Railway Plans: Connecting the Scandinavian and German rail networks via the Fehmarnbelt tunnel

Project in Railway Technology

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Abstract

This project is part of a master's programme course named Project in Railway Technology at Chalmers University of Technology. The report investigates the construction of the Fehmarnbelt fixed link between Denmark and Germany and analyses the effects and the coming demand following its opening. The opening of this sub-sea tunnel will have a massive impact on the transportation systems, in particular the railway networks of both Germany and Denmark, as well as Sweden and Norway. The research has been conducted through literature studies based on the available documents on construction and plans for its connections in the four most affected countries. The results indicate that Denmark has successfully improved and planned their infrastructure network for the opening of the connection, while Germany, Sweden and Norway are lagging behind, which in turn will result in the Fehmarnbelt fixed link not being able to meet its expected capacity until certain bottlenecks will be improved. The most critical bottlenecks that likely will still be in place after the opening of the tunnel is the Fehmarnsundbridge and the Swedish Southern Mainline.

Acknowledgement of use of AI: AI was used to refine the layout of the document and proofread.

Front page figure: Aerial view of the Rødbyhavn construction site on the Danish island of Lolland, showing the port area and surrounding landscape. Source: Femern A/S

List of Abbreviations

ATC	Automatic Train Control
CEF	Connecting Europe Facility
DB	Deutsche Bahn
DG MOVE	Directorate-General for Mobility and Transport
DSB	Danske Statsbaner (Danish State Railways)
EIA	Environmental Impact Assessment
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
EU	European Union
FBC	Fehmarn Belt Contractors
FBFL	Fehmarnbelt Fixed Link
FLC	Femern Link Contractors
FSC	Femern Systems Contractors
ICE	Intercity-Express
NOK	Norwegian Krone
ScanMed	Scandinavian–Mediterranean (Corridor)
TEN-T	Trans-European Transport Network
TSI	Technical Specification for Interoperability

Contents

1 Introduction

Europe's railway system is under increasing pressure to handle growing passenger and freight demands while supporting the shift towards lower-emission transport. In this context, cross-border railway corridors play an important role, but their performance depends not only on individual infrastructure projects, but also on the capacity and coordination of the surrounding network.

This report focuses on the Fehmarnbelt Fixed Link (FBFL), an 18 km immersed tunnel currently under construction between Denmark and Germany. The project will connect Rødbyhavn on the Danish island of Lolland with Puttgarden on the German island of Fehmarn. It forms a key part of the Scandinavian–Mediterranean Corridor within the Trans-European Transport Network (TEN-T), improving the rail connection between Scandinavia and Central Europe (Femern A/S, 2024; European Commission, 2024).

The FBFL is expected to significantly reduce travel time between Copenhagen and Hamburg and strengthen the role of rail in both passenger and freight transport. However, the tunnel alone cannot deliver the full benefits of the corridor. Its effectiveness depends on whether the railway infrastructure in Germany, Denmark, Sweden, and Norway can handle the additional traffic generated by the fixed link. Previous studies indicate that several bottlenecks remain along the northern part of the ScanMed corridor, particularly in Germany and Sweden, which may limit future capacity and reduce the overall impact of the project (Sweco, 2025).

1.1 Background

The Fehmarnbelt Fixed Link is more than a single tunnel project. It is part of a wider transport system connecting Scandinavia with mainland Europe. On the Danish side, major upgrades are being carried out between Rødbyhavn, Ringsted, and Copenhagen, including electrification, double-tracking, speed improvements, and European Rail Traffic Management System (ERTMS) deployment (Banedanmark, 2025; Trafik-, Bygge- og Boligstyrelsen, 2019). These measures are intended to prepare the Danish network for the opening of the fixed link.

On the German side, the situation is more complex. Capacity constraints remain in the Hamburg rail node, on the Hamburg–Hannover line, and on the Hamburg–Lübeck–Puttgarden corridor. Some of these projects are planned or under construction, but several are expected to be completed only after the FBFL opens (Sweco, 2025; Eisenbahn-Bundesamt, 2025). This creates a risk that the tunnel may be ready before parts of the connecting network can fully support its expected traffic flows.

Further north, Sweden and Norway are also affected by the corridor development. In Sweden, the Southern Main Line and the West Coast Line are already heavily used by passenger and freight trains. Expected increases in rail freight after the opening of the FBFL may therefore place additional pressure on existing bottlenecks (Sweco, 2025; Trafikverket, 2025). In Norway, capacity challenges around Oslo and the Alnabru terminal may also become more important as the corridor develops (Det kongelige samferdselsdepartement, 2024).

1.2 Project description

The aim of this report is to analyse the Fehmarnbelt Fixed Link as a corridor-wide railway project, rather than only as a tunnel construction project. The report examines the technical construction of the tunnel, the planning framework behind the project, and the infrastructure improvements required along the wider ScanMed corridor.

The report gives particular attention to capacity improvements and bottleneck mitigation in Germany, Denmark, Sweden, and Norway. This includes rail upgrades, terminal capacity, signalling systems such as

ERTMS, and cross-border coordination issues. The purpose is to assess whether the surrounding railway network is developing at a sufficient pace to support the expected benefits of the FBFL.

1.3 Project report structure

The report is structured as follows. Section 2 gives an overview of the Fehmarnbelt Fixed Link, focusing on the construction method, tunnel elements, marine works, workforce, financing, and contractors. Section 3 discusses the planning framework, corridor timeline, and identified infrastructure bottlenecks. Section 4 examines capacity improvements and bottleneck mitigation in Germany, Denmark, Sweden, and Norway. Section 5 presents the conclusion, followed by Section 6 outlining potential future research.

1.4 Methodology

This report is conducted as a qualitative literature and document study, where information was gathered from scientific articles, industry reports, official project documentation, and relevant technical sources, with additional references identified through the reviewed material itself.

2 Project Overview

The Fehmarnbelt Fixed Link is one of the most ambitious infrastructure projects in European history. Stretching 18 kilometres beneath the Baltic Sea, it will become the world's longest immersed tunnel upon completion, connecting the Danish island of Lolland (at Rødbyhavn) with the German island of Fehmarn (at Puttgarden). The project replaces a heavily used ferry crossing that currently takes 45 minutes — the tunnel will reduce this to just 10 minutes by car and 7 minutes by train (Femern A/S, 2024).

The project is owned and financed by Femern A/S, a Danish state-owned company, and is classified by the European Commission as one of the five most strategically important cross-border infrastructure projects in Europe (ICE, 2024). It forms a critical part of the Trans-European Transport Network (TEN-T) Scandinavian–Mediterranean Corridor, linking Scandinavia directly to Central Europe (Femern A/S, 2024). Once open, the Hamburg–Copenhagen train journey will be cut from 4.5 hours to approximately 2.5 hours, fundamentally reshaping rail freight and passenger flows across Northern Europe (European Commission, 2024).

