Market research freight locomotives NL - Development ETCS-OBU for locomotives to ProRail B.V. - Programmadirectie ERTMS

SCI / Verkehr

Persoonsgegevens (namen)
/ Cologne /
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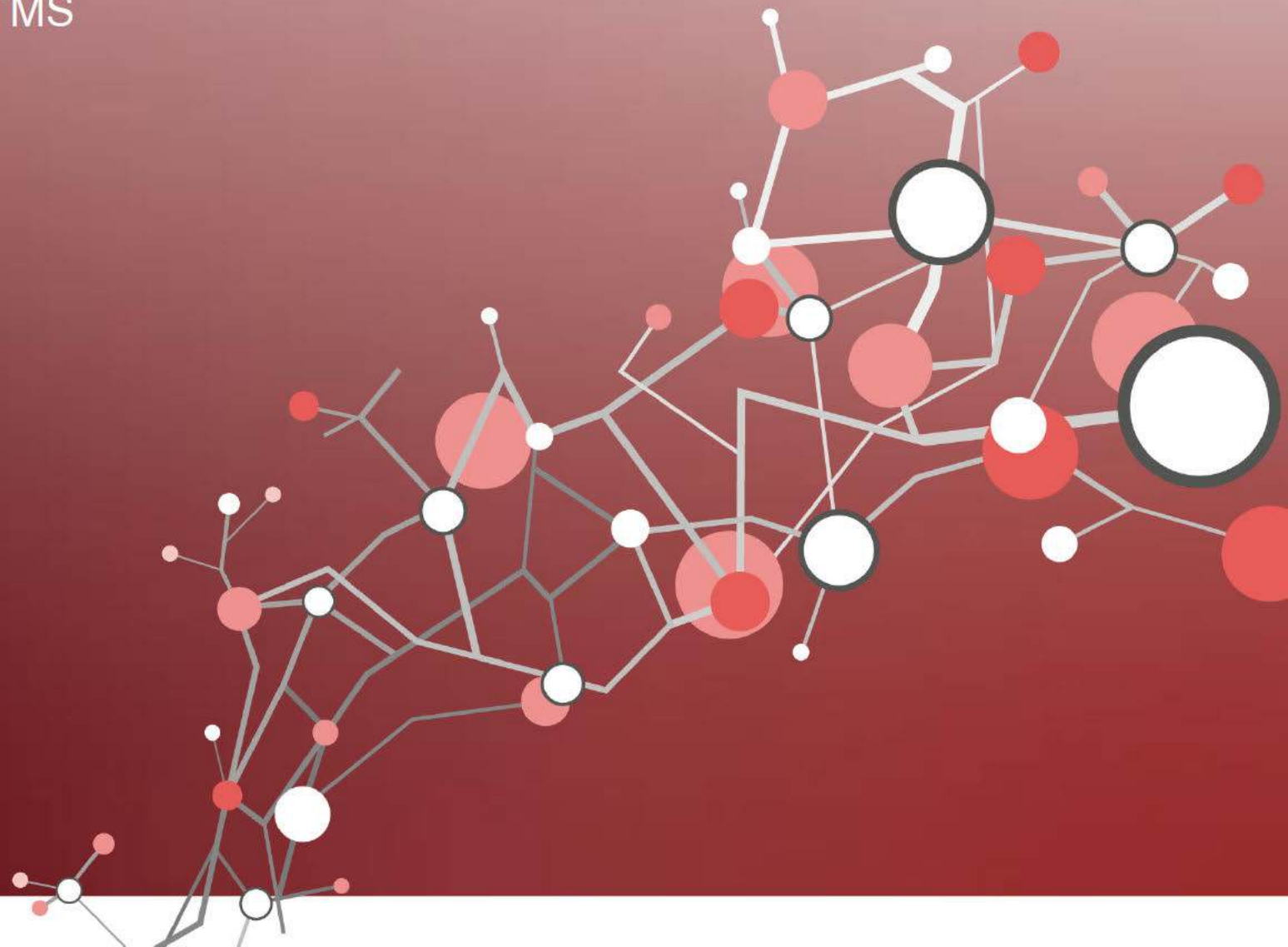

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Agenda

SCI/Verkehr

1

Executive Summary and scope of work

SCI Verkehr has been awarded to provide a market research for freight locomotives in NL and the development of ETCS-OBU supply to support ETCS-only operation on important line in 2030

01 Loco fleet forecast

- Forecast freight locomotive fleet development 2025-2035

02 Roadmap ERTMS

- Roadmap of the ERTMS-OBU suppliers

03 ERTMS versions

- Availability of ERTMS versions for relevant locomotive types

04 Determining factors

- Determining factors that influence the number of required locomotives per migration step

05 Barriers

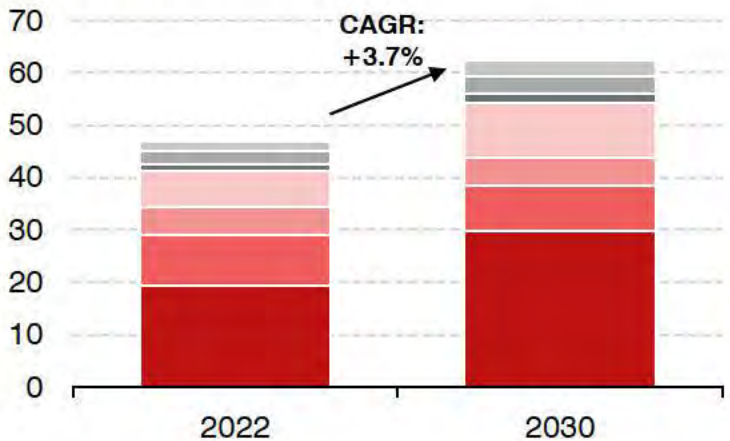
- Identification of barriers that impede and hinder the development of a suitable fleet for NL

Based on the five working packages, SCI created a new structure containing all relevant questions from the customer

1. Rail freight forecast and determining factors
2. ERTMS roadmap and ERTMS versions
3. Freight locomotive fleet and forecast
4. Barriers

Rail freight forecast 2022-2030: According to the WLO forecast, demand for rail freight locomotives will grow until 2030 despite cost effects of ERTMS BL 3 introduction

Rail freight commodity shares in the Netherlands
(2019-2030, million tons)



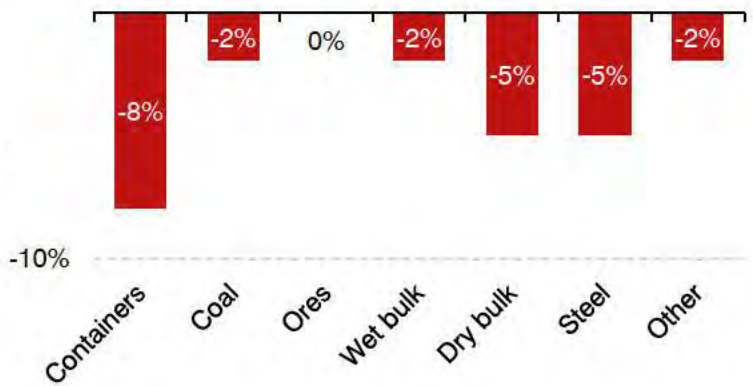
1. The **rail freight volume** is expected to grow between 2022 and 2030 by the WLO forecast. Containers and wet bulk are expected to grow in relative importance while coal and ores will decline.

