VESTLANDSBANEN FEASIBILITY STUDY - DELIVERY 1

Deliverable 0: High Level Project Goals

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1 INTRODUCTION

1.1 The Purpose of Vestlandsbanen and this investigation

The Vestlandsbanen over Haukeli is a planned high-speed railway for long-distance, regional, and freight traffic between Bergen, Haugesund, and Stavanger in the west, and Oslo and Skien in the east. Between 2008 and 2012, Norsk Bane AS engaged Deutsche Bahn International (DBI) for an extensive study of high-speed railways in Norway. The results were very positive for both the Vestlandsbanen and the Dovresambandet (Oslo – Trondheim/Ålesund) and laid some groundwork for the Norwegian Parliament's decision in 2009 that further investigations should aim at constructing high-speed railways.

The following high-speed study from the Jernbaneverket in 2010 – 2012 came to negative conclusions, although it also found that passenger ticket revenues would cover both operation and maintenance costs. However, the concepts underlying these two studies are so different that they are difficult to compare. E.g. the DBI's study included freight traffic and around 20 stations on each line, while Jernbaneverket's study was based on 3 – 5 stations, without freight traffic.

However, the material from DBI is now over a decade old, and much has changed in the meantime. Norsk Bane AS has now requested SENER to conduct a new feasibility study of the Vestlandsbanen over Haukeli, based on a new, fresh and independent approach. This is specified in detail in the scope of work and summarized as follows:

Based on a conscientious approach, the new study shall examine whether Vestlandsbanen is a well-founded project, whether the effects for climate, nature and the environment will be positive and whether the project will be economically profitable for the society.

This work shall begin with the identification of problems and needs and the definition of objectives and basic premises. On this basis, solutions for infrastructure and operation shall be developed, future traffic and costs shall be calculated, and various environmental and economic effects shall be determined, evaluated and optimized in an iterative process.

1.2 Prerequisites and concept for Vestlandsbanen

SENER's initial investigations showed a large market potential for a high-speed railway in the catchment area of the proposed Vestlandsbanen.

The distance between the West Coast of Norway and Oslo is only slightly more than 400 km, measured along the running distance of a new railway line. At the same time, this part of Norway is characterized by significant passenger and freight traffic, even in international comparison. For instance, there are only a few stretches worldwide that are shorter than 500 km, don't cross a sea, and have flight connections with more than about 30 daily departures in each direction and more than two million passengers per year. Oslo – Bergen is one of these few stretches, and Oslo – Stavanger and Oslo – Haugesund together have roughly the same level of traffic (2019, before covid).

Such traffic potential and the network concept of the Vestlandsbanen will contribute in several ways to the efficient utilization of the capacity of the new railway. For instance, the relatively short driving distances between the end points will make it possible to offer highly attractive alternatives to air travel, even if the trains make frequent stops at intermediate stations. Thus, serving many stations and offering short travel times and many departures, high-speed trains on Vestlandsbanen can also become a widely used alternative to private cars on both longer and shorter distances.

An important question is whether the new railway should be built for both passenger and freight trains, or for passenger trains only. Countries already having railways with good conditions for freight traffic, most often build high-speed lines exclusively for passenger transport. In Norway, about 93 % of the railways are singletrack, old, winding and steep. This results in low attractivity and capacity for both passenger and freight train services, giving strong arguments to include freight trains in the Vestlandsbanen project. This will also strengthen the climate effect, traffic security and other economical and socioeconomical effects.

This multi-purpose concept of Vestlandsbanen, serving both long-distance, regional, and freight traffic will thus be essential to many of the effects and results this railway network could give. On this basis, SENER has conducted a detailed examination of the Vestlandsbanen's concept and technical feasibility – and its potential to contribute to societal development.

2 PROJECT GOALS

2.1 Why define some high-level goals?

When planning a new railway and a new train service, it's important to know what one aims to achieve. This presupposes having an overview of the main issues, challenges, and needs, including those related to business, settlement, climate, and nature. It's also crucial to understand the possibilities that a modern railway can offer for societal development.