Key Record: The Fehmarnbelt Tunnel will be the world's longest immersed tunnel (18 km), the world's longest combined road and rail tunnel, and the deepest immersed tunnel carrying both road and rail traffic (ICE, 2024). It is approximately five times the size of the tunnel portion of the Øresund Link between Denmark and Sweden (TEC Tunnel, 2024).

Tunnel Dimensions

Parameter	Value
Total tunnel length	18.2 km (18,200 m)
Max depth below sea level	~40 m (45 m at deepest trench point)
Total tunnel width (standard element)	42 m
Number of internal tubes	5 (2 road, 2 rail, 1 service/escape)
Road lanes	2 × 2-lane motorway (dual carriageway)
Rail tracks	2 electrified single tracks
Emergency exits spacing	Every 110 m along full length
Design lifespan	120 years
Placement precision (underwater)	12–15 mm
Maximum railway speed	200 km/h

Table 1: Tunnel design parameters

2.1 Tunnel Elements & Production Factory

The Fehmarnbelt tunnel is not bored through rock like the Channel Tunnel. Instead, it uses the immersed tunnel method: giant hollow concrete elements are prefabricated on land, floated out to sea, and precisely sunk into a prepared trench on the seabed (Femern A/S, 2024). This method was chosen because the Fehmarn Belt is relatively shallow and the seabed geology — while complex — is more suitable for trench excavation than rock boring (New Civil Engineer, 2024).

2.2 The 89 Tunnel Elements

The tunnel is assembled from 89 individual reinforced concrete elements in two types (Femern A/S, 2024). The 79 standard elements form the main tunnel body, while 10 special elements — placed roughly every 1.8 km — house the tunnel's electrical and technical installations on a second basement level, and provide maintenance access without crossing the road lanes (Construction Briefing, 2024).

Element Type	Count	Length	Width	Weight
Standard element	79	217 m	42 m	73,500 tonnes
Special element (2-storey)	10	39 m	46.5 m	21,000 tonnes
Total elements	89	—	—	~6.0 million tonnes total

Table 2: Element types and specifications

2.3 The World's Largest Tunnel Factory — Rødbyhavn, Denmark

To produce elements of this unprecedented scale, an entirely new industrial facility was constructed at Rødbyhavn on the Danish island of Lolland (Femern A/S, 2024). This is the world's largest tunnel production facility.

The factory consists of three vast production halls housing five production lines for standard elements and one dedicated line for the ten special elements (Construction Briefing, 2024). All halls are climate-controlled to maintain approximately 20°C, ensuring optimal concrete curing conditions and minimising the risk of thermal cracking in elements designed for a 120-year lifespan (PERI, 2023).

Each standard element is built from nine individual 24-metre segments cast sequentially on the production line (Construction Briefing, 2024). Each segment pour requires approximately 3,300 cubic metres of concrete, poured continuously over 30–36 hours without interruption — stopping would create cold joints that compromise structural integrity (New Civil Engineer, 2024). Two giant concrete batching plants serve the factory with a combined output capacity of 600 m^3 per hour (PERI, 2023). Once cast, segments are pushed forward along epoxy-coated skidding beams by hydraulic rams. After all nine segments are complete, the full 217 m element undergoes a three-week curing period before immersion preparation begins (Femern A/S, 2024).

Factory Metric	Figure
Production halls	3 halls
Production lines (standard elements)	5 lines
Production lines (special elements)	1 dedicated line
Segments per standard element	9 segments of 24 m each
Concrete per segment pour	~3,300 m^3
Pour duration (non-stop)	30–36 hours
Workers per casting operation	50–60 people
Concrete batching capacity	600 m^3/hour combined
Time to produce one full element (target)	~9 weeks
Curing time after casting	3 weeks minimum
Dry dock basin volume (total, 3 basins)	~1.6 million m^3 of water

Factory Metric	Figure
Basin depth	~11 m each

Table 3: Factory production metrics

2.4 Material: Steel, Concrete & Formwork

The sheer volume of raw materials required for the Fehmarnbelt project places it among the most resource-intensive construction projects in European history. The production of 89 tunnel elements, each comprising thousands of tonnes of reinforced concrete, demands an unprecedented and highly organised material supply chain operating continuously for several years.

2.4.1 Steel Reinforcement: the Panel Factory

Steel reinforcement (rebar) is so central to the project that a dedicated Panel Factory was established in 2023 within the Rødbyhavn construction site. The Panel Factory covers approximately 25,000 m^2 (with the main steel processing hall covering 13,000 m^2) and operates in two shifts, employing around 120 workers. Its sole function is to receive, cut, and weld steel rods into the large grid structures that form the internal skeleton of each tunnel segment before they are transported to the casting halls.

The steel arrives in rods up to 15 metres long and 32 mm in diameter. To meet production demands, two robotic welding machines — prototypes built by Spanish manufacturer DCM-Wire — handle over 70% of all welding (Global Highways, 2024). These machines are the first in the world used to weld rebar of this thickness (Premier Construction News, 2024). A magnetic crane capable of lifting up to 5 tonnes feeds each robot. Manual welders handle fine or complex connections. The combined output is approximately 1,500 tonnes of processed reinforcement steel per week, delivered continuously to the casting lines (Global Highways, 2024).

Material / Resource	Quantity / Detail
Rebar production rate	1,500 tonnes / week
Steel rod length	up to 15 m
Steel rod diameter	32 mm
Panel Factory floor area	25,000 m^2 (main hall: 13,000 m^2)
Panel Factory workers	~120 (2 shifts)
Robotic welding share	>70% (2 robots by DCM-Wire, Spain)
Magnetic crane capacity (per robot)	5 tonnes
Concrete per segment	~3,300 m^3
Total planned concrete pours	>700 castings over project life
Formwork system total weight (PERI)	10,000 tonnes delivered
Formwork total parts delivered	~1.2 million parts
Formwork logistics	200+ truck loads + 12 ship loads
Steel / formwork origin	Poland, Italy, Germany (Weißenhorn)

Table 4: Material and resource requirements

Figure 1: Aerial view of the Rødbyhavn construction site. Source: Femern A/S

2.5 Dredging, Immersion & Marine Operations

Before a single tunnel element can be placed, an 18-kilometre trench must be excavated across the floor of the Baltic Sea with extraordinary precision. This marine phase of the project, managed by the Fehmarn Belt Contractors (FBC) consortium, took approximately three years to complete and represents one of the largest marine excavation operations ever undertaken in Europe.