Increase of locomotive demand until 2030

- Driven by growth of rail freight volume.
- However, rail freight growth dampened by cost effects of ERTMS BL 3 introduction.
- Locomotive demand growth further affected by more efficient operations.

3. The **influence of determining factors** like average train length, average train weight and electrification also impact the number of trains needed, as operations grow more efficient over time.

Cost effects of ERTMS BL 3 introduction
(2030, percentage)



2. Due to the invest into new ERTMS on-board units (OBU) and/or new locomotives, a report compiled by Bridgecraft[1] shows that rail freight transport services will increase in cost. These **cost increases** will dampen demand from shippers.

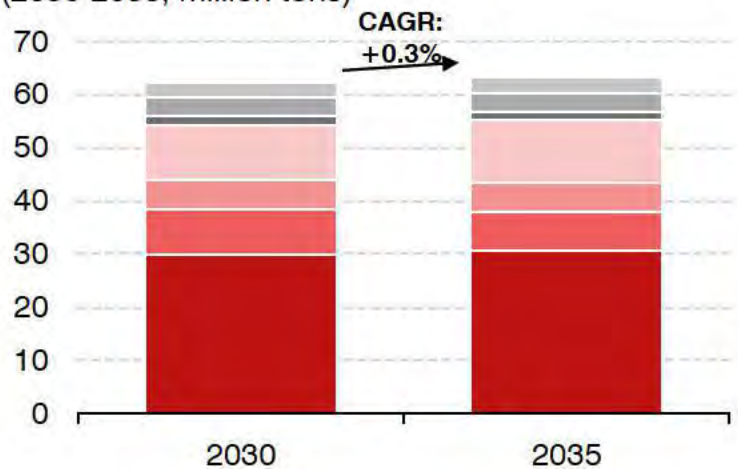
Source: ProRail, WLO forecast (pre-requisite), Report "Implementatie van ERTMS in het spoorgoederenvervoer", SCI Verkehr database

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

1: Report "Implementatie van ERTMS in het spoorgoederenvervoer"

Rail freight forecast 2030 - 2035: Growth of rail freight volume will slow down, leading to decreasing demand for locomotives due to increased efficiency

Rail freight commodity shares in the Netherlands
(2030-2035, million tons)



1. The WLO High forecast assumes a compound annual growth rate (CAGR) of +0.3% between 2030 and 2035 for overall **rail freight transport** demand in the Netherlands.

Decrease of locomotive demand 2030-2035

- Hardly any growth between 2030 and 2035 in overall rail freight transport demand.
- Locomotive demand growth further affected by more efficient operations.

2. The **influence of determining factors** like average train length, average train weight and electrification also impact the number of trains needed, as operations grow more efficient over time.

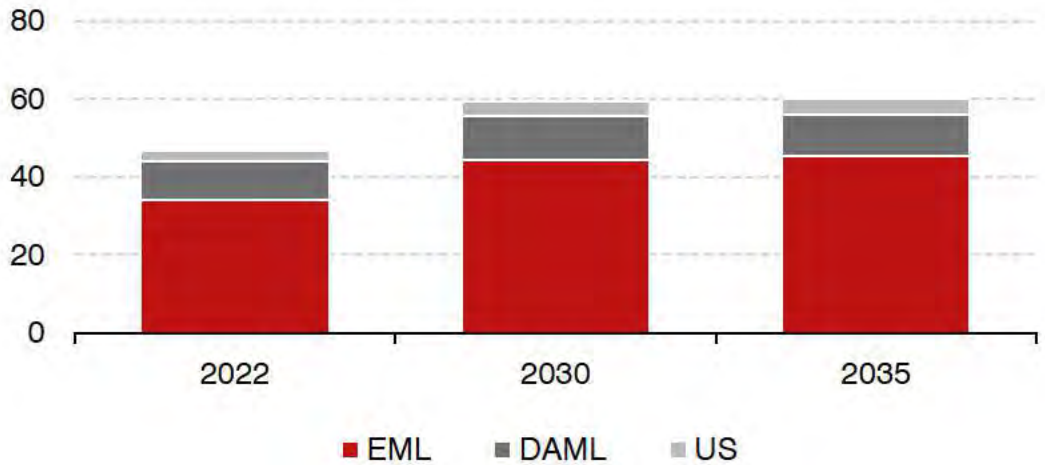
- The **total rail freight transport volume** will be 59.4 million tons in 2030, while the transport volume in 2035 will be only slightly higher at 60.2 million tons.
- The **average train length** in the Netherlands is constantly growing, resulting in less demand for locomotives.
- The **average train weight** for both intermodal and other trains increases, which implies a declining demand for locomotives as less trains are needed for the same volume of goods.

Source: ProRail, WLO forecast, Report "Implementatie van ERTMS in het spoorgoederenvervoer", SCI Verkehr database

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

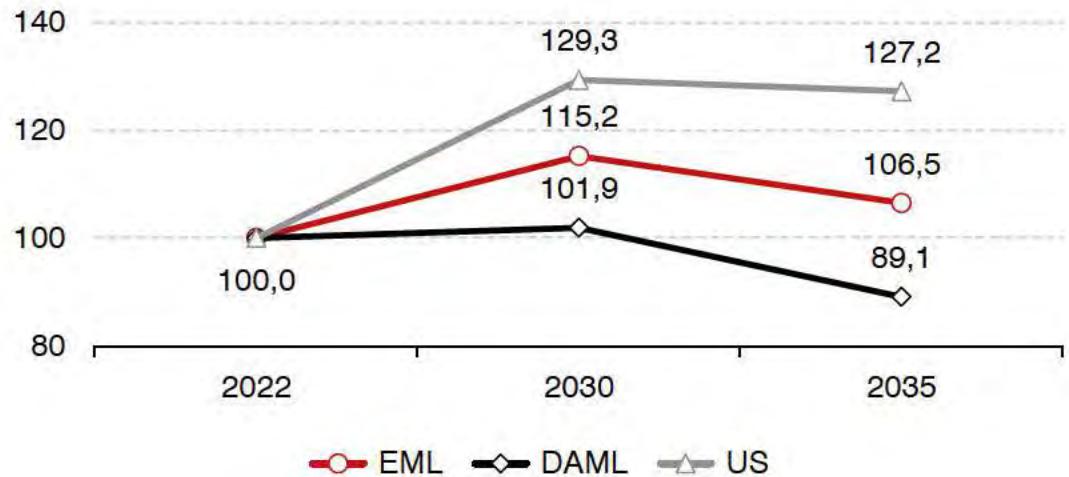
Locomotive fleet 2022-2035: Despite an increase until 2030, the demanded locomotive fleet will decrease afterwards due to lower growth rate of transport volume and increasing efficiency

Rail freight transport in the Netherlands by locomotive type
(2022-2035, million tons)



- The forecast of locomotive demand differentiates three main locomotive types and their respective shares in rail freight transport by commodity type: Electric mainline locos (EML), diesel and alternative mainline locos (DAML) and universal shunter (US).

