Report

Scandinavia's maintenance debt

The road to reduced CO_2-emissions from asphalt

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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 CO_2e emissions annually. With higher production levels, emissions could rise to as much as 1,100,000 tons of CO_2e 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.

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"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

1 The Scandinavian road system

The Scandinavian road system comprises a structured framework with distinct road types that are managed by different actors. This section presents an overview of these road types and the parties responsible for their governance.

1.1 Different types of roads and their governance

In Denmark, roads are classified into state roads, municipal roads[2], and private roads, (Samkom, 2010). State roads, which form part of the national network, are managed and funded by the Danish Road Directorate (Vejdirektoratet). These roads are essential connectors between major urban centers, primarily consisting of motorways and main roads. Local authorities are responsible for maintaining municipal roads, which make up most of the road network, see Figure 1 below.

Norway's road infrastructure comprises national roads managed by the Norwegian Public Roads Administration (Statens vegvesen), county roads under county management, and municipal roads maintained by local authorities. Norway's road management has undergone several shifts in recent years. In 2020, the management of county roads was transferred from the Norwegian Public Roads Administration to county administrations, which also resulted a merger of counties. However, three of these merged counties will separate again in 2024. In addition, a private road company called Nye Veier AS was established in 2016. Funded by the government, Nye Veier AS focuses on planning, constructing, and maintaining a segment of the national road network, with a primary emphasis on constructing four-lane motorways. The company's portfolio, initially spanning around 530 kilometers of roads, expanded to approximately 1,270 kilometers in 2022 (Nya Veier, 2023).

Sweden's road infrastructure is categorized into three distinct classes: public roads; municipal roads, which are under the purview of local municipalities; and private roads[3] (SKR, 2023). Public roads fall under the jurisdiction of the Swedish Transport Administration (Trafikverket), municipal roads are under the purview of local municipalities, and private roads are overseen by various entities, including road associations, community associations and individual property owners. Figure 1 provides an overview of the various road types in each country and the percentage of the total network that each road type represents.[4]

[2] A significant portion of the Danish road network consists of public roads, accounting for 75 percent. The remaining 25 percent are private roads. Within the realm of public roads, 95 percent are categorized as municipal roads, with the remaining 5 percent designated as state roads.

[3] Private roads in Sweden are divided into private roads with and without state funding. In total, private roads amount to 480,000 kilometers. In this report, we have decided to include roads with state funding (SKR, 2023).

[4] Norway also has approximately 100,000 kilometers of private roads, a significant portion of which consists of gravel roads. Hence, these private roads are not included in the overview.

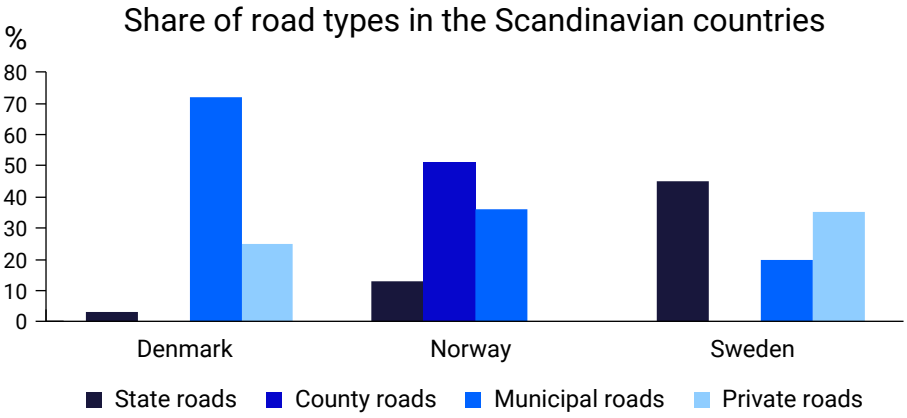


Figure 1 The share of different road types in the Scandinavian countries.

1.2 The different countries' characteristics

The future of the Scandinavian road system is shaped by past policy and different physical, geographic and demographic conditions. This also partly explains the differences in terms of the share of different road types in the three countries.

In Denmark, road infrastructure has seen dramatic growth, with state funding contributing to a well-connected motorway network in the shape of an "H." The Great Belt Bridge's inauguration in 1998 marked a significant milestone, followed by continual enhancements to the national road network (Samkom, 2010). The focus on expanding road networks inadvertently led to overlooking the maintenance of existing roads and gradually accumulating a maintenance debt. The country is much smaller in size than Norway and Sweden, which may be a contributing factor to its small share of state roads and very large share of municipal roads compared to Norway and Sweden.

Although state roads comprise only 5 percent of the road network and 95 percent are public roads, the total traffic volume on the state roads is nearly equivalent to that on municipal roads. Norway's road network is characterized by a significant portion with low traffic volumes. This means that track wear is often not the primary challenge. Instead, on the county road network, pavement deterioration is attributable to factors such as inadequate road structure, frost heaving, water damage, and insufficient compaction of the road body. These are often roads where the foundation needs to be rebuilt (for example, old track roads) for the pavement to have a longer lifespan. In many cases, rebuilding these roads is also not financially viable due to low traffic volumes. Moreover, there is a very high prevalence of gravel on private roads.

Sweden's road network is relatively old, with approximately 60 percent constructed before 1970, giving rise to a pressing need for maintenance (Trafikverket, 2021). Over the years, the traffic volume has surged, and vehicles have grown heavier, placing an additional strain on the infrastructure. The national plan (see section 2.4) anticipates deteriorating conditions for both low- and high-traffic roads in the short term, but investments in load capacity are expected to bolster the resilience of vital, heavily trafficked routes.

1.3 Traffic demand is expected to rise

All Scandinavian countries are expecting an increase in traffic, which will exacerbate the wear and tear on the road network, increasing the need for maintenance and new investments. This especially holds true for state roads. In addition to increased traffic, heavier vehicles are also contributing to the wear and tear on roads.

In Denmark, significant growth in traffic is anticipated. According to projections from the Danish Ministry of Transportation, motorway traffic is expected to experience an annual growth rate of 2.1 percent, while other road categories are projected to see a 0.7 percent increase (Vejdirektoratet, 2023). Additionally, the findings from a report by the Technical University of Denmark, which includes estimates of traffic flow development, indicate that a 16 percent increase in car traffic and a 12 percent increase in goods transportation can be expected by 2030 (DTU, 2018).

Forecasts also show that traffic volumes in Norway will continue to grow in the years to come, but at a lower rate than earlier. The car traffic forecast for 2060 is about 30 percent higher than 2020, while the truck traffic forecast for 2060 is about 60 percent higher.

According to the traffic forecasts by the Swedish Transport Administration for 2023, passenger traffic is expected to see a nationwide increase of 28 percent from 2017 to 2040, along with 47 percent growth in vehicle kilometers up to 2065 (Trafikverket, 2023). In terms of truck traffic, the number of vehicle kilometers is expected to increase in across all counties in the country, with a national projection of a 43 percent increase from 2017 to 2040 and a substantial 92 percent increase by 2065.

Chapter 1 summary – 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.

2 A greater need for maintenance

This section presents an overview of the conditions of the Scandinavian road system as well as the maintenance and investment debt in Scandinavia. It also provides insights into the consequences that can be expected if investments are not carried out, the conditions of the road network, and the origins and development of the countries' maintenance debt.

2.1 Failure to invest in roads will lead to challenges

The Scandinavian road network is crucial for the functionality of society. Neglecting road maintenance has an adverse impact on the overall standard of Scandinavian roads. Robust road infrastructure is essential for preserving and enhancing traffic safety, bolstering competitiveness, and ensuring nationwide accessibility, as noted by Kristin Eklöf in a study from 2021.

A decline in road quality results in higher expenses for businesses, leading to increased consumer prices and diminished economic growth. As road quality deteriorates, companies must allocate more funds for repairs and utilize additional packaging materials to safeguard their products.

According to a 2010 report by Hilda Van Rooyen, these additional costs are often ultimately transferred to consumers. A study by the Confederation of Swedish Enterprise (Svenskt Näringsliv, 2023) emphasizes that haulage companies are greatly impacted by the lack of road maintenance. This deficiency has profound consequences on their businesses, primarily resulting in vehicle damage, extended travel distances, and disruptions to deliveries, leading to delays and damaged goods.

Insufficient allocation of resources for the upkeep of roads inevitably leads to a decline in their standard, with adverse consequences for road safety. Poor road conditions not only pose higher occupational risks for drivers but, more critically, also increase the likelihood of accidents. Neglected maintenance heightens the risk of road surfaces becoming rutted, consequently increasing the risk of hydroplaning. It also exacerbates the potential for off-road incidents as road edges weaken.

In Norway, factors related to maintenance led to approximately 30 fatal accidents per year during the period 2017–2021 (Opplysningsrådet for veitrafikken, 2023).

In Denmark and Sweden, no fatal accidents related to maintenance have been recorded. However, the Technical University of Denmark (DTU, 2019) conducted a study exploring the statistical link between municipal road conditions and traffic accidents. Their analysis of data from 44 municipalities revealed a higher likelihood of accidents on roads with diverse surface damage.

Deteriorating asphalt and road structures also leads to increased fuel consumption. When the surface becomes uneven due to cracks and potholes, the movement of vehicles becomes less efficient. This results in increased drag and hence higher fuel consumption to compensate for the extra force required to drive on these damaged surfaces.

With growing climate challenges, the demand for immediate sustainable infrastructure solutions is also increasing. An analysis by Irene Bronx Nielsen et al. (2020) revealed that increased temperature fluctuations result in road deterioration, underscoring the impact of climate change on road quality.

2.2 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.

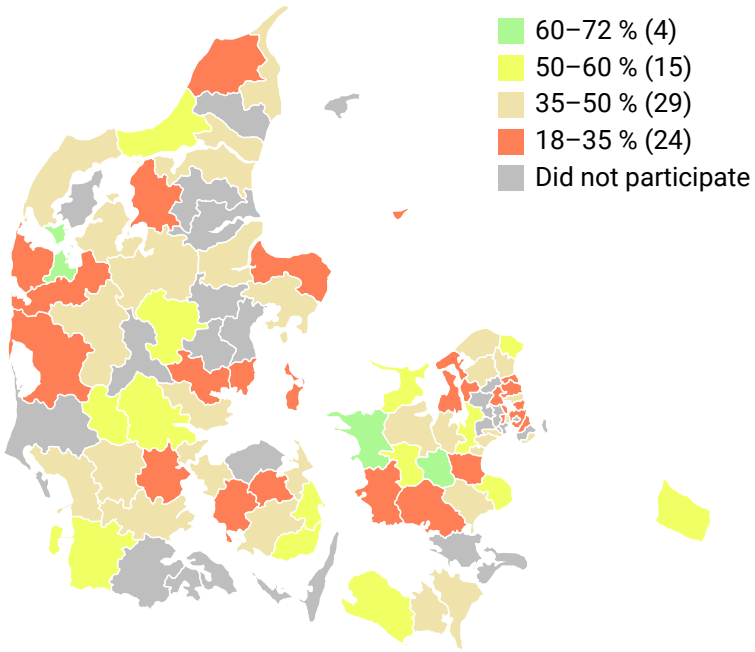


Figure 2 The above map shows the distribution of municipal roads according to lifespan in 2017. Municipalities colored in grey did not participate in the assessment. Green indicates municipalities with a low maintenance debt, while red indicates municipalities with a high maintenance debt.

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.

