VESTLANDSBANEN FEASIBILITY STUDY - DELIVERY 1

Deliverable 1: Study Area Characterization

Rev 07

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REV06	October 2024	S.S.L	All	Norsk Bane comments
REV07	November 2024	S.S.L	All	Norsk Bane comments

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1 INTRODUCTION

The initial document in SENER's series of reports on the Vestlandsbanen study included a brief description of the proposed high-speed railway and outlined the project's high-level objectives. Vestlandsbanen is envisioned not just as a high-speed railway for long-distance travel, but also as a state-of-the-art and secure network designed to enhance regional connectivity and support freight transportation. This ambitious project aims to revolutionize the transportation infrastructure by providing efficient and reliable services for both passengers and goods, thereby boosting economic and regional development. Additionally, the new network will incorporate advanced safety features and modern technology to ensure a smooth and safe travel experience for all users.

This document is the second in the set of reports and presents a comprehensive description and overview of the study area, drawing on data collected from SENER's recent research. It includes detailed information on the region's geography, population, climate, socioeconomic characteristics, energy supply and consumption, as well as existing and planned infrastructure. Additionally, the document discusses how the Vestlandsbanen project aligns with these characteristics and identifies considerations for the development of train services and the broader transport system to meet the objectives set forth in the "High-Level Goals." The results of these analyses form the basis for the subsequent study deliverables.

Key Project Features from DBI Alignment	
Length of double track lines to be constructed	650.0 km
Number of stations in the network, total / new	31 / 17
Design speed (with some exceptions)	270 - 300 km/h
Track distance Bergen - Oslo	411 km
Track distance Stavanger - Oslo	431 km
Track distance Bergen - Stavanger	276 km
Track distance Skien - Oslo	148 km
Highest point of railway (outside tunnel)	649 masl.
Length of bedrock tunnels and culverts	383.9 km (59 %)
Length of viaducts and shelter constructions	57.8 km (9 %)
Length of tracks at grade or in cuttings/fillings	208.3 km (32 %)
Length of the longest subsea tunnel	43.3 km
Length of the longest non-subsea tunnel	29.2 km
Number of depots estimated	5

TRAVEL TIME (expected by DBI Study)

- Oslo – Bergen: 2.25 hrs
- Oslo – Stavanger: 2.25 hrs
- Bergen – Stavanger: 1.35 hrs
- Bergen – Haugesund: 1.15 hrs

The study also envisages more stations in smaller towns along the corridor

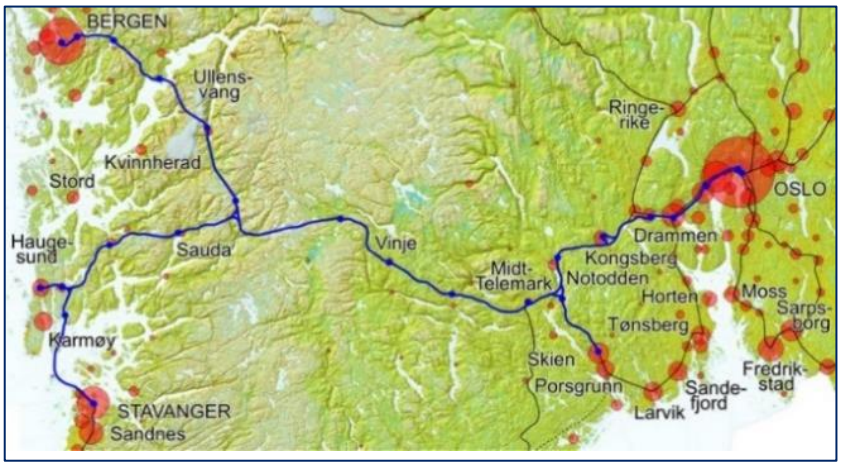
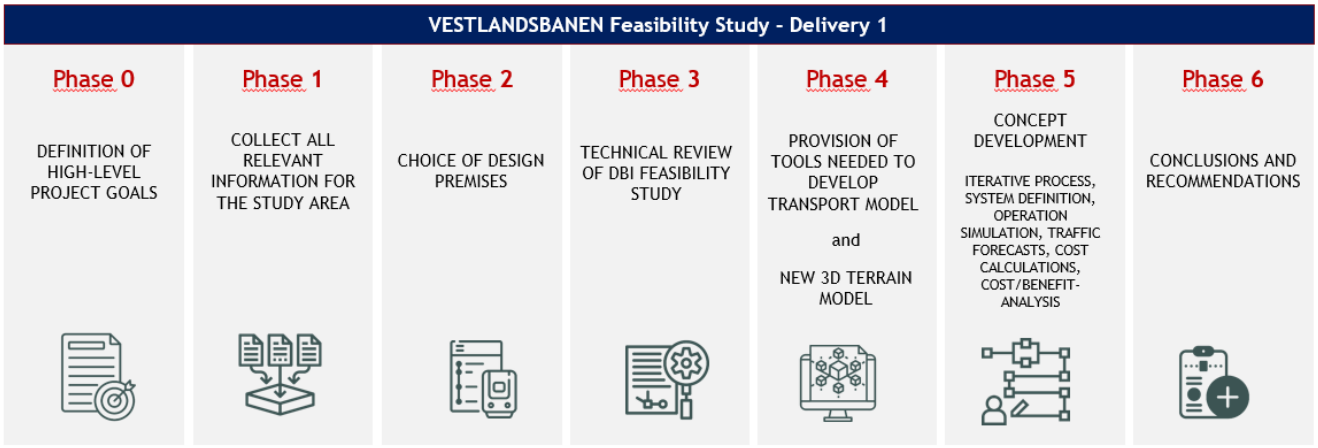


Figure 1: DBI Vestlandsbanen Project Key Features

SENER commenced its work by defining the high-level project goals in collaboration with Norsk Bane. Based on those goals, solutions for infrastructure and operations were to be developed, future traffic and costs estimated, and various environmental and economic impacts identified, evaluated, and optimized through an iterative process. However, within the scope of "Delivery 1," the investigation of potential alternative corridors and track alignments were limited to advisable adjustments of the DBI alignment within the proposed corridor. This is due to the fact that a new and updated assessment of the economic, social, and environmental impacts of the planned high-speed line was initially considered highly interesting.

Below is an overview of the phases of SENER Delivery 1:



2 CARACTERISATION OF THE STUDY AREA

2.1 Topography and climate

Norway covers a total area of 324 000 km^2 (excl. Spitsbergen, Jan Mayen and Bjørnøya), situated in Northern Europe, bordered by the Russian Federation, Finland and Sweden. The country is dominated by mountainous terrain and has an indented coastline along the North Sea, the Norwegian Sea and the Barents Sea in the Arctic Ocean, with thousands of fjords and about 50,000 islands.

Norway has long and cold winters, especially in the northern and south-eastern part of the country, and in the high mountain areas between Vestlandet and Eastern Norway. These conditions pose significant challenges for all modes of transport and constructing a new railway line for high speeds and with low gradients, is no exception. However, railway operations are less vulnerable to wind, ice and snow than road and air traffic – which impacts both regularity and safety. A double track railway also needs just about half the space of a four-lane highway, despite a much higher capacity.

These system advantages for the railway can have great importance, but this requires that one resolves several fundamental challenges for a modern railway in the mountainous terrain in the Vestlandsbanen area. One of these challenges is finding a suitable location to cross the high mountain area between Vestlandet and Østlandet. DBI had recommended the Haukelifjell route as it would allow a crossing with a tunnel less than 30 km long and a maximum track altitude below 650 meters above sea level. Further south, and especially further north, one would either have to accept a significantly longer tunnel and/or construct the railway in areas at much higher elevations. This would require more and longer sections of maximum gradient, worsen operational conditions (particularly for freight trains), and create major safety and operational stability issues during winter in areas with sparse vegetation.

The only exception is Filefjell, approximately 180 km north of Haukeli. There, the topographical conditions are suitable for a railway crossing of the mountain area. For trains between Bergen and Oslo, however, a route via Filefjell would entail a significant detour of at least 50 km, compared with a route via Haukeli. Nor would a route via Filefjell be practical for a fast connection between Rogaland and Eastern Norway. For illustration, the DBI's proposal shows a 431 km route from Stavanger to Oslo via Haukeli, which is 157 km shorter than the Sørlandsbanen via Kristiansand, and still likely around 100 km shorter than a possible new line along the Southern Coast.

Including the 29.2 km tunnel under Haukelifjell, the DBI's proposal for Vestlandsbanen includes eleven tunnels over 10 km in length, along with many shorter tunnels. Together, these tunnels account for nearly 60% of the total track length and significantly contribute to the construction costs of Vestlandsbanen. However, the numerous tunnels are not only due to mountainous areas and challenging topography but also consider agricultural land and sensitive natural areas, the need for safe railway operations in areas prone to landslides and flooding, and the need for fast railway connections with well-located stations in densely populated areas, especially in and near Oslo. For example, the plans for the Vestlandsbanen include a station underground at the public transport hub in Majorstua, Oslo.

It should also be mentioned that the construction costs for tunnels on the Vestlandsbanen will be lower than one might expect in many other countries due to well-developed tunnelling techniques in Norway and generally favourable geological conditions for tunnelling in bedrock. These rock formations are found in most areas where the Vestlandsbanen is planned, though less so on the approximately 70 km stretch between Oslo and Kongsberg, and in a few other locations, such as near Skien.

Additionally, the planned fjord crossings in Vestlandet contribute to higher construction costs for Vestlandsbanen. The planned combined road and rail bridge over the Hardangerfjord, with a free span of over 1500 meters, will be one of the longest in the world. The plans also include a 43.6 km undersea tunnel beneath the Boknafjord, one of the eleven long tunnels mentioned above. The rail tunnel will largely run parallel to the Rogfast road tunnel and can partly be built from cross-passages from the latter.

Even if these fjord crossings will have high construction costs, they are a core element of the concept for Vestlandsbanen. They will make it possible to combine several railway lines to one network, thus creating a foundation for competitive passenger and freight train services in several different markets, and achieving large traffic volumes, high operating incomes and great socio-economic benefits, compared to the size of investment:

- The fjord crossings will facilitate a fast railway connection between Bergen and Stavanger, two of Norway’s four largest cities. Alternative routes, completely bypassing Hardanger- and Boknafjorden or using bridges no longer than 1000 meters over the innermost fjord arms, would be at least 100 km longer and make it much harder to establish a competitive rail service for both freight and passenger traffic.
- The planned Bergen-Stavanger rail link will connect Bergensbanen and Sørlandsbanen and link large regions without railways to the national rail network. The Haugesund area is among the nine most populous regions in Europe that still have no railway at all.
- The Vestlandsbanen is planned so that both passenger and freight trains from Oslo to Bergen will run the first 279 km (or 68% of the total 411 km distance) on exactly the same line as trains from Oslo to Haugesund and Stavanger (384 and 431 km from Oslo, respectively). As one can expect approximately equal traffic from Eastern Norway to Hordaland (the southern part of Vestland county) and from Eastern Norway to Rogaland, this 279 km shared section will thus see about double the long-distance traffic compared to a new line that only went from Oslo to Bergen or from Oslo to Stavanger.

The same applies to the section from Stavanger via Haugesund to Bergen. The southern part will be a shared section for trains from Stavanger heading both to Hordaland and Eastern Norway, while the northern part will be a shared section for trains from Bergen heading both to Rogaland and Eastern Norway.

Additionally, the connection to and from Skien will provide rail traffic from Vestlandet to Grenland and onwards to Vestfold and Agder, as well as from Oslo to Grenland and onwards to Sørlandet, in addition to the connection via Bø.

Vestlandsbanen is thus not planned as a connection from A to B but as a network for several significant traffic flows in different directions, connecting three of Norway's four largest cities and many regions in between. This will require large investments but also generate much more rail traffic and operating incomes per kilometre of new track than most other concepts.

However, these are just some of the high-level key points in the plan. The concept for Vestlandsbanen consists of many different components, adapted to various conditions in different parts of the Vestlandsbanen area. This will become clear in the following chapters on different regions.

2.2 Oslo and Akershus

As the capital city of Norway, Oslo stands as a vital hub for transportation, commerce and activities, with a high number of working places in both public and private sector. Vestlandsbanen will provide fast and reliable railway connections between Oslo, Western Akershus, Vestfold, Telemark and major parts of the Western and Southern regions in Norway.

A crucial element in this plan is a new westbound double track line all the way from Oslo Central station to Drammen, with large parts in tunnel. It is planned in a separate alignment, independent from the existing railways, but with connections to the existing line (Askerbanen) between Lysaker and Sandvika.

The aim is both to double capacity, reduce train travel times by around 15 minutes between Oslo Central Station and Drammen (to approx. 18 - 20 minutes), reduce travel times to and from the nearest railway station by constructing new stations at Majorstua and Nesbru, and ensure high operational stability throughout the area.

The existing Drammen Line is currently characterised by frequent infrastructure failures and many delayed or cancelled train departures. Over many years, the line has been closed for several weeks every summer for railway work. But the periods without train services have been too short for a complete renewal of the entire stretch, including the substructure, tracks, power supply, and signalling systems. This has resulted in vulnerable combinations of new and old equipment and ongoing problems.