Demanded locomotive fleet by locomotive type
(2022-2035, percentage points)



- As a consequence of the expected rail freight volume, demand for locomotives will increase until 2030, but drop again afterwards.
- The highest growth is expected for the universal shunter segment, followed by the electric mainline segment. The demand for diesel and alternative mainline locomotives is expected to drop below the 2022 level in 2035.

EML: Electric main line; DAML: Diesel an alternative mainline; US: Universal Shunter

ETCS OBU: The supply with OBUs is highly dependent on very few suppliers and will be a major challenge for locomotive keepers until 2030 – capacity for approval processes additional challenge

1

ETCS on-board retrofit to Baseline 3 becomes necessary in the Netherlands but is quite complex

- Each vehicle (sub)type requires a specific ETCS OBU version which makes retrofits very complex
- ERTMS Baselines and Sub-versions are continuously developed further which creates uncertainty for OBU suppliers

2

Only very few OBU suppliers are really active in the market which shifts market power towards suppliers

- Insufficiently documented interfaces to TCMS and STM‘s make ETCS retrofits a risky black box for OBU suppliers
- The ETCS OBU market is rather not transparent for vehicle owners / operators which makes it hard to find a potential partner for retrofits

3

The problematic situation in the ETCS market will not change fundamentally by 2030

- Capacity constraints of the ETCS OBU suppliers will remain
- Attention must also be paid from the network operator / regulator side to have practicable and streamlined approval processes for ETCS OBU to provide sufficient capacity for testing and approval

"It is not just the OBU, but also other components [like the TCMS] need to be considered."

1

ETCS on-board retrofit to Baseline 3 becomes necessary in the Netherlands but is quite complex

Key takeaways

- Each vehicle (sub)type requires a specific ETCS OBU version which makes retrofits very complex – the main challenge is not in the ETCS but rather in the connection to the TCMS and installed STM's
- Public attention focuses mostly on the different ETCS Levels but ignores that there are also different Baselines and system versions determining compatibility
- ERTMS Baselines and Sub-versions are continuously developed further – OBU miss transparency about next regulatory steps incl. timeframe
- There is a short-term need to equip rolling stock with ETCS Baseline 3 in NL and BE – in DE, FR and LU no such need exists currently because of different ETCS strategies

"OBU development is a people, legacy and documentation business."
"At the end of the day it's a question of demand and supply – and of willingness to take risks."

2

Only very few OBU suppliers are really active in the market which shifts market power towards suppliers

Key takeaways

- Insufficiently documented interfaces to TCMS and STM's make ETCS retrofits a risky black box for OBU suppliers
- The ETCS OBU market is not transparent for vehicle owners / operators – this makes it hard to find a potential partner for retrofits and even harder to receive a (binding) offer
- Only very few suppliers provide ETCS OBU solutions due to high project risks and insufficient capacities – especially regarding skilled personnel
  - Alstom is the market leader for ETCS OBU – BL 3.6 rollout seems to follow an intern roadmap
  - Siemens focuses on ETCS for its new assets – Retrofits are an optional business only
  - The Signaling Company could provide an easy to install solutions in the long-run – as of now a 3.4.0 system is tested
  - Stadler has proven that an on-board installation without OE involvement is possible – no strategy for further development is reported

"If something like OCORA should be implemented, it needs to be well managed, otherwise the suppliers will have big disadvantages and will eventually drop out."

3

The problematic situation in the ETCS market will not change fundamentally by 2030

Key takeaways

- Capacity constraints remain for established suppliers because the suppliers either do not have the capabilities for capacity expansions and / or do not want to expand their capacities
- New suppliers are only entering the market to a limited extent as they would be especially affected from the associated risks with ETCS retrofits and the dependency from skilled personnel
- OCORA is generally interesting but Implementation until 2030 is doubtful as of now because a genuine platform solution with open interfaces must be very well managed
- **Beside the challenges on the supplier side, network operators / regulators need to make approval processes practicable and streamlined for not to create additional costs, efforts and time expenditures**

Economic risks, uncertainty, capacity constraints and financing problems are the main challenges for ETCS OBU supply

Challenges

- Due to the product and market characteristics, there is a high risk for suppliers and vehicle owners / operators to engage in ETCS OBU development
- Rapid and continuous ETCS development creates uncertainty for all stakeholders
- ETCS OBU development and installation is challenging and labour-intensive which leads to capacity constraints
- As ETCS OBU installation does not pay off for vehicle owners / operators, public funding is required

Barriers

Barriers

- Each vehicle (sub)type requires a specific ETCS OBU version
- Interfaces to TCMS and STM's are often insufficiently documented
- The market for ETCS OBU has a monopolistic structure with Alstom being the undisputed leader
- Unforeseeable risks of ETCS retrofit projects for OBU suppliers
- ETCS Baselines and sub-versions are continuously developed further
- There is a high dependency on / a lack of skilled personnel for ETCS OBU development
- Insufficient capacities for R&D and a limited number of workshops to carry out retrofits
- Funding schemes are insufficient and / or application requirements are too high

Possible solution approaches

- Freezing the applicable ETCS baselines for a certain period of time
- Establishing reliability and predictability regarding infrastructure equipment
- Support for training and further education programs including industry-wide exchange
- Support for measures to increase market transparency
- Creation of incentives to improve documentation in the context of subsidized retrofits
- Adaptation of subsidy programs to reduce project risk of operators (e.g., by giving feedback earlier or provide support in discussion with suppliers)
- Optimisation (simplification) of approval process to reduce effort for homologation and testing, e.g. ESC tests.

ETCS OBU: It is essential for the Dutch Ministry of Infrastructure and Water Management to further engage in the topic of ETCS retrofits – regarding finance and regulatory environment

Since retrofits are complex, expensive, risky and the potential benefits only materialize in the long-term, retrofits are usually not economically viable.

Current approval processes are very time consuming which could lead to additional delays on the availability of ETCS OBU

The Ministry of Infrastructure and Water Management should make retrofit projects financially / economically attractive for suppliers

- Continue public funding for ETCS retrofit projects and / or provide alternative mechanisms to mitigate project risks for OBU suppliers (and vehicle owners / operators).
- Consider the given market characteristics (capacity constraints, supplier market etc.) when setting up funding programs.