In this context, SENER aimed to define some high-level goals to guide the design of the Vestlandsbanen over Haukeli and the future train service.

2.2 Efficient, environmentally friendly and safe

The primary objective of the Norwegian National Transport Plan for 2025 - 2036 is to establish an efficient, environmentally friendly, and safe transport system. These goals clearly outline the main priorities for future Norwegian transport policy. Vestlandsbanen would significantly contribute to achieving these objectives and could become a pivotal project in developing a modern national railway network in Norway, including links to Sweden and the rest of Europe.

Modern high-speed railways, designed for multiple purposes, can significantly shorten travel and freight transport times, making it easier to cover large distances in Norway. This will expand options for where people can work and live. Fast, affordable, and climate-neutral transport for both people and goods will reduce time and costs, enhance competitiveness, and boost productivity for many decades.

Electric trains powered by renewable energy are considered free of greenhouse gas emissions. Unlike road vehicles, trains do not cause tire and road wear, which is the largest source of microplastic pollution on land in Norway. Additionally, trains require much less space than roads and generate far less noise. While electric airplanes for long distances and many passengers may not be available for several decades, high-speed trains are already a well-developed and proven technology. While planes don't stop along their way, trains could play a completely different role in connecting cities and regions more closely together.

In line with this, five main goals have been defined for Vestlandsbanen:

1. Better national connectivity
2. Achieving climate and environmental goals
3. Increased competitiveness
4. More value for money
5. Traffic safety

2.3 Key project goals

Better national connectivity

Fast and efficient cross-country connections between major city areas in Norway (Oslo, Bergen and Stavanger) and between intermediate and surrounding regions. Creating connectivity, reducing traffic congestion and stimulating development in both urban and non-urban areas.

Achieving climate and environmental goals

Electric trains on renewable energy are free of greenhouse gas emissions and microplastic pollution. Attractive travel and shipping times will transfer traffic from airplanes, trailers and passenger cars and thus reduce environmental pollution and energy consumption in transport. Railways have a far larger capacity and use much less land compared to roads.

Increased competitiveness

Travel and freight transport times will be cut to half or even a third of the current durations on trains and roads in Norway. This will lower time and costs for businesses, boost productivity, and expand areas for living, working and accessing expertise. Train travellers will also reach city centers faster than by airplane and enjoy more productive time on board. Additionally, access to sustainable transport will provide a competitive edge in both industry and tourism.

More value for money

Vestlandsbanen will form six very fast railway connections between Oslo, Skien, Stavanger and Bergen, as well as connections to adjacent lines. More than half of Norway's population will have access to the nearest station within about 30 minutes. The benefits to society and the traffic potential will be further strengthened through a multi-use concept for long-distance, regional and freight traffic. A new westbound railway line from Oslo S will also solve capacity and regularity problems in the capital area.

Traffic safety

Rail is an exceptionally safe mode of transport for both passengers and freight, significantly reducing the number of traffic fatalities and injuries. This is especially crucial in a country like Norway, where long winters result in many slippery roads. By providing a reliable alternative to road travel, rail transport can help mitigate the risks associated with hazardous driving conditions. Additionally, the enhanced safety of rail travel can lead to fewer accidents, contributing to overall public health and safety.

2.4 Better national connectivity

Passenger trains between the largest cities in Norway are among the slowest in Europe. It currently takes around 7 hours to travel by train from Oslo to Bergen and around 8 hours from Oslo to Stavanger. By car, it takes around 7 hours for both routes, but often longer in winter. There are no trains between Bergen and Stavanger, and it takes 4 ½ hours to travel by car, which will be reduced to 3:50 hours with Rogfast. Haugesund is one of the largest cities in Europe without a railway in its immediate vicinity and the road connection eastwards is also poor.

An important goal of Vestlandsbanen is to reduce train travel times to around 2 ½ hours Oslo – Bergen and Oslo – Stavanger, including many stops along the way. This means that most people will arrive faster by train than by

plane or car. At these train speeds, it will also only take around two hours to travel from Oslo to Haugesund and around one and a half hours from Stavanger to Bergen. With a connection to Skien and Vestfoldbanen via Bø/Notodden, the Grenland area, Vestfold and parts of Agder also will be included, with journey times such as Skien – Oslo of around 1 hour and Sandefjord – Bergen/Stavanger of around 2½ hours.