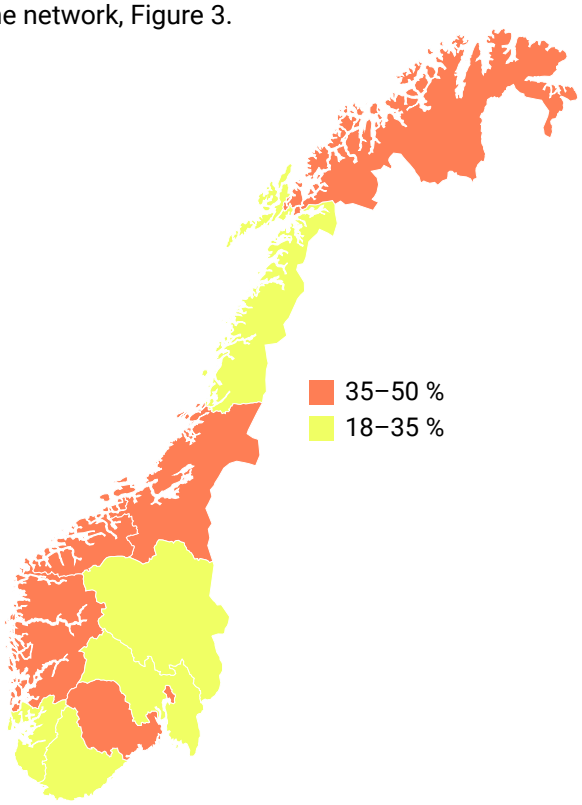


Figure 3 Share of the county road network with bad or very bad pavement conditions in 2020 (Source: Statistics Norway, 2023)

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.**

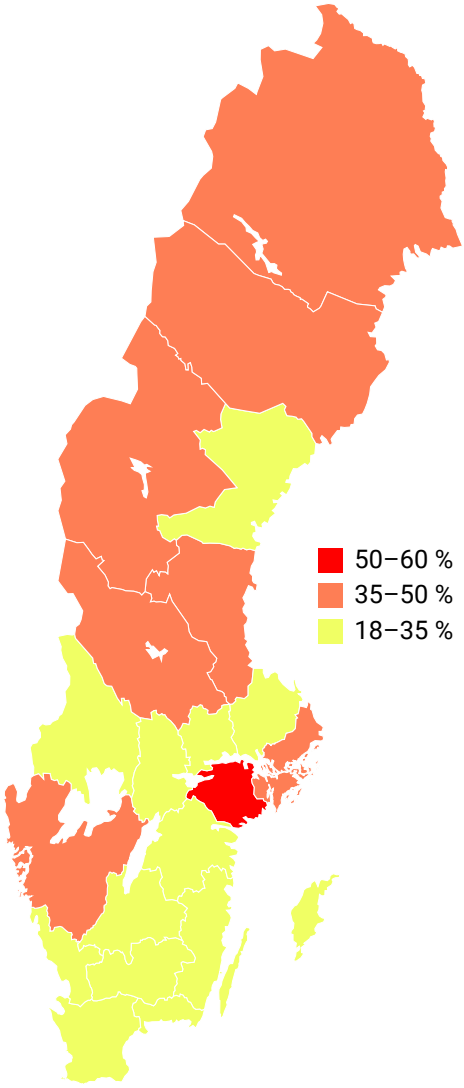


Figure 4 Share of the county road network with poor or very poor roads

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.

2.3 The Scandinavian maintenance debt

In this report, we have used data from official figures provided by the authorities of each Scandinavian country, such as the national plans. Additionally, we have used data from national statistics, research papers, and trade associations to further enhance the reliability of our analyses.

As upkeep in the road system is deferred, a “debt” accumulates, making eventual repairs more extensive and often more costly. All Scandinavian countries have failed to keep up with the necessary road maintenance to varying degrees, leading to an accumulating backlog. There is a lack of a universally agreed-upon definition of maintenance debt, and maintenance debt is therefore defined differently in the various Scandinavian countries.

In Sweden, maintenance debt refers to roads whose International Roughness Index[5] (IRI), which describes the longitudinal unevenness of the road, or track depth exceeds the Swedish Transport Administration’s maintenance standard, or whose age exceeds their expected lifetime. The maintenance debt comprises the cost for fixing these roads (Eklöf 2021).

In Norway the requirement for maintenance is established by considering the lifespan of the pavement. The pavement lifespan factor serves as an indicator for this assessment. The lifespan factor for a road segment is defined as the ratio between the functional pavement lifespan and the normative pavement lifespan.

[5] International Roughness Index (IRI) is measured in millimeters per meter and describes the longitudinal unevenness of the road.

In Denmark, two systems are used for to assess the condition of roads. The first, carried out by the Danish Road Directorate, is called “damage points.” In this system, damages are evaluated as a percentage of the total area or length. A weight factor is applied based on the severity of the damage, resulting in a total damage point calculation. Subsequently, the remaining lifetime can be assessed. In the second system, Sweco’s RoSy (Road Systems), the percentage of every single damage is evaluated in the same way as in Danish Road Directorate’s system, but with limit values per damage type.

A maintenance debt arises when roads fall below an acceptable condition, typically when their remaining lifespan falls below 50 percent of their original capacity, as defined by the Danish Road Directorate in 2017 (Vejdirektoratet, 2017). When roads reach this critical threshold of around 50 percent remaining lifespan, they are evaluated for potential replacement. To sustain this level, municipalities must allocate resources to road maintenance, ensuring that the average remaining lifespan remains at or above 50 percent.

For instance, if a road has a technical lifespan of 50 years, and it is determined during an inspection that the average technical lifespan of the road is less than 25 years, it becomes necessary to invest in maintenance. However, if the average remaining lifespan surpasses 25 years, no immediate investment is required.

The maintenance debt in the Scandinavian countries

Different analyses have been conducted in the Scandinavian countries to estimate the size of the maintenance debt, expressed in monetary terms. Estimates have been conducted for different road types and at different points in time. This is illustrated in the following chapter.

The maintenance debt in Denmark

In Denmark, a focus on expanding road networks has led to overlooking the maintenance of existing roads and gradually accumulating a maintenance debt, especially for municipal roads, which make up the vast majority of the road system. Nevertheless, it is noteworthy that state roads in Denmark have a nearly equivalent total traffic volume compared to municipal roads.

4 billion DKK
Maintenance debt on municipality roads in Denmark

An analysis conducted by the Danish Road Directorate in 2017 unveiled a maintenance debt of DKK 4 billion for municipal roads in Denmark (Vejdirektoratet, 2017). As for the maintenance debt concerning state roads, it is noteworthy that these roads are currently in good condition, and while some maintenance will always be required, it is not expected to be extensive. According to the annual report Statsvejnettet by the Danish Road Directorate (Vejdirektoratet, 2022), state roads reached maintenance equilibrium by the end of 2021, indicating that the maintenance debt for state roads is more or less zero.

The maintenance debt in Norway

In 2013, the Norwegian Road Administration assessed the maintenance debt for Norway's national and county road networks. The maintenance debt was estimated at approximately NOK 25–40 billion for the national road network, with approximately 25 percent of this amount allocated to road foundations and pavement. **This corresponds to a maintenance debt for road foundations and pavement in the national road network of approximately NOK 6–10 billion.**

41 billion NOK
Maintenance debt on state and county roads in Norway

The maintenance debt for the county road network was revised in 2023, with the results showing that the maintenance debt had increased by approximately 5–18 percent between 2014 and 2021 (Statens vegvesen, 2023). The estimated maintenance debt for the county road network now stands between NOK 85 billion and NOK 95 billion. This encompasses upkeep for bridges, tunnels, drainage, road equipment, and pavement and road foundations. **This report concentrates specifically on the maintenance of pavement and road foundations, which amounts to NOK 33 billion.** However, according to Consulting Engineers' Association (RIF) (2023), the estimated debt is most likely higher than the estimates provided by Statens vegvesen, 2022.

The maintenance debt in Sweden

In Sweden, several estimates of the size of the maintenance debt for national roads have been carried out in the recent years. A report by Eklöf (2021) estimates that SEK 19.7 billion was needed for 2020 and SEK 41.8 billion for 2030. To stop the negative development of the maintenance debt and maintain the road network, the maintenance budget would need to increase by SEK 2 billion per year, from SEK 3.4 billion to SEK 5.4 billion.

45 billion SEK
in maintenance debt on state and municipal roads in Sweden

In a report written on behalf of the Confederation of Swedish Enterprise (Svenskt Näringsliv, 2023), a higher estimate is presented. The study found that by 2033, **the accumulated maintenance debt for national roads is expected to reach SEK 76.5 billion.** That is almost a threefold increase from 2015, when the maintenance debt was calculated at SEK 20 billion.[6]

The increase is explained by the fact that the maintenance backlog for public roads is growing due to a focus on new investments rather than managing the existing road network. To carry out all deferred maintenance in the Swedish public road network, appropriations for road maintenance would have to increase by SEK 8.1 billion annually for the next ten years. This corresponds to a 60 percent increase. **In 2023, the maintenance debt will amount to SEK 33.1 billion. For municipal roads, a 2016 study conducted by the Swedish Association of Local Authorities and Regions (SKR, 2016) estimated the maintenance debt of Swedish municipalities at SEK 12 billion.**

[6] Expressed at the 2021 price level.

Additionally, it was determined that there was an imminent need to prioritize maintenance efforts for approximately 8 percent of the roads in the next year i.e., 2017. Furthermore, over the course of the next five years, the upkeep of roughly 40 percent of all municipal roads needed to be addressed in a maintenance plan. Including the maintenance debt for state roads, the total maintenance debt in Sweden for 2023 will amount to at least SEK 45 billion.

Table 1 provides an overview of the maintenance debt in the Scandinavian countries in 2023 in euros.

Year	Denmark	Norway	Sweden	Total maintenance debt Scandinavian countries
2023	DKK 4 billion	NOK 41 billion	SEK 45 billion	
2023	€ 0.5 billion[7]	€ 3.5 billion[8]	€ 3.8 billion[9]	€ 7.8 billion

Table 1 Overview of maintenance debt in the Scandinavian countries in 2023 in euros.

2.4 Scandinavia's future investments and reinvestments in infrastructure

Future plans in Denmark

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 (Infrastrukturplan, 2021).

Struggling with budget constraints, municipalities are being confronted with difficult choices regarding resource allocation. As a result, maintenance prioritization can vary widely from one municipality to another, often less heavily trafficked roads often neglected.

The 2023 infrastructure plan includes DKK 2 billion for road maintenance and DKK 700 million for other state infrastructure maintenance. According to the annual report Statsvejnettet by the Danish Road Directorate, state roads reached maintenance equilibrium by the end of 2021, indicating that the maintenance debt for state roads is more or less zero (Vejdirektoratet, 2022).

[7] DKK 1 amounts to €0.13 as of September 2023.

[8] NOK 1 amounts to €0.087 of September 2023.

[9] SEK 1 amounts to €0.084 of September 2023.

Figure 5 illustrates the average annual expenditures derived from Infrastrukturplan 2035, encompassing both new road projects and road maintenance expenditures from 2022 to 2035. This depiction does not portray the actual annual distribution between new investments and maintenance. In practice, the allocation between investments and maintenance is expected to vary each year, reflecting the fluctuating costs associated with different scheduled projects.