When a new, parallel line between Oslo Central Station and Drammen is completed as part of Vestlandsbanen, it will be possible to close the existing line for a sufficiently long period to allow a full renewal. After that, Vestlandsbanen, Drammenbanen, and the connecting tracks between them (for trains from Sandvika to Majorstua and from Nesbru to Lysaker, and vice versa) will form a modern transport system with high redundancy and great flexibility in the event of operational disruptions.

Passenger traffic

In addition, passenger trains will be faster, more frequent, and serve more stations than today. This is due to:

- a new line between Oslo Central Station and Drammen designed for speeds of 250 km/h or more, with long-distance trains serving both Majorstua, Nationaltheatret, Skøyen, Lysaker, Sandvika, Asker and Nesbru, following a varying but regular stopping pattern.
- the significant potential – even by international comparison – for more trains entering and leaving the capital, when many of those who currently travel by plane or car between Eastern Norway and Vestlandet or parts of Sørlandet choose high-speed trains instead. As detailed in the market report, more than 30,000 new daily train passengers are expected on the railway lines west of Oslo Central Station. This corresponds to about 50 – 100 additional trains a day in both directions, depending on the capacity of each train.
- the relatively short distances between Oslo and the coastal areas in Western Norway, which will make it possible to offer competitive train travel times compared to flying – around 2½ hours, even with 8 to 10 stops at intermediate stations on each departure. Since approximately twice as many stations are planned along each route, the trains on such an operation scheme will, on average, stop at every second station, following a varying but regular pattern. However, this will not be a noticeable disadvantage when the railway lines between Oslo Central Station and Drammen are served by many passenger trains per hour in both directions.

This last point, however, assumes a prioritisation of improved train services on regional distances and corresponding reductions in parallel car traffic, rather than further reductions in travel times for long-distance passengers to and from Oslo Central Station. This will really be possible. Many of those travelling by high-speed train from Hordaland, Rogaland, and Sørlandet to Eastern Norway will not stay on the trains all the way to Oslo Central Station but will alight at stations such as Notodden, Kongsberg, Drammen, or others west of the capital. This will free up seats for passengers boarding on regional routes. The trains will have considerable spare capacity, as long-distance demand peaks later in the day than regional traffic, both in the morning and afternoon. For example, regional travel demand will be significant between 6 and 8 o'clock in the morning, but the first long-distance trains from Bergen or Stavanger will not arrive in Drammen before about 7:30 a.m., and many travellers one or two hours later.

This also means that the need for separate regional trains will be significantly reduced, saving costs, freeing up space for other trains on the lines, and thus positively contributing to operational stability. Some spare capacity on the railway lines west of Oslo will also be an important reserve for future traffic growth.

All these gains will benefit businesses and residents, boost productivity and economic development, and reduce car traffic, pollution, noise and emissions of greenhouse gases, while improving traffic safety and living quality in the capital area.

Freight traffic

With Vestlandsbanen, a new and faster freight service will be established, offering much greater capacity and higher operational stability than is possible on the existing railway lines. This will also be of great importance for Oslo and Akershus, not least in reducing the extensive heavy road transport through the city and the region.

At the same time, significantly larger freight volumes on the railway will also provide a basis for a more extensive network of frequently used freight terminals, which will reduce the extent of distribution driving by lorry from Alnabru to large parts of central Eastern Norway.

It will also be crucial to run many more direct freight trains, especially to and from Sweden and Central Europe. For example, very little freight is currently transported by train from Southern Norway towards Gothenburg and further south. Most of it goes by lorry. This can partly be explained by the transshipment of goods from Vestlandet and Trøndelag at Alnabru. Here, some cargo from a train from Bergen, some cargo from a train from Stavanger, and some cargo from a train from Trondheim are gathered before there is enough to run a southbound train from Oslo. This transshipment costs time and money, making it less attractive to use trains instead of lorries, while also reducing the valuable capacity at Alnabru. However, with Vestlandsbanen and significantly larger freight volumes by rail, it will be possible to run many more direct freight trains, especially between Vestlandet, Sweden, and Central Europe.

An important prerequisite for this is that freight trains can operate frequently both at night and during the day, meaning they will also need to run between much faster passenger trains on Vestlandsbanen. Possible options for this are discussed in detail in the report analysing the DBI's proposal. It is also important to view Vestlandsbanen as part of a modern, national rail network, and to realise the benefits of its integration with similar railway investments in other regions.

Figure 2: Map of Norway, and counties

2.3 Buskerud, Vestfold and Telemark

These are populous counties in Norway, playing a significant role in the country's economy. However, the area still has some differences in development. Akershus is e.g. the county in Norway with the greatest population growth, while Vest-Telemark is losing people, activities and opportunities, despite some positive exceptions.

The high-speed corridor will lead to enhanced connectivity within the counties and with other counties, leading to improved accessibility for both commuters and businesses. This will foster regional integration and encourage economic development across industries and municipalities. At the same time, the connections between Vestfoldbanen and Vestlandsbanen, in both Drammen and Skien, will greatly increase travel opportunities to and from Vestfold County. For instance, train journeys between Oslo and Vestfold could be 15 minutes faster than today. It will also be possible to offer a “ring service” Oslo – Drammen – Kongsberg – Notodden – Skien – Porsgrunn – Vestfold – Drammen – Oslo t/r. In addition, many parts of Agder county will get improved connectivity in many directions, due to fast train services via Bø in Telemark or via Skien, a corresponding bus service or a future railway near the Skagerak coast (“Grenlandsbanen”). At the same time, Vestlandsbanen will avoid most of the disadvantages that such a railway towards Kristiansand would bring to inner Telemark and inner Agder without Vestlandsbanen.

2.4 Vestland and Rogaland

The two counties host large industrial activities in sectors such as oil and gas and marine and maritime businesses, and are among the largest export counties in Norway, both in volumes and value, also when oil and gas export is not included. Products from fisheries, aquaculture and agriculture (especially in Jæren) account for significant parts of exports and long-distance domestic transports. This creates a need for fast, high-frequency and reliable transport all year round, also in winter.

The two counties are also known for their stunning natural beauty and thriving tourism industry. They will witness great advantages from the high-speed railway. The new transportation infrastructure will facilitate improved movements of personnel, equipment, and resources, thereby boosting efficiency and productivity and attracting more business and residents.

This will have special significance in the inner parts of Vestland and Rogaland, where the population is expected to decline without Vestlandsbanen.

The proposed high-speed corridor for Vestlandsbanen through Oslo, Akershus, Buskerud, Telemark, Vestland and Rogaland holds tremendous potential for the region. By enhancing connectivity and reducing travel and freight transport times, the project will both benefit the residents and businesses, contribute to economic development, regional integration and an improved transportation infrastructure. At the same time, it will be possible to achieve many positive effects for climate, energy use, nature, environment and traffic safety, due to reductions in other modes of transport. Vestlandsbanen is a visionary initiative that aligns with the long-term targets of promoting sustainable development and fostering prosperity in Norway.

3 POPULATION

Norway had 5,550 million inhabitants per 1.1.2024. While the total population continues to grow, the growth rate has slowed due to a decline in immigration over the past decade. Norway has the second-lowest population density in Europe, after Iceland, with 15 people per square kilometer (World Bank, 2021) [1].

Norway's population has seen a steady increase in the past decades with a projected population of 6.1 million by 2050. The trend is not observed in every county of the country. Akershus county is expected to experience the highest growth (20% from 2024), followed by Oslo and Østfold (14%), Buskerud (13%), Vestfold and Agder (12%), and Trøndelag (10%). Other counties are expected to experience minor growth, like Vestland (6%) and Rogaland (9%), Telemark (4,9%). Nordland county is expected to have fewer inhabitants in 2050 than in 2024.[2]

In 2024, counties and communities in the influence area of Vestlandsbanen (limited here to communities with from zero to about one hour travel time to nearest station) had a population of 3.313 million, corresponding to 59.7% of population in the whole country.[3] This figure will probably raise to 3.7 million in 2050, or almost 61% of the entire Norwegian population in 2050, according to SSB's forecast (see the list of the municipalities included her in the appendix).

With about two thirds of Norway´s population living within its influence, the project has the potential to greatly improve the lives of many Norwegians. This indicates the wide reach and importance of the Vestlandsbanen project in connecting and improving transportation infrastructure in Norway. Vestlandsbanen could probably also strengthen development in areas that have expected lower growth without this line. The same will be a possibility for such high-speed lines in other parts of the country as well.

[1] https://ec.europa.eu/eurostat/web/interactive-publications/
[2] https://www.ssb.no/en/statbank/table/14288/
[3] https://www.ssb.no/befolkning/faktaside/befolkningen

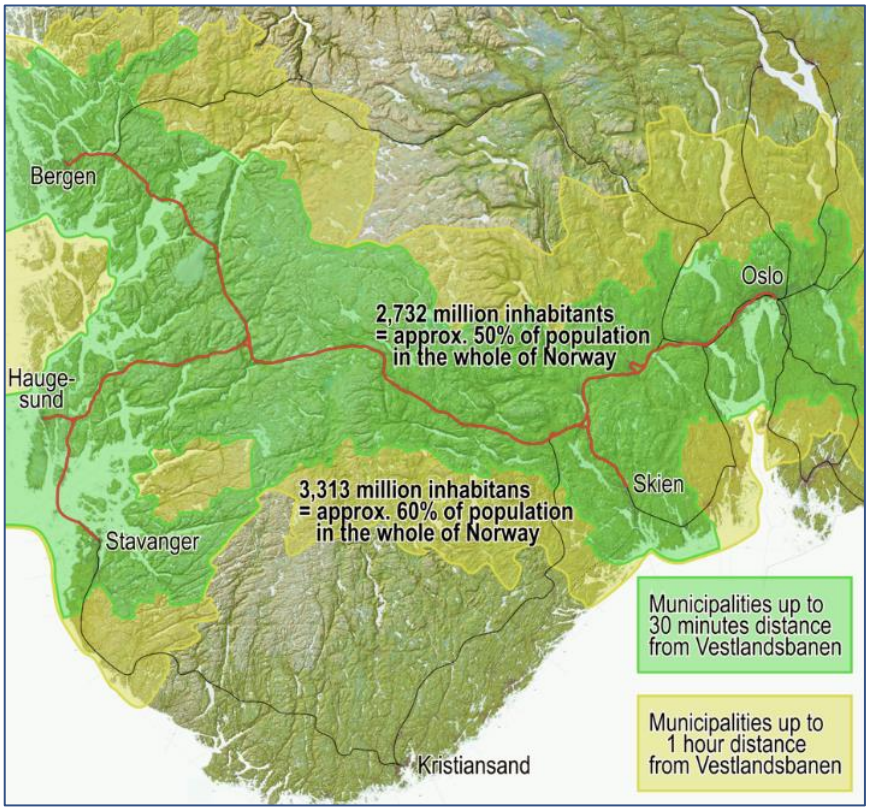


*Figure 3: **Number of inhabitants in the influence area of Vestlandsbanen***

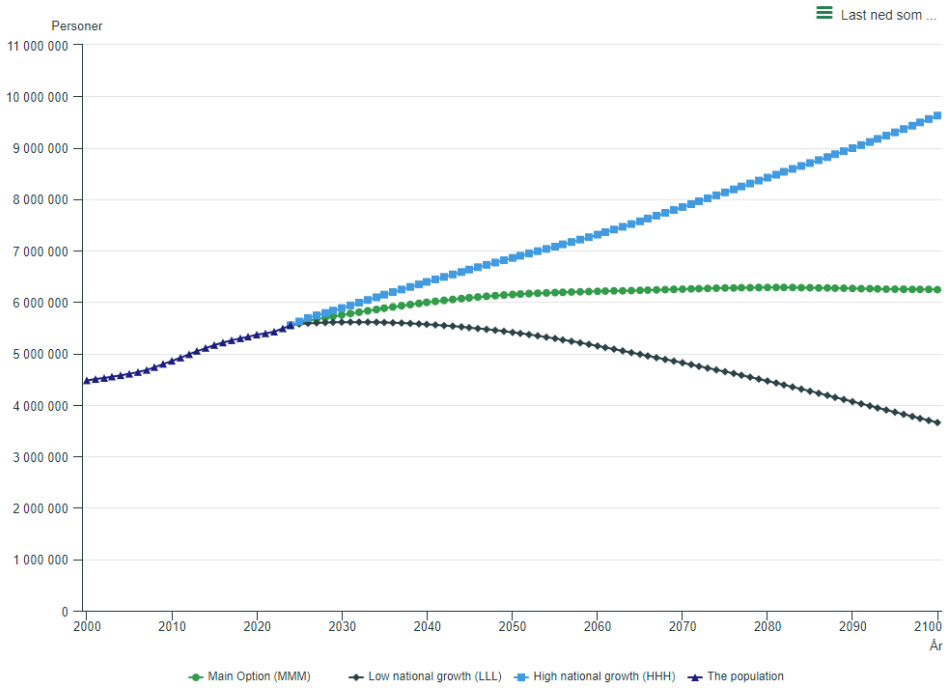


Figure 4: Norway's population[4]

[4] https://www.ssb.no/befolkning/faktaside/befolkningen

4 ECONOMY

Norway economy has a longstanding history of stability and continued to exhibit resilience even amid the challenges posed by the Covid-19 pandemic. Despite the adverse effects of the global health crisis, the nation maintained a robust economic position, characterized by favorable employment indicators.