The Ministry of Infrastructure and Water Management should focus its attention on large fleets, as well as big operators and lessors

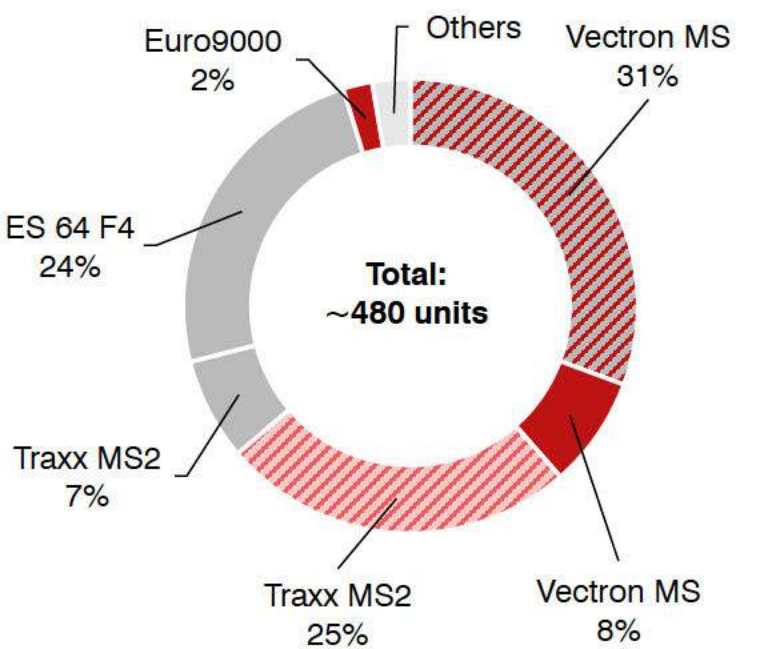
- For small retrofit projects, there is hardly a chance to find a supplier as the associated project risks are too high and economies of scale too low.
- The effort involved in setting up the project or obtaining funding is too great for operators / lessors in small retrofit projects.

The Ministry of Infrastructure and Water Management should make approval processes user-friendly and capable for OBU supplier

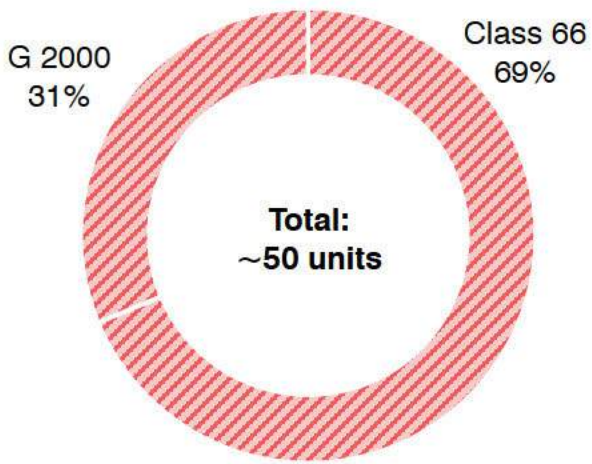
- Beside the challenges on the supplier side, network operators / regulators need to make approval processes practicable and streamlined (limited resources available for certification and testing).
- This is necessary to avoid additional costs, efforts and delays in available ETCS BL3 locomotives.

Locomotives: SCI Verkehr identified a target fleet of approx. 675 locomotives* with 48 ETCS BL 3.4/ BL 3.6 installed, 412 BL 3.4/BL 3.6 contracted, and 213 BL 3.4/BL 3.6 not contracted/installed

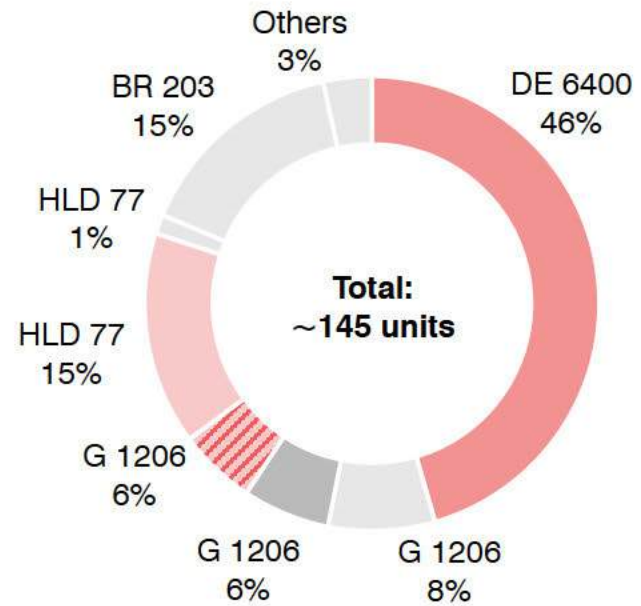
Electric mainline freight locomotive target fleet in 2022 (units)[2]



Diesel mainline freight locomotive target fleet in 2022 (units)



Universal/shunting locomotive target fleet in 2023 (units)

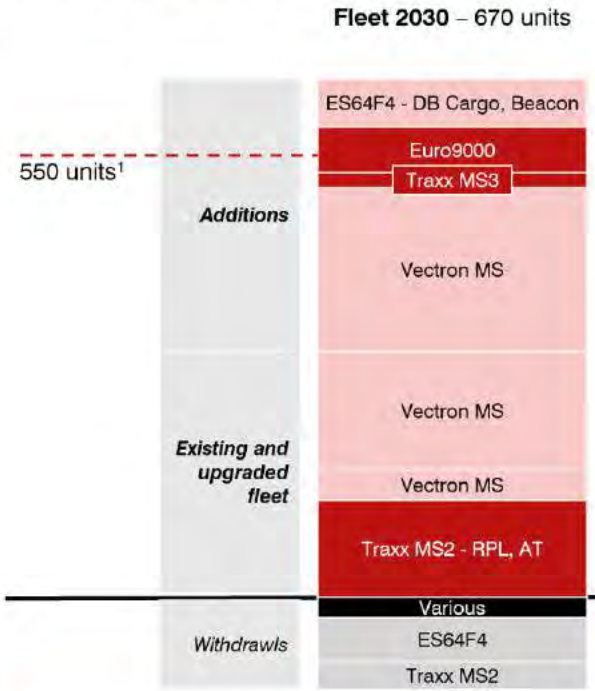


BL 3.4 | BL 2.3 (BL 3.4[1]) | BL 2.3 (BL 3.6[1]) | BL 2.3 | No ETCS | BL 2.3 (BL 3.6 contracted) | (BL 3.6[1]) | (BL 3.4[1]) | BL 2.3 | BL 2.3 (BL 3.6) | No ETCS

1: Retrofit contracted; 2: in line with the rail freight forecast, SCI Verkehr uses the year 2022 as the basis also for the locomotive forecast
* in Dec. 2022.

