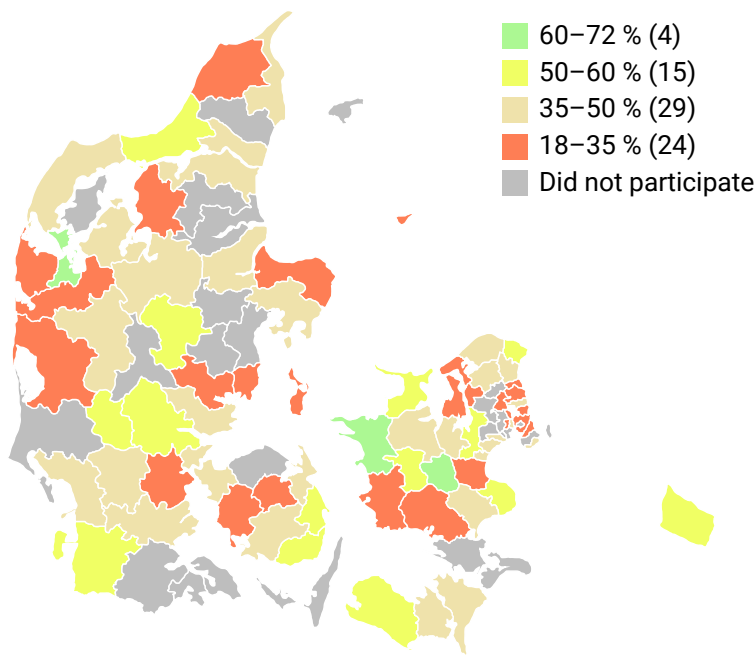


Figure 2 The above map shows the distribution of municipal roads according to lifespan in 2017. Municipalities colored in grey did not participate in the assessment. Green indicates municipalities with a low maintenance debt, while red indicates municipalities with a high maintenance debt.

Figure 2 suggests a wide variation in projected lifespans for roads across different municipalities. A lighter color indicates a shorter projected lifespan, quantified by the estimated remaining lifespan. With 72 out of 98 municipalities participating, the analysis revealed an average remaining lifespan of 42 percent nationwide. Approximately 75 percent of the municipalities have a remaining lifespan below 50 percent, and nearly 20 percent have a lifespan of less than 30 percent, which is considered low and below an acceptable condition.

The municipalities of Kalundborg, Struer, and Ringsted have the lowest remaining maintenance debts, with a technical lifespan ranging from 60 to 72 percent. In contrast, the municipalities of Norddjurs, Samsø, Lemvig, and Herlev face the highest maintenance debts, with a remaining lifespan of only 18 percent to 21 percent.

This disparity between municipalities may stem from the lack of a unified national investment strategy for road infrastructure and maintenance. Different areas might prioritize differently, perhaps missing the importance of a robust road network. Such an oversight could occur, for example, if a municipality's main industries do not depend heavily on well-maintained roads.

Road conditions in Norway

A significant portion, 30 percent, of the county road network in Norway has poor pavement conditions due to inadequate road structures and several years of insufficient funding (Statistics Norway, 2023).

The counties themselves have reported bad pavement conditions in large parts of the network, Figure 3.