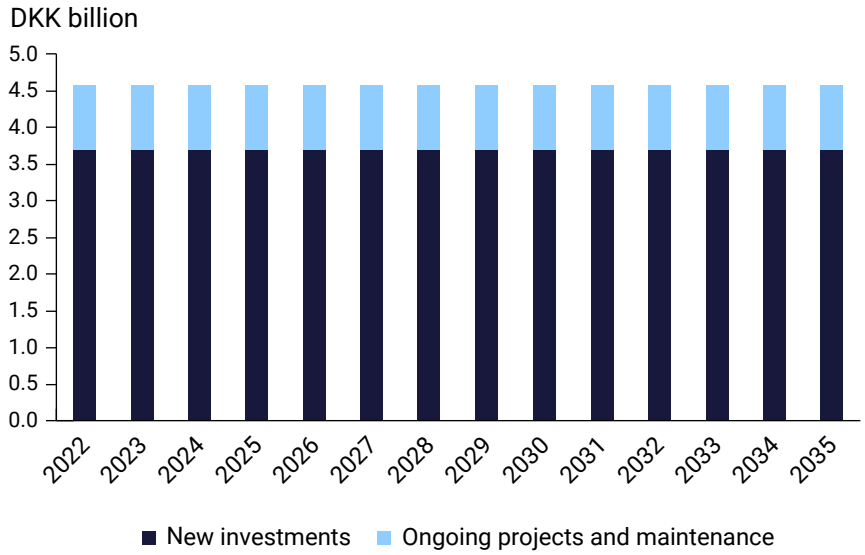


Figure 5 Average annual allocation between investments and maintenance for roads, derived from Infrastrukturplan 2035. The allocation is derived from an average calculated by dividing the total expenses by the number of years spanning from 2022 to 2035.

Figure 6 below shows the location of new investments and investigation projects for roads from Infrastrukturplan 2035. As shown in the figure, many of the projects are located in the Central Denmark Region and the Capital Region of Denmark.

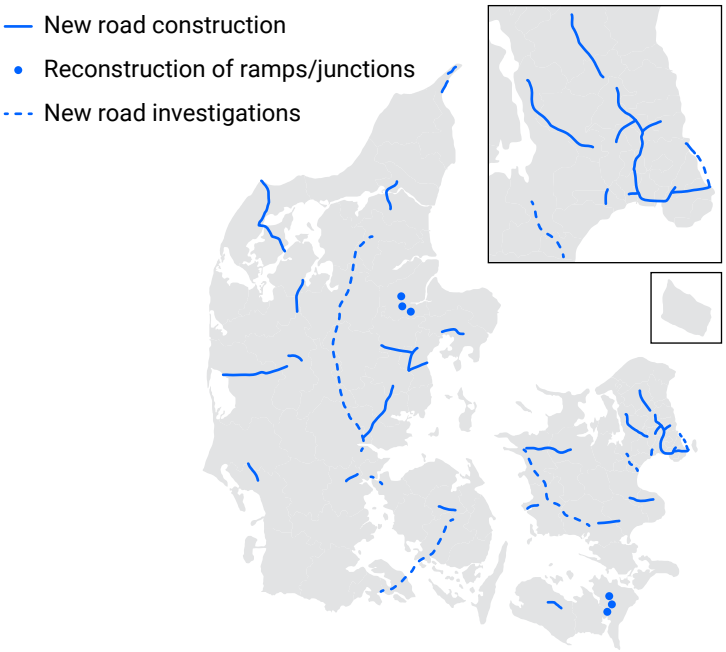


Figure 6 Location of new investments and investigation projects for roads, 2020–2035

Future plans in Norway

In Norway, the road budget has experienced a notable increase over the past decade. However, there has been a decrease in the budget over the last two years. Additionally, due to substantial price increases in 2021 and 2022, there has been a decline in the level of activity in road-related projects.

The current strategic plan for the state transport network spans from 2022 to 2033. The planned budgets for investments, operation and maintenance for roads under the current plan are presented in Figure 7 below.

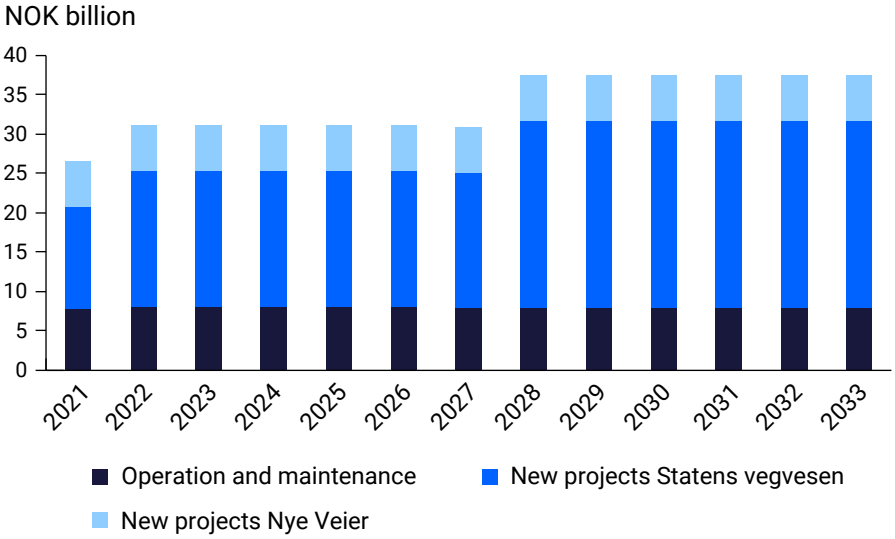


Figure 7 Planned budgets for road investments, operation and maintenance (National Transport Plan 2022–2033)

The figure shows that the level of operation and maintenance expenditures will remain relatively constant throughout the period, while there is a planned increase in road investments during the final six years. The annual budget for operation and maintenance is around NOK 8 billion, with only approximately NOK 1 billion allocated for paving purposes (Regeringen, 2021.).

The upcoming strategic plan, which will span from 2025 to 2036, will be submitted to parliament (Stortinget) in spring 2024. Preliminary signals indicate that the strategy for road development will be changed due to the economic situation and a greater emphasis on sustainability demands. The most important changes are expected to be:

- Reduced road budgets.
- Downscaling of new motorway projects
- Fewer new road projects and more maintenance

Nye Veier AS operates with a consistent annual budget of approximately NOK 6 billion. With a portfolio estimated at NOK 286 billion, it is projected that the completion of these projects will span approximately 50 years. The prioritized projects (for the next 10–15 years) are mainly located in Eastern Norway, Southern Norway and Central Norway.

When it comes to county and municipal roads, the outlook appears more pessimistic. The significant maintenance debt requires substantial resources, and while there is a growing focus on addressing this debt, it is unlikely that there will be a significant budget increase.

County administrations face difficult decisions when it comes to allocating funds between roads, public transport, and high schools, and historical experience indicates that roads often receive lower priority. Additionally, rising costs present another challenge. There is therefore reason to expect that the asphalt levels for regional and local roads will remain relatively stable in the future.

The planned investments, which include new projects, are distributed across the country, see Figure 8. However, there is a noticeable emphasis on the eastern and western regions of Norway, suggesting a greater allocation of resources in these areas (Regeringen, 2021).

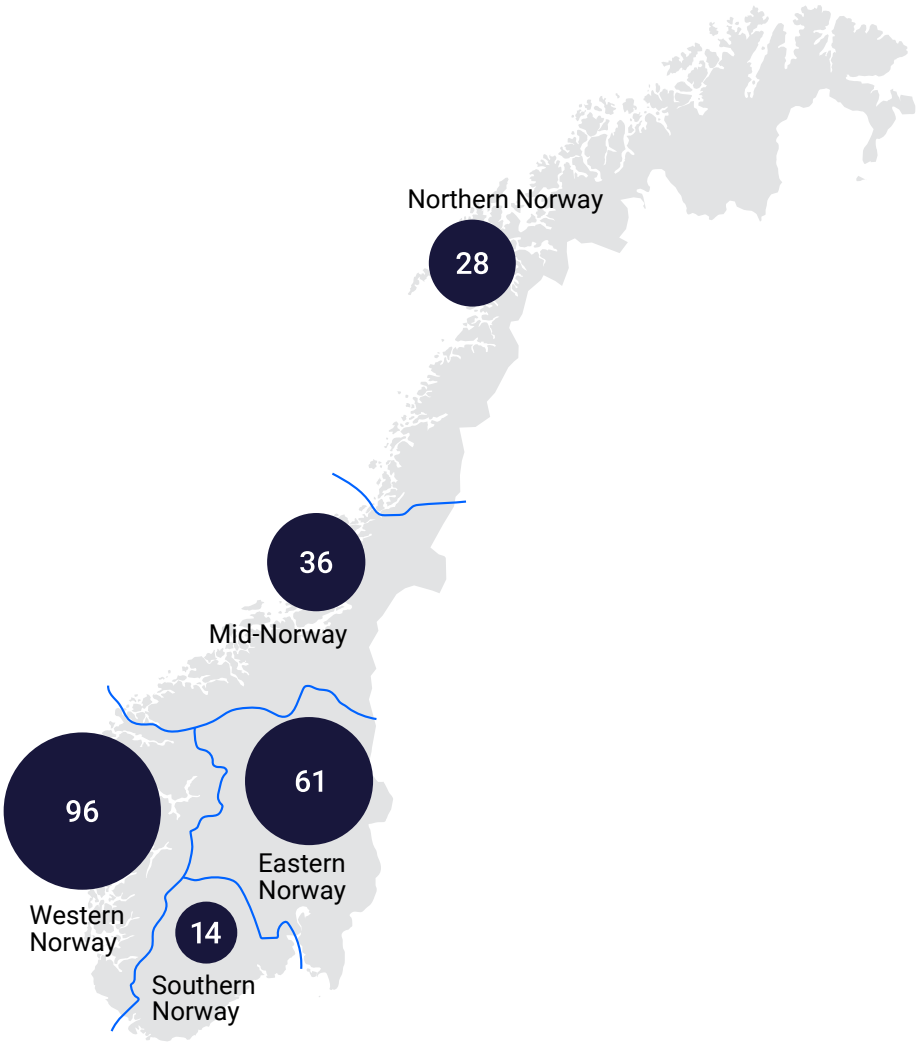


Figure 8 New road projects 2022–2033 geographically distributed (NOK billion)

The current national Norwegian transport plan features several major road projects, predominantly involving expensive bridges and tunnels. This trend is particularly noticeable in Western Norway, where asphalt-related investments represent a relatively small portion of the overall project expenditure (Regeringen, 2021).

Planning for road maintenance poses a considerable challenge as it is more of an adaptable and dynamic process, lacking a fixed, predetermined set of roads, and plans. Therefore road maintenance projects are not published by the Norwegian Public Roads Administration.

According to the Norwegian Public Roads Administration (Statens vegvesen, 2023), the maintenance debt in Norwegian counties was estimated at NOK 33 billion (see section 3.3.). From 2014 to 2021, this figure increased by approximately 5 to 18 percent. Assuming this pattern continues, **the maintenance debt in Norwegian counties could reach about NOK 50 billion by 2045.**

Future plans in Sweden

In Sweden, the Swedish Transport Administration's has underscored the fact that the need for road maintenance exceeds the funding available in the country's recent national plan from 2021. This is despite a 13 percent increase in the allocation for state road maintenance compared to the previous plan.

The current plan applies from 2022 to 2033 and 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.

Figure 9 shows the average annual expenditures for both new investments and maintenance costs for roads spanning from 2022 to 2033. Similar to the Danish context, the figure does not accurately represent the specific yearly allocation between new investments and maintenance, as it relies on calculated averages. In reality, the distribution between investments and maintenance is expected to fluctuate annually, reflecting the varying costs associated with different scheduled projects.