An equally important goal is to foster benefits and development along the entire route, as regional traffic will constitute a significant portion of Vestlandsbanen's potential. Therefore, prioritizing stops at numerous stations along the line is essential, even if it means slightly longer journey times between the endpoints. Additionally, the aim is for the train operation scheme and the trains' competitiveness over long and regional distances to support a high service frequency. This way, with a varied stop pattern, many stations and locations will be included and get excellent train service.

This will be significant in many ways. For example, travellers who currently fly from Odda to Oslo spend almost three hours by car before arriving at Bergen Airport and starting their flight to Oslo. With Vestlandsbanen, they would already have arrived in Oslo in two hours. The same is true elsewhere, where you first have to travel far in the opposite direction to the nearest airport.

Trains also offer a significantly comfortable travel experience, allowing passengers to make the most of their time. High speed trains provide spacious seating and the freedom to move around. This comfort enables passengers to relax, enjoy the scenery, or focus on work with fewer interruptions.

Moreover, the availability of amenities such as Wi-Fi, power outlets, and quiet carriages makes it easier for travelers to enjoy and stay productive during their journey. The smoother ride of trains, compared to the turbulence often experienced on flights, further enhances the ability to work or rest effectively.

In addition, the convenience of boarding and disembarking at centrally located stations. This saves valuable time compared to air travel that typically involves other transport modes to and from the airports, lengthy security checks and boarding procedures. This makes trains an ideal choice for both leisure and business travelers and anyone looking to maximize their efficiency and comfort while on the move.

Another important difference is that while airplanes don't stop along the way, the plan for Vestlandsbanen shows a total of 31 stations throughout the network.

At the speeds for which Vestlandsbanen is planned, and with varying stop patterns, it will be possible to offer completely new journey times for both national and regional distances, including on stretches where a journey currently takes a very long time. For example, it should be possible to offer travel times such as Odda – Bergen in approx. 35 minutes, Sauda – Stavanger in approx. 40 minutes, Sauda – Oslo in approx. 1:45 hours, Åmot i Vinje – Stavanger/Bergen/Oslo in approx. 1:15 hours and Åmot i Vinje – Skien in approx. 45 minutes. Vestlandsbanen will also connect Sørlandsbanen and Bergensbanen, thus offering short journey times in Western Norway on the entire section between Egersund and Voss. Many connections to other railways will increase demand, improve quality, increase service frequency and boost profitability of investments in these adjacent railways as well.

Vestlandsbanen also includes a new double-track railway from Oslo Central Station to Drammen. It is an important goal to offer journey times on this line of 18 – 20 minutes, including stops at both new and existing stations in Oslo, Bærum and Asker municipalities on each departure. This will reduce the journey time from Oslo to Drammen and subsequent lines (such as Vestfoldbanen and towards Kongsberg) by around 15 minutes, as well as increasing the capacity of the railway to twice its current level (see more about this in the Study Area Characterization report).

In summary, the aim of Vestlandsbanen is to create faster and better travel options for both every day and less frequent journeys, for commuters, business and leisure travellers, for both urban and non-urban areas and for a very large part of Norway's population – and thus better connect the country. Vestlandsbanen should also be a very attractive option for tourist traffic. Furthermore, railways avoid the congestion problems that exist on roads, and Vestlandsbanen is planned with a large capacity for possible traffic increases in the future.

It's an important goal to contribute to fast and efficient transport between different parts of the country and major cities, but also to and from other areas along the railway. This will stimulate settlement and business development along the entire line, alleviate the pressure on the major cities and contribute to a balanced development of the country. Vestlandsbanen, and similar lines in Norway, shall thus also support an active regional policy in Norway.

For freight train traffic, the target is freight transport times of 5 – 6 hours between western and eastern Norway and 3 – 4 hours between the Stavanger and Bergen areas. Double tracks, low gradients and a modern alignment will result in a major increase in capacity and regularity, compared with the railway today. Compared to road transport, freight transport on Vestlandsbanen should also be faster and cheaper. It will not have the problems of slippery roads in winter that trailer traffic can encounter in the high mountains and elsewhere.