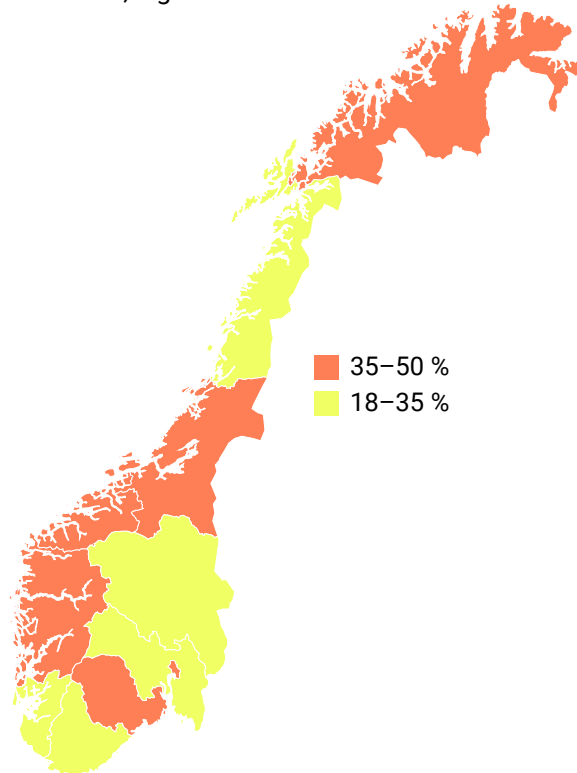


Figure 3 Share of the county road network with bad or very bad pavement conditions in 2020 (Source: Statistics Norway, 2023)

A significant portion of the county road network is antiquated and ill-suited to meet the demands of modern traffic and climate conditions. In practice, the counties often find it necessary to undertake more extensive projects beyond mere reinforcement and paving. In many instances, they prioritize widening the roads, straightening curves, and enhancing safety measures. Consequently, the financial requirements for these projects are considerably higher.

According to the Norwegian Public Roads Administration, in 2022, 92 percent of the pavement on national roads met the required standards. However, due to price increases in 2021 and 2022, this percentage is expected to decline in 2023 (Statens vegvesen, 2022).

Road conditions in Sweden

Eklöf's study (2021) shows that the current maintenance falls short of the needs. In an updated version with data for 2021, the study found (Figure 4) that **the percentage of roads in poor condition in Sweden has increased, and one third of state roads are in bad or very bad condition.**

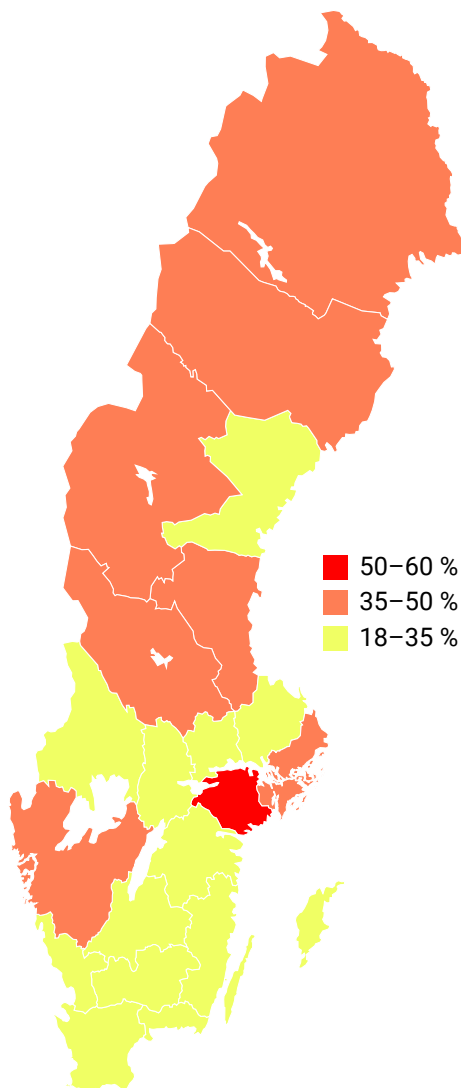


Figure 4 Share of the county road network with poor or very poor roads

The research shows that the condition of the roads differs between regions. About 40 percent of roads in Sweden's northern and central regions are in poor or very poor condition, while the corresponding figure in the southern region is 25 percent.

Need for maintenance

Large parts of Scandinavian roads are in bad condition. As upkeep in the road system is deferred, a “debt” accumulates, making repairs more extensive and more costly. All Scandinavian countries have failed to keep up with the necessary road maintenance to varying degrees, leading to an accumulating backlog. The total maintenance debt in Scandinavia was €7.9 billion in 2023 and is expected to increase.