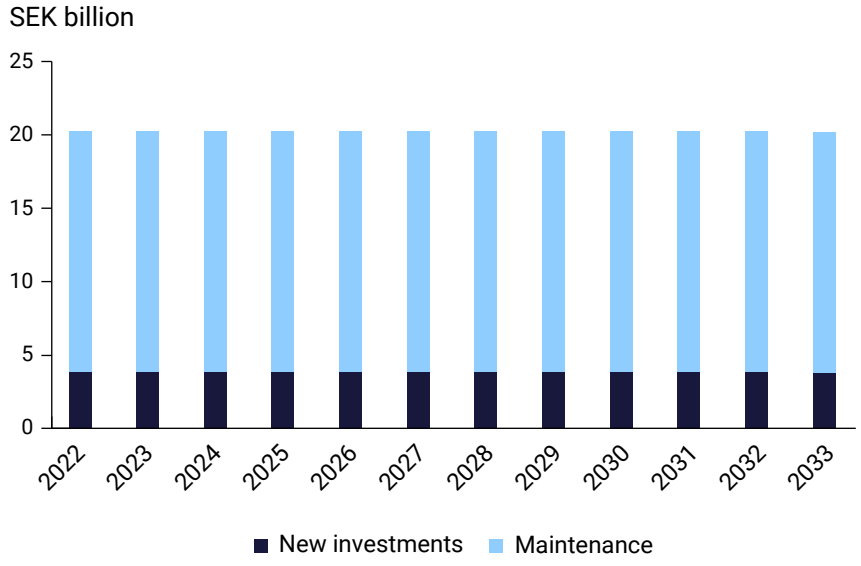


Figure 9 Average annual allocation between investments and maintenance for roads, derived from the national plan for 2022–2033. The allocation is derived from an average calculated by dividing the total expenses by the number of years spanning from 2022 to 2033.

Figure 10 presents a comprehensive overview of the major initiatives outlined in the proposed plan. These initiatives encompass investments in the national road network with costs exceeding SEK 100 million and reinvestments in national roads with costs surpassing SEK 300 million.

According to the Confederation of Swedish Enterprise (Svenskt Näringsliv, 2023), the cumulative maintenance debt for national roads is projected to reach SEK 76.5 billion by 2033. This represents nearly a threefold increase from the 2015 figure, which stood at SEK 20 billion. If this trend persists, the maintenance debt for state roads in Sweden could amount to approximately SEK 130 billion by 2045. Figure 9 below shows the location of new investment and reinvestment projects (blue dots) for roads according to the national plan for 2022–2033. As shown in the figure, many of the projects are located in the central and western regions of Sweden.

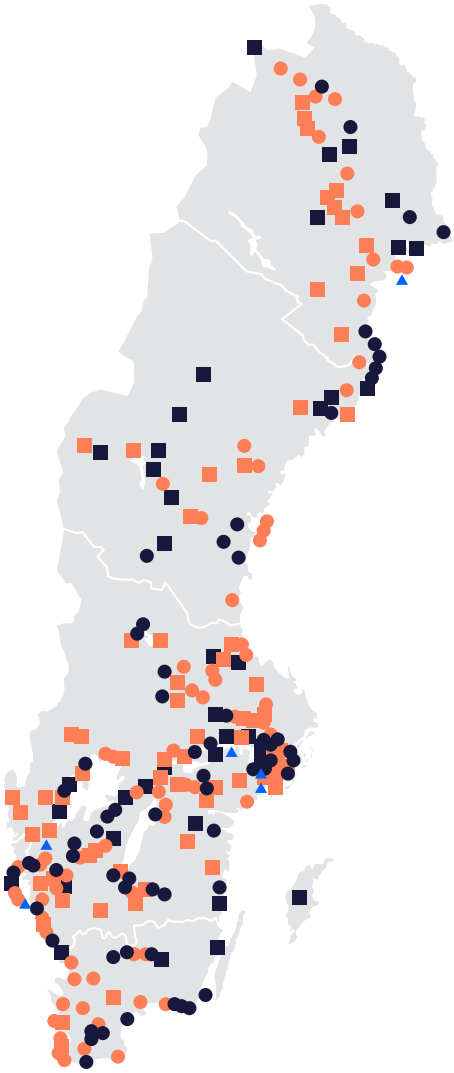


Figure 10 Principal investments and reinvestments in Sweden scheduled up to 2033. The dark blue dots illustrate road investments with costs over SEK 100 million and the dark blue squares illustrate road reinvestments with costs over SEK 300 million. The orange dots illustrate investments in railways and the orange squares illustrate railway reinvestments with costs over SEK 300 million. The light blue triangles illustrate maritime shipping.

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[10]	€ 10.8 billion[11]	€ 15.6 billion

Table 2 Overview of maintenance debt in the Scandinavian countries in 2023 and in 2045 in euros. Based on official numbers.

[10] 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

[11] 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

Chapter 2 summary – 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.


NCC

3 Climate targets and emissions from asphalt

To effectively reduce the maintenance backlog and to fulfill Scandinavia's future investments and reinvestments in infrastructure, an increased asphalt output beyond the current levels is essential.

Innovative approaches to asphalt production, road construction requirements, and other practices must be explored and implemented throughout the Scandinavian countries to mitigate the negative environmental impacts of asphalt production. This section provides data on the current level of emissions from asphalt production, while Chapter 5 provides data on the development of future emissions.

The Scandinavian countries share a dedication to the United Nations Sustainable Development Goals (SDGs). This section provides an overview of the Scandinavian countries' commitments over the coming years, see Table 3.

Table 3: Overview of national climate commitments in the Scandinavian countries

Denmark	Norway	Sweden
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. **As of 2021, greenhouse gas emissions in Denmark totaled 41.1 million tons of CO_2e.**[12]	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. 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. **In Norway, the total greenhouse gas emissions for the year 2022 reached 48.9 million tons of CO_2e.**[13]	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. **As of 2022, greenhouse gas emissions in Sweden totaled 45.2 million tons of CO_2e.**[14]

[12] The Danish Energy Agency (2021)

[13] The Norwegian Ministry of Climate and Environment (2022)

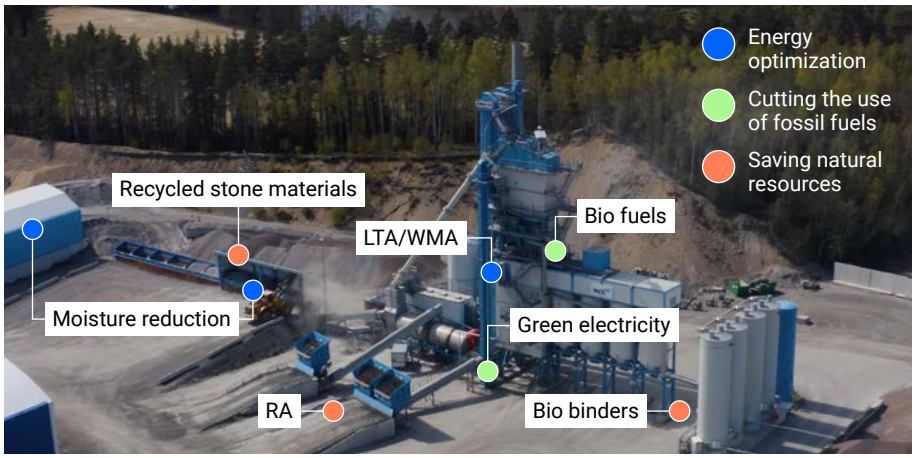
[14] The Swedish Environmental Protection Agency (2023

CO_2-emissions from asphalt

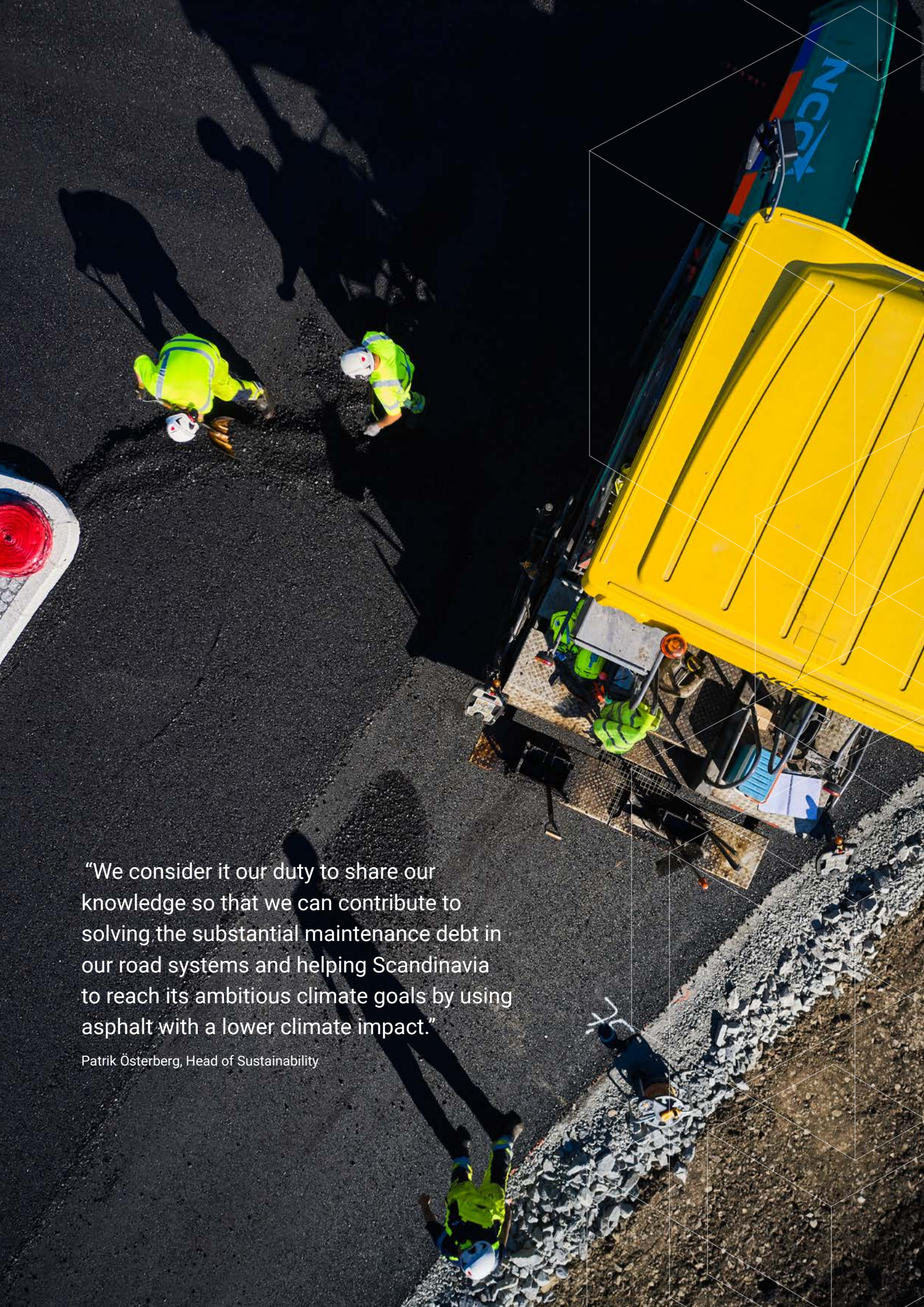
The asphalt industry contributes to significant greenhouse gas emissions in Scandinavia, which is summarized in Table 4. The different transportation agencies have addressed this issue in different ways and to varying degrees, which is briefly outlined in the table and elaborated further in Chapter 6.

When it comes to reducing the CO_2 emissions from asphalt there are three central areas within asphalt production that have the possibility to significantly reduce greenhouse gas emissions; reducing the use of fossil fuels, increasing energy efficiency and saving natural resources. Within those three central areas there are essentially four aspects involved in reducing CO_2 emissions.

- The first involves replacing the fossil fuel used in asphalt plants with biofuels. By using biofuels, direct CO_2 emissions in the asphalt manufacturing process can be reduced.
- Another way to reduce environmental impact is by recycling old asphalt. By adding reclaimed asphalt pavement to the production of new asphalt, the need for new raw materials is reduced, thus lowering the emissions associated with producing and transporting these materials.
- The temperature during the manufacturing process also plays a significant role in terms of climate impact. Lower production temperatures can reduce energy consumption and, consequently, CO_2 emissions.
- There is also significant potential to reduce CO_2 emissions by using alternative binding agents. A new technology that is currently being developed in the asphalt industry is the replacement of a portion of bitumen, the black component in asphalt that acts as a binder, with biogenic alternatives such as Tall Oil Pitch or lignin. This innovation has the potential to further reduce dependence on fossil resources and the environmental impact of asphalt production.