2.5.1 Dredging the 18 km Trench

The tunnel trench runs 18 km between the Danish portal at Rødbyhavn and the German portal at Puttgarden. On average, the trench is 12 metres deep into the seabed and 40–50 metres wide, though exact dimensions vary depending on local water depth and geology (Femern A/S, 2024). The seabed composition presented significant challenges, ranging from soft clay and sand to hard limestone and ancient Ice Age granite boulders (Geoengineer.org, 2024). One single granite block weighed approximately 70 tonnes and is now displayed at the Rødbyhavn construction site. The total volume of material removed was approximately 19–20 million cubic metres of sand, stone, and soil — much of which was reused to create approximately 300 hectares of new natural land areas along the Danish and German coastlines (Geoengineer.org, 2024). Dredging was completed in April 2024 (Femern A/S, 2024).

Dredging Parameter	Value
Trench length	18 km
Average trench depth (into seabed)	12 m
Trench width	40–50 m
Total material dredged	~19–20 million m^3
Reused dredge material	~300 hectares of new nature areas
Peak vessels operating simultaneously	70 vessels
Duration of dredging works	~3 years (2021–2024)
Dredging completion date	April 2024
Deepest tunnel trench section	35 m below sea surface

Table 5: Main dredging parameters for the Fehmarnbelt Tunnel

2.5.2 Element Immersion: the Specialised Vessel Fleet

Once the trench is prepared, each completed tunnel element must be floated out from the factory dry dock and precisely lowered onto the gravel bed at the bottom of the sea. Despite weighing up to 73,500 tonnes, the elements are designed as hollow structures that can float using internal ballast tanks. A specially designed catamaran pontoon system transports each element from the work harbour to the immersion site — a journey that, combined with the immersion operation itself, takes approximately 50 hours per element. Once positioned, 4,000 m^3 of additional ballast concrete is pumped in so that the element can no longer float independently.

Vessel	Role
Maya (multi-purpose pontoon)	Lays the precise gravel foundation bed in the trench
Ivy 1 & Ivy 2 (immersion pontoons)	Support elements during tow and control descent into trench
NP460 (spreader pontoon)	Places gravel and stones along element sides to lock it in position

Vessel	Role
Wismar (protection pontoon)	Lays a protective stone layer over each placed element
Tugboats	Tow completed elements from work harbour to immersion site

Table 6: Specialised vessels used during tunnel immersion

Milestone: The first 73,500-tonne tunnel element was officially inaugurated and immersed on 17 June 2024 by King Frederik X of Denmark. The element was towed from the Rødbyhavn factory, positioned in the tunnel trench with millimetre precision, and locked into the seabed — marking the moment the tunnel physically began to exist under the Baltic Sea.

Figure 2: Inside the Rødbyhavn tunnel production factory. Source: Femern A/S

2.6 Workforce & Budget

The Fehmarnbelt project is one of Northern Europe's largest active employment sites. At its peak, approximately 2,000 workers are employed directly on the Danish and German construction sites, supported by a further network of around 700 subcontractor companies throughout Denmark and beyond (Construction Briefing, 2024). Of the on-site workforce, roughly 1,200 workers — many from Eastern Europe — live in a purpose-built temporary village in Rødbyhavn complete with cinemas, gaming rooms, communal kitchens, a laundry, and a barber's shop (Construction Briefing, 2024). The Panel Factory alone runs on two shifts and employs around 120 dedicated steel workers (Global Highways, 2024). Each concrete casting operation directly involves 50–60 people working non-stop through the 30–36 hour pour (New Civil Engineer, 2024).

Workforce category	Number
Direct workers (Danish + German sites)	~2,000
On-site resident workers (workers' village)	~1,200
Subcontractor companies involved	~700
Panel factory steel workers	~120 (2 shifts)
Workers per concrete casting operation	50–60
Supply vessel arrivals (Denmark)	~1 every 3 days

Table 7: Construction Workforce Overview

Budget & Financing

The Fehmarnbelt Fixed Link is financed through state-guaranteed loans that will be repaid entirely through tolls collected from road and railway users once the tunnel opens (Wikipedia, 2024). The total project budget stands at approximately 7.4 billion EUR (52.6 billion DKK), making it the largest single infrastructure investment in Danish history (ICE, 2024). The European Union has contributed 1.288 billion EUR in Connecting Europe Facility (CEF) funds, reflecting the tunnel's strategic importance to the TEN-T (Trans-European Transport Network) network. Germany is separately investing approximately 800 million–1 billion EUR in the road and rail hinterland connections on its side of the border (Femern A/S, 2024).

The Fehmarn Belt Fixed Link has progressed through a structured development phase spanning over two decades. Following the Germany–Denmark treaty in 2008 and Denmark's selection of an immersed tunnel concept in 2011, construction approval and €589 M in EU CEF funding were secured in 2015. Active work began in 2020–2021, with major milestones including the signing of key contractor agreements, delivery of PERI's 10,000-tonne formwork system, and completion of the 18 km seabed trench by April 2024. The first full tunnel element was immersed and inaugurated by King Frederik X of Denmark on June 17 2024, with tunnel opening now targeted for 2031. The project is led by state-owned Femern A/S as owner and developer, supported by four primary consortia: FLC (tunnel construction immersion), FBC (marine dredging), FSC (electro-mechanical systems), and Elecnor (power supply), alongside specialist contractors including PERI, DCM-Wire, and the Ramboll + Arup + TEC design consortium. A detailed breakdown of the construction timeline and contractor structure is provided in Appendix B (Tables B1 and B2).

Budget Item	Amount
Total project budget	7.4 billion EUR (52.6 billion DKK)
EU Connecting Europe Facility	1.288 billion EUR
German hinterland connections	800 million – 1 billion EUR
Financing method	State-guaranteed loans, repaid by tolls
Historical significance	Largest investment in history of Denmark

Table 8: Budgeting for the overall project

3 Planning

3.1 Introduction

The Fehmarn Belt Fixed Link (FBFL) is one of the most important transport infrastructure projects in Europe. It will connect Denmark and Germany through an 18 km immersed tunnel under the Fehmarn Belt. However, the tunnel alone does not solve the full transport challenge — its effectiveness depends on the development of rail infrastructure in the surrounding regions.

This chapter focuses on the planning aspect of the project, especially in the context of the Scandinavian–Mediterranean Corridor (ScanMed corridor). This corridor connects Hamburg with Denmark, Sweden, and Norway, and plays a key role in both freight and passenger transport. The project is often described as closing one of the last missing links in the Trans-European Transport Network (TEN-T) in Northern Europe (Schleswig-Holstein, 2024) as seen in Figure 3.