In 2020, the employment rate stood impressively high at 70.3%, reflecting the country's ability to provide opportunities for a significant portion of its workforce. This statistic underscores the country's commitment to nurturing a productive labor market and promoting job creation.

Furthermore, the nation boasts an admirably low unemployment rate of 3.2% in 2023. This figure emphasizes the effectiveness of the country's economic policies and labor market initiatives in ensuring stable employment opportunities for its citizens. The low unemployment rate is a testament to the government's commitment to fostering a thriving economy and reducing joblessness.

The nation's prosperous economic climate has allowed for a substantial proportion of the population to engage in the services sector. With 78.5% of the workforce employed in services, the country demonstrates a strong service-oriented economy. This trend reflects the nation's ability to adapt to evolving market demands and capitalize on the growing service industry.

Moreover, the average monthly income of 45,839 NOK further highlights the positive economic conditions prevailing in the country. This figure signifies that the country's workforce enjoys a decent income level, contributing to a higher standard of living for its citizens. The combination of a high employment rate, low unemployment rate, and a substantial presence in the services sector has contributed to this favorable income situation.

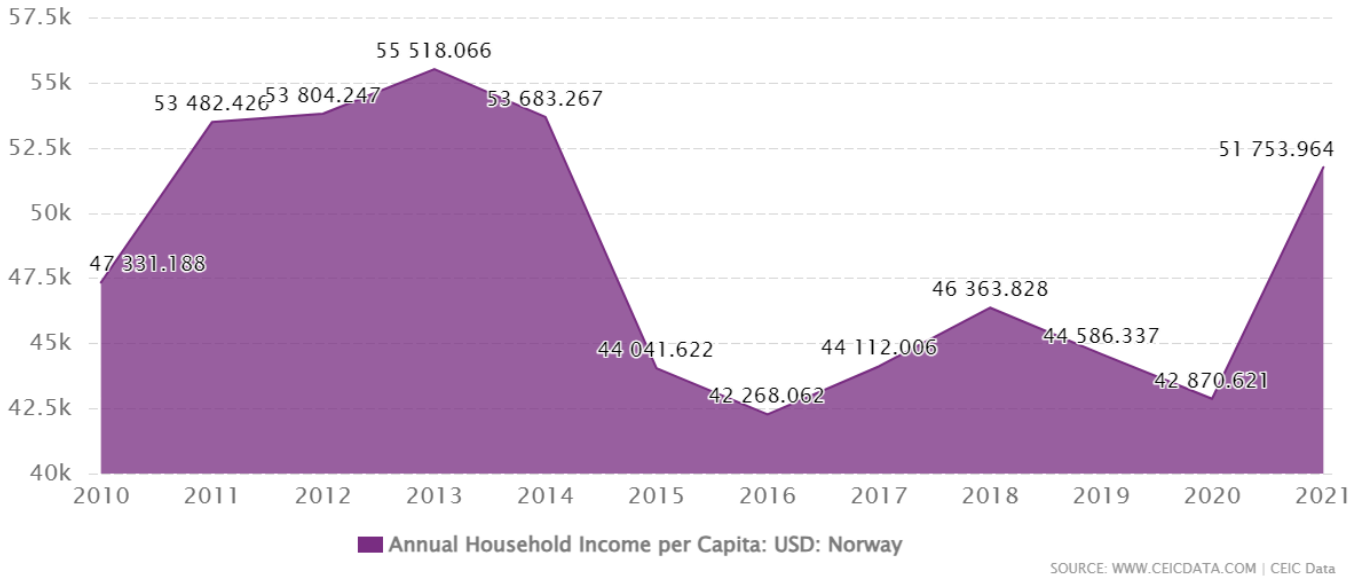


Figure 5: Annual Household Income per Capita[5]

[5] Source : https://www.CEICDATA.com

The Government Pension Fund Global (The oil fund/«Oljefondet»)

The Government Pension Fund Global,[6] popular called The Oil Fund (Oljefondet in Norwegian), was established after Norway discovered oil in the North Sea. The aim of the fund is to use the money responsibly, think long-term and thus secure future of the Norwegian economy. The fund is now one of the world's largest funds and passed NOK 19,000 billion in the first part of October 2024.

Although revenue from oil and gas production is transferred to the fund, these deposits account for less than half the value of the fund. Most of it has been earned by investing in equities, fixed income, real estate and renewable energy infrastructure. It was decided that the fund should only be invested abroad.

But each year, the Norwegian government can spend a small part of the fund. To ensure that the fund continues to benefit as many people as possible in the future too, politicians have agreed on a fiscal rule which ensures that no more is spent than the expected return on the fund. On average, the government should only spend the equivalent of the fund`s the real return on, which is estimated at around 3 percent per year.

With a fund of NOK 19,000 billion, the government will have up to NOK 570 billion available for annual expenditure in line with the fiscal rule. The projected use of oil revenues in the 2025 state budget is NOK 460 billion, which is anticipated to represent 2.5 percent of the Oil Fund's value at the beginning of the year.

This financial strategy places Norway in a unique position compared to most other nations. The remaining revenue, up to a 3 percent annual return, could potentially be allocated to a fund dedicated to investing in permanent assets and values, such as high-speed railways. These investments are expected to enhance efficiency and productivity for businesses, thereby bolstering Norway's competitiveness for many decades to come.

5 CURRENT TRANSPORT SITUATION

Norway's transportation network is served by a combination of state-wide, private, and municipal companies. The country's low population density, narrow shape, and long coastline have greatly influenced its transport system.

Road, rail, and air transport have increased in importance during the 20th century. The country's rail network, run by the government-owned railway company Bane NOR links major cities such as Oslo, Bergen, Trondheim, and Bodø, but consist of about 93 % old and single track, winding and often with steep gradients.

5.1 Air Traffic

Aviation has had a massive growth as a passenger transport mode in Norway since the 1960s.

Aircraft is the commonly used mode of transport on long distances. Despite its relatively small population of around 5.5 million people in 2024, Norway ranks high in air traffic. Based on EUROSTAT data regarding "Population as of January 1st"[7] and "National air passenger transport by reporting country"[8] for 2019, there were 2.97 domestic air trips per inhabitant in Norway. Compared to other countries in Europe. This indicates 8.3 times more domestic air traffic than elsewhere in Europe.

[6] Sources: https://www.nbim.no/en/, https://snl.no/Statens_pensjonsfond_utland, https://e24.no/boers-og-finans/i/al48va/oljefondet-passerer-19000-milliarder
[7] https://ec.europa.eu/eurostat/databrowser/product/page/AVIA_PANC
[8] https://ec.europa.eu/eurostat/databrowser/product/page/TPS00001

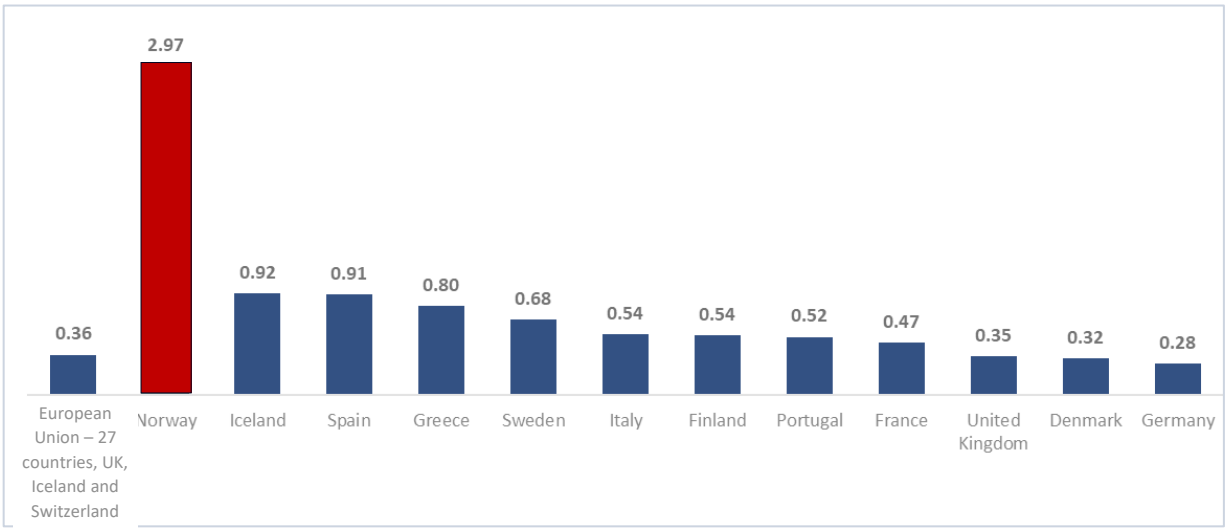


Figure 6: Annual domestic air trips per inhabitant in 2019. Source: Own from EUROSTAT

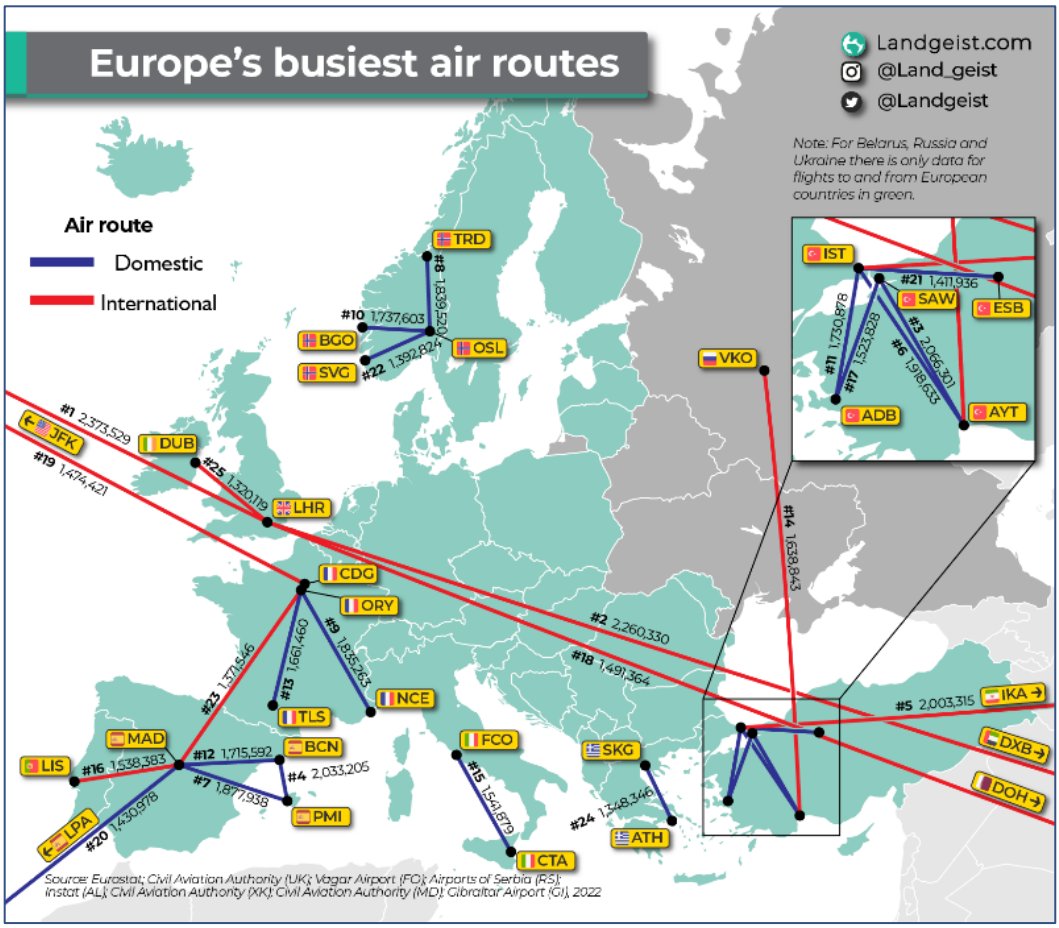


Figure 7: Busiest flight routes in, to and from the EU, UK, Switzerland, Iceland and Norway. Source: Eurostat, 2022.