SENER will investigate whether and how these goals can be achieved with Vestlandsbanen, and also assess the opportunities and limitations of the current Norwegian railway network.

2.5 Achieving climate and environmental goals

One of the objectives of Vestlandsbanen high-speed railway, designed for multiple purposes including long-distance, regional, and freight traffic, is to maximize their positive climate and environmental impact. This is achieved by offering a highly competitive train service compared to airplanes, trucks, and private cars.

Norway has a target of virtually zero greenhouse gas emissions by 2050. Vestlandsbanen, and similar railway lines, will make a very important contribution to achieving these goals. Electric trains on renewable energy generate no greenhouse gas emissions. And freight trains and high-speed trains are already a well-developed and proven technology, easily accessible. Given Norway's strong emphasis on electric vehicles, it is likely that most passenger cars in the country will be battery-electric by 2050. However, concerns have been raised about the availability of materials for battery production if the rest of the world were to adopt battery-electric cars at a similar rate.

On the other hand, the development of climate-neutral airplanes and trucks seems to be taking longer, with the exception of short-haul flights and local transport. This is due to the challenges posed by the increasing weight of the batteries, the more cargo and the longer distances are to be handled, as well as the costs and energy needs for the production of synthetic fuels. The more Vestlandsbanen contributes to a reduction in trailer and air traffic, the greater the climate effects will be, while reduced passenger car traffic will contribute less in this context. A reduction in car traffic could nevertheless have major positive climate and environmental effects in other ways, see below.

SENER will calculate the potential for reduced greenhouse gas emissions after the opening of Vestlandsbanen. SENER will also calculate emissions during construction of the railway and how many years it will take before emissions during construction will be compensated through reduced emissions in the operation phase. These calculations must also take into account ongoing developments and processes for reducing emissions during railway construction, as well as national targets for this. In addition, such calculations will be seen in the context of likely emissions from the development and operation of other infrastructure if Vestlandsbanen will not be built. Emissions during the production of transport vehicles will also be included in the assessments.

Additionally, Vestlandsbanen aims to achieve several important environmental policy goals:

Trains do not cause tire and road wear, which is the largest source of land-based microplastic pollution in Norway. This advantage supports the case for an excellent train service, encouraging more people to choose trains over cars. Trains also require significantly less space than roads, have much greater capacity, and produce far less noise. With a high proportion of tunnels planned for Vestlandsbanen, the land use will be even further minimized.

However, any construction of infrastructure will entail interventions. Through careful planning, the aim is to minimise these as much as possible. At the same time, the construction of Vestlandsbanen, with a capacity equivalent to a 16-lane motorway, must also be seen in the context of traffic development.

Collectively, Norway is experiencing positive trends in population growth, mobility, and economic activity. These factors contribute to a continuously increasing traffic volume. A substantial shift of traffic from airplanes, passenger cars, and trucks to modern railways will generally allow for the avoidance or postponement of otherwise necessary expansions of airports and roads.

In rural areas, many roads are not on the brink of immediate capacity expansions. Car traffic there is often fairly limited and could increase significantly before reaching capacity limits. However, in several locations, increased car use could potentially lead to reaching this capacity limit fairly soon.

In many places in the central part of Eastern Norway and along the West Coast, road traffic is already at a level where further traffic growth will trigger a need to increase road capacity very early. Such construction projects typically involve improving road standards, which strongly encourage more driving, increased need of energy, urban sprawl, and other societal changes that lead to increased transportation and space requirements, thereby fostering further traffic growth and road construction needs. On the other hand, rail transport has a positive, structuring effect on transport and social development.

Therefore, a train service that convinces a considerable portion of travellers to choose trains over cars would have significant positive implications for climate, nature, and the environment. This carries clear consequences for the design of the train service on the Vestlandsbanen and for coordination with other public transportation services, including train services on adjacent railway lines.