Figure 3: Scandinavian–Mediterranean (ScanMed) Corridor including the Fehmarn Belt Fixed Link. Source: Femern A/S (2024).

According to Sweco (2025), rail freight volumes across the corridor are expected to increase by about 20% by 2040, while road freight may grow by at least 50%; passenger demand is also expected to increase significantly, with overall passenger traffic projected to roughly double following the opening of the fixed link (Femern A/S). This difference is mainly caused by about 15 existing bottlenecks in the rail network, which limit capacity and reduce the overall efficiency of the corridor. The FBFL will significantly reduce travel time between Scandinavia and Central Europe, by around 2.5 hours for rail transport (Sweco, 2023). It is also a key part of the Trans-European Transport Network (TEN-T), specifically the Scandinavian–Mediterranean Corridor, which connects Northern Europe with the Mediterranean region.

3.2 Planning Framework and Timeline

The legal basis for the project is the 2008 State Treaty between Denmark and Germany (Deutschland/Danmark, 2008). According to this agreement:

- Denmark is responsible for constructing and financing the tunnel.
- Germany is responsible for developing hinterland infrastructure (i.e. the rail infrastructure outside the tunnel, including lines connecting to major cities and the wider network).
- Both countries must coordinate timelines.

In addition, the EU's TEN-T regulation sets overall planning guidelines. The updated regulation from 2024 defines infrastructure standards for the corridor (Sweco, 2025).

Figure 4 presents the key milestones in the development of the FBFL project, including planning, approval, construction, and expected operation phases.

Figure 4: Key milestones in the development of the Fehmarn Belt Fixed Link. Source: Compiled from Femern A/S (2025), VINCI (2024), and European Commission (2024).

3.3 Infrastructure Bottlenecks and Planning Status

3.3.1 Bottleneck Assessment Methodology

Sweco (2025) identified 15 critical infrastructure bottlenecks north of Hannover along the Scandinavian–Mediterranean Corridor (see Figure 3). These bottlenecks were assessed based on their expected impact on rail freight performance and the progress of planning and implementation measures.

A three-tier classification system was applied:

• Red — bottlenecks expected to remain unresolved by 2029, significantly limiting rail freight capacity and performance,

• Orange — bottlenecks requiring accelerated planning or implementation to reduce negative impacts,

• Green — bottlenecks where planning and implementation are progressing adequately, with a high likelihood of resolution within the expected timeframe.

This classification allows for a structured evaluation of infrastructure readiness along the corridor and highlights areas requiring urgent intervention.

3.3.2 Current Bottleneck Status

The detailed planning status of all identified bottlenecks is presented in Appendix A (Table A1).

The results indicate that a significant share of bottlenecks are classified as Red, particularly in Germany and Sweden. This reflects substantial delays in infrastructure development, especially in key nodes such as Hamburg, where capacity constraints and insufficient rail infrastructure upgrades continue to limit system performance.

In addition, several bottlenecks related to terminal capacity, railway line modernization, and ERTMS implementation remain unresolved or lack clear timelines.

Only a limited number of bottlenecks, such as those located in the Copenhagen area, are classified as Green, indicating that they are on track for completion by 2029. A number of bottlenecks fall into the Orange category, particularly in cross-border sections, suggesting uncertainty and the need for accelerated planning and investment.

Overall, the findings highlight that despite ongoing improvements, infrastructure development is not progressing uniformly across the corridor.

3.3.3 Visual Overview

Figure 5 illustrates the geographical distribution of the identified bottlenecks and their respective planning status across the northern ScanMed corridor.

The spatial distribution reveals a concentration of critical (Red) bottlenecks in Northern Germany (Hamburg region), Southern Sweden, and Norway (Oslo region). In contrast, fewer bottlenecks are classified as Green, primarily located in Denmark, indicating relatively further advanced planning and progress in this area.

The visualization confirms that, despite the construction of the Fehmarnbelt Fixed Link, the overall effectiveness of the corridor will remain constrained unless complementary infrastructure investments are implemented across multiple countries.

Figure 5: Bottlenecks along the northern ScanMed corridor and their planning status. Source: Sweco (2025).

3.4 Cross-Border Coordination Challenges

3.4.1 Institutional Fragmentation

A key issue in corridor planning is the lack of integrated cross-border coordination. Infrastructure planning is still mainly done at the national level, which means that connections between countries are often less developed than domestic networks. As highlighted by Sweco (2025), planning processes tend to stop at national borders, creating imbalances in infrastructure development.

3.4.2 Timeline Misalignment

Another major challenge is the mismatch in infrastructure development timelines across countries, as shown in Table 9.

Different countries are progressing at different speeds. Denmark is expected to complete key upgrades by around 2029, while Germany and Sweden face delays extending into the 2040s. This creates a situation where parts of the corridor are ready, but others remain constrained, limiting overall performance.

Country	ERTMS completion	Major capacity improvements	Cross-border link status
Denmark	2033	2029 (FBFL connection)	On track
Germany	2040s	Hamburg–Hannover: ~2040	Significantly delayed
Sweden	2042	Southern Main Line: 2035–2050	Severely constrained
Norway	2034	Oslo improvements: 2031–2036	Limited progress

Table 9: Comparative planning timelines by country. Source: Compiled from national transport plans and Sweco (2025).

Overall, the identified challenges highlight that existing bottlenecks and coordination issues may limit the full benefits of the Fehmarn Belt Fixed Link. To address these constraints, it is necessary to examine the planned infrastructure upgrades and capacity improvements in greater detail. These measures are discussed in Chapter 4.

4 Capacity Improvements and Bottleneck Mitigation along the Corridor

As previously discussed in Section 3.3, the Scandinavian–Mediterranean Corridor has significant bottlenecks between Hamburg and northern Scandinavia. For the FBFL to achieve its intended effect, its potential must not be constrained by bottlenecks elsewhere along the corridor. This chapter examines current efforts to remove these bottlenecks and increase capacity across the corridor as a whole.

4.1 Germany

Northern Germany represents a critical section of the Scandinavian–Mediterranean Corridor, where several infrastructure and operational constraints currently limit capacity. In particular, bottlenecks on the Hannover–Hamburg line, in the Hamburg rail node, and on the Hamburg–Puttgarden section may restrict the full capacity benefits of the FBFL. This subsection examines ongoing measures to address these constraints, including infrastructure upgrades and European Train Control System (ETCS)/ERTMS deployment.

4.1.1 Capacity Constraints and Upgrades on Hannover–Hamburg

The railway line between Hannover and Hamburg is one of Germany's most congested routes, with capacity utilization reaching 147%. Consequently, it is also among the country's most delay-prone routes (Bundesministerium für Verkehr, 2025).