Denmark

State roads are currently in good condition, with the disclaimer that certain maintenance is always required. The maintenance debt for municipal roads in 2017 amounted to DKK 4 billion. The exact trajectory of the municipal debt is difficult to determine, as each municipality operates with its own budget and is responsible for maintaining its respective roads (Vejdirektoratet, 2017).

As Denmark looks ahead to its 2035 infrastructure plan, the country is emphasizing new road construction. This plan allocates a significant DKK 51.7 billion for new projects, while a comparably small DKK 12.1 billion is reserved for maintenance and ongoing investments. The imbalance between new investments and maintenance funding highlights the critical need to reevaluate investment priorities.

Norway

Norway’s national road network has a maintenance debt estimated at approximately NOK 10 billion. For the county road network, the figure is around NOK 21 billion.

A revision of the mapping carried out in 2013 is scheduled to be presented in early 2024. The current strategic plan spans from 2022 to 2033. The level of operation and maintenance expenditures is expected to remain relatively constant throughout this entire period, while there is a planned increase in new road investments during the final six years.

Sweden

For Sweden, two different estimates of the maintenance debt for national roads in Sweden are presented. In the first, the figure is estimated at SEK 19.7 billion for 2020 and SEK 41.8 billion for 2030 (Eklöf, 2021). In the second, the Confederation of Swedish Enterprise makes a higher estimate: SEK 33.1 billion for 2023 and SEK 76.5 billion for 2033.

For municipal roads, a 2016 study conducted by the Swedish Association of Local Authorities and Regions (SKR) estimated the maintenance debt in Swedish municipalities at SEK 12 billion.

The current strategic plan for Sweden also spans from 2022 to 2033. The plan totals SEK 799 billion, based on 2021 price levels. SEK 197 billion is allocated for the maintenance of state roads, including improvements in load capacity, frost protection, and state co-financing for private road projects, and SEK 46 billion is allocated for new investments.

Overview of maintenance debt

Year	Denmark	Norway	Sweden	Total maintenance debt Scandinavian countries
2023	DKK 4 billion	NOK 41 billion	SEK 45 billion	
2045	DKK 4 billion	NOK 50 billion	SEK 130 billion	
2023	€ 0.5 billion	€ 3.5 billion	€ 3.8 billion	€ 7.8 billion
2045	€ 0.5 billion	€ 4.3 billion ¹	€ 10.8 billion ²	€ 15.6 billion

Table 1 Overview of maintenance debt in the Scandinavian countries in 2023 and in 2045 in euros. Based on official numbers.

¹ The projected amount for 2045 is based on the assumption that the maintenance debt will continue to increase by approximately 5–18%, mirroring the trends observed between 2014 and 2021. NOK 1 amounted to €0.085 in September 2023

² The projected amount for 2045 is based on the assumption that the maintenance debt will continue to increase at a similar rate as observed between 2015 and 2023. SEK 1 amounted to €0.085 in September 2023

Future demand for asphalt

This section notes that Scandinavia produces approximately 19 million tons of asphalt annually, a figure that has remained remarkably stable over the past decade. However, there are trends that indicate that production levels (in a high scenario) could increase to 22³ million tons of asphalt by 2045. This would result in an increase from 980,000 tons of CO₂e each year to about 1,100,000 tons of CO₂e in 2045.

To effectively reduce the maintenance backlog, an increased asphalt output beyond the current levels is essential for alleviating the maintenance debt. For example, to significantly reduce Sweden's maintenance debt over the next decade, the annual asphalt used for maintenance must increase by 100 percent compared to the present figures. The Scandinavian countries, driven by their ambitious climate goals, must figure out how to increase asphalt production while also minimizing emissions from asphalt. Maintaining this balance will be imperative for the Scandinavian countries as they strive to attain their ambitious climate objectives. Maintaining this is imperative for the Scandinavian countries as they strive to attain their ambitious climate objectives.