Rank	Airport 1	Airport 2	2019
1	Madrid/Barajas	Barcelona/El Prat	2,572,893
2	Frankfurt	Berlin/Tegel	2,249,667
3	Toulouse/Blagnac	Paris/Orly	2,217,892
4	Barcelona/El Prat	Palma de Mallorca	2,173,939
5	Oslo/Gardermoen	Trondheim	2,106,440
6	Nice	Paris/Orly	2,052,649
7	Oslo/Gardermoen	Bergen	2,003,406
8	Madrid/Barajas	Palma de Mallorca	1,995,104
9	Berlin/Tegel	Munich	1,933,817
10	London/Heathrow	Dublin	1,855,333
11	Catania/Fontanarossa	Rome/Fiumicino	1,824,428
12	Amsterdam/Schiphol	London/Heathrow	1,747,789
13	Munich	Hamburg	1,739,939
14	Oslo/Gardermoen	Stavanger	1,681,335
15	Madrid/Barajas	Gran Canaria	1,659,106
16	London/Gatwick	Barcelona/El Prat	1,586,967
17	Rome/Fiumicino	Palermo/Falcone Borsellino	1,579,946
18	Madrid/Barajas	Lisbon	1,557,398
19	London/Heathrow	Frankfurt	1,548,995
20	Palma de Mallorca	Düsseldorf	1,544,710
21	Madrid/Barajas	Tenerife North	1,493,755
22	Munich	Düsseldorf	1,488,322
23	Copenhagen	Oslo/Gardermoen	1,479,320
24	London/Heathrow	Madrid/Barajas	1,476,551
25	Frankfurt	Hamburg	1,426,073
26	Barcelona/El Prat	Rome/Fiumicino	1,402,757
27	Stockholm/Arlanda	Copenhagen	1,387,544
28	Barcelona/El Prat	Amsterdam/Schiphol	1,384,848
29	Stockholm/Arlanda	Oslo/Gardermoen	1,379,312
30	Barcelona/El Prat	Paris/CDG	1,373,128

Rank	Airport 1	Airport 2	2022
1	Barcelona/El Prat	Palma de Mallorca	2,033,205
2	Madrid/Barajas	Palma de Mallorca	1,877,938
3	Oslo/Gardermoen	Trondheim	1,839,520
4	Oslo/Gardermoen	Bergen	1,737,598
5	Madrid/Barajas	Barcelona/El Prat	1,715,592
6	Rome/Fiumicino	Catania	1,541,879
7	Madrid/Barajas	Lisbon	1,538,344
8	Madrid/Barajas	Gran Canaria	1,430,978
9	Oslo/Gardermoen	Stavanger	1,392,824
10	Madrid/Barajas	Tenerife Norte	1,291,140
	Athens/El. Venizelos	Thessaloniki/Macedonia	1,204,852
	Rome/Fiumicino	Palermo/Falcone Borsellino	1,176,181
	Madrid/Barajas	Paris/Orly	1,371,546
	Amsterdam/Schiphol	Madrid/Barajas	1,207,458
	Madrid/Barajas	Rome/Fiumicino	1,291,186

Figure 8: Busiest flight routes inside the EU, UK, Switzerland, Iceland and Norway.
Source: Eurostat

As shown in the table above, Oslo-Trondheim and Oslo-Bergen were the fifth and seventh busiest routes in Europe in 2019 (before the COVID-19 pandemic). In addition, the Oslo-Stavanger route was the fourteenth busiest in the same year. By 2022, they had moved up to 3rd, 4th and 9th place respectively. The figures for 2022 were admittedly still affected by covid. Figures for 2023 are only partially available at the time of writing.

It's also worth noting that the routes to Mallorca, Catania, Tenerife and Gran Canaria in the table above cross oceans, making train travel an unlikely option. If you disregard these, and only look at overland routes, the Norwegian routes are in 1st, 2nd and 5th place respectively on the list of the most travelled routes in 2022. This highlights the significant demand for air travel between the Norwegian cities and underscores the potential benefits of enhancing alternative transportation options, such as high-speed rail, to reduce air traffic and improve connectivity within the country.

5.2 Road traffic

Road traffic in Norway is greatly impacted by adverse weather conditions throughout the year. Wintertime brings the challenges of snow and ice, as well as the risk of avalanches, making driving conditions treacherous. To mitigate these issues, motorists often engage in organized queue driving during bad weather periods, where vehicles form lines on the road to maintain a safe distance from one another.

Despite the challenges posed by bad weather, Norway shows high road traffic volumes on long distances. Both passenger and freight traffic are prevalent on the country's roads, with long-distance journeys being common for both individuals and businesses.

Norway has a high rate of car usage. According to the Norwegian Central Bureau of Statistics, the total and average distances covered by Norwegian passenger cars have been increasing.

A 2017 article from SSB reported that Norwegians had the second highest car usage in Europe, measured in passenger kilometers (pkm) per day per inhabitant[9].

The Norwegian transport industry is emphasizing greener freight transport and aims to shift more traffic from road to rail. Heavy traffic also contributes significantly to road wear. It's important to note that some many sections of the rail network in Norway are currently overloaded, meaning that demand is higher than supply. Therefore, successful transfer of freight traffic from road to rail will depend on the capacity of the rail network to handle increased volumes.

The implementation of the Vestlandsbanen project could potentially have a significant impact on freight traffic. The high-speed, double-track network would lay the foundation for a new quality, speed, and capacity in freight train traffic. This could lead to a substantial amount of freight being transferred from road to rail, thereby reducing road wear, traffic accidents and contributing to environmental sustainability.

5.3 Rail traffic

The rail network is spanning about 4,000 kilometers, connecting most of major cities, towns, and industrial centers.

[9] https://www.ssb.no/transport-og-reiseliv/artikler-og-publikasjoner/koyrer-nest-mest-i-europa

However, the Norwegian rail network consist of 93 % single track, most of them around 100 years old, winding and with long sections of steep gradients compared with modern standard for freight train, which greatly reduces the load capacity per train. Short crossing sections also limit the length and load capacity of freight trains. Thus, the Norwegian rail network faces various challenges that hinder efficient and reliable travel and transport times.

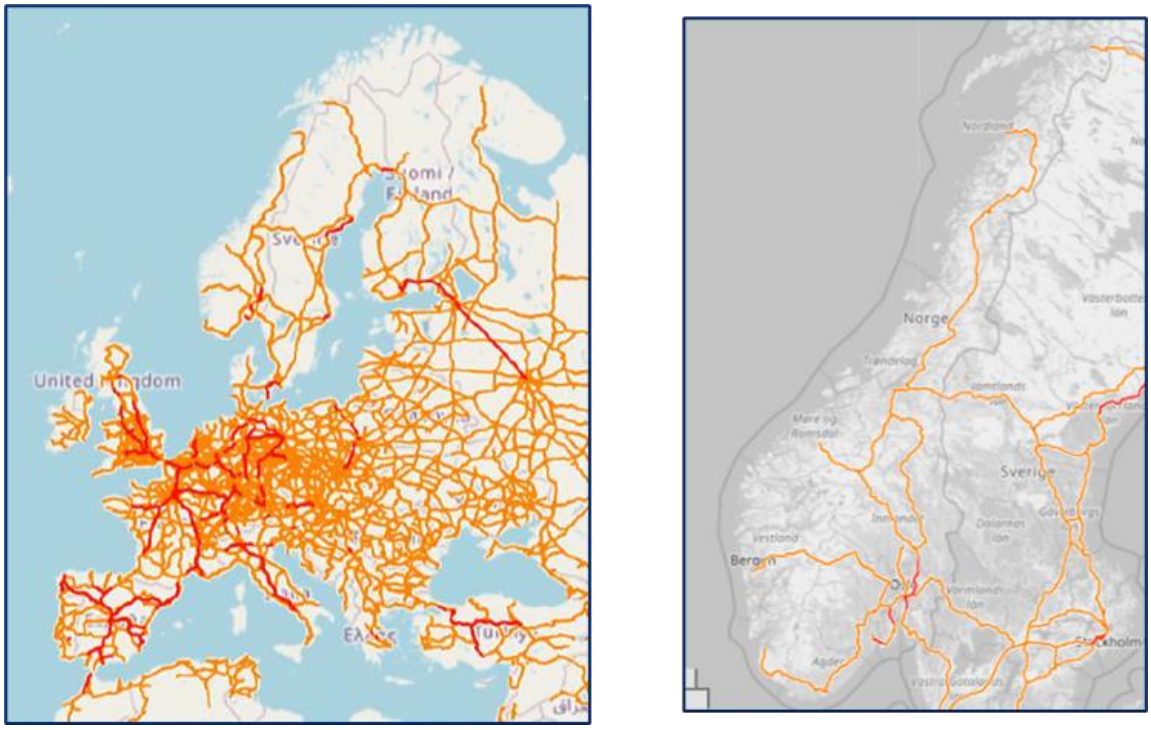


Figure 9: Rail network in Europe and Norway[10]

Haugesund, along with Ålesund and Tromsø, are among the nine largest cities in the EU/EEA that lack a railway connection, defined as within 50 kilometers around the city

5.4 Travel Time

One of the primary considerations for rail travel is the time it takes for passengers or goods to reach their destinations. In general, the average travel times by train in Norway are long. For example, traveling from Trondheim - Bodø, a distance of about 730 kilometers, takes about 10 hours. Similarly, a journey from Oslo to Stavanger, a distance of about 591 kilometers, takes almost 8 hours (fastest option). These travel times reflect the challenges faced by the Norwegian rail system, including numerous single-track sections, steep gradients, and bottlenecks at major junctions.

The illustration below, provided by AVINOR and titled “Limited Alternatives to Air Travel,” highlights the reasons why air travel is a popular choice for many people in Norway.

[10] https://openrailwaymap.org.

Figure 10: Limited alternatives to air travel, "Avinor and Norwegian aviation 2017"[11]

Below is an overview and comparison of travel times and average speeds by train between Oslo and the three largest cities in Norway—Trondheim, Bergen, and Stavanger—compared to similar distances in other European countries:

Route	Distance (km)	Travel Time (hours)	Average Speed (km/h)
Norway			
Oslo - Trondheim	549	6.75 - 7.5	73 - 80
Oslo - Bergen	483	6.5 - 7.5	64 - 74
Oslo - Stavanger	591	7.5 – 8,5	70 - 79
France			
Paris - Lyon	425	2	213
Spain			
Madrid - Barcelona	621	2.5 - 3	207 - 248
Germany			
Berlin - Munich	623	4 - 4.5	138 - 156
Italy			
Rome - Milan	573	3	191

Figure 11: Average train speeds in Norway and some routes in other European countries[12]

[11] https://avinor.no/globalassets/_konsern/om-oss/rapporter/en/avinor-rapport_uk_v1.pdf, page 10
[12] Source: https://en.wikipedia.org/wiki/LGV_Sud-Est

5.5 Freight Transport

Norway's rail freight transport faces some challenges. While the country has a railway system comprising about 4,196 km of standard gauge track, of which 2,456 km is electrified and 296 km is double track (in 2022, Jernbanedirektoratet), it still struggles with capacity issues. Capacity constraints are becoming apparent on some lines; these constraints severely limit the potential for further growth.

The limited capacity on most railway lines due to congested single track sections hinders further development of the market for rail freight traffic. This is a significant challenge that needs to be addressed to fully realize the potential of rail freight transport in Norway.

5.6 Investment Opportunities

Recognizing the importance of rail as a mode of transport, the Norwegian government has initiated significant investments to upgrade the rail network, in particular in the greater Oslo area.

Investing in upgrades can improve certain aspects of a rail network, but it may not achieve the same level of performance as a new modern double-track line. This is due to several factors:

1. **Geographical Constraints**: Norway's terrain is characterized by mountains, valleys and numerous fjords. These natural features can limit the speed and capacity of trains, especially on existing corridors with steep gradients.
2. **Infrastructure Limitations**: Existing rail lines may have been built with older technology and standards that limit their potential for speed and capacity, even with upgrades. A double track has several times the capacity of single tracks.
3. **Cost and Feasibility**: Rebuilding an entire existing line to modern standards can be prohibitively expensive compared to building a new line and may not be feasible due to environmental or logistical constraints.

6 ENERGY PROVISION PLAN

As stated in the IEA Energy Policy Review 2022, Norway has set ambitious targets for reducing greenhouse gas (GHG) emissions and establishing a low emissions society by 2050. As an energy-rich country, Norway is in a unique starting position with respect to the energy transition. An abundance of affordable hydropower has enabled the development of energy-intensive industries and a high level of electrification of homes and businesses with limited GHG emissions. At the same time, as a major oil and gas producer and exporter, Norway will need to support an evolution of its energy sector amid a global energy transition.

Thanks to its ample reserves of oil and natural gas, Norway is a net energy exporter: in 2020, 87% of its energy production was exported. From a global perspective, Norway is the seventh-largest natural gas producer in the world, supplying 3% of global gas consumption. Norway is also a significant oil producer, accounting for 2.3% of global oil production in 2020. As a reputable and reliable producer, Norway has played a stabilizing role in the world's oil and gas supply, particularly in meeting European demand.

In addition, its extensive hydropower resources covered 92% of electricity generation, supporting an almost completely renewables-based power sector. Moreover, Norway's energy demand is highly electrified: in 2020, electricity covered almost half of the country's total final consumption (TFC), the highest share among IEA member countries. Norway has tremendous potential to further leverage its clean electricity system to decarbonize other sectors of the economy through additional electrification.

Nonetheless, to meet its ambitious target of being a low emissions society by 2050, Norway has considerable work ahead, especially since electricity generation is already zero emissions and the country already has

substantial electrification of the buildings sector and almost half of industry, thereby also achieving low emissions in these sectors.

As a result, many of the easy wins for reducing emissions have already been achieved and the remaining emissions reductions will be more complex, challenging and costly, notably in transport and industry.