As of 2025, Deutsche Bahn regards the construction of a new, more direct high-speed line between Hannover and Hamburg as the only feasible long-term solution (Kircher, 2025). The purpose of this line is twofold: firstly, travel time for ICE services is expected to be reduced by 20 minutes, to a total journey time of 59 minutes (Kircher, 2025). Secondly, by diverting ICE trains from the existing line to a new dedicated route, capacity can be freed up on the conventional line for freight and regional services.

The proposed plans are expected to be decided upon by the Bundestag in 2026 (Sweco, 2025). However, given the scale and complexity of the project, Sweco (2025) estimates completion no earlier than 2040, approximately ten years after the expected delivery of the FBFL. This may result in capacity constraints persisting during the initial decade of FBFL operation.

4.1.2 Capacity Constraints and Upgrades in the Hamburg Rail Node

Hamburg is a critical rail and freight hub, but capacity constraints in the Hamburg rail node are significant. Despite serving Europe's largest rail port and one of its busiest stations, Hamburg Hauptbahnhof has limited track capacity relative to comparable major stations (Sweco, 2025; Piva, 2025). Addressing these constraints is critical, particularly given projected growth in long-distance rail traffic associated with the FBFL (Ramboll, 2018).

Several projects are underway to increase capacity in the Hamburg rail node, including the S4 rapid transit line in eastern Hamburg. By shifting suburban traffic onto dedicated tracks and rapid transit platforms at Hamburg Hauptbahnhof, the project is expected to reduce traffic on the main platforms by 110 trains daily (roughly 15% of the current daily traffic), thereby freeing capacity for freight and long-distance services (Ramboll, 2018). The S4 is expected to be operational by 2030 (Sweco, 2025).

Simultaneously, a project is underway to expand a crossing between two freight lines from two to four tracks, separating freight traffic flows and increasing capacity (Sweco, 2025). This measure is crucial to allow Europe's largest rail port to efficiently utilise the corridor up to Scandinavia. Construction on this expansion appears to be on track for commissioning at the end of 2026 (Deutsche Bahn, 2019; Deutsche Bahn 2025B).

Hamburg will still remain a critical bottleneck given the density of traffic passing through. Yet the construction of additional freight lines and rapid transit lines will result in significant capacity gains on the main long-distance lines as well as platforms at Hamburg HBF prior to commissioning of the FBFL.

4.1.3 Capacity Constraints and Upgrades on Hamburg–Lübeck–Puttgarden

The Hamburg–Lübeck–Puttgarden corridor is a critical section of the hinterland connection to the FBFL. Planned upgrades include electrification, new tracks, additional passing stations, and extensions of passing tracks to 850 metres, aimed at increasing both capacity and freight compatibility (Sweco, 2025).

A key remaining constraint is the Fehmarnsund Bridge, which currently connects the German mainland with the island of Fehmarn, where the Fehmarnbelt Fixed Link to Denmark originates. It will continue to act as a capacity bottleneck until the planned Fehmarnsund tunnel is completed. Current estimates place the opening of the Fehmarnsund tunnel no earlier than the end of 2032, creating a risk that this critical component will not be ready when the FBFL opens (Eisenbahn-Bundesamt, 2025).

The delays with the construction of the Fehmarnsund tunnel are worrying. The absence of the tunnel will significantly reduce capacity for trains leaving and entering the tunnel, which reduces the attractiveness of the corridor as a whole.

4.1.4 ETCS/ERTMS Deployment as a System-Level Capacity Measure

ERTMS is a key enabler of the Single European Rail Area, supporting cross-border interoperability and increased capacity through reduced train headways (Ruete, 2026; Preston, 2026). Its deployment is therefore critical for the effective utilisation of the FBFL corridor.

As of 2024, ETCS installation is underway on sections between Uelzen–Hamburg and Lübeck–Puttgarden. Deutsche Bahn aims to implement ERTMS along the full Hannover–Puttgarden corridor by 2030 (Ruete, 2026). However, these plans remain highly ambitious: only around 5% of Germany's core network was equipped with ETCS in 2024, and approximately 90% of planned deployment is still outstanding, making Germany one of the slowest countries in trackside rollout (Ruete, 2026).

Progress has been hindered by structural and technical challenges. These include incomplete electrification, infrastructure incompatibilities, and issues such as stray currents, which limit the operation of ETCS-equipped trains (Lang, 2026). In addition, the fragmented administrative structure and technical diversity of the German rail network contribute to higher costs and implementation delays (Lang, 2026).

As noted by Elisabeth Werner, a European Commission official formerly in DG MOVE, ERTMS only delivers a positive business case once implementation reaches sufficient scale (cited in International Railway Journal, 2020). This is particularly relevant in Germany, where fragmentation of infrastructure and rolling stock discourages operators from investing in ETCS. As a result, adoption remains limited, with only 10–15% of the fleet expected to be ETCS-equipped by 2030 (Ruete, 2025).

4.2 Denmark

Denmark demonstrates the most advanced planning progress along the corridor (see Table 9). Banedanmark's 2025 infrastructure plan outlines comprehensive measures for the domestic network (Banedanmark, 2025). Based on the plans and results outlined in the following section, it can be seen that Denmark's infrastructure will be ready to adequately handle the increased train traffic as a consequence of the FBFL.

Project	Status	Expected Completion
Ringsted–Rødby rail upgrade	Under construction	2029

Project	Status	Expected Completion
Ringsted grade separation	Planning phase	2028–2030
Copenhagen Airport station expansion	Under construction	2027
Kalvebod passing tracks	EIA approved; planning ongoing	2028

Table 10: Danish planning status for FBFL-related infrastructure. Source: Data from Banedanmark (2025) and Sund & Bælt (2025).

Overall, Denmark's approach is characterised by a high degree of coordination between infrastructure upgrades, signalling deployment, and capacity expansion. Unlike other corridor countries, where upgrades are often phased or fragmented, the Danish strategy combines speed increases, electrification, and ERTMS implementation within a single, coherent programme (Banedanmark, 2025). This integrated approach is a key factor in ensuring that the network will be operationally ready for the opening of the FBFL.

4.2.1 The Line from Copenhagen to Rødbyhavn

The railway between the Fehmarnbelt (Rødbyhavn) and Copenhagen can be divided into two main sections.

The first section runs from Rødbyhavn to Ringsted. This 115 km stretch passes largely through rural areas and is therefore undergoing extensive upgrades. These include track renewal, curve realignment, relocation of station platforms, and the construction of a new double track alongside the existing line (Duddu, 2014; Vasundhara, 2023). The new track is being built in parallel with upgrades to the original single track, enabling operational speeds of up to 200 km/h (M.J. Eriksson, 2026). Overall, these improvements will raise speeds along the entire section from 120–160 km/h to 200 km/h, delivering significant travel time reductions (Vasundhara, 2023).