³ Denmark is expected to achieve production levels of approximately 4 million tons by 2045, while the corresponding figure in Norway is around 9 million tons. Sweden, on the other hand, anticipates production levels of 9 million tons, with a high likelihood of a production increase due to the country's significant maintenance debt.

Table 2: Overview of national climate commitments in the Scandinavian countries

Denmark	Norway	Sweden
<p>National commitments In 2020, Denmark made significant strides by passing the Climate Act, a landmark decision that committed the country to a substantial 70 percent reduction in greenhouse gases by 2030 compared to 1990 levels, with a vision of achieving complete carbon neutrality by 2050.</p> <p>As of 2021, greenhouse gas emissions in Denmark totaled 41.1 million tons of CO₂e.⁴</p>	<p>National commitments In 2020, Norway expanded its reduction target from at least 40 percent to at least 55 percent by 2030 compared to the 1990 level. This sets a specific emission target of 23.1 million tons by 2030.</p> <p>The Climate Change Act sets out a statutory target for Norway to be a low-emission society by 2050. In quantitative terms, the Act specifies that the target is to achieve reductions of greenhouse gas emissions in the order of 90–95 percent from the level in the reference year 1990.</p> <p>In Norway, the total greenhouse gas emissions for the year 2022 reached 48.9 million tons of CO₂e.⁵</p>	<p>National commitments In 2017, Sweden adopted a climate policy framework. The framework consists of a climate act, climate targets and a climate policy council. The long-term goal for Sweden is to have zero net emissions of greenhouse gases into the atmosphere by 2045 at the latest.</p> <p>As of 2022, greenhouse gas emissions in Sweden totaled 45.2 million tons of CO₂e.⁶</p>

Table 3: Overview of asphalt production and demand, along with the associated greenhouse gas emissions, in the Scandinavian countries

	Current and historical production of asphalt	Estimated future production of asphalt in 2045	Total current annual emissions from asphalt	Percentage of total national emissions
Denmark	Approx. 3.5–3.8 tons over the last ten years	Approx. 4 million tons by 2045 ⁷	240,000 tons CO ₂ e ⁸	0.6 %
Norway	Approx. 7 million tons annual production over the last ten years (noticeable reduction in the last five years)	Approximately 9 million tons by 2045	340,000 tons CO ₂ e ⁹	0.7 %
Sweden	Approx. 8.2 million tons annual production.	Approx. 9 million tons by 2045 ¹⁰	400,000 tons CO ₂ e ¹¹	0.9 %

⁴ The Danish Energy Agency (2021)

⁵ The Norwegian Ministry of Climate and Environment (2022)

⁶ The Swedish Environmental Protection Agency (2023)

⁷ Based on extrapolating average trends of asphalt production from 2012 to 2022, the estimate is approximately 4 million tons.

⁸ In Denmark, approximately 3.8 million tons of asphalt are produced annually. The average emission factor for Denmark is 63 kg CO₂e/ton. 3.8 million* 0.063g CO₂e/ton yields the total annual emissions from asphalt (Asfaltindustrien, 2022).

⁹ In Norway, approximately 7 million tons of asphalt are produced annually. The average emission factor for Norway is 48 kg CO₂e/ton. 7 million* 0.048kg CO₂e/ton yields the total annual emissions from asphalt.

¹⁰ Personal communication with NCC, 2023.

¹¹ In Sweden, approximately 8.2 million tons of asphalt are produced annually. The emission factor for asphalt for Sweden is provided by Klimatkalkyl and is set to 49 kg CO₂e/ton asphalt. Klimatkalkyl is developed by the Swedish Transport Administration to be able to efficiently and consistently calculate the energy use and climate load that the transport infrastructure gives rise to from a life cycle perspective. 8.2 million* 0.049kg CO₂e/ton yields the total annual emissions from asphalt (Tyréns, 2020).