NCC's asphalt plant Riksten situated in the region of Stockholm, Sweden



"We consider it our duty to share our knowledge so that we can contribute to solving the substantial maintenance debt in our road systems and helping Scandinavia to reach its ambitious climate goals by using asphalt with a lower climate impact."

Patrik Österberg, Head of Sustainability

4 Asphalt production in Scandinavia

This chapter covers expected future asphalt demand in Scandinavia, an overview of which is presented in Table 4. The chapter also covers how the Scandinavian countries are working to lower their environmental footprint from asphalt.

Scandinavia produces around 19 million tons of asphalt annually, leading to an estimated 980,000[15] tons of CO_2e each year. This figure represents roughly 0.7 percent of Scandinavia's total CO_2e, or approximately the combined yearly emissions from the residents of the cities of Roskilde[16], Ålesund[17], and Helsingborg[18].

Hence, it is evident that the asphalt industry, due to its role in road construction and maintenance, has a significant impact on the environment. Consequently, it is crucial for the Scandinavian countries to prioritize the sustainability of their road construction and maintenance practices.

The use of asphalt causes greenhouse gas emissions along the entire value chain: from the extraction of bitumen to heating and end-of-life treatment. This requires conscious planning for the use of asphalt in order to ensure a balance between a well-functioning transport system and limiting greenhouse gas emissions.

[15] See Chapter 5 for calculations.

[16] According to the World Bank (2020), per capita CO_2 emissions in Denmark amount to 4.7 tons of CO_2 per person. When the total current annual emissions from asphalt are divided by this figure, it equates to the emissions of approximately 50,000 people.

[17] According to the World Bank (2020), per capita CO_2 emissions in Norway amount to 6.7 tons of CO_2 per person. When the total current annual emissions from asphalt are divided by this figure, it equates to the emissions of approximately 50,000 people.

[18] According to the World Bank (2020), per capita CO_2 emissions in Sweden amount to 3.2 tons of CO_2 per person. When the total current annual emissions from asphalt are divided by this figure, it equates to the emissions of approximately 125,000 people.

Table 4: 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[19]	240,000 tons CO_2e[20]	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_2e[21]	0.7 %
Sweden	Approx. 8.2 million tons annual production.	Approx. 9 million tons by 2045[22]	400,000 tons CO_2e[23]	0.9 %

In 2020, Denmark committed to a 70 percent green house 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 CO_2e, with the highest average CO_2e per ton of asphalt, 63 kg, among Scandinavian countries.

In Norway, total greenhouse gas emissions for 2022 reached 48.9 million tons of CO_2e. 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 CO_2e were emitted per ton of asphalt produced. By 2023, this figure had been substantially reduced to about 48 kg of CO_2e 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 CO_2e emissions are given significant emphasis when awarding most maintenance contracts for the national road network.

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

[20] In Denmark, approximately 3.8 million tons of asphalt are produced annually. The average emission factor for Denmark is 63 kg CO_2e/ton. 3.8 million* 0.063g CO_2e/ton yields the total annual emissions from asphalt (Asfaltindustrien, 2022).

[21] In Norway, approximately 7 million tons of asphalt are produced annually. The average emission factor for Norway is 48 kg CO_2e/ton. 7 million* 0.048kg CO_2e/ton yields the total annual emissions from asphalt.

[22] Personal communication with NCC, 2023.

[23] 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 CO_2e/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 CO_2e/ton yields the total annual emissions from asphalt (Tyréns, 2020).

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 CO_2 equivalent, with a emission factor of 49 kg of CO_2 per ton of asphalt produced, slightly higher than the equivalent figure for Norway.

4.1 Production and demand for asphalt

Denmark

According to the trade organization for the asphalt industry in Denmark (Asfaltindustrien), the annual production of asphalt in Denmark amounts to 3.5–3.8 million tons, of which 1 million tons (around 30 percent) is recycled asphalt. Figure 11 shows the development of asphalt production in the period from 2012 to 2022, Asfaltindustrien, 2022a.

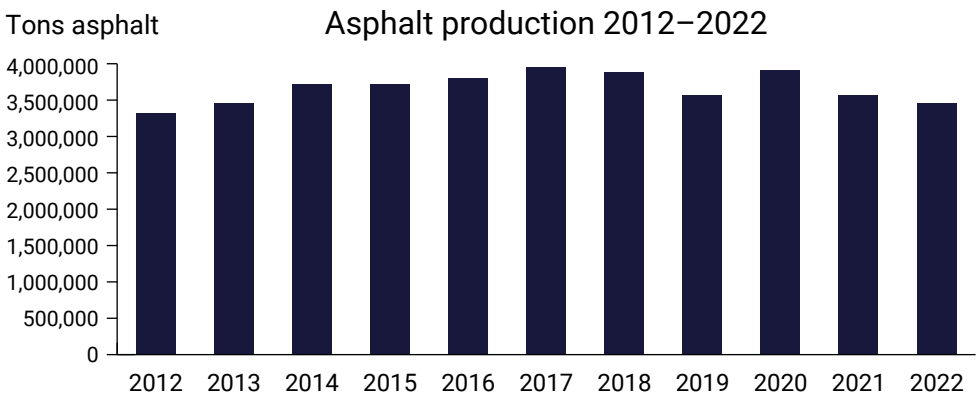


Figure 11 Annual asphalt production 2012–2022 Source: Asfaltindustrien, 2022a.

As Figure 11 shows, the number of tons produced has remained relatively stable at 3.3–3.8 million tons.

Norway

Asphalt production in Norway experienced a significant increase between 2003 and 2017, primarily due to a gradual rise in road infrastructure investments. The peak production year was 2017, with a total of 7.8 million tons of asphalt produced. However, in the last five years, there has been a noticeable reduction in production (EBA, 2023).

The average asphalt production in Norway over the last ten years has been approximately 7 million tons. This period saw a notable increase in production up until 2017 as a result of rising investments in road infrastructure. However, production has since declined in the past five years, as illustrated by Figure 12.

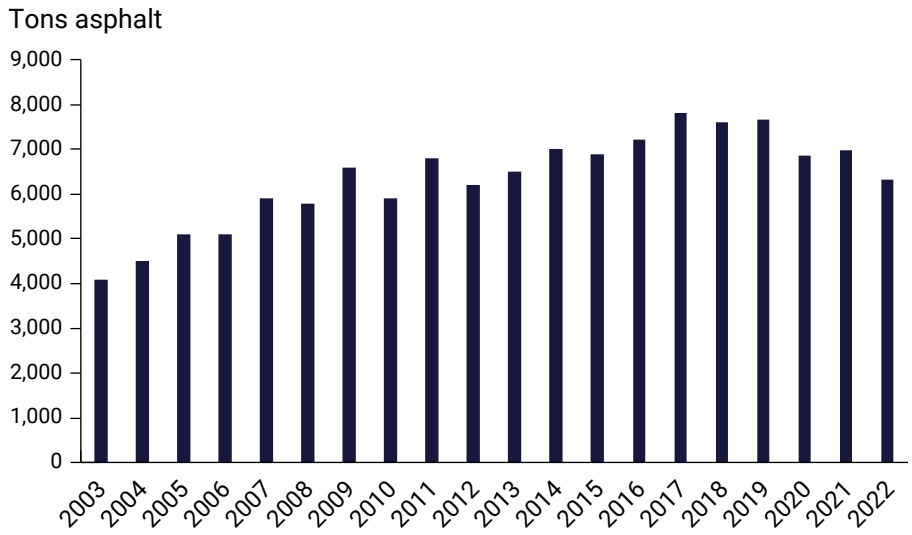


Figure 12 Annual asphalt production 2003–2022, (EBA, 2023).

Sweden

Sweden's annual asphalt production amounts to approximately 8.2 million tons, according to the European Asphalt Pavement Association (EAPA, 2021). Figures from 2016 and onwards are estimates, see Figure 13.

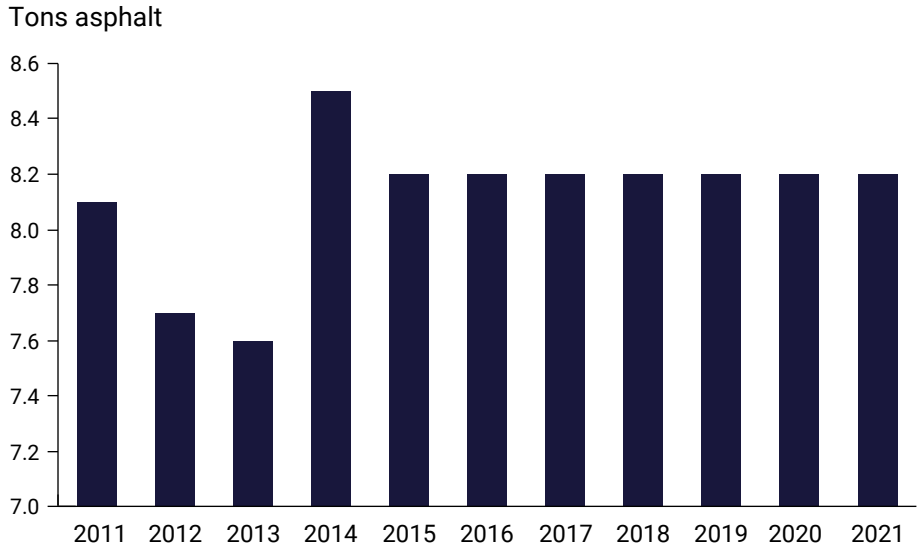


Figure 13 Annual asphalt production 2011–2021

Historically, about two-thirds of the total asphalt volume used in the Swedish Transport Administration's projects has been used for maintenance activities. The remaining one-third of the total volume has been used in investments, which include the construction of new infrastructure. This share has remained relatively stable.

4.2 Future demand for asphalt

Future demand for asphalt in Denmark

In accordance with the Infrastrukturplan 2035 agreement, the Danish asphalt industry has formulated projections regarding the asphalt quantities required for planned projects spanning from 2021 to 2026. These estimates also include the anticipated costs at both the state and the municipal level, categorizing them into new investments and maintenance expenses. The estimates are presented in Table 5. The total amount of asphalt expected to be used at both the state and the municipal level in 2023 is 3.1 million tons, and this figure is expected to increase by 100,000 tons each year up until 2026.

Municipal spending on asphalt for road maintenance declined by DKK 0.5 million annually from 2018 to 2022, according to a representative from Asfaltindustrien (2023). This decline coincides with the escalating climate challenges that have placed even greater stress on road networks, necessitating increased maintenance efforts. This discrepancy suggests either insufficient financial resources or a lack of political prioritization.

Table 5: Costs and tons of asphalt for state roads and municipal roads in Denmark 2023 to 2026. Source: Asfaltindustrien, 2022b

	State roads		Municipal roads		Total	
	New investments (DDK billion)	Operations/ maintenance (DDK billion)	New investments (DDK billion)	Operations/ maintenance (DDK billion)	Total	Asphalt (million tons)
2023	3.1	2.6	4.1	5.1	14.8	3.1
2024	3.7	2.2	4.0	5.0	14.9	3.2
2025	4.9	1.9	4.0	5.0	15.8	3.3
2026	5.3	2.2	4.0	4.0	16.5	3.4

In Table 5, Asfaltindustrien has provided estimates for the number of tons of asphalt used for roads in the period 2021–2026. It is estimated that 3.1 million tons of asphalt will be used for roads in 2023 and 3.4 million tons in 2026. This data suggests an annual increase in the use of asphalt for roads of 0.1 million ton from 2023 to 2026.