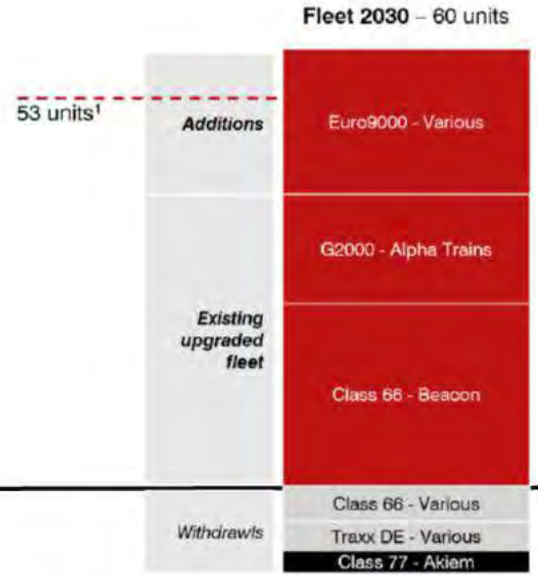
Locomotives: SCI Verkehr estimates that there will be sufficient mainline locomotives available in 2030 under the given framework conditions – special actions required for universal locomotives

Electric mainline locomotives (EML)



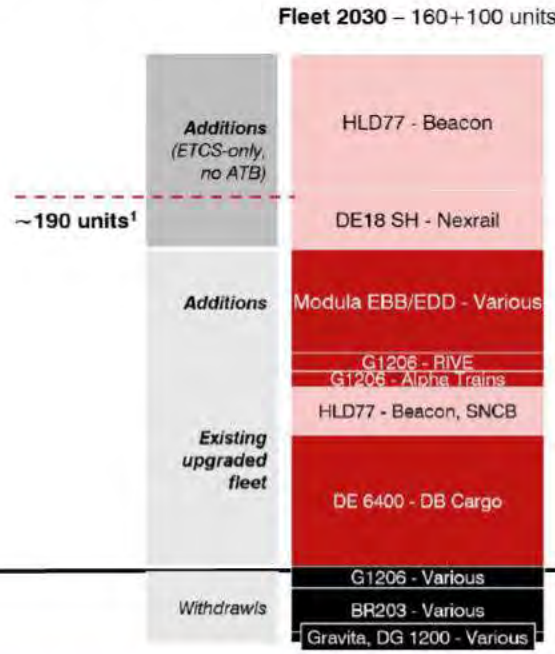
Required target fleet is smaller than the forecasted ETCS BL 3 fleet by SCI and takes different trend – **not the entire SCI forecasted fleet will be needed to cover demand for ETCS locos in NL**

Diesel and alternative mainline locomotives (DAML)



Required target fleet is smaller than the forecasted ETCS BL 3 fleet by SCI, but: **both the Euro9000[2] and the EuroDual would be needed to cover the demand for catenary-free ETCS locos.**

Universal Shunters (US)

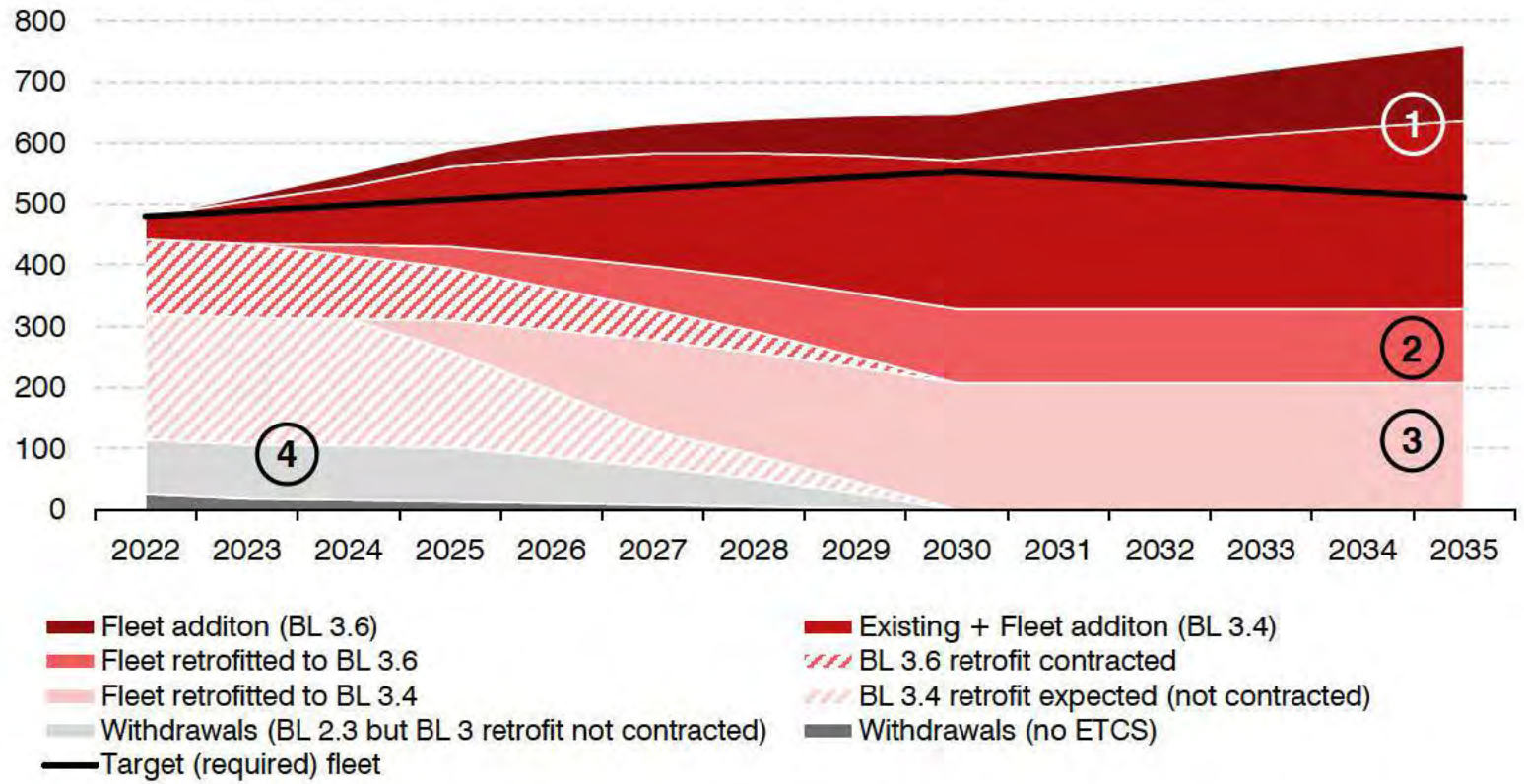


Required target fleet in 2030 will be only large enough to meet the demand under the assumption that **ETCS-only** operation will be possible on BL 3 corridor lines to increase the locomotive supply

1: 2030-demand generated from rail freight forecast; 2: E-mainline locomotive with strong last-mile diesel engines that can replace diesel mainline locomotives
Dark red: BL 3.6 (contracted) | light red: BL 3.4 (contracted) | light grey: BL 2.3 | black: no ETCS

Electric mainline: Contracted as well as expected ETCS retrofit projects accompanied by new fleet additions will be able to cover the demand for ETCS BL 3 assets up to 2030

ETCS electric mainline freight locomotive fleet SCI Verkehr prognose and target fleet[1] (units)



1: Derived on the base of prognosed transport volume in tonnes dedicated to asset type

1. Fleet of existing **BL 3.4** (**Vectron MS**) and new additions of BL 3.4 (Vectron MS) and **BL 3.6** (**Traxx MS3, Euro9000**) – the fleet is forecasted to reach **~320 units in 2030**
2. Assets contracted for **BL 3.6 retrofit** (**Traxx MS2**, ~120 units) – estimated to be retrofitted until 2030
3. SCI Verkehr expects the **older Vectron MS** (BL 2.3) and **parts of the Eurosprinter** fleet (BL 2.3) gradually to be **retrofitted to BL 3.4** until 2030 – these assets are mostly not contracted as of spring 2024
4. **Fleet of BL 2.3 assets** (ES64F4, Traxx MS2) that is **neither contracted for BL 3.4/3.6 retrofit nor expected** – expected gradually to be replaced with retrofitted or new assets