As an example, the national transport agencies' proposal for a new national transport plan shows, on the basis of the report "*Kraftbehov til transport. Nullutslippsscenarier for 2050*" from Miljøverndirektoratet in 2022[13], that the need for renewable power will increase from 2 TWh to 60 TWh by 2050, based on projections of traffic with the current distribution of modes of transport. Since the annual production of renewable power in Norway is now approx. 150 TWh, an increase in consumption within transport from 2 to 60 TWh would in that case be a major and costly challenge.

Miljøverndirektoratet comments this as follows: "*Much transport can be avoided or moved to more energy-efficient forms of transport. A more energy-efficient transport sector will result in less need for power and be less demanding on resources and land*."

Rail traffic is indeed the most energy efficient transport mode by far compared with planes, lorries, buses and cars. Being able to transfer traffic from more energy-demanding forms of transport to competitive trains will therefore provide a basis for also saving a lot of energy, and thus also the costs and interventions in nature that the development of the same amount of energy will require.

IEA Energy Policy Review 2022 Assessment

Norway has been a global standard-bearer in the health and safety, environmental standards, and stability of oil and gas production for decades. The established system based on a predictable regulatory framework, well-known taxation system and direct involvement of state assets in the exploration make the whole system aligned and serve the overriding goal of Norwegian policy that the society benefits as much as possible from the income generated from oil and gas production.




The government has no plans to reduce its holdings in upstream activities in Norway and the system of established management over the state's interests in the upstream activities seems to be a model on maximising returns to society while at the same time guaranteeing stability of returns for investors. This alignment of benefits and obligations has for a long time been a major incentive for foreign companies to compete for stakes in the Norwegian upstream industry, which is set to remain the case for the coming years.

However, success in achieving this alignment does not mean that the Norwegian oil and gas sector does not face challenges. The most important challenge it faces remains its future in the post-2025 outlook. The country's commitment to a clean energy transition and net zero before 2050 are new dimensions determining the future of oil and gas exploration in Norway. However, replacing the role of the oil and gas production in the domestic economy seems to be impossible in the short to medium term.

[13] https://www.miljodirektoratet.no/publikasjoner/2022/november/kraftbehov-til-transport-nullutslippsscenarier-for-2050/

Decarbonising the upstream sector in Norway will present challenges, especially with very high targets set by the parliament at 55% emissions reductions by 2030 compared to 1990.

Electrification of offshore production with clean electric power from shore is one idea. However, in the context of high electricity prices and Norway's attempts to electrify numerous other sectors that will drive increased demand for electricity, political and public opposition has grown to the offshore industry's attempts to access onshore power, potentially hindering its attempts to decarbonize upstream operations.

The national debate on the future of extraction and the opening up of new exploration areas is a hotly debated political and social topic in Norway. The government will have to engage further to clarify its positions to society and set policies serving the public's expectations.

Additionally, while the oil and gas industry continue to employ a large number of highly skilled workers, as the market transitions to low-carbon energy sources, attention should be given to how to transition the personnel and make them adaptable to changing needs.

Despite unparalleled government promotion of electric vehicles leading to a strong consumer uptake, oil demand in transport has not decreased much in Norway in the past decade, aside from 2020 marked by the Covid-19 outbreak. Many consumers have kept internal combustion engine vehicles, even if they have also purchased EVs. However, with Norway having the world's highest uptake of EVs (at 85% of new car sales in 2021), domestic oil consumption in passenger car transport is inevitably set to decrease.

Reducing fossil fuel in transport is also supported by the promotion of biofuels. Norway has introduced a very high biofuels blending mandate at 24.5% and made significant progress in increasing biofuels consumption in transport. However, it has not developed domestic biofuels production to the same degree and relies on imports, at time being 99 %, which may lead to dependency while the country's potential in that regard remains untapped.

As mentioned in Deliverable 0 – High Level Project Goals, shifting significant traffic to trains could significantly reduce Norway's demand for renewable energy production. This would have numerous benefits, including reducing the need to develop new wind and hydroelectric power facilities, which would benefit the environment.

The construction of Vestlandsbanen and other subprojects in a modern Norwegian and Nordic railway network will be important for Norway's transition to electric and climate-neutral transportation.

The initial projections for the Vestlandsbanen high-speed rail project indicate potential high energy savings annually. To illustrate such savings, see the illustration comparing the energy use of different transportation modes per passenger-kilometer and ton-km.

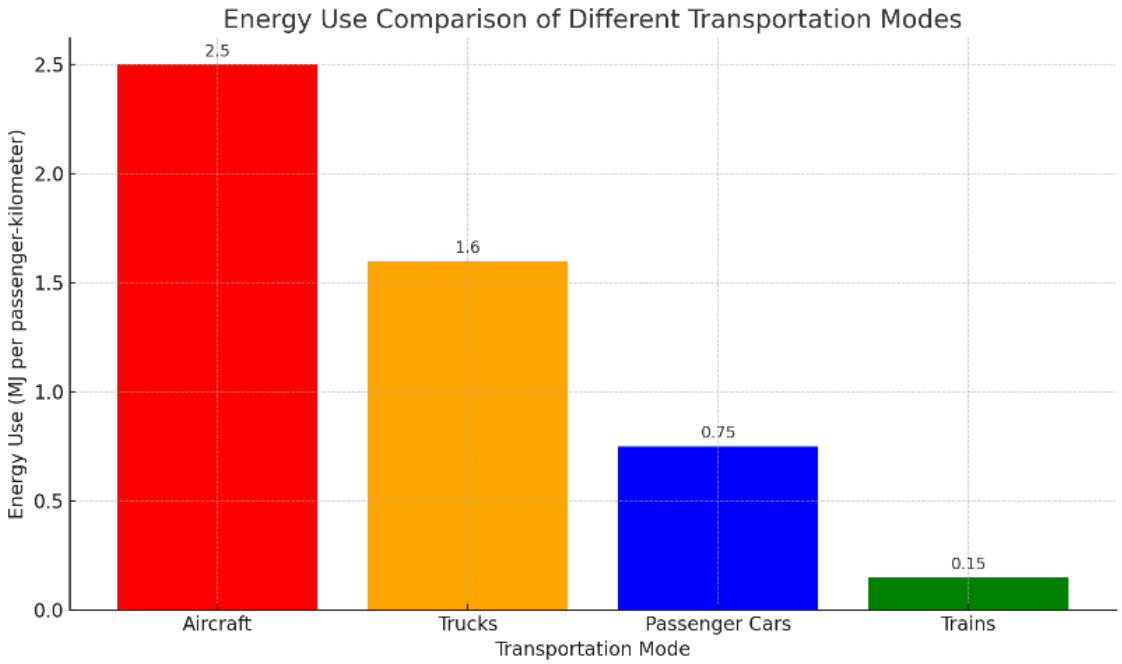


Figure 12: Energy use, comparison of different transportation modes

The columns and figures in the illustration above highlight the considerable differences in energy efficiency among transportation modes. Trains, such as those on the proposed Vestlandsbanen high-speed line, stand out as significantly more energy-efficient compared to aircraft, trucks, and passenger cars.

7 AGRICULTURAL

Vestlandsbanen will provide a more efficient and sustainable mode of transportation for the agricultural and forestry sectors in the area, supporting the growth and success of these industries in the future.

The purpose of this chapter is not to provide a detailed analysis of the agriculture and forestry in the country, but to highlight key messages to be taken into account during the study:

- The mountainous areas of southern Norway impose big challenges for transportation, particularly in the agricultural industry. A faster and more efficient mode of transportation would greatly benefit the area and also facilitate business operations.

- The importance of the agricultural sector varies considerably across regions. Rogaland County in southwestern Norway, and in particular Jæren, is the main farming region with respect to gross product

and employment. However, agriculture's role in the regional economy is highest in the former Nord-Trøndelag County.

- The crop and animal production sector plays a relatively minor and shrinking role in the economy, at only 0.6% of Gross Value Added (GVA) and 1.4% of employment, while forestry is responsible for just 0.2% of GVA. In contrast, the share of fisheries and aquaculture is growing. Most of agriculture production value (62%) comes from livestock products.

Shares of the sector in the economy (%), 2018[1]

	Agriculture land area[2]	Gross value added[3]					Employment[4]					Agro-food exports[5]	Agro-food imports[5]
		Total: Agriculture, forestry and fishing	Crop and animal production and hunting	Forestry and logging	Fishing and aquaculture	Total: Manufacture of food and beverages	Total: Agriculture, forestry and fishing	Crop and animal production and hunting	Forestry and logging	Fishing and aquaculture	Total: Manufacture of food and beverages		
Norway	2.7	2.2	0.55	0.19	1.49	1.56	2.1	1.42	0.16	0.51	1.69	1.0	9.0
Canada	6.4	2.0	1.52	0.37	0.11	1.73	1.9	..	..	..	..	11.0	7.9
Denmark	65.8	1.2	0.91	0.11	0.16	1.77	2.2	1.94	0.17	0.08	2.03	16.5	12.3
Finland	7.5	2.8	0.65	2.13	0.06	1.32	..	2.82	0.82	..	1.51	2.4	7.5
France	52.4	1.7	1.55	0.15	0.04	2.14	2.5	2.29	0.11	0.06	2.47	12.6	9.0
Iceland	18.7	4.2	0.96	0.01	3.21	4.13	..	1.41	..	2.57	..	6.2	8.4
Japan	12.2	1.2	..	..	..	2.46	3.2	..	..	..	..	0.7	8.0
Korea	17.2	2.0	..	..	..	..	5.0	..	..	..	..	1.1	5.2
Sweden	7.4	1.6	0.77	0.83	0.03	1.11	1.7	1.10	0.60	0.03	0.89	3.6	7.6
Switzerland	38.3	0.7	0.62	0.05	0.01	1.95	..	2.81	0.14	..	1.63	3.2	4.5
United States	44.3	0.9	0.86	0.07	0.02	1.31	1.6	..	..	..	..	10.2	5.5
EU28[6]	42.9	1.5	1.27	0.18	0.05	2.12	4.0	3.70	0.23	0.07	2.19	6.8	5.6
OECD[7]	34.3	1.5	..	..	..	..	4.5	..	..	..	..	8.4	7.6

Notes: ..: not available. 1. or latest available year. 2. Share of total land area. 3. Share of total gross value added. For Norway, it refers to the country total. 4. Share of employed persons, aged 15 years and over, in total NACE activities. 5. Share of total exports (or imports). Agro-food definition does not include fish and fish products. Agro-food codes in H0: 01, 02, 04 to 24 (excluding 1504, 1603, 1604 and 1605), 3301, 3501 to 3505, 4101 to 4103, 4301, 5001 to 5003, 5101 to 5103, 5201 to 5203, 5301, 5302, 290543/44, 380910, 382360. 6. For EU28, imports and exports include only extra-EU trade. 7. For OECD, imports and exports include both intra- and extra-OECD trade. OECD does not include Colombia.
Source: Authors' calculations based on OECD (2020[6]), System of National Accounts and Annual Labour Force Statistics (databases), http://stats.oecd.org/; UN (2020[7]), UN Comtrade database, https://comtrade.un.org/; Eurostat (2020[8]), [nama10_a10], [lfsa_egan2], http://ec.europa.eu/eurostat/data; FAO (2019[9]), FAOSTAT, Land use (database), http://www.fao.org/faostat/en/.

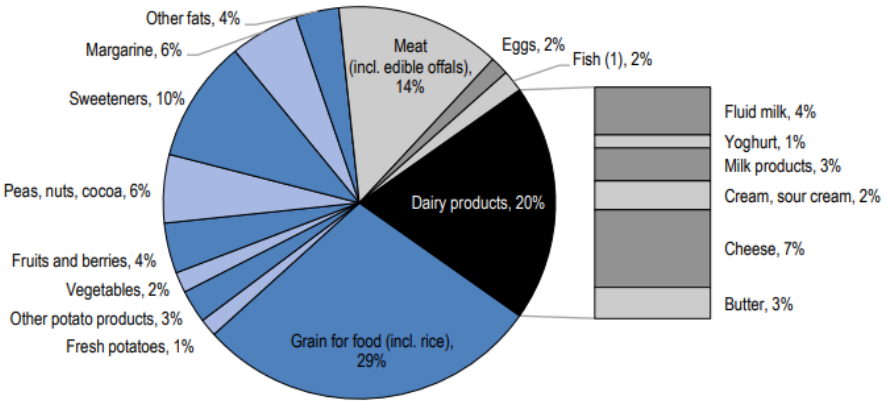
Key statistics of the Norwegian forestry sector, 2017

	Unit	Value
Sales of timber for industrial purposes	million m^3	10.5
Gross value of timber for industrial purposes	million	3 714
Employment		
Forestry and related services	people	5 682
Timber and wood products industry	people	13 008
Paper and stationery industry	people	2 732
Total forestry and wood-based industry	*people*	*21 422*
Turnover		
Timber and wood products industry	million	32 274
Paper and stationery industry	million	10 846
Total wood-based industry (without furniture)	*million*	*43 120*
Production value		
Timber and wood products industry	million	29 312
Paper and stationery industry	million	14 590
Total wood-based industry (without furniture)	*million*	*43 920*

Notes: Production value means turnover adjusted for changes in inventory of finished goods, work in progress and goods and services purchased for resale. Purchases of goods and services for resale have been deducted, while capitalised own investment work has been added.
Source: Statistics Norway (2020[10]), provided data.