Vestlandsbanen, and other similar high-speed projects, can also contribute to a more balanced development in both urban and non-urban areas. This can also give decreased costs for the society, by reduced migration from rural areas to the outskirts of the main cities, due to less need of constructing new houses, schools, roads, etc. for new citizen.

A more balanced settlement structure can also lead to reductions in land use and negative impacts on nature and environment. In addition, increased attractivity of living and business areas near railway stations and terminals can reduce needs of transport.

Trains are also by far the most energy-efficient motorised means of transport for both passengers and goods. At a time when more and more in society is switching to electric solutions due to climate challenges, it's important to think about energy efficiency in all sectors – including transport.

Climate-neutral operation of planes and trucks for longer distances would require approximately 5 – 10 times more energy per passenger and cargo volume than operating trains on modern tracks, even assuming significant efficiency improvements for all transportation modes. Furthermore, the operation of battery-electric passenger cars requires about 2 – 3 times more energy per passenger than running trains on modern tracks.

For air traffic on the busiest domestic routes, long-haul road transport, and a significant portion of maritime traffic hydrogen, ammonia, and synthetic fuels are under continuous development as alternatives energy sources. These can be produced using renewable energy, but only around 30 – 40% of the energy is utilized in the vehicles, with the rest being lost.

In the report "*Kraftbehov til transport. Nullutslippsscenarier for 2050*" from Miljøverndirektoratet in 2022[1], it is estimated that the need for renewable power in Norwegian transport will increase from 2 TWh to 60 TWh by 2050, based on projections of traffic with the current distribution of modes of transport. Such an increase is equivalent to the energy production of 90 new Alta power plants or 150 new offshore wind projects like «Hywind Tampen».[2] However, the report from Miljøverndirektoratet also says: "*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*."

Based on a calculation of transferred traffic to Vestlandsbanen from more energy-demanding modes of transport (airplanes, trucks, passenger cars), SENER will calculate the annual savings of energy that will be possible after commissioning of Vestlandsbanen. This will be of interest also regarding other projects in a future, modern Norwegian and Nordic railway network. The energy saved will save equally the costs, greenhouse gas emissions and environmental impacts required to produce the same amount of energy.

[1] https://www.miljodirektoratet.no/publikasjoner/2022/november/kraftbehov-til-transport-nullutslippsscenarier-for-2050/
[2] https://www.equinor.com/energy/hywind-tampen

2.6 Increased competitiveness

With Vestlandsbanen, journey times in the entire area between Bergen, Stavanger, Skien and Oslo will be reduced down to as little as a third of today's journey times by train and car. A 2 ½ hour train journey from city centre to city centre will also be as fast or faster than a flight, including access and egress times, check-in and waiting. Vestlandsbanen will also offer many more stations and travel options than air travel. Time savings will thus be even higher for those travelling long distances in "wrong" direction to/from airports.

On board trains, a far greater proportion of journey time can be used for work than on air and car journeys, which will save a lot of time and money. In addition, there will be high gains for many travellers and freight skippers like good comfort, reliable passenger and freight services even in winter, and few damages on cargo.

A key objective of Vestlandsbanen is to enhance efficiency and productivity for businesses for many decades. This goal extends to other similar railway lines in Norway. The high quality of train service will be crucial for the business community.

Moreover, by offering excellent regional train services, Vestlandsbanen will expand living and working areas, thereby improving companies' access to labor and expertise. This is particularly important for businesses located outside the most densely populated areas.

A new, westbound tunnel and double-track railway from Oslo S to Drammen – with new stations, short travel times, largely increased redundancy and train service frequency – will contribute to solve capacity, regularity and congestion problems. This will have great importance to commuters throughout central eastern Norway.

Vestlandsbanen will also contribute to increased flexibility and redundancy for all transport between western and eastern Norway, especially during wintertime.

Freight transport on Vestlandsbanen will be much faster than on rail and road today. Slower gradients than in the existing Norwegian railway network will also double the capacity per train, corresponding to approximately 70 trailers. This will contribute to more efficient and cheaper freight transport for businesses. Double tracks on new railway lines will further increase the capacity and regularity of rail freight traffic. At the same time, society will save large sums on road maintenance due to reduced trailer traffic. In line with the increasing focus on climate issues, climate neutral transport solutions will become increasingly important for the competitiveness of Norwegian companies. This also includes the tourist businesses in Norway.