In 2020, Denmark committed to a 70 percent greenhouse gas reduction by 2030 and carbon neutrality by 2050 through the Climate Act. By 2021, the country's greenhouse gas emissions totaled 41.1 million tons of CO₂e, with the highest average CO₂e per ton of asphalt, 63 kg, among Scandinavian countries.

In Norway, total greenhouse gas emissions for 2022 reached 48.9 million tons of CO₂e. To align with the country's environmental goals, there is a target to achieve a 50 percent reduction in emissions compared to 1990 levels. This sets a specific emission target of 23.1 million tons by 2030 (Norwegian Ministry of Climate and Environment, 2022).

The Norwegian Public Roads Administration has a crucial role to play in achieving this reduction. In 2020, on average, 62 kg of CO₂e were emitted per ton of asphalt produced. By 2023, this figure had been substantially reduced to about 48 kg of CO₂e per ton of asphalt, marking an impressive reduction of nearly 25 percent. According to the Norwegian Public Roads Administration, the main reason for this reduction is that CO₂e emissions are given significant emphasis when awarding most maintenance contracts for the national road network.

In 2017, Sweden implemented a robust climate policy framework, targeting net-zero greenhouse gas emissions by 2045. By 2022, emissions reached 45.2 million tons of CO₂ equivalent, with an emission factor of 49 kg of CO₂ per ton of asphalt produced, slightly higher than the equivalent figure for Norway.

How to ensure a sustainable and functional road system

Public procurement could serve as a pathway for tackling environmental concerns within the road sector. Through the integration of stringent environmental criteria in the tendering process, the Scandinavian governments have the potential to promote the adoption of sustainable materials, energy-efficient technologies, and innovative construction methods.

However, a significant emphasis on securing the lowest price, particularly prevalent in municipalities and counties, presents a formidable obstacle to the realization of environmentally sustainable infrastructure.

Denmark

Denmark's significant and prevalent dependence on natural gas in its asphalt plants highlights the urgency of transitioning to alternative energy sources. Initiating strategic measures as part of the procurement process could play a pivotal role in driving this transition away from natural gas. By embracing and scaling up the use of lower-emission asphalt, Denmark could make a more substantial and positive contribution to lowering its carbon footprint, thereby contributing to the country's climate-related goals.

A proactive approach in public procurement could guide the market towards more environmentally responsible solutions. As government projects prioritize ecological considerations, suppliers are incentivized to develop and offer greener alternatives, leading to industry-wide innovation and more sustainable, cost-effective methods.

Norway

The Norwegian Public Roads Administration has transitioned from awarding asphalt contracts based solely on the lowest price to placing greater emphasis on climate and environmental requirements.

Norway has also incorporated a bonus-malus system into its procurement. It awards a bonus (no surcharge) to the supplier with the lowest total CO_{2e} emissions, while others receive a surcharge (penalty). By taking CO_{2e} emissions into account in addition to price, the contractor can contribute to reducing the environmental impact from asphalt. This system also encourages contractors to reduce the emissions from asphalt.

Sweden

In Sweden, the Swedish Transport Administration is adopting a new approach focused on limiting CO₂ emissions. A study has shown that the market can already produce sufficient low-emission asphalt to meet the Swedish Transport Administration's standards for 2030, revealing a notable gap between potential CO₂ reduction and current standards. The lack of rewards for exceeding these requirements hinders contractors from pursuing higher performance levels, inhibits competition, and leads to suboptimal results. Through its framework agreements, the Swedish Association of Local Authorities and Regions has the opportunity to incorporate climate considerations and break the norm of lowest price prioritization in Sweden.

Recommendations

The Scandinavian countries share ambitious climate goals, with a vision of achieving complete carbon neutrality by 2045–2050. In light of their massive maintenance debt, all the Scandinavian countries need to find a balance between increasing asphalt production for maintenance to address the poor conditions of the Scandinavian roads and at the same time minimizing asphalt-related emissions.

The study recommends eight reforms designed to address the growing maintenance debt within the road sector in Scandinavia.