As depicted in Figure 11, the data on asphalt production spans from 2012 to 2022. Extrapolating this data to 2045 reveals an average annual growth rate, suggesting a potential production of approximately 3.98 tons.

Future demand for asphalt in Norway

In Norway, it is likely that the asphalt production will increase in the future, but the exact magnitude remains uncertain. If the trends from 2003, as illustrated in Figure 12, are extrapolated to the present day, a production level of approximately 9 million tons could be reached by 2045.

Of the approximately 4 million tons related to public roads, the Norwegian Public Roads Administration purchased about 1.4 million tons in 2021, the counties and municipalities about 2.4 tons and Nye Veier about 0.3 million tons.

To project future developments in this context up to the year 2050, a consistent approach was taken. The same percentage increase observed for asphalt production (Figure 12) between 2013 and 2022 was applied to extrapolate these figures into the future. The figures reflect three scenarios and their respective effects on the maintenance debt. The annual expenditure influences whether the maintenance debt increases or remains constant, or what would be required to eliminate the maintenance debt. It is notable that an investment of approximately NOK 1 billion per year would prevent further deterioration. If the yearly investment in maintenance is raised to NOK 2 billion, the maintenance debt could be eliminated by 2050. If the investment is further doubled to NOK 4 billion per year, the maintenance debt could be eliminated as early as 2033.

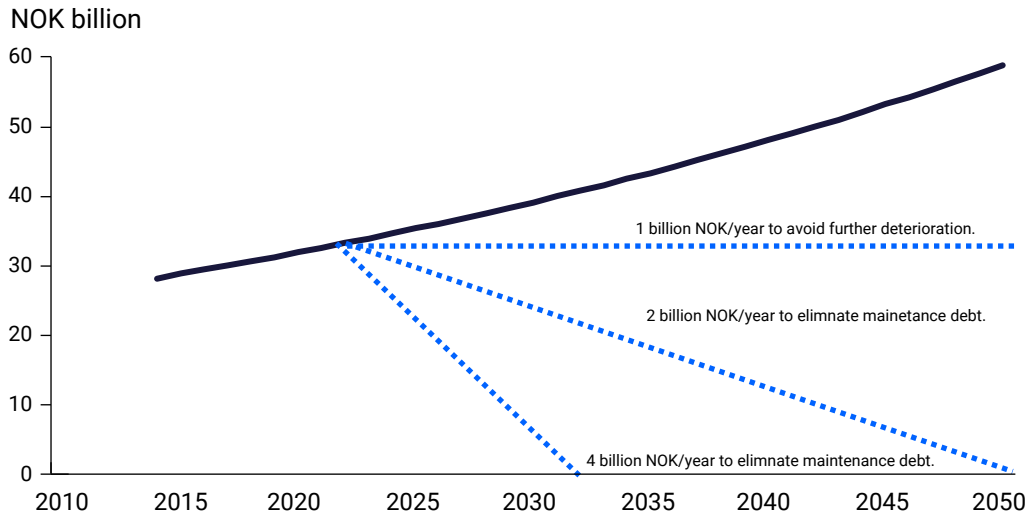


Figure 14 Potential development of the maintenance debt in the counties in Norway

Future demand for asphalt in Sweden

In Sweden, it is likely that asphalt production will increase in the future due to the country's high maintenance debt. It is possible that production levels could reach 9 million tons by 2045 (NCC, 2033).

Looking at new investment projects scheduled for 2023, a representative from the Swedish Transport Administration estimates the projects will consume around 1 million tons of asphalt. According to their assessment, this figure is likely to remain relatively stable, signifying a consistent demand

for asphalt in new infrastructure projects. In addition, the Swedish Transport Administration has a budget which allows them to use roughly 1.5 million tons of asphalt annually for maintenance. However, the maintenance needs are significantly higher, with approximately 3 million tons of asphalt required each year for ten years to effectively address these needs, see Figure 15. This indicates a substantial gap, 1.5 million tons of asphalt annually, between the current production levels and the actual requirements for maintenance.

Based on the estimates provided above, the trajectory of the country's maintenance debt can be extrapolated. In Figure 15, the blue line shows the anticipated progression of this debt through 2045 under the assumption of a business-as-usual scenario, where only 1.5 million tons are produced annually.

On the contrary, if investments are undertaken to increase production to 3 million tons per year, as shown by the light blue line, the maintenance debt in Sweden can be eliminated by 2033. This highlights the significant impact that proactive investments can have in swiftly addressing and resolving infrastructure maintenance issues and reducing the risk of substantial growth in the maintenance debt.

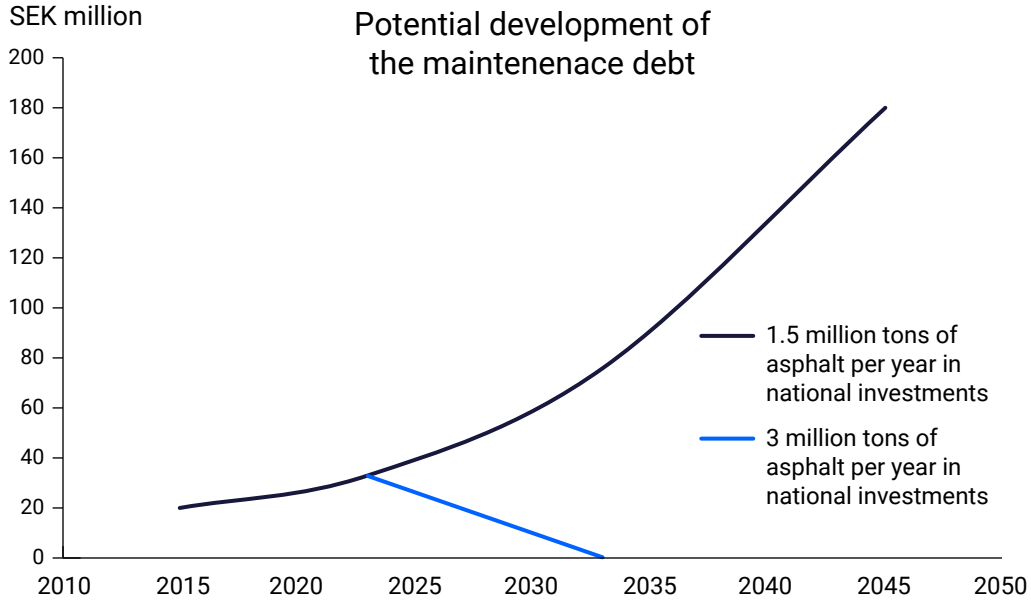


Figure 15 Development of the maintenance debt for state roads in Sweden

Historically, maintenance activities have represented a significant share of the Swedish Transport Administration's projects, accounting for about two-thirds of the total asphalt paving volume. The remaining third of the total volume has consisted of investments, which include the construction of new infrastructure. Moreover, it is expected that this allocation will increase over the years to come, with an increased focus on maintenance activities underlining the importance of maintaining and enhancing existing infrastructure alongside new developments.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Chapter 4 Summary – 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 22[24] million tons of asphalt by 2045. This would result in an increase from 980,000 tons of CO_2e each year to about 1,100,000 tons of CO_2e 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.

[24] 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.

5 How to ensure a sustainable and functional road system

This section provides a description of what needs to be done in Scandinavia to ensure a sustainable and functional road system. The section also explains the crucial role of public procurement and the governments' national plans when it comes to creating a solid and sustainable road system

Maintenance is favorable according to the Swedish transport administration's cost-benefit analysis

The Swedish Transport Administration employs a social cost-benefit analysis to assess the profitability of a given investment, forming a crucial basis for decision-making when selecting which projects to undertake. This analysis involves weighing quantifiable and non-quantifiable benefits against costs, with the overall impact expressed as a net present value ratio (NPVR). A positive NPVR signifies that the investment will generate a positive return (Trafikverket, 2021). New investments result in improved quality, increased capacity, and a reduction in bottlenecks on existing infrastructure. However, it is generally more economically advantageous to maintain and manage the existing infrastructure (Trafikverket, 2021).

Figure 16 below provides a visual representation of the costs and benefits associated with investments outlined in the national plan as well as investment candidates that fall outside the scope of the national plan. NPVR=0 is depicted as a dashed line in the chart.

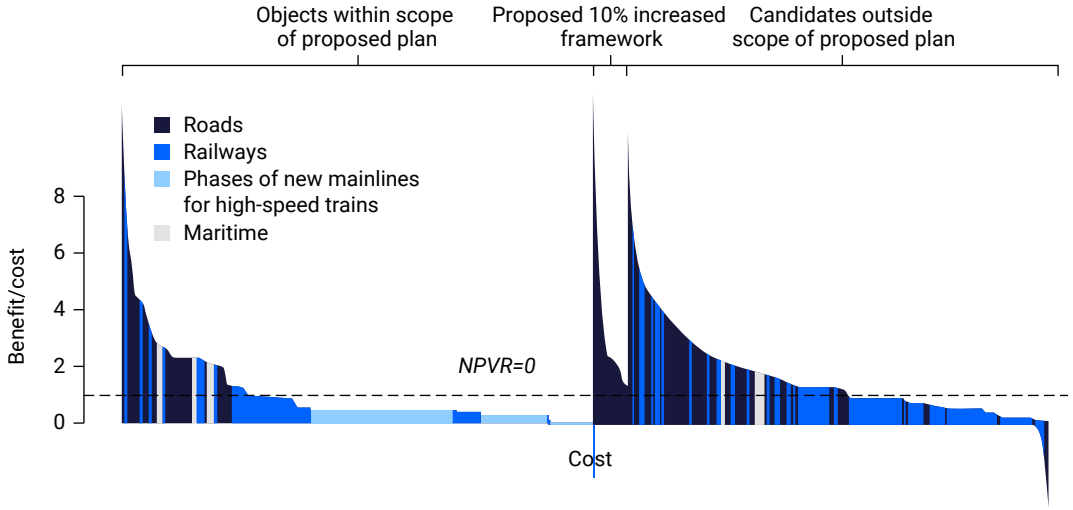


Figure 16 Costs and benefits associated with investments in the national plan and outside the scope of the national plan. The dashed line represents socio-economic profitability, that is, benefit/cost>1, which corresponds to NPVR>0 (benefits are greater than costs).

Each bar represents a specific investment. The height and width of the bar indicate its NPVR and cost, respectively. Dark blue represents road investments, blue represents railway investments except for new mainlines, light blue represents new mainlines, and light grey denotes maritime infrastructure. The national plan is displayed in the left part of the diagram. The investments are ranked by financial return, with the highest financial return on the far left (Trafikverket, 2021).

From the figure it is evident that all road investments have a positive return, while the return on almost all railway investments is negative. New mainlines, in particular, have a very low return. For every Swedish krona invested, society receives 20 to 40 Swedish öre back, and the overall socio-economic return is a deficit of SEK 170 billion[25].

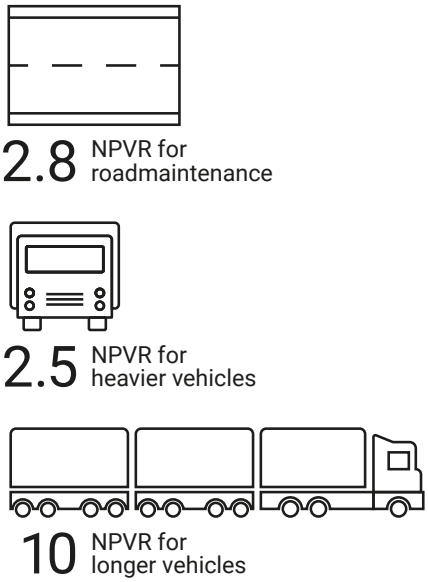
The right part of the figure showcases projects that, for various reasons, were not incorporated into the national plan. These projects, in general, demonstrate higher socio-economic viability compared to those included in the plan, with road projects standing out as significantly more profitable than railway projects. This implies that there is potential for substantially greater societal benefits from these investments compared to what the proposed national plan suggests (Trafikverket, 2021).