Source: POLICIES FOR THE FUTURE OF FARMING AND FOOD IN NORWAY © OECD 2021

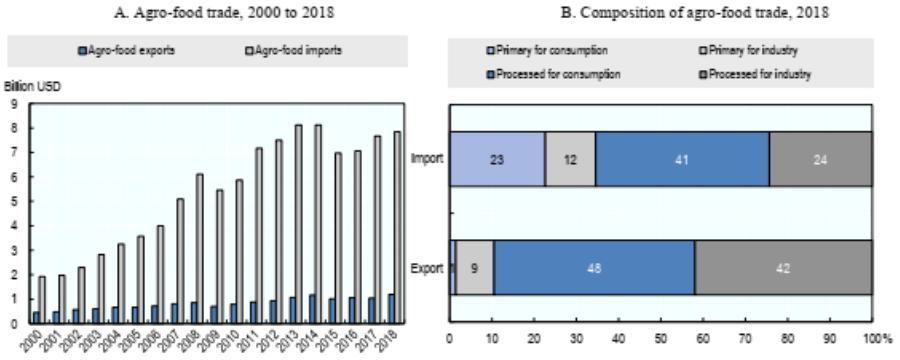
- Given its orientation towards the domestic market, domestic demand for food shapes the potential for Norwegian agriculture. This can be affected by demographic trends, price trends of domestic and competing imported commodities, trade policies and agreements, the appearance of new products on the market as well as evolving food trends and consumer expectations. However, the potential for agricultural production is limited by Norway's natural conditions. The Norwegian diet has changed over the last two decades. The Norwegian government encourages efforts towards a healthy and varied diet for the entire population. The Minister of Health and Care Services has reached out to the major actors in the food industry and plans to work with them to reduce added sugar, saturated fat and salt content in food, as well as promoting an increased consumption of fruits, berries, vegetables, whole grain food, and fish.



Notes: Food consumption in terms of energy content, at the wholesale level (estimates). 1. Based on uncertain data.
Source: Statistics Norway (2020[10]), provided data.

Figure 13: Composition of food consumption, 2018.
Source: POLICIES FOR THE FUTURE OF FARMING AND FOOD IN NORWAY © OECD 2021

- As a member of the European Free Trade Association and the European Economic Area, Norway has low barriers to trade and investment in most sectors (including fish and forest products), except primary agriculture. Norway is a net importer of most agro-food products except for fish, but its cumulated trade balance, including fish, shows a net exporting position. Norway's main trading partner is by far the European Union.

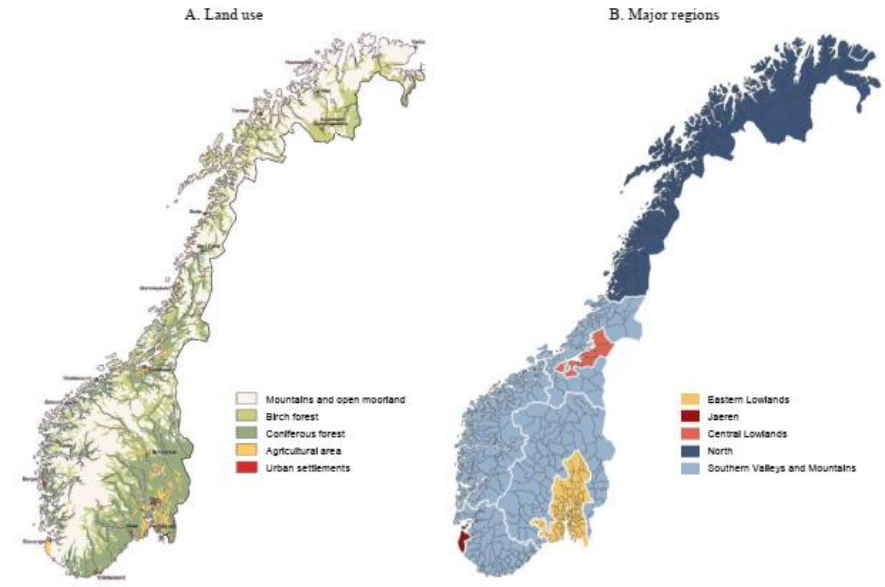


Notes: The definition of agro-food trade does not include fish and fish products. Agro-food codes in H0: 01, 02, 04 to 24 (excluding 1504, 1603, 1604 and 1605), 3301, 3501 to 3505, 4101 to 4103, 4301, 5001 to 5003, 5101 to 5103, 5201 to 5203, 5301, 5302, 290543/44, 380910, 382360. Numbers may not add up to 100 due to rounding.
Source: UN (2020[7]), UN Comtrade (database), http://comtrade.un.org/ (accessed January 2020).

Source: POLICIES FOR THE FUTURE OF FARMING AND FOOD IN NORWAY © OECD 2021

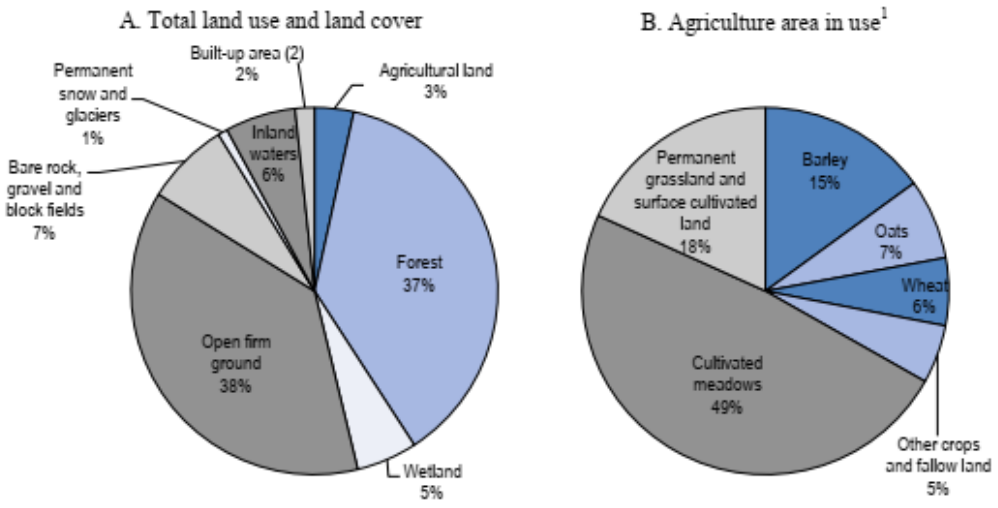
The figures above show import and export of agro-food trade in Norway and the composition av agro-food trade in Norway.

- Only 3% of Norway's total land area is cultivated land, although extensive grazing covers above 40% of total land area and agricultural properties are present on around 77% of the territory. Policy, landscape and climate determine the distribution of production, which is highly differentiated among regions, with crops more concentrated in the Eastern lowlands and livestock spread across the rest of the country. Renting has facilitated the consolidation of agricultural land in recent years, but average farm area remains small, and most farm-households have significant off-farm income.



Notes: Panel B presents five major regions defined based on common agricultural characteristics.
Source: Panel A: Adapted from Statistics Norway (2018[18]); Panel B: Provided by NIBIO (2020[19]).

Land use by area classification, 2018



Notes: Numbers may not add up to 100 due to rounding.
1. Agricultural area in use accounted for 88% of the agricultural land in 2018.
2. Built-up area includes unclassified undeveloped areas that account for less than 0.01% of the total.
Source: Statistics Norway (2020[21]), Land use and land cover and Holdings, agricultural area and livestock (databases) [tables: 09594 and 11506], https://www.ssb.no/en/statbank/ (accessed February 2020).

Source: POLICIES FOR THE FUTURE OF FARMING AND FOOD IN NORWAY © OECD 2021

- Climate change is expected to have on average, positive effects on agriculture in Norway, but extreme events are likely to become more frequent, and forestry is likely to experience less favorable conditions due to pathogens and fire.

- Labour costs are high, but the Norwegian labour market is able to adapt through wage negotiations and the inflow of economic immigrants, which is particularly important in agriculture.

- Norway attaches great importance to food safety and animal health with strict standards in regulations.

7.1 Infrastructure and rural development

Investments in physical and knowledge infrastructure are essential to overall growth and development as they facilitate the delivery of and access to important services. In this sense, investment such Vestlandsbanen can play a critical role in linking farmers and related businesses to markets. Short travel- and shipping times and low costs also may boost agriculture productivity and encourage investment in innovative techniques and products. New infrastructure increase opportunities of off-farm income and employment, mitigate the income risks of farm households, facilitate on-farm investment, and enable a wider range of choices for farm production. Modern and clean infrastructures to support good quality rural services, are essential to ensure the connectivity and attractiveness for residents, businesses, customers, suppliers, and collaborators in and for the municipalities of the area of Vestlandsbanen.

In view of Norway's low population density (17 persons per km^2), high concentration in the main urban centres and urban settlements (over 80 % of the Norwegian population), and the large geographical distances, the provision of infrastructure and services throughout the country presents specific challenges. Every four years, the Norwegian Government publishes "National expectations to regional and municipal planning". In the edition for the period 2018-29; the government emphasized the need for the regional transport network to contribute to resource efficiency, industrial development, settlement, and social sustainability in various parts of the country.

8 FUTURE TRANSPORT PLAN FOR NORWAY

The Norwegian Transport Plan (NTP) is a comprehensive strategic document that guides the development and allocation of transport infrastructure in Norway. The plan aims to promote sustainable mobility, improve connectivity, and enhance the overall quality of life for Norwegian residents.

In recent years, the Norwegian government has made significant investments in expanding and modernizing the country's rail network, especially in the so-called InterCity railway network in the region around Oslo. These investments aim to address growing demand, reduce travel times, and improve the overall efficiency of the transport network, especially around Oslo.

But it is important to note that the possibility of building a new national rail network and achieving better connectivity through more efficient, safe, and modern transport modes such as high-speed lines has not been extensively considered in the latest NTPs.

9 ENVIRONMENTAL IMPACT

The planning of Vestlandsbanen high-speed line needs to consider multiples aspects. Whether the effects for climate, nature and the environment will be positive is a key aspect to be considered.

On the negative side, two significant impacts can be the Barrier Effect and Visual Impact. The construction of a new high-speed rail line often requires extensive infrastructure, which can act as a barrier, dividing natural habitats and disrupting the movement of wildlife. Fragmentation can have detrimental effects on ecosystems and biodiversity.

Furthermore, the visual impact of high-speed rail lines can be a concern. The construction of large rail infrastructure, including bridges, and elevated tracks, can alter the natural landscape and may impact the aesthetics and overall visual appeal of the surrounding areas.

A careful planning, and a high proportion of tunnels will reduce barriers and negative visual effects. DBI had proposed a track alignment for Vestlandsbanen with a tunnel share of almost 60%.

High-speed rail lines also offer several positive environmental benefits. One of the key advantages is the low energy consumption and the reduction of greenhouse gas emissions.

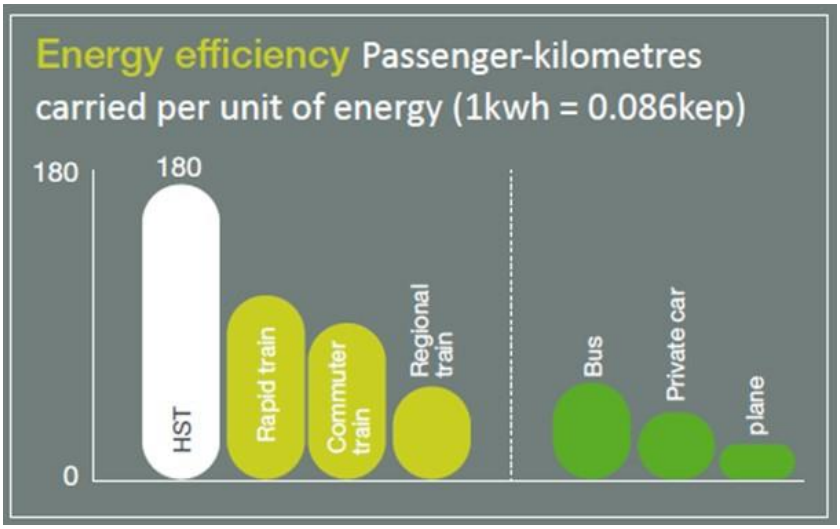


Figure 14 UIC High speed rail - Fast track to sustainable mobility, November 2010

On clean, green electricity, like in Norway, the greenhouse gas emissions from trains are about zero. High-speed trains generally consume significantly less energy per passenger-kilometre compared to other modes of transportation, such as cars or airplanes. This leads to a reduction in both energy consumption and greenhouse gas emissions and contributes positively to the fight against climate change.

A double-track railway also has much higher capacity, but uses far less land, than four-lane motorways. The railway does not create microplastic pollution, as cars do from tire and road wear. Another positive aspect is the reduced noise pollution associated with high-speed rail. Compared to road transport, high-speed trains produce significantly less noise, leading to a quieter and more pleasant environment for both passengers and nearby communities.