The second section, from Ringsted to Copenhagen, is already largely modernized. At Ringsted, the southern line from Lolland connects with the western line from Odense, making it a key junction for rail traffic to Denmark's capital. Since 2019, a 60 km high-speed line has linked Ringsted and Copenhagen, designed for speeds up to 250 km/h. The project included a new electrified double track, additional station platforms, and upgrades at Ringsted station (Banedanmark, 2026).

Together, the modernization of the rural section and the new high-speed line are expected to deliver a fully electrified corridor with operational speeds of at least 200 km/h by 2029 (Banedanmark, 2026), ensuring the Danish network is ready for the Fehmarnbelt Fixed Link to enter operation by 2030. In addition to higher speeds, the double-tracking and infrastructure upgrades significantly increase line capacity, which is essential for accommodating the expected growth in both passenger and freight traffic following the opening of the FBFL.

4.2.2 ERTMS Deployment in Denmark

Denmark is one of the European frontrunners regarding ETCS deployment. As of 2024, the majority of the railway line from Rødbyhavn to Copenhagen has active ETCS or active construction of ETCS (Ruete, 2026), and the whole section is expected to have ETCS deployment by 2029, as part of the previously mentioned modernization efforts (Banedanmark, 2026).

According to the Danish National Implementation Plan, the whole network will be equipped with ERTMS level 2, where movement authorities are continuously transmitted to the train via radio and lineside signals are not required. Moreover, on all the lines where ERTMS is commissioned the old class B system is directly taken out of operation, making the lines ERTMS only (Trafik-, Bygge- og Boligstyrelsen, 2019).

As many of the railway lines are being converted to ERTMS only, the portion of ETCS equipped vehicles in Denmark is quite high, at above 70% in 2024, making it the third highest in Europe. The portion of ETCS equipped vehicles is planned to be fully ETCS-equipped by 2030 (Ruete, 2026). However, as some of Banedanmarks trains operate on the Øresund link and enter Sweden, these are also equipped with the Swedish class B system (ATC 2) (Trafik-, Bygge- og Boligstyrelsen, 2019); for more information on ERTMS deployment in Sweden see Section 4.3.5.

A key driver behind Denmark's full transition to ERTMS is the condition of its legacy signalling system. The national Class B ATC system had reached the end of its technical lifecycle and was increasingly regarded as outdated and unreliable, making substantial reinvestment unavoidable (Trafik-, Bygge- og Boligstyrelsen, 2019). In this context, Denmark chose to invest directly in ERTMS rather than upgrading legacy systems, thereby aligning necessary renewal investments with long-term goals of interoperability, capacity, and operational efficiency.

This transition to an ERTMS-only network places Denmark at the forefront of European rail signalling interoperability. It reduces technical barriers for international traffic and is expected to facilitate smoother cross-border operations along the Scandinavian–Mediterranean Corridor, particularly in contrast to neighbouring networks where legacy signalling systems remain in use.

4.2.3 The Øresund Link

The Øresund Fixed Link has proven to be a strong demonstration of the potential of fixed-link railway connections. Its role in connecting the Scandinavian peninsula to the European mainland is expected to grow further with the opening of the Fehmarnbelt Fixed Link (FBFL). According to a study by Trafikverket (2024), the Øresund link is projected to have sufficient capacity until approximately 2050.

However, findings from a Swedish parliamentary inquiry indicate that rail traffic forecasts have historically underestimated growth rates (Widman et al., 2026). In addition, the opening of the FBFL is likely to generate induced demand, the scale of which remains uncertain. Even accounting for potential underestimation, current analyses suggest that capacity constraints on the Swedish Southern Main Line will become binding before additional capacity across the Øresund link is required (Sweco, 2025).

While current assessments indicate sufficient capacity on the Øresund link in the medium term, it remains a critical single crossing between Denmark and Sweden, making it a potential long-term constraint in the corridor. In case of an emergency, malfunction or accident it is pertinent that alternative ways exist for traffic to reach Scandinavia. Building additional infrastructure for the sole purpose of redundancy has been found to be not cost-effective (Sweco, 2025).

Several projects are under discussion as additional fixed links between Denmark and Sweden. A metro between Helsingør and Helsingborg has long been discussed but was in 2022 rejected by the Danish government due to high costs; instead the Øresund metro is currently seen as the more likely candidate (de Kemmeter, 2024). Regardless, there are currently no concrete plans for additional capacity or redundancy measures across the Øresund, making it reasonable to assume that any such infrastructure remains many years away.

4.3 Sweden

Sweden is a major end of the trade flow between mainland Europe and Scandinavia, where between Sweden and Germany alone, trade volumes by rail transport make up 52% of all goods between mainland Europe and Scandinavia (Sweco, 2023). In addition to the opening of the Fehmarn-Belt fixed link, freight volumes by rail over Øresund to Sweden will increase by 30–40%, which will increase stress on the major lines and nodes of the Swedish railway network. However, it can be noted that scenarios are heavily influenced by what costs would be implemented on rail transport compared to other transport modes (Trafikverket, 2026).

4.3.1 Background

The planning of Swedish connections has diverged between different planning strategies. Until December 2022, the Swedish government planned for a major high-speed rail programme, which was then halted (Swedish Government, 2022). The high-speed rail programme aimed to connect Stockholm to Gothenburg and Malmö, via Jönköping. From Malmö the network would be connected towards mainland Europe. By October 2023, the strategy shifted towards conventional rail upgrades and focus on regional rail improvements (Swedish Government, 2023).

A high-speed rail system in Sweden would improve both capacity and mobility on the Swedish railway network. Its strengths would be to relieve current main lines from their current stress and dividing up faster rail traffic to their own system, instead of sharing the infrastructure with slower freight and local passenger trains. This would result in a more robust network which is not as vulnerable to delays. With a new network complementing the old network, the system gets an improved mobility, as they can complement each other in case of a disruption. In Figure 6 the current freight train traffic distribution can be seen. Here it can be noted that the Swedish Southern Mainline accounts for a majority of the volume and economic value flowing into Sweden.

Figure 6: Current freight goods on the Scandinavian railway network by tonnes (left) and by economic value (right). Source: Trafikverket (2026).

According to the national plan for 2026–2037 by Trafikverket (the Swedish Transportation Administration), 78% of infrastructure investments during this period are aimed for upgrading and implementing new rail infrastructure. All of these will benefit the Swedish railway network, while several are vital improvements for the opening of the FBFL.