In the current national plan, the allocations designated for road maintenance have a high NPVR (2.8), which indicates that the total benefits exceed the overall costs by a substantial margin. However, to ensure the functionality of the road network, the Swedish Transport Administration must prioritize actions that give immediate results, such as addressing cracks or potholes in the asphalt, when what is actually needed is to reconstruct the road structure and apply a fresh layer of asphalt, as the sub-base often deteriorates to an alarming extent.

While emergency asphalt repairs by the Swedish Transport Administration temporarily restore road functionality and ensure the safety of road users, they are conducted with the awareness that a more comprehensive repair will be necessary soon. This approach becomes more expensive in the long run and leads to greater disturbances for both passenger and freight traffic. Carrying out maintenance at the right time saves money in the long run compared to patching and short-term fixes (Natanaelsson, 2021).

[25] Including the main railway line sections, the average NPVR is -0.4 (net present value of SEK -145 billion). For railway projects excluding new mainlines, the average NPVR is -0.2 (net present value of SEK -26 billion). This totals SEK -170 billion

There are also other investments that have a high NPVR. For example, investments aimed at increasing load capacity, where the advantages of enabling heavier and longer vehicles on the road clearly outweigh the associated expenses. Specifically, investments in a higher load capacity class to accommodate heavier vehicles has a NPVR of 2.5, while the corresponding investment for longer vehicles has a NPVR exceeding 10 (Trafikverket, 2021, Svenskt Näringsliv, 2023). It is important to note that these NPVR are averages, as they can fluctuate depending on factors such as the type of measure and traffic volumes on the roads.



"We strive to maintain standard and established functionality, but this increasingly being accomplished through urgent and short-lived repairs because the available funds are not sufficient to cover preventive maintenance for the entire public road network. As a result, the standard of both the low- and high-traffic areas is deteriorating, which is leading to a growing need for maintenance and reinvestment."

– The Swedish Transport Administration Annual Report 2022

In contrast to the practice in Sweden, the manual for socio-economic cost-benefit analysis issued by the Danish Ministry of Transport does not provide figures for NVPR. However, NPVR is employed as one component of the decision-making process. Likewise, the Danish Road Directorate's comprehensive economic analyses incorporate NPVR and shadow prices as integral elements in the decision-making process for new initiatives aimed at enhancing mobility and safety on Danish state roads.

The Norwegian Transport Agency also uses social cost-benefit analysis to assess the profitability of a given investment, expressed in NPVR. For instance, in the national transport plan, socio-economic analyses are conducted, but they primarily apply to individual projects, particularly significant investments, rather than addressing maintenance debt.

5.1 Public procurement in Scandinavia

A significant portion of the asphalt used in Scandinavia is purchased through public procurement processes. Public procurement offers possibilities to address environmental challenges within the road sector. By incorporating rigorous environmental standards into the tendering process, the Scandinavian governments have the possibility to promote the use of sustainable materials, energy-efficient technologies, and innovative construction practices. This section provides a description of how public procurement is used in the Scandinavian countries.

Public procurement in Denmark

Infrastructure investments in Denmark are primarily governed by the procurement law (Udbudsloven), which mainly focuses on the economic utilization of public funds. The Danish national legislation mandates efficiency in public spending and has historically offered limited incentives for environmentally responsible practices within infrastructure investments.

However, the country's procurement law aligns with the European Union's requirements for green public procurement (see box below) in accordance with EU objectives. In Denmark, all municipalities are subject to Anlægsloftet. Anlægsloftet imposes restrictions on the amount municipalities can allocate for new investments and maintenance, whether for roads or new buildings. This constraint can influence their purchasing decisions and the allocation of funds across various projects.

In Denmark, there is a predominant focus on price. This, in combination with Anlægsloftet, can serve as a potential barrier to the promotion of greener infrastructure. Denmark's substantial and prevalent dependence on natural gas within its asphalt plants highlights the urgency of shifting towards alternative energy sources. Initiating strategic measures within the procurement process could play a pivotal role in transitioning away from natural gas, leading to a significant reduction in the environmental footprint of asphalt use in Denmark. This is also important in the broader attempt to alleviate the climate impact linked to asphalt use in Denmark.

Some of the country's regulations call for environmentally friendly procurement in alignment with EU objectives. Notably, recent developments indicate a gradual shift towards a more balanced and sustainable approach to public procurement at the state level. At the municipal level, municipalities are being urged to incorporate environmental considerations into their procurement processes. A gradual shift has also been noted in some of Denmark's larger cities

Overall, Denmark is only in its infancy when it comes to integrating requirements and incentives that promote the use of lower-emission asphalt into public procurement. There is substantial untapped potential in this regard.

There remains a major emphasis on securing the lowest price in the Danish public procurement landscape. By embracing and scaling up the use of lower-emission asphalt, the public sector can make a more substantial and positive impact in terms of lowering its carbon footprint, thereby contributing to the country's climate-related goals as well as encouraging industry to develop low-emission asphalt and advancing overall sustainability.

The European union's requirements for green public spending

§ 7–9. Minimization of environmental impact

The client must place emphasis on minimizing the environmental impact and promoting climate-friendly solutions in its procurements and can set environmental requirements and criteria at all stages of the procurement process where it is relevant and linked to the delivery. Where the environment is used as an award criterion, as a general rule it should be weighted at least 30 per cent.

§ 16–7. Quality assurance standards and environmental management standards

(2) The client may require the presentation of certificates issued by independent bodies as documentation that the supplier meets certain environmental management systems or standards. The client must refer to the EU scheme for environmental management and environmental audit (EMAS), other recognized environmental management systems in Regulation (EC) No. 1221/2009 Article 45 or other environmental management standards based on relevant European or international standards from accredited bodies. The client must accept corresponding certificates issued by bodies in other EEA states.

According to § 18 the award criteria can include life cycle costs, costs that are due to environmental burdens linked to the goods, services or construction and construction work throughout the life cycle, including costs for emissions of greenhouse gases and other polluting emissions and other climate action costs. This only applies if the value can be quantified and verified.

Public procurement in Norway

Norwegian infrastructure investments are governed by the Regulations on Public Procurement (Anskaffelsesforskriften). Similar to Denmark, this regulation promotes cost efficiency in spending and also aligns with the European Union's directives on green public procurement. However, according to the Norwegian Public Roads Administration[26], Norway stands out as a global leader in climate reduction efforts related to asphalt. The agency has set an ambitious goal of reducing CO_2e from asphalt production by 70 percent by 2030. Simultaneously, they intend to increase the lifespan of asphalt roads.

The Norwegian Public Roads Administration has implemented stringent climate requirements for suppliers in new asphalt contracts. In the past, the primary criterion for awarding asphalt contracts was the lowest price, but climate and environmental requirements now take precedence. As of 2022, CO_2e are given significant emphasis when awarding most maintenance contracts for the national road network, see Figure 17. From 2019 until 2022, the number of tenders from the Norwegian Public Roads Administration with CO_2e weighting for asphalt has increased from 2 to 24.

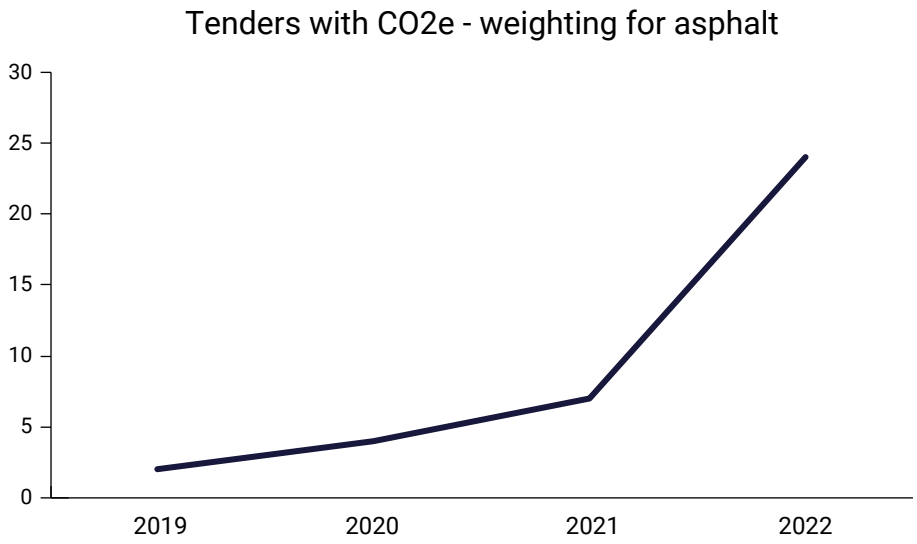


Figure 17 Number of maintenance contracts with the Norwegian Public Roads Administration with CO_2e weighting for asphalt

In addition, bonus and penalty clauses are included in contracts, where the bonus/penalty comes into effect if the CO_2 emissions deviate from the amount stated in the offer, see example on page 51.

[26] According to a representative from the Norwegian Public Roads Administration in an interview conducted as part of the project.

About half of the counties and some of the municipalities use the same contract model for maintenance as the Public Roads Administration, and the development shows that more counties and municipalities are starting to use the same contract model. However, only about 15 percent of the asphalt tenders include rewards for reduced CO_2 emissions. There is significant potential for sustainable asphalt in new road projects in the counties and municipalities and among other purchasers. About 40 percent of total asphalt production is not related to public roads (airports, parking lots, private roads, etc.). For these contracts, there is seldom any emphasis on CO_2 emissions.

To increase the lifespan of asphalt pavement, pilot contracts have been implemented that feature fewer specifications and more functional requirements, combined with bonuses related to quality characteristics. The goal is to promote increased innovation in the contractor industry and promote more durable pavement. However, this is not common yet.

Bonus-malus system used in Norwegian procurement to encourage lower emissions

In Norway, a bonus-malus system is used in procurement processes. In a bonus-malus system, the supplier with the lowest total CO_2 emissions receives a bonus (no surcharge) on the total tender amount, whereas the other suppliers receive a surcharge (penalty). The surcharge is based on the difference in emissions between their offer and the offer with the lowest emissions. This difference is priced at NOK 5/kg CO_2e. The surcharge thus amounts to the difference stated in kg CO_2e multiplied by NOK 5/kg. Consequently, suppliers must factor in their CO_2e in addition to their proposed price in order to secure a contract. This approach thus favors suppliers who actively strive to minimize their CO_2 emissions.

Supplier	Total tender amount (NOK)	Total CO_2e /kg	Difference CO_2e	Total differen-ce x NOK 5/kg CO_2e	Competitive total NOK
A	50,100,000	2,500,000	900,000	4,500,000	54,600,000
B	**50,400,000**	**1,600,000**			**50,400,000**
C	60,000,000	2,000,000	400,000	2,000,000	62,000,000

The contract is awarded according to the ranking of which offer has the lowest competitive total: in this case, Supplier B. After the award, the supplier's environmental product declaration (EPD) is reviewed by the client/control council and a control plan is prepared.

By taking CO_2e into account in addition to price, the contractor can contribute to reducing the environmental impact from the production and laying of asphalt.

Public procurement in Sweden

Public procurement in Sweden is governed by laws and regulations, primarily through the Public Procurement Act (Lagen om offentlig upphandling or LOU) and the Act on Procurement of Concessions (Lagen om upphandling av koncessioner or LUK). These laws aim to ensure that the procurement process is fair, competitive, and transparent.