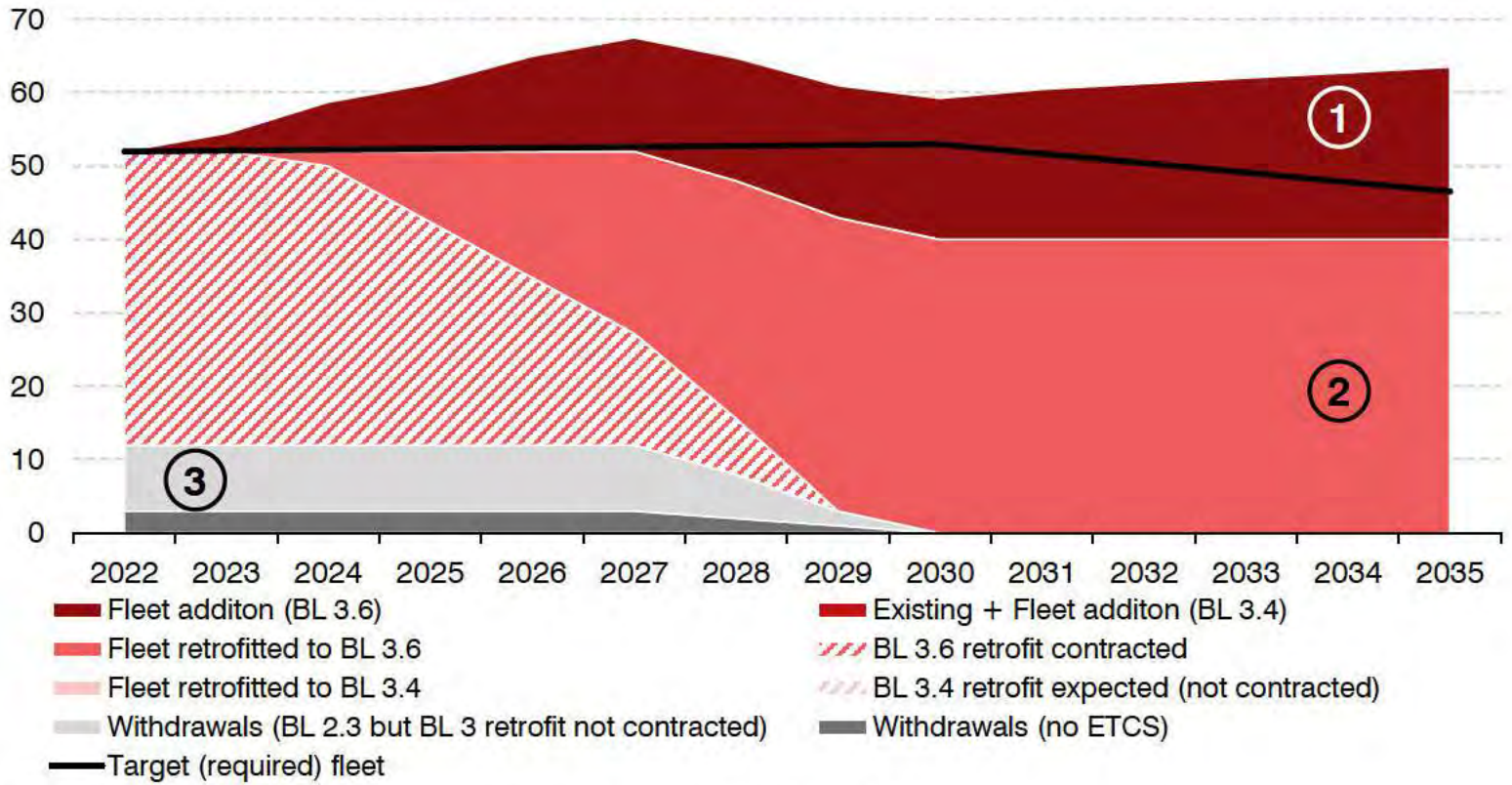
Target fleet[1] is smaller than the SCI Verkehr forecasted fleet and takes different trend – not the entire SCI forecasted fleet will be needed to cover demand for ETCS locomotives in NL

Electric mainline: Focus on Eurosprinter refit (especially DB and Beacon) as well as momentary support for Vectron refit recommended

Type	Relevance for operation	ETCS status	Rationale/Recommendation
Vectron MS	• **Very popular** among operators and most widespread and demanded corridor asset in for international operation in Europe • In the fleet of various operators and lessors	• A large number is on order with BL 3.4 as of spring 2024 • However, most existing assets are equipped with **BL 2.3 only** – some retrofit contracts or contract option in place	• To secure overall operability of the Vectron MS fleet in NL**, BL 3.4 retrofits should be supported monetarily by extending subsidies for BL 3.4 retrofit.** Financial support for delivered or ordered Vectron's before July 2017 should be sufficient.
Traxx MS2	• **Large fleet** of widespread locomotive type operating in NL • Widespread locomotive type especially in the fleet of lessors Railpool, Alpha Trains and Akiem	• Alpha Trains and Railpool with fix contracts and fixed schedule for BL 3.6 refits that will be ready before 2030 • It is expected that Akiem will also contract ETCS refit for Traxx MS2 soon	• Due to the necessary change from EBICab to Atlas, the most important lessors must refit the Traxx MS2 fleet to BL 3.6. • **No additional action required.**
Eurosprinter	• **Large mid-aged fleet** with importance for Dutch rail freight transports • Three important owners with DB Cargo, Beacon and Akiem	• So far, Beacon hosts **two first-in-class prototype** locos for BL 3.4 (ex MRCE). • DB Cargo and Akiem would like to upgrade generally but not receiving reasonable offers (high uncertainty) from Alstom.	• **Focus on DB** to check possibilities for **first-in-class** and **series subsidies to reduce risk of losing transport** (DB: 50% market share in NL). **BL 3.4 refit must be completed until the end of 2029.** • **Convince Beacon to sign contract for serial upgrade during 2024.**
Euro9000	• Small but increasing new fleet	• New deliveries with BL 3.6	• **No action required**

Diesel and alternative mainline: Euro9000 and the EuroDual would be needed to cover the demand for catenary-free ETCS BL 3 assets up to 2030 – 2022-fleet is not enough due to expected withdrawals

ETCS diesel mainline freight locomotive fleet prognose (units)



1: Derived on the base of prognosed transport volume in tonnes dedicated to asset type

1. New additions with **BL 3.6** (**Euro9000**) – the fleet is forecasted to reach ~**20 units in 2030** and ~**25 in 2035**

2. Fleet of lessors Beacon Rail and Alpha Trains contracted for **ETCS BL 3.6** (**G 2000**, ~15 units, and **Class 66**, ~25 units) retrofit – 4 years estimated retrofit duration, 2025-2030