4.3.2 The West Coast Line

The Swedish West Coast line (Västkustbanan) is one of two major lines running north into Sweden from Malmö. This line runs along the western coast of Sweden up to Gothenburg, a major hub for rail traffic and also the location of Northern Europe's largest and busiest port. From Gothenburg there are further connecting railways into Norway and central Sweden.

The Swedish West Coast line has undergone several improvements in recent decades, with it systematically being rebuilt to double tracks, including larger projects such as the Hallandsås tunnel. As of 2026, the line is double tracked nearly the whole way, with the exception of the five kilometre north entrance to Helsingborg, which remains a bottleneck for now. There are proposals to expand this section, including a new tunnel under the city, to increase capacity and robustness (Helsingborgs Stad, 2024). Goods traffic through Skåne to the West Coast line are rerouted to a separate railway corridor, the Scanian freight corridor between Ängelholm and Malmö, which has undergone major improvements implemented in 2020.

According to the national plan for 2026–2037, four new passing tracks are planned to be constructed on the West Coast line between Halmstad and Kungsbacka, making overtaking slower freight trains easier (Trafikverket, 2025). The plan also mentions an upgrade to the Halmstad railway node, which is one of the bigger cities and railway hubs along the route, to be able to handle a higher goods volume.

In the Gothenburg metropolitan area, railways have to share space with commuter trains, which leads to capacity issues. For the West Coast Line, Kungsbacka–Gothenburg is highly used and would eventually need four tracks (Sweco, 2025). There are no further plans as of 2026 on how to increase the capacity on this section. A similar situation exists on the Gothenburg–Alingsås and Gothenburg–Älvängen railway sections, where freight volumes, commuter trains, regional and long-distance trains all exist in significant volume and would benefit from upgrades to four tracks from today's two tracks. The Västlänken project, building a commuter train tunnel under central Gothenburg, helps relieve the most inner junctions and sections by Olskroken when it opens around year 2030 (Trafikverket, 2023).

4.3.3 The Southern Swedish Main Line

The second major rail connection from Skåne to Europe is the Swedish Southern Main Line (Södra Stambanan). The rail corridor consists of two parallel double tracks through Malmö, newly opened four tracks between Malmö and Lund, and the rest is double track all the way up to Katrineholm. At Mjölby, much of the freight traffic diverts toward the Hallsberg rail node, as seen in Figure 6.

The Swedish Transport Administration (Trafikverket) identifies the Southern Main Line as the primary remaining bottleneck for international rail traffic to Sweden (Trafikverket, 2025b). Severe congestion on this line has increased freight transport times by several hours over the past 10–15 years. The Swedish Southern Mainline receives the majority of goods transports between Skåne and the rest of Sweden. The corridor also shares the tracks with high-speed trains connecting main cities, as well as local and regional trains. With an increasing number of trains in the last 20 years, since 2000 the travel time for freight traffic between Hallsberg and Malmö has increased by two hours (Sweco, 2025).

The national plan mentions building a second set of double tracks between Lund and Hässleholm, which would relieve the high stress on this stretch (Trafikverket, 2025). The initial plan was that this would be part of the high-speed network in a new corridor but now planning has gone more towards building out the existing corridor to four tracks. However, this is a long stretch of around 65 km and the continuing line up to Alvesta would still remain a major bottleneck. New passing tracks are to be implemented, as mentioned in the national plan, which will improve the capacity slightly, but more measures are needed. The Hässleholm goods terminal will also be rebuilt to be able to handle more freight volumes, making it into a major node for freight trains (Trafikverket, 2025).

An option could be to build a new rail line between Markaryd and Värnamo, partly on the old railway line that existed there. Today there is an electrified railway Hässleholm–Markaryd and the line Värnamo–Nässjö has plans for electrification and other upgrades. With a new rail line, freight traffic can be rerouted to another track, which would not receive other significant traffic. At the same time, the municipalities along this route would likely welcome new rail projects connecting their areas. A new track corridor would also have the purpose of redirecting trains in an event of a disruption along the main line, so that the most vital traffic can get through. Today the only other electrified railway between Nässjö and Hässleholm is via the West Coast railway, which requires long detours on tracks that are already close to maximum capacity.

4.3.4 Transport Hubs

In addition to an increase in rail traffic, a higher pressure is put on the existing hubs and railway yards, especially in Scania. There are plans to build a new major rail yard for freight traffic in Southern Sweden (Region Skåne, 2024). The existing rail yard in Malmö is already receiving a lot of traffic and volume will increase when the FBFL opens. Proposed locations for this rail hub include Marieholm, Hässleholm and Älmhult. However, in addition to the planning of this rail yard, additional planning for further effects on rail lines has to be made. For example, a hub at Marieholm would increase freight volumes on branch lines in Skåne, while a hub in Hässleholm would increase volumes on Skånebanan Helsingborg–Hässleholm.

4.3.5 ERTMS and Other Rail Technical Properties of Sweden

ERTMS is an important part of connecting the European railway networks. The new European safety system will benefit trains travelling from different countries in Europe, which today have their own signalling systems, just like Sweden does. The Swedish system, also known as ATC 2, is outdated and would need an upgrade. In 2026, there are relatively few ERTMS-equipped railway sections in Sweden (Ruete, 2026). Yet there are ambitious plans according to the national plan to implement the system in the very near future. The aim is that all major railway lines are implemented with ERTMS by 2042 (Trafikverket, 2025). This will be around 12 years after the opening of the FBFL. Sweden is therefore lagging behind and this will have an impact on traffic along the corridor for these years.

Another barrier for international rail transport in Europe is differences in electrification systems. While Sweden and Germany both use 15 kV 16.7 Hz AC, Denmark operates primarily on 25 kV 50 Hz AC on newer lines. The EU's TSI Energy framework does not standardise a single system but instead defines interoperability requirements that allow multiple electrification standards, provided rolling stock is multi-system compatible. As a result, electrification differences remain a persistent constraint on cross-border interoperability.

4.4 Norway and Swedish-Norwegian Connections

Norway's National Transport Plan 2025–2036 allocates approximately 16 billion NOK for Østfold Line improvements (Det kongelige samferdselsdepartement, 2024), which partly includes new double tracks on the stretch. Both in Norway approaching Oslo and in Sweden approaching Gothenburg, the tracks are shared by commuter, regional, long-distance and freight trains, while between Skälebol and Halden there is mainly only long-distance passenger and freight trains.