9.1 Energy consumption and greenhouse gas emissions

In Norway, emissions from road transport amount to approximately 8.5 million tonnes of CO_2 per year and domestic air traffic around 1.2 million tonnes of CO_2 per year, together 9.7 million tonnes of CO_2 per year; around 20% of total Norwegian emissions of 48.9 million tonnes of CO_2 per year (2022), according to https://miljostatus.miljodirektoratet.no/.

In addition, emissions from e.g. asphalting of roads amounts to around 400,000 tonnes of CO_2 per year (2021). The indirect climate emissions during the production of all new passenger cars sold in Norway in 2021 also amounted to a whopping 2.5 million tonnes of CO_2 equivalents during this year alone, according to Stakeholder AS's report for NHO Transport of March 2022.

Fast, frequent, and affordable high-speed trains will significantly reduce carbon emissions and energy use in transport in several ways:

- **Physics favors high-speed rail**

Steel wheels on steel rails offer superior energy efficiency to rubber wheels on any driving surface. Train wheels have smaller contact area, are designed for minimum friction. Long, snake-shaped trains have low air resistance and high capacity.

- **Fast trains catalyze better, more energy efficient cities and towns**

Fast, frequent, and affordable trains make communities more walkable, more interconnected, and more efficient. Railways commonly operate from stations in the centre of town, making it easy to integrate with local public transport. Travelers can move seamlessly between trains and public transit, downtown destinations, and tourist attractions or accommodations.

On the other hand, both airports and personal cars contribute to urban sprawl. Cars require roads that divide and disrupt cities. Airports' enormous footprint for terminals and runways mean they are predominantly located in outlying or suburban areas.

- **High-Speed rail makes public transit work better**

High-speed trains dramatically collapse travel times and so draw massive ridership. Amplified passenger activity is focused on train stations, typically in town or city centres and usually with connections to local transit. This has a structuring effect on development, helping reduce sprawl and car traffic.

The benefits here can compound, as more frequent and higher-quality public transit leads to increased ridership and city walkability, which leads to further public transit investment. All along the way, emissions continue to decline.

- **High capacity**

High speed rail can alleviate the demand for further capacity increases of roads and airports.

- **Freight traffic**

The plans for the Vestlandsbanen also include freight traffic. This will make a further large contribution to the climate and energy effects of the planned rail network. Rail freight can also be easily combined with battery-electric solutions for trucks for further distribution of goods on local and regional routes. But battery-electric solutions for heavy trailers over long distances will be more complicated.

- **Energy savings**

Transferring traffic from more energy-demanding transport modes, such as air, lorry and passenger car traffic to energy-efficient trains will be able to save large amounts of energy. This will also reduce the need for the construction of new power plants.

- **Balanced development along the line**

The Vestlandsbanen is planned with a high number of stations. This can make a positive contribution to maintaining and strengthening the current settlement pattern to a greater extent and thus counteracting centralization pressure, with the environmental and climate effects this may cause.

9.2 Reducing Fossil Fuels in Norway

The report from the Norwegian "Climate Committee 2050" (Klimautvalget 2050) states that Norway has reduced its climate emissions by less than 5% in the 31 years between 1990 and 2021. While emissions from industrial production in the period have fallen sharply in Norway, emissions from the transport sector in Norway increased due to traffic growth.

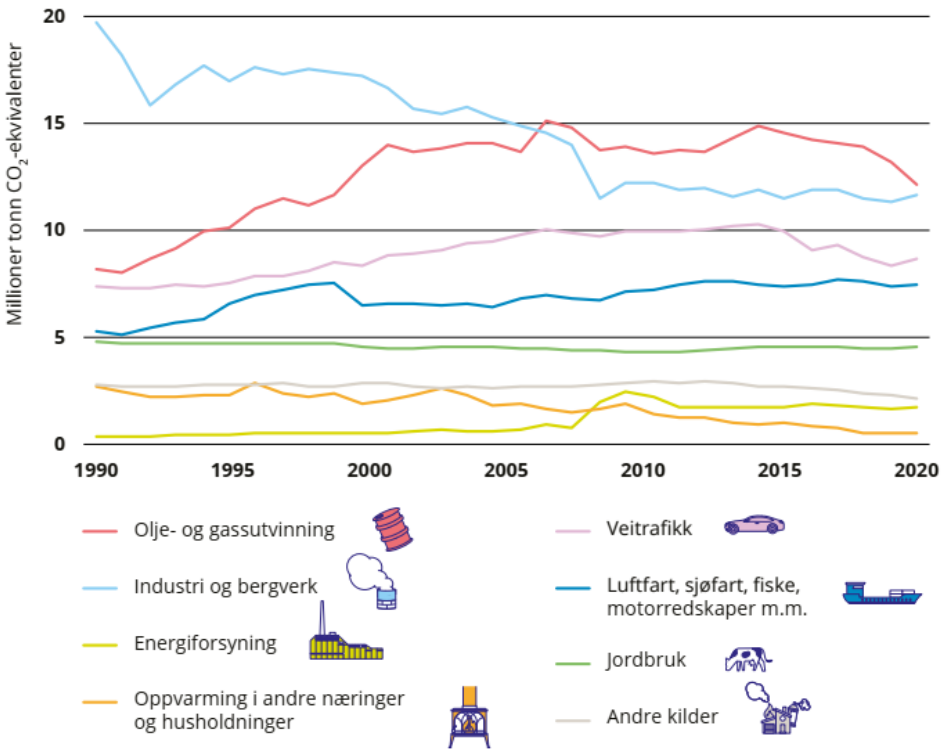


Figure 15 Norwegian emissions 1990-2021 by sector.
Emissions and removals in the forestry and land use sector are not included in the figure.
Sources: Klimautvalget 2050, page 34/Statistics Norway and the Norwegian Environment Agency

The EU's 27 member states have on average reduced its emissions by 31 percent between 1990 and 2020 (European Environment Agency, 2022). Between 2019 and 2020, emissions fell by almost 10 percent. In comparison, Norway has in the period between 1990 and 2022 reduced emissions by 4.7 per cent (SSB, 2023).

Norway has a high emission of greenhouse gases per person, approximately 70 percent higher than the global average and 33 percent higher than the EU average (Klimautvalget 2050, s. 29).

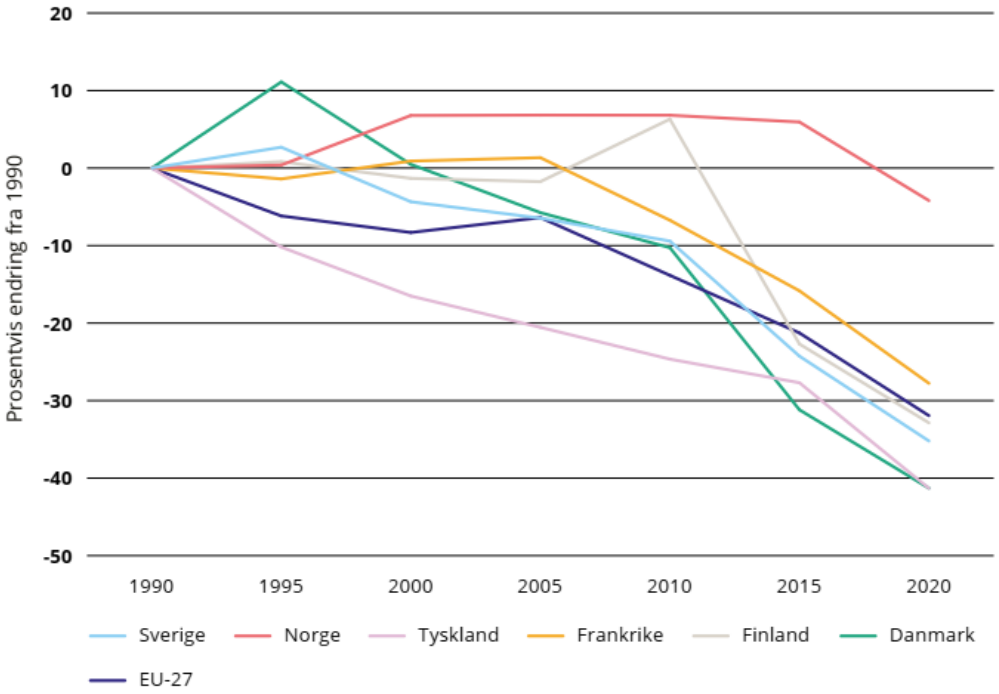
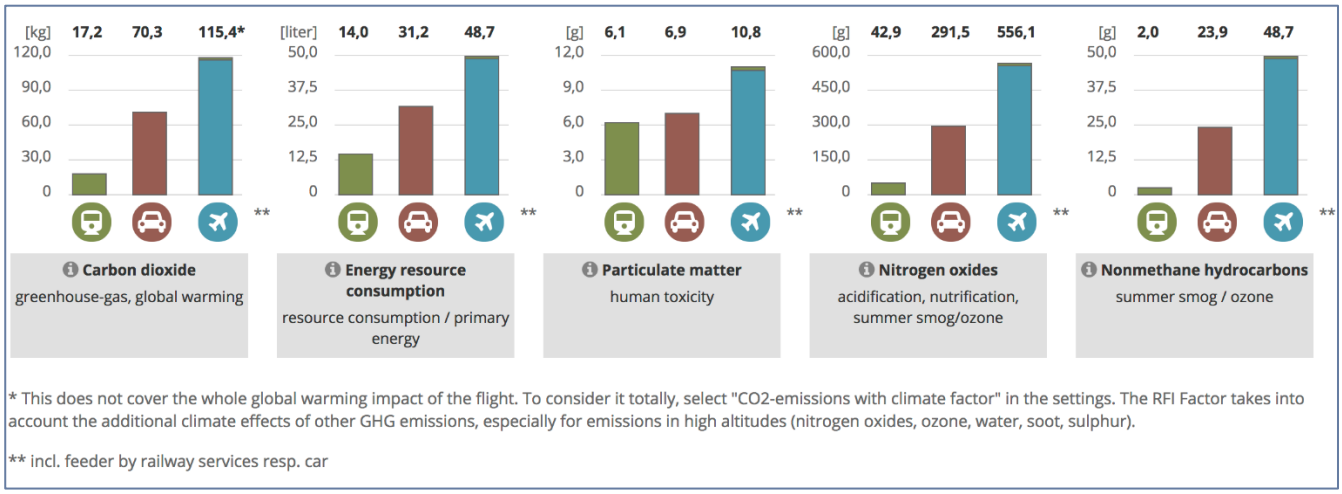


Figure 16: Change in greenhouse gas emissions since 1990 in the EU-27 and selected countries. Source: Klimautvalget 2025, page 29, European Environment Agency, 2022.

The figure shows that many northern European countries have significantly reduced their emissions over the past 30 years, while Norway has only recently achieved a certain reduction in emissions.

Transportation creates roughly 30 percent of the Norway economy's total greenhouse gas emissions – more than any other sector. Road and air traffic alone create about 20 percent of greenhouse gas emissions.

The figure below shows the environmental benefits look like for a trip from Paris to Marseille (France), which is roughly the distance to be covered by Vestlandsbanen railway network. This chart from *EcoPassenger* compares the efficiency and emissions of rail (the left bar) to other modes in passenger transport, and it offers a glimpse of the big win for the environment that comes from replacing cars and planes with a high-speed rail line.



Rail networks carry between 7 and 8 percent of freight and motorized passenger traffic, globally, yet they account for just 2 percent of energy use in the transportation sector.

And the conditions for cutting greenhouse gases are considerable better for Vestlandsbanen high-speed line than for other comparable projects. That's because it will run on 100 percent renewable energy and use electrified trains – the most energy-efficient mode of motorized transport. In electrified trains, about 90 percent of the energy transfers to the wheels from overhead powerlines, versus a 30 to 35 percent transfer rate in diesel-powered trains.

As written in chapter 6, the report "*Kraftbehov til transport. Nullutslippsscenarier for 2050*" from Miljøverndirektoratet in 2022 also shows that the need for renewable power in Norway will increase from 2 TWh to 60 TWh by 2050, based on projections of traffic with the current distribution of modes of transport. In comparison, the Norwegian electrical energy production today is around 150 TWh annually.

Which means we can't solve climate change until we fundamentally transform the way we move around.

The new Vestlandsbanen will take a lot of cars and trucks off the road, reduce the number of flights, and replace those options with the most energy-efficient mass-transportation mode there is.

In short: high-speed rail is crucial to meeting Norway's climate change goals in the near term. And it will enhance Norway's role as a problem-solving, paradigm-shifting country in the global fight against climate change.

9.3 Traffic Pollution and Car Accidents

High-speed rail systems operate independently of road traffic and offer a compelling advantage in mitigating both pollution and car accidents. In contrast to automobiles that frequently find themselves stuck in congested traffic, high-speed trains travel along dedicated tracks, free from the stop-and-go patterns that often lead to fuel inefficiency and emissions in road transportation. Thus, High-speed rail systems reduce significantly air pollution and greenhouse gas emissions, aligns with sustainability goals and contributes to a more environmentally friendly and sustainable future. High-speed rail stands out as an attractive choice for reducing pollution and combating climate change, but they also contribute significantly to increased traffic safety.