3. Fleet **currently not contracted for BL 3 retrofit**, ~**10 units** in 2023 – expected **gradually to be replaced with retrofitted/new assets**, to fully extent **until 2029**

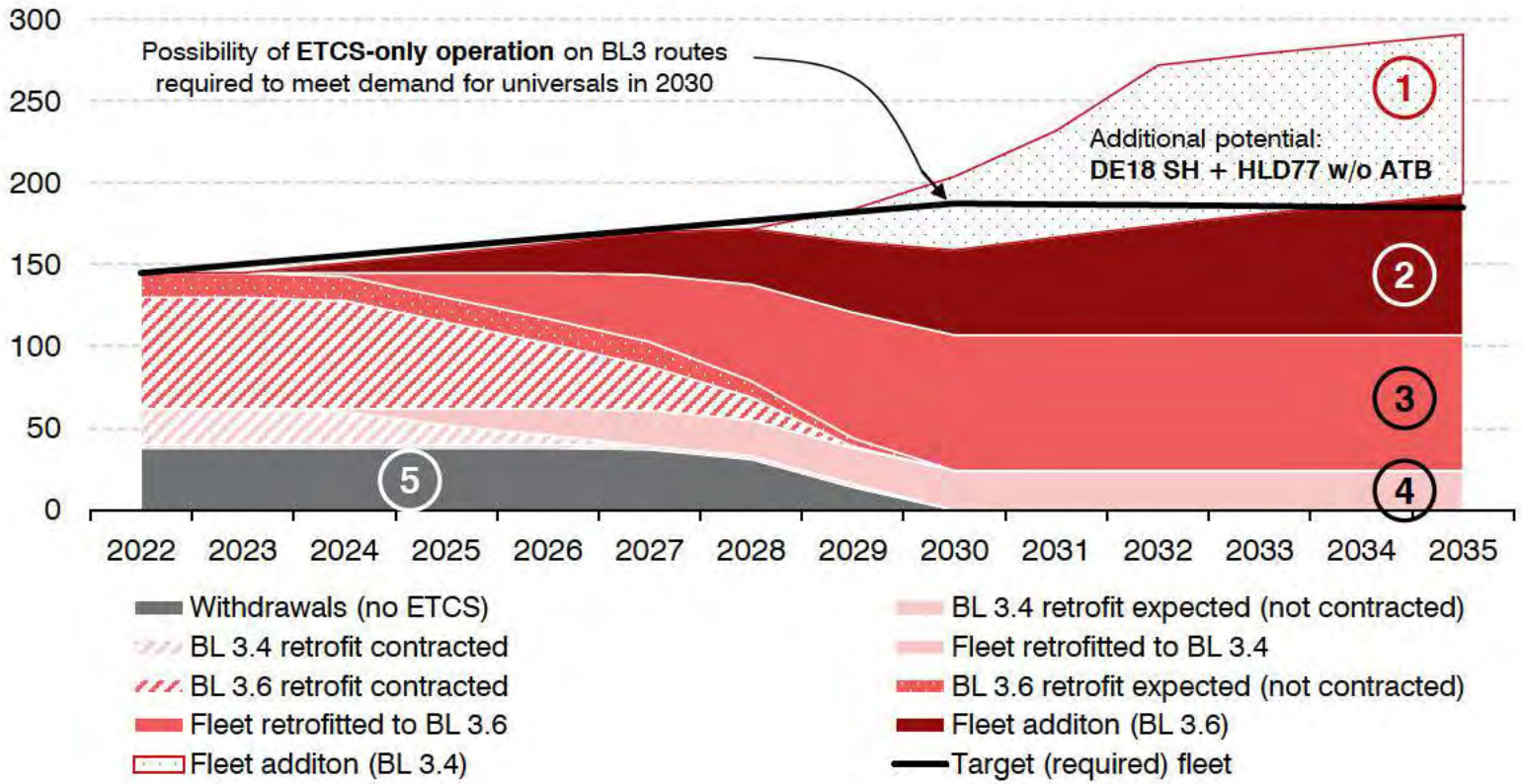
The target (required) fleet[1] is smaller than the SCI Verkehr forecasted fleet and takes different trend, but: both the Euro9000 and the EuroDual would be needed to cover the demand for catenary-free ETCS BL 3 assets up to 2030 – the 2023-operating fleet is not sufficiently large due to expected withdrawals.

Diesel and alternative mainline: Class 66 and G2000 locomotives will be equipped with ETCS BL3 until 2030 – Focus on supporting EuroDual ETCS-only operation to increase available fleet size

Type	Relevance for operation	ETCS status	Rationale/Recommendation
Class 66	• Around 30 units estimated for deployment in NL as primary operation area • Main owner is Beacon that also manage approx. 10 Class 66 locos from other operators.	• The prototype installation with Alstom Atlas Baseline 3.6.0 is complete; testing should be finalized by the end of 2024. • All 34 locomotives that Beacons owns and manage are contracted.	• Class 66 equipment with new Atlas BL 3.6 is on track with finalisation expected before 2030. No possibility to equip more Class 66 locos with ETCS BL 3. • **No additional action required.**
G2000	• Around 15 units estimated for deployment in NL as primary operation area • Main owner is Alpha Trains	• The 2021-contract with Alstom/ Bombardier for retrofit of 77 locomotives to BL 3.6 includes G 2000 locomotives	• G2000 locos from Alpha Trains will be readily equipped with new Atlas BL 3.6. • **No additional action required.**
EuroDual	• So far not relevant for operation in the NL • Lessor ELP intends to authorize its DE/AT-homologated EuroDual for the Betuwe route already up to 2025 • Very interesting for DE/AT operators to increase the available fleet in the NL.	• New locomotive and equipped with ETCS BL 3 that is sufficient for operation on ETCS-only lines in the Netherlands (without the ATB system) .	• **The ministry is recommended to further support the initiative of ETCS-only operation in the Netherlands**. • However, as this is also associated with initial costs, the ministry should **review a first-in-class subsidy** also for the EuroDual locomotive.
Euro9000	• E-loco that will replace some diesel locos	• New deliveries with BL 3.6	• **No action required.**

Universal and heavy shunting: Fleet in 2030 will be sufficiently large to meet the demand under the assumption that ETCS-only operation will be possible on BL 3 corridor lines to increase supply

Universal/shunting locomotive fleet prognose (units)



1. Belgian **DE18 SH and HLD77** (BL 3.4) w/o Dutch ATB can increase supply on corridor lines – **prerequisite: ETCS-only** operations are possible and prepared in 2030
2. New **Modula** assets (in the long-term new universal locomotives like the Traxx shunter as well) will enter the market with **BL 3.6**
3. A large fleet of **DE 6400** (mainly **DB Cargo**) **and Alpha Trains' G1206 fleet** will be **retrofitted to BL 3.6**
4. **HLD77 with** Dutch **ATB** on board will be retrofitted with **BL 3.4** (mainly for **Lineas**)
5. Mainly outdated **BR203** locomotives **will leave the fleet** that is able to operate along the Dutch mainline – "behind the fence"-operation likely beyond 2030