However, progress on the Gothenburg–Oslo connection remains limited, as Bane NOR has not yet resumed detailed planning work (Bane NOR, 2025). The Norwegian Jernbanedirektoratet (the Norwegian Transportation Administration) and the Swedish Trafikverket conducted a study that looked into alternatives for improving the section Oslo–Dalsland–Göteborg (Jernbanedirektoratet, 2023). The rail line has limitations in speed, steep gradients and length restrictions, primarily between Skälebol and Moss. There are recommendations to build out the corridor to double track all the way, however this is not to be completed within the next 20 years. At the moment the National Plan mentions no further upgrades on this section.

In the Oslo region, the rail tracks are highly used by both passenger trains and freight trains (Sweco, 2025). The Alnabru terminal is the largest cargo terminal in the Nordic countries and is of great importance for Norwegian goods traffic. However, the terminal is meeting capacity problems, which likely would worsen with the opening of the FBFL and is also to some degree not modern enough to meet the growing demand for freight. At the moment there are no major plans decided for improvements, only studies into alternatives.

5 Conclusions

The construction of the FBFL is one of Europe's largest and most complex infrastructure projects. The project involves several nations, hundreds of subcontractors, and represents the largest ongoing Danish infrastructure investment.

The scope of the project is extensive, as it does not simply end where the tunnel meets land on the German and Danish sides, but instead affects a much larger part of a corridor extending into Sweden and Norway. The TEN-T network requires many cross-border infrastructure projects with corridor-wide impacts. Based on the FBFL, several lessons can be learnt and applied to similar projects in the future.

Firstly, financing infrastructure projects through state-guaranteed loans repaid via usage fees has proven to be a viable funding strategy, following its novel implementation for the Øresund Fixed Link. This approach enables stable financing during construction while maintaining good prospects for long-term repayment.

Secondly, the importance of planning such construction projects from a system or corridor perspective should be emphasised. This requires broad, low-resolution planning with a broad scope to ensure timeline alignment between central and peripheral projects. This becomes particularly complex when several nations are involved, yet it is essential to the functioning of a cross-border corridor. It is not possible to improve the heart of a system without addressing its arteries.

Building on this, the more detailed planning and realization phases can and should be divided between nations in order to reduce the complexity of individual subprojects. This is demonstrated by the construction agreement between Germany and Denmark, where each nation is responsible for distinct parts of the corridor. Yet due to insufficient timeline alignment the FBFL is expected to open before several crucial corridor improvements have been completed.

Thirdly, fragmentation within the railway sector represents a major obstacle to corridor development and large-scale system shifts. This fragmentation exists both internationally, where it complicates project coordination, and domestically, where responsibilities are divided among many actors. System shifts may become ineffective or even counterproductive when only isolated parts of the system are upgraded. It is therefore essential that such transitions are proactively coordinated by central actors capable of influencing the fragmented parts of the railway system. This requires active involvement from major stakeholders such as the EU, DB, DSB, and similar organisations with a large sphere of influence.

Finally, the importance of long-term planning is emphasised. The railway sector evolves slowly, not only due to institutional inefficiencies, but also because of the substantial time required to plan and construct large infrastructure projects. National infrastructure plans should therefore reflect these realities and provide sufficiently long planning horizons to support continuity and long-term implementation.

6 Future Research

For future research, there are several areas that could be explored further. Firstly, for projects of this scale, particularly within the railway industry, the environmental impact is an important consideration. This report did not examine either the environmental impact of the construction process or the long-term environmental effects of the completed infrastructure, and further research in this area could therefore provide valuable insight. In addition, future studies could investigate the long-term operational performance and capacity effects of the project, and the bottleneck mitigation, once fully implemented, as many of the expected benefits can only be properly evaluated after several years of operation.

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Appendix A

Table A1: Planning Status of 15 Infrastructure Bottlenecks in the Northern ScanMed Corridor. Source: Status classifications from Sweco (2025).

#	Bottleneck	Location	Status	Expected Resolution
1	Railway node Hamburg	Germany	Red	Partial by 2030
2	Hamburg–Hannover railway	Germany	Red	~2040
3	Hamburg terminal capacity	Germany	Red	No clear timeline
4	Lübeck–Puttgarden–FBFL	Germany	Orange	Fehmarnsund tunnel: 2032+
5	Terminal availability (DK)	Denmark	Red	Not by 2029
6	Copenhagen bottlenecks	Denmark	Green	On track for 2029
7	Øresund redundancy	DK/SE	Orange	Under investigation
8	Malmö area	Sweden	Orange	2030+
9	Southern Main Line	Sweden	Red	2035–2050
10	West Coast Line (Gothenburg)	Sweden	Red	No plans
11	Western Main Line	Sweden	Orange	2030s
12	Oslo–Gothenburg railway	NO/SE	Red	No decided measures
13	Oslo region/Alnabru terminal	Norway	Red	2031–2036
14	Train lengths (SE/NO)	SE/NO	Orange	2040
15	ERTMS implementation	All	Red	DK/NO: 2034; SE/DE: 2040s

Table A1: Planning Status of 15 Infrastructure Bottlenecks in the Northern ScanMed Corridor.

Appendix B

Table B1: Construction timeline and key milestones for the Fehmarnbelt Fixed Link.

Year / Date	Milestone
2008	Germany–Denmark treaty signed (3 September)
2011	Danish parliament selects immersed tunnel over bridge
2015	Construction approved; EU awards 589 M in CEF funding
January 2020	Marine and site preparation begins on Danish side
January 2021	Full construction officially starts on German side
May 2022	FSC systems contract signed with Femern
December 2022	Elecnor signs transformer station contract
Spring 2023	PERI formwork (10,000 t) fully delivered; Panel Factory opens
July 2023	First concrete segment cast in tunnel factory
April 2024	Dredging of full 18 km trench completed
May 2024	First full 73,500-tonne element cast complete
17 June 2024	First tunnel element immersed; inaugurated by King Frederik X
2029–2031	Scheduled tunnel opening (revised target: 2031)

Table B1: Construction timeline and key milestones for the Fehmarnbelt Fixed Link.

Table B2: Key contractor structure for the Fehmarnbelt Fixed Link.

Consortium / Company	Role
Femern A/S (Danish state-owned)	Owner, client, and project developer
FLC — Femern Link Contractors (incl. VINCI)	Main tunnel construction & element immersion
FBC — Fehmarn Belt Contractors	Marine dredging & seabed preparation
FSC — Femern Systems Contractors	Electro-mechanical systems & tunnel technology
Elecnor (Spain)	Transformer station & power supply
PERI (Germany)	Custom tunnel formwork system (10,000 t)
DCM-Wire (Spain)	Robotic rebar welding machines (world first)
Ramboll + Arup + TEC	Winning design consortium

Table B2: Key contractor structure for the Fehmarnbelt Fixed Link.