Potentially there will be decreased costs for business and households, due to railway system advantages like low energy consumption and high capacity. Rising energy prices and increasingly stringent environmental requirements could increase the importance of this.

2.7 More value for money

An important goal of Vestlandsbanen is to develop a concept that maximises the benefits for the society. The multi-purpose high-speed line concept, serving both long-distance, regional, and freight traffic will maximise the societal benefits and environmental effects, but also the revenues.

Vestlandsbanen will serve six lines with 31 stations in one single network: Oslo – Bergen, Oslo – Stavanger, Bergen – Stavanger, Oslo – Skien, Skien – Bergen and Skien – Stavanger. In addition, the plan comprises many connections to existing railway lines.

The network will include three of Norway's largest cities. Vestlandsbanen will serve about half the Norwegian population with very short travel and freight transport times (see more in the Study Area Characterization report). This will provide great benefits for the society and a huge market for train operators.

Vestlandsbanen will also offer a highly competitive alternative to one of the busiest domestic air routes in Europe, Oslo – Bergen. In addition, Oslo – Stavanger/Haugesund has similar air traffic.

With a new railway tunnel and double track westwards from Oslo Central Station to Drammen, Vestlandsbanen will also solve the capacity and regularity problems that the Oslo area has struggled with for a long time. This new railway will also enable a fundamental renewal of the existing Oslo – Drammen railway. (See more in Study Area Characterisation report).

The investments in Vestlandsbanen will thus be of great value to a great many people and a great many areas in Norway and help to solve many of society's challenges.

The huge market potential for Vestlandsbanen indicates high ticketing and freight revenues, with favorable and competitive prices compared to other modes. Much shorter running times than today will also result in major productivity gains for train operations and thus lower operating costs. This provides opportunities for ticket and freight revenues that can cover both the operation and maintenance of trains and tracks, and possibly parts of the infrastructure. However, SENER will carry out detailed calculations of this, including the economy for train operators and the infrastructure manager, as well as the socio-economic results of Vestlandsbanen. These results will also be seen in context with the results of other projects in the National transport plan (NTP).

2.8 Traffic safety

Railway transport is a very safe transport mode for both passengers and freight. This safety advantage is even more pronounced in the context of Norway's harsh winter conditions, where snow, ice, and slippery roads pose significant hazards.

SENER will conduct a detailed analysis to estimate the reduction in traffic fatalities and injuries following the commissioning of Vestlandsbanen. By reducing the reliance on road transport, Vestlandsbanen will not only improve overall safety but also contribute to a more efficient and resilient transportation network in Norway. This will be a critical step towards ensuring safer travel for both people and goods, regardless of the season.

Major parts of the existing railway network in Norway are old and built under different conditions than today. With changing climate, the Norwegian railway network becomes more susceptible to flooding and landslides. If such situations arise, they can also hinder railway traffic for a long time, as was the case for Dovrebanen when the Randklev bridge collapsed during the extreme weather event 'Hans' in August 2023.

The Vestlandsbanen railway is being planned in line with modern standards, with a strong emphasis on safety in route planning to avoid the risk of flooding and landslides. High-speed railways are also built without level crossings and do not have a corresponding risk of collisions with other vehicles.

In the existing Norwegian railway network, an average of 2,000 animals were hit by trains annually in the period 2012 to 2021.[3] To avoid animal collisions on Vestlandsbanen the tracks will be 100% fenced, where there is no tunnel. Passages for wildlife crossing of Vestlandsbanen will be facilitated with tunnels, bridges and dedicated wildlife crossings.

[3] Bane NOR, «Handlingsplan for å forebygge dyrepåkjørsler på jernbanen i perioden 2022 – 2025», chapter 4.1.1: www.banenor.no/siteassets/handlingsplan-for-a-forebygge-dyrepakjorsler-pa-jernbanen-i-perioden-2022---2025-2.pdf