1. Increase funding for road maintenance

About 30 percent of Scandinavian roads are in bad condition. To reduce the mounting maintenance backlog, increased government and municipal funding is essential. In 2023, Scandinavia's maintenance debt amounted to €7.8 billion, with this figure projected to reach at least €15.6 billion by 2045. Neglecting maintenance leads to growing costs and an unsustainable outcome in terms of road quality and safety.

2. Allocate infrastructure funding on socio economic profitability

Maintenance of the Scandinavian road system has been neglected even though almost all road investments have a positive return and a higher socio-economic viability compared to other projects.

The Scandinavian governments should instruct their respective infrastructure agencies to incorporate NPVR into their national plans in a more thorough and systematic way. In doing so, the Scandinavian countries can ensure that public resources are allocated efficiently, targeting projects that generate the most significant societal benefits in relation to the cost incurred.

3. Scandinavian transport agencies should set stricter CO₂ threshold values

In Scandinavia, public procurement has the potential to promote environmental change in the road sector. To align with ambitious climate goals, the Scandinavian countries should set stricter CO₂ emission standards for asphalt procurement. At present, there is a substantial disparity between what can feasibly be achieved in terms of reducing CO₂ emissions and the existing standards.

By setting strict environmental standards for tenders, the Scandinavian governments can encourage a market transition towards more environmentally friendly solutions, pushing contractors to innovate and ultimately leading to sustainable, cost-effective practices.

4. Scandinavian municipalities should implement mandatory climate requirements in procurement

Implementing mandatory climate requirements at the regional, county and municipal levels through the various Scandinavian public procurement acts could be a crucial step in the right direction. These requirements should, for example, take the form of published EPD:s.

By integrating these criteria into their procurement processes, municipalities can ensure that the products and materials they use have a lower environmental impact throughout their life cycle, further contributing to the achievement of climate goals and environmental sustainability. This approach aligns public spending with a commitment to reducing CO₂ emissions and creating a more sustainable future, in line with the EU's approach to green public spending.

5. Public procurement should focus on functional requirements

Functional requirements play a pivotal role in defining desired outcomes and objectives without dictating the specific methods, technologies or products that must be employed.

Allowing contractors to make informed choices while adhering to these functional criteria fosters a more dynamic and innovative approach to asphalt selection. This approach ensures that the chosen asphalt is not only suitable for the project, but also encourages the development of environmentally responsible practices and materials, enabling the industry to tackle the challenges of reducing CO₂ emissions and advancing overall sustainability.

For example, utilizing RA has the potential to significantly reduce greenhouse gas emissions but is in many cases hindered by strict technical requirements.

6. Introduce bonus-malus systems in Sweden and Denmark

A bonus-malus system encourages contractors to cut their CO₂ emissions by offering them bonuses for mitigating their carbon footprint. It also enforces penalties for undesirable actions like excessive emissions, holding contractors financially accountable for their environmental impact. Financial consequences can encourage contractors to change undesirable behavior and influence corporate investments. Bonuses for emission reductions and penalties for excess emissions can shape strategic decisions, prompting businesses to invest in sustainable initiatives. This should be regarded as a policy model for Sweden and Denmark in their procurement processes, offering a means to reduce emissions and advance their climate objectives.

7. Increase the use of biofuels in Denmark

By substituting traditional fossil fuels with biofuels, Denmark can effectively reduce the climate impact associated with asphalt production.

Implementing a quota obligation that favors renewable fuels in asphalt plants could alleviate Denmark's dependence on natural gas and shift its asphalt production towards a more sustainable solution.

8. Reform Anlægsloftet so that it aligns with the Danish climate goals

In Denmark, Anlægsloftet presents a significant impediment to municipal development. Anlægsloftet, which translates to "investment ceiling" in English, imposes limitations on the financial resources that municipalities can allocate for new investments and maintenance projects.

A governmental investigation should be initiated to examine the constraints imposed by Anlægsloftet and how prioritization of projects based on immediate financial considerations affects long-term sustainability goals.

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