The Swedish Transport Administration is committed to reducing emissions in its operations, incorporating measures such as emission requirements in procurement. Additionally, the agency maintains a continuous focus on energy efficiency when selecting measures, carrying out the climate assessments necessary in order to prioritize the most suitable measures from a climate perspective.

The Swedish Transport Administration has used EPDs in its procurements, particularly in road construction projects. Although EPDs are used as a framework for evaluation and benchmarking, the requirements themselves are relatively modest. To illustrate this point, in a project situated in Northern Sweden, environmental criteria were integrated into the procurement process, albeit at a notably relaxed level. Consequently, heavy fuel oil met the environmental standards set by the Swedish Transport Administration and was chosen over bio-oil with lower CO_2e due primarily to cost considerations, since it still aligned with the Swedish Transport Administration's environmental criteria.

The Swedish Transport Administration has adopted an approach characterized by stringent requirements and associated fines rather than focusing on incentives. Their rationale for this approach is based inclusivity – it aims to ensure that all relevant actors are actively involved in meeting the specified standards. However, there is a growing recognition of the potential benefits of changing to an incentive-based system, where actors have the opportunity to earn rewards or compensation if they surpass the set requirements.

For example, the Swedish Association of Local Authorities and Regions, operating through ADDA, currently has framework agreements in place that prioritize the lowest price. However, it would be beneficial for the association to introduce climate considerations, such as limiting CO_2e, into these framework agreements. A shift away from a sole reliance on the lowest price is needed to tackle the expected increase in emissions from asphalt.

The evaluation of procurements in Norway, described above, is an example of an incentive-based system. By incorporating incentives, this model not only encourages compliance with established standards, but also incentivizes innovation and a lower environmental impact. It empowers contractors to strive for higher performance levels, fostering competition

and ultimately leading to improved outcomes. The adoption of incentive-driven strategies could serve as a forward-looking paradigm shift in Sweden's approach to transportation planning, potentially resulting in higher efficiency, innovation, and overall better results.

The Swedish Transport Administration is in the process of adopting a new approach, centered around limiting maximum CO_2e. The model relies on a structured table that defines maximum allowable CO_2e per year from asphalt.

Initially, the emphasis is placed on the years 2024–2030. The Swedish Transport Administration has chosen not to set requirements too far into the future due to potential technological developments (Trafikverket, 2023). It is up to the contractor to choose the fuel and manufacturing methods to stay within the emission limits.

Most contractors are expected to meet the 2024 requirements, but the criteria will become stricter from 2025 onwards. The development is expected to progress rapidly, and the Swedish Transportation Administration aims to involve the entire market. The limits have been formulated in cooperation with industry to ensure that all contractors have access to the stipulations pertaining to various pavement types for each calendar year.

The Swedish Transport Administration recognizes ABT as one of the most commonly used types of asphalt. Under the new regulations, emissions associated with ABT are slated to decrease from 34 kg to 19 kg of CO_2e per ton of asphalt between 2024 and 2030. To contextualize these requirements in relation to the market, see the case below.

CASE: Swedish National Road 25 – a project designed to reduce CO_2 emissions by more than 50 percent

On behalf of the Swedish Transport Administration, NCC has rebuilt National Road 25 in southern Sweden into a divided highway with a central guardrail. The road has been widened, and a new 4 km stretch of divided highway has been added. NCC's assignment also included two interchanges, a traffic control point, two commuter parking lots, bus stops, and the reconstruction and new construction of connecting public and private roads.

As part of the public procurement process, the Swedish Transport Administration set a requirement that the entire project was to yield a CO_2e reduction of at least 15 percent.

Over the course of the project, NCC produced asphalt with an average of 15 kg CO_2e/ton of asphalt mass for the project as a whole and an average of 20 kg CO_2e/ton of asphalt mass for the wearing surface. Compared with Klimatkalkyl's emission factor of 49 kg CO_2e/ton of asphalt mass, NCC achieved a reduction of approximately 70 percent for the total amount of asphalt mass produced and approximately 60 percent for the wearing surface.

This substantial reduction in CO_2 emissions was mainly possible due to NCC's ability to produce asphalt with a low environmental product declaration (EPD) value at its asphalt plant in Ubbarp. By utilizing biofuel for over 90 percent of the plant's energy consumption and using recycled asphalt (RA), NCC was able to deliver an asphalt with less co^2 without affecting the quality of the finished pavement.

This case demonstrates that the market is already capable of producing asphalt with emission levels that meet the requirements set by the Swedish Transport Administration for the year 2030. This indicates a significant disparity between what can be accomplished in terms of CO_2e reduction and the established standards. This situation is a clear indication that the market is ready for more aggressive and ambitious targets.

A significant challenge is the lack of rewards for emission reductions beyond the established requirement, which hinders contractors from pursuing higher performance levels, thereby inhibiting competition and ultimately resulting in poorer outcomes. The environmental impact from asphalt could already be significantly reduced if incentives were provided, as in the case in Norway.

Procurement by the Swedish municipalities

Municipalities frequently enter into framework agreements and send out a unit price list for resource pricing. These lists are prepared in accordance with administrative regulations and the bill of quantities. In the bill of quantities, the contractor aligns their prices with the required quantities, which is subsequently employed for price comparison during bid evaluation. Consequently, to secure contracts, suppliers must adopt a strategic approach to their pricing. This often entails submitting the lowest bid possible, as intense competition often results in the quoting of low prices that do not accurately reflect the actual costs. This, in turn, poses challenges when it comes to project execution.

Applying the same rationale as in the case above, we can infer that emissions from municipal contracts amount to 49 kg of CO_2e per ton of asphalt, given that CO_2 emission requirements are not factored into the tender process. Once again, using the case of NCC's CO_2 emissions per ton of ABT asphalt, the gap is even greater, resulting in an average loss of savings amounting to 30 kg CO_2e per ton of asphalt mass. Figure 18 helps to visualize the substantial potential for CO_2e emission reduction from asphalt in the Swedish municipalities.

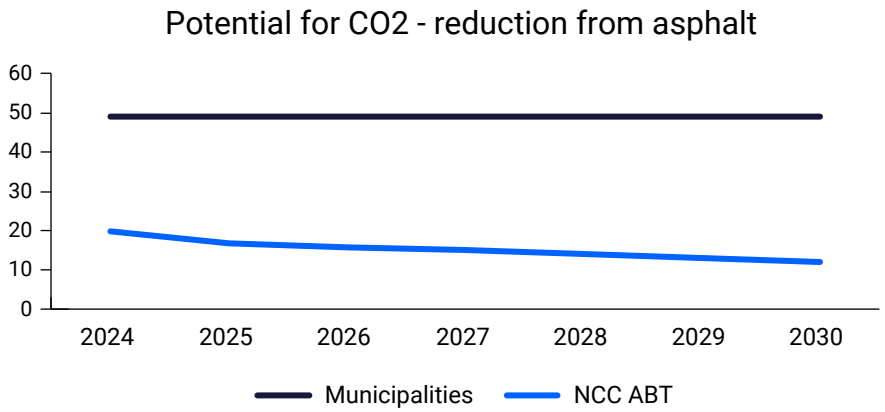


Figure 18 shows the potential for reducing CO_2e from asphalt if requirements are set based on market capabilities. A significant gap exists between the municipal benchmark for kg of CO_2e per ton and the market.

Formalized procurement processes are not the only way to promote new alternatives. To combat issues such as speculation and strategic pricing, Kalmar and Kristianstad have introduced partnering agreements. Partnering is a collaborative approach in which stakeholders work together in an open dialogue and a transparent working environment for the benefit of the project. This approach is built on complete transparency, where all parties, including the contractor, jointly assess what is genuinely best for the specific project and what represents the most efficient solution, as opposed to relying solely on a unit price list.

CO_2 reduced asphalt at fossil-free preschool in Gothenburg

The City of Gothenburg's local administration established rigorous environmental criteria in its procurement for the construction of a preschool in Gothenburg. The primary emphasis was on maximizing the use of fossil-free methods and materials. This project specifically involved the development of a parking lot and other areas.

In order to guarantee compliance with the environmental criteria, the verification process employed EPDs. This method ensured that decisions were grounded in verifiable data, fostering transparency and facilitating comparisons.

To secure the project, NCC adopted the use of heating materials that substantially reduced CO_2 emissions, in sharp contrast to conventional oil-based alternatives. Furthermore, all machinery and transportation involved in the project operated on HVO (hydrogenated vegetable oil), a renewable and sustainable fuel source.

Overall, the focus of Swedish municipalities continues to be on the lowest price, and unlike the Swedish Transport Administration, the municipalities have not yet implemented environmental requirements or EPDs in their procurement processes. The municipalities are in the process of catching up, but have yet to fully embrace these practices.

Chapter 5 Summary – 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 CO_2 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 CO_2 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.

6 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 maintanance 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 CO_2 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 CO_2 emission standards for asphalt procurement. At present, there is a substantial disparity between what can feasibly be achieved in terms of reducing CO_2 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 CO_2 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 CO_2 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 CO_2 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.

7 Our Offering

NCC specializes in executing complex projects, often involving multiple stakeholders, to achieve our clients' objectives. Our expertise in asphalt, combined with professional project management, forms the basis for ensuring on-time delivery, top-notch quality, and cost-effectiveness. With a strong presence across Scandinavia, we possess in-depth local knowledge that allows us to harness the advantages of a large construction and civil engineering firm on a regional scale. We staff each project according to its unique requirements, ensuring the right experience and skills are deployed. NCC prioritizes a safe and healthy work environment, emphasizing a commitment to creating an accident-free workplace for all employees and partners.

NCC offers asphalt mixtures with known environmental impacts, through Environmental product declarations (EPDs), linked to the specific asphalt production plant to meets customer's high demands on the product's environmental impact.

Efficient co-operation through partnering

NCC recognizes the substantial benefits of adopting a partnering approach in asphalt projects. Partnering is a well-established form of collaboration in the construction industry, though it's less commonly used in the asphalt sector.

Partnering is a structured collaboration model where all stakeholders work together in an open and transparent environment for the benefit of the project. This approach, rooted in complete transparency, creates added value for all involved parties.

NCC's experience shows that partnering projects result in the highest customer satisfaction. It is a contemporary form of collaboration that maximizes value for the customer.

CASE: Partnering with Kristianstad Municipality in Sweden

NCC and the municipality have entered into a unique partnering agreement for asphalt. The municipality was looking to move away from the traditional strategic pricing and complexity associated with asphalt agreements. Through innovative thinking, the municipality and NCC are leading the way in reshaping the asphalt industry.

The framework agreement encompasses paving work, repairs, restoration, maintenance, and new construction. It is unique as it marks the first time the municipality has procured paving work through partnering. The agreement is valid for two years, with the option of annual extensions for up to two years. By shifting the focus from solely the lowest price, NCC, in collaboration with our customers, aims to deliver higher value, including enhanced quality and long-term cost-effectiveness.

Environmental product declarations

EPDs present a product's environmental performance from a lifecycle perspective in a transparent, objective, and standardized manner. An EPD encompasses a climate declaration, detailing greenhouse gas emissions, as well as data on the product's overall environmental impact, including factors such as eutrophication, acidification, and resource consumption. In our calculations for an EPD for an asphalt plant, we consider factors like fuel, bitumen, adhesive agents, and the transportation of raw materials.

EPDs are required for all types of construction to gauge a project's environmental impact and meet sustainability goals. By employing an own third-party certified method for developing EPDs linked to the originating asphalt plant, we provide highly specific information that generic data alone cannot achieve.

Customer benefits:

- Transparent, fact-based and precise basis for environmental and climate calculations
- Possibility to make data informed choices based on detailed plant and product-specific EPDs
- Environmental data that is regularly updated
- Third-party guarantee that can be used in sustainability communications

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