Highlights from European Road Safety Observatory – National Road Safety Profile for Norway (2023)

According to the European Road Safety Observatory – National Road Safety Profile (2023), Norway witnessed a decline in its road mortality rate since 2001. The profile states that in 2020, a total of 93 people were killed in reported traffic accidents in Norway. This translates to a mortality rate of 17 road fatalities per million inhabitants.

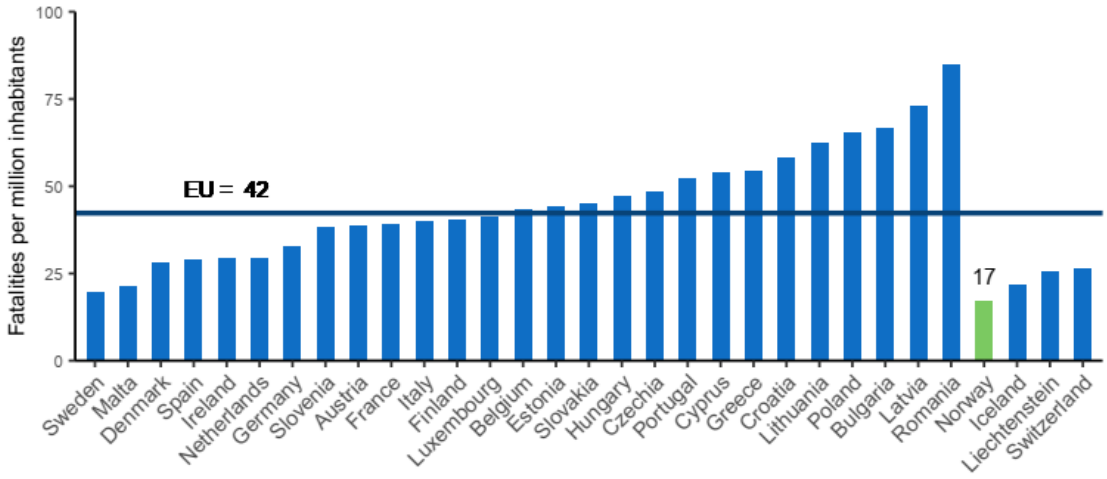


Figure 17: Number of road fatalities per million inhabitants (2020). Source: CARE & EUROSTAT

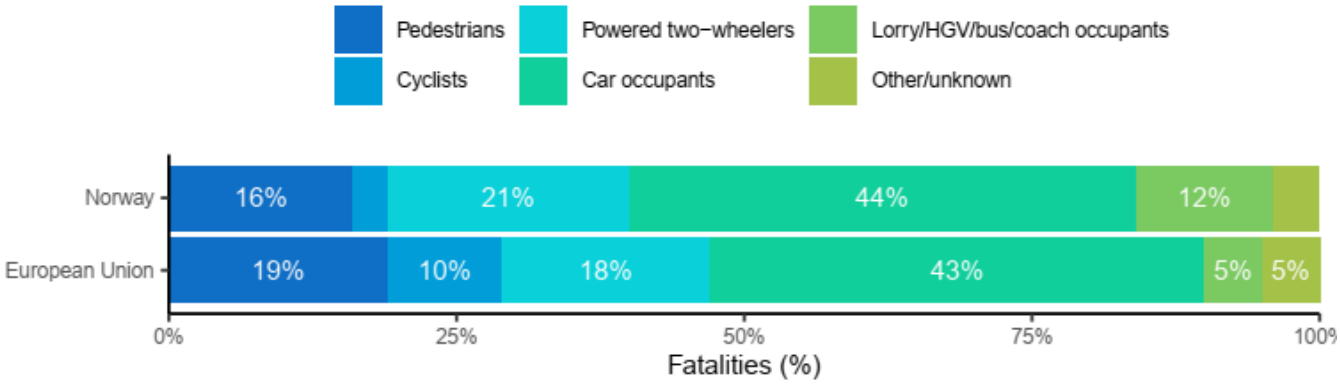


Figure 18: Number of road fatalities by transport mode (2020). Source: CARE

Road safety outcomes

- In 2020 a total of 93 people were killed in reported traffic accidents in Norway.
- Norway performs better than all EU countries in terms of the number of fatalities per million inhabitants. Over the past twenty years this rate has decreased a little more than in the European Union.
- Compared to the EU average, the distribution of fatalities in Norway shows a relatively high proportion of fatalities that occur on rural roads.
- Over the past ten years the number of fatalities decreased more than in the European Union.
- According to Statistic Norway, in 2022, however, the number of killed persons killed in traffic accidents increased again to 116, and then 110 in 2023.

The operation of high-speed rail on an own network, separate from conventional cars plays a pivotal role in reducing the number of accidents. High-speed rail systems are designed with dedicated tracks that are isolated from regular road traffic, eliminating the risk of collisions with cars and other vehicles at level crossings.

This separation ensures that trains can maintain their high speeds and adhere to strict schedules without the unpredictable factors that often lead to accidents on roadways. Furthermore, these rail networks are equipped with advanced signaling systems and automatic train control and are well-maintained. All this contributes to enhanced safety measures. The result is a transportation system that significantly reduces the risk of accidents, providing a safer and more reliable mode of travel for passengers and contributing to overall road safety.

Another crucial reason for the higher safety of high-speed rail systems is their strict adherence to established safety standards and regulations. High-speed rail operators and authorities place a strong emphasis on safety protocols, including rigorous maintenance schedules, regular inspections, and comprehensive staff training.

Unlike road traffic, where adherence to safety measures can vary widely, the rail industry consistently enforces safety standards. Additionally, high-speed trains are equipped with advanced safety features such as automatic braking systems and obstacle detection. These built-in safety mechanisms further reduce the risk of accidents and ensure that even in unforeseen circumstances, the trains can react swiftly and effectively to minimize the risk for harm. As a result, passengers on high-speed rail systems can have confidence in a transportation mode that prioritizes safety at every level, from infrastructure design to operational procedures.

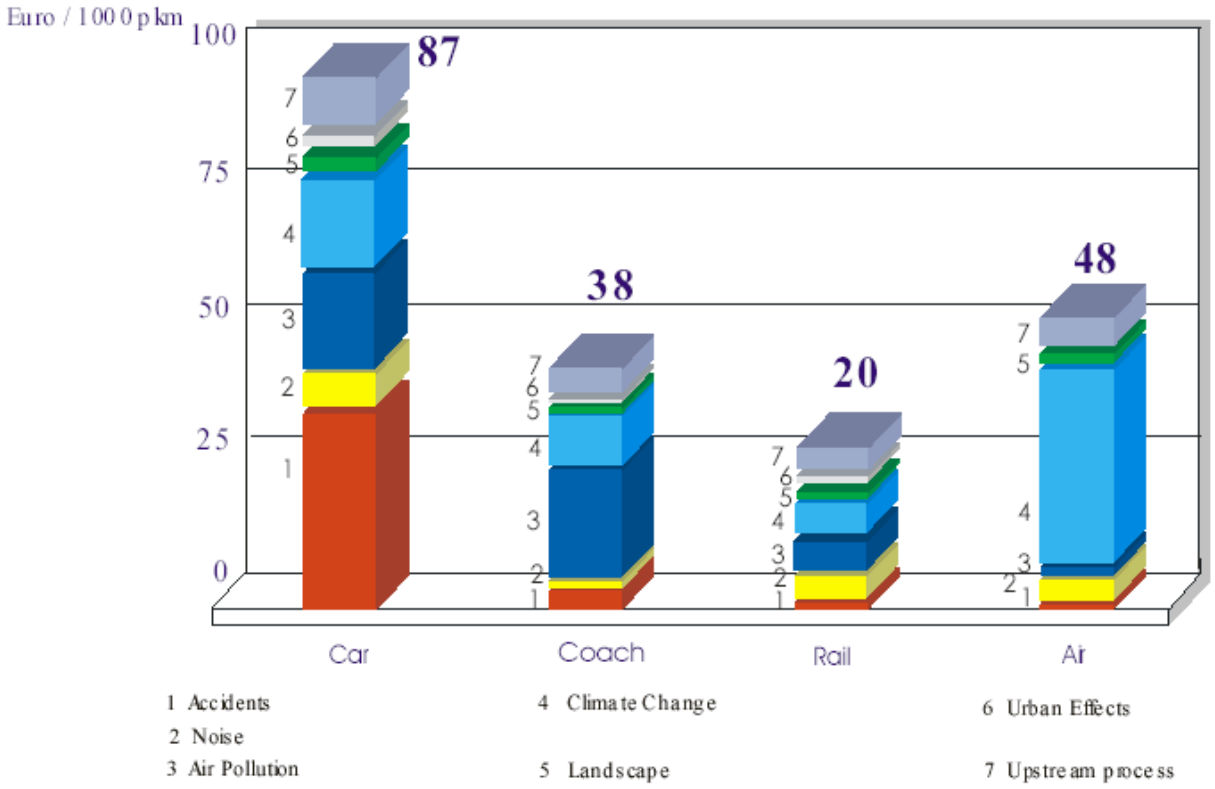


Figure 19: Comparison of average external costs of different modes of transport (passenger). Source: UIC

The robust safety measures inherent in high-speed rail systems have significant economic consequences that extend beyond the immediate benefits of protecting human lives and reducing property damage. First and foremost, the enhanced safety record of high-speed rail encourages more people to choose rail travel over less safe modes of transportation, such as driving. This shift in transportation preferences can lead to a decrease in road accidents, reducing healthcare costs, vehicle repair expenses, and insurance claims, thereby saving individuals and society at large significant financial resources. Moreover, a safer high-speed rail system can attract foreign and domestic investment in rail infrastructure and technology, creating job opportunities and fostering economic development.

Additionally, reduced accidents and fatalities translate to lower legal and administrative costs for managing road accidents, freeing up resources that can be redirected towards other essential public services.

In sum, the economic consequences of high-speed rail safety include not only savings in healthcare and insurance but also increased economic productivity and investment in sustainable transportation infrastructure.

10 CONCLUSION

The construction of Vestlandsbanen high-speed rail line connecting Oslo, Skien, Bergen, and Stavanger, the regions in between and adjacent railway lines, could have significant implications for the country's transport infrastructure, settlement structure, business development, the country's competitiveness and the environment.

Transport Infrastructure and Settlement Structure:

- Vestlandsbanen will provide fast and efficient train services for both passenger and freight transport.
- It could influence the future location of residential and industrial areas by making certain locations more accessible.
- The share of public transport solutions could increase as high-speed rail provides a fast and efficient alternative to road and air travel.
- Vestlandsbanen will serve one of the busiest national transport corridors and provide an opportunity for both cities and smaller towns/municipalities along the route to develop.
- While road-based solutions often lead to more driving with subsequent pressure for new expansions of road capacity, large land and energy requirements and the sprawl of cities and towns, rail has positive, structuring effects on transport and social development.

Environmental Impact:

- High-speed trains are an already long developed and well-proven electrically powered means of transport. In Norway, with about 100 % renewable energy, the annular greenhouse gas emissions from high-speed trains will be close to zero.
- High-speed passenger trains and high-capacity freight trains are far more energy-efficient than passenger cars, trucks or airplanes.
- Railways use far less land and have far higher capacity than motorways.
- Vestlandsbanen could alleviate the demand for further capacity increases of roads and airports.
- However, to avoid deforestation and land degradation during constructing the lines, railway projects must be carefully developed to reduce such impacts to a minimum, as well as mitigating actions must be implemented.
- Climate change exacerbates adverse conditions such as excessive heat, flooding, landslides, sea-level rise, which threaten the safety and reliability of all infrastructure and will impact on alignment solution, structures typologies and tunnels sections.

The construction and operation of high-speed lines require careful planning. It is important to minimize disruption to ecosystems, habitats, and wildlife. Mitigation measures, such as wildlife crossings and noise reduction, should be implemented to minimize negative impacts. Additionally, long-term monitoring and maintenance of the high-speed line are essential to ensure its sustainability and compliance with environmental regulations.

While the construction of high-speed rail lines may have negative impacts such as the barrier effect and visual impact, the positive environmental aspects, including energy efficiency, reduced greenhouse gas emissions, noise reduction, increased safety, and greater transport capacity must be seen in relation to, and can outweigh the negatives. It is important to consider all these factors when evaluating the overall environmental impact of Vestlandsbanen project.

Vestlandsbanen can also reduce the need for further capacity increases of roads and airports that can arise as a result of increased traffic demand due to population growth, economic development and tourism development, increased commuting and changes in travel patterns.

In summary, it is expected that Vestlandsbanen high-speed rail will offer numerous benefits including connectivity, accessibility, efficiency gains, large reduction in emissions of greenhouse gases and large reduction in energy use. Large time savings will also provide cost reductions and increased efficiency for businesses and society for many decades to come.

The Vestlandsbanen high-speed line represents a unique opportunity for Norway. It will not only reduce travel times but also contribute to productivity growth, job creation, and sustainable development. By modernizing the country's transport network, Norway can attract more investments, foster innovation, and enhance its competitiveness in the global economy.