Universal fleet in 2030 will be sufficiently large to meet the demand under the assumption that ETCS-only operation will be possible (and prepared) on BL 3 corridor lines to increase the locomotive supply

Universal and heavy shunting: BR 203, DE6400 and G1206: DE6400 will remain the backbone fleet, BR 203 will be taken out of service and fleet size of G1206 will decrease until 2030

Type	Relevance for operation	ETCS status	Rationale/Recommendation
BR 203	• 22 BR 203 for NL homologated locos are expected to be withdrawn from the overall target fleet, but **to remain deployed within closed networks (yards)** where no ETCS is required **from 2030 on**	• No unit contracted for ETCS BL 3 retrofit – the **series is not sufficiently distributed in terms on fleet size and too outdated in terms of performance**	• BR 203 fleet will be withdrawn from mainline operation and probably used in shunting yards (no ETCS required). • **No action required.**
DE6400	• With 66 locos largest fleet with high relevance for NL operation. • Main owner is DB Cargo with 60 locos	• Signed contract with Alstom in 2021 for DE 6400 fleet ETCS retrofit (BL 3.6) for services in the Netherlands and Belgium will be ready before 2030.	• DE6400 will remain a backbone of the universal and heavy shunting fleet in NL with new Alstom Atlas BL 3.6 • **No action required.**
G1206	• With 28 locomotives operational in the NL, important fleet of universal locomotives. • G1206 is the most widespread universal locomotive type in Europe, especially DE. • Main owners are Alpha Trains and RIVE.	• The 2021-contract from Alpha Trains for retrofit of 77 locomotives to BL 3.6 includes 8 G 1206 locomotives. • 9 additional locos are equipped with BL 2.3 and 11 G1206 are not equipped with ETCS. • The 9 locos with BL 2.3 is not contracted for retrofit so far but could follow.	• The G1206 fleet in the NL will decrease in the coming years as 11 locos without ETCS will be taken out of service. • Also, this locomotive type is currently highly demanded in DE without requirements of ETCS installation. • **Additional action could be to support/convince RIVE to install ETCS.**

Universal and heavy shunting: Hld 77, DE18 SH and Modula: SCI Verkehr recommends to include Hld 77 and DE18 SH for ETCS only operation in subsidy program to extend available fleet

Type	Relevance for operation	ETCS status	Rationale/Recommendation
Hld 77 (incl. ATB)	• 20 locomotives of Lineas Hld 77 fleet are equipped with ATB for operation in NL.	• Contract with **signalling company** for 20 Hld 77 includes NL-homologation, but focus is on Hld 77 for Belgium operation.	• 20 Hld77 locos will be equipped with ETCS BL 3.4 for operation in NL. • **No action required.**
Hld 77 (excl. ATB)	• Lineas operates in total **109 Hld 77** locomotives owned by Beacon Rail that is the largest shunting fleet in BeNelux.	• Lineas ETCS retrofit program for **88 units** signed in 2020 with signalling company. • There will be a **large fleet of HLD 77 locos in Belgium with ETCS BL 3.4**	• The large Hld 77 fleet in Belgium could be **further potential** for ETCS-only operation • Check **first-in-class support** for ETCS-only operation to support mod. and tests.
DE18 SH	• DE18 **SmartHybrid** (SH) version is ordered by **Nexrail in larger quantities.** • DE 18 **SmartHybrid will remain the most modern universal locomotive** with a powerful diesel engine in the BENELUX market and **production will continue.**	• The DE18 SH will feature the **Belgian homologation incl. ETCS BL 3.4 but will not have the NL homologation or ATB.**	• SCI Verkehr recommends to **provide support for the DE18 SH as well** to increase the supply on BL3 ETCS-only corridor lines as (Belgian) operators would then be able to offer transports in the Netherlands as well.
Modula	• New platform for operation with and without catenary, ordered mainly by leasing companies RIVE and Railpool	• ETCS-ready and will feature new Siemens' Trainguard communication-based train control	• **No action required.**

Commercial risks, high order backlog and lack of competition are the main challenges for locomotive operators/keepers

Challenges

- The **commercial risk** for ETCS retrofitting for a relatively small market is still high, despite generally attractive subsidy program in the Netherlands
- ETCS-OBU suppliers may not be able to meet their **timetables** for existing and upcoming **ETCS upgrades;** capacity for **testing and homologation** is limited as well
- Large number of **different stakeholders** with different interests prevent swift adjustments to general framework

Barriers

Barriers

- Limited **capacity** and **resource** of:
  - ETCS OBU-suppliers
  - Notified bodies and infrastructure managers
- High **order backlog** and **no real competition** of supplier (OBU-supplier, locomotive OEM)
  - Insecure contractual situation or no complete and attractive offers
  - High refit costs but no real operational and commercial advantages
- A retrofit cycle for all vehicles takes longer than the planned timescales for implementing new ETCS versions

Possible solution approaches

- Mitigation of commercial risks taking into account ETCS-only operation and changing contractual conditions between OEMs and locomotive owners.
- Building the **necessary capacities and procedures** to put all vehicles into operation on time especially for vehicles with BL 3.4 ETCS equipment, which must be approved by the end of 2029.
- Ensure a **reliable schedule** with sufficient advance schedule (based on infrastructure planning) for the industry and operators and generally equalise it in a longer term.
- **New market participants** for ETCS-OBU supply could be encouraged e.g., by support with navigating STM requirements, sufficient capacity for homologation, etc.

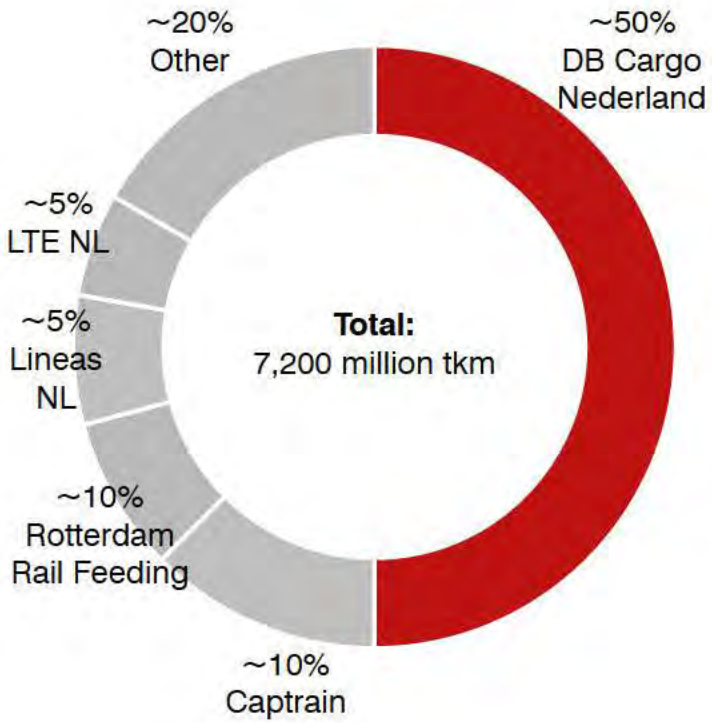
2

Rail freight forecast and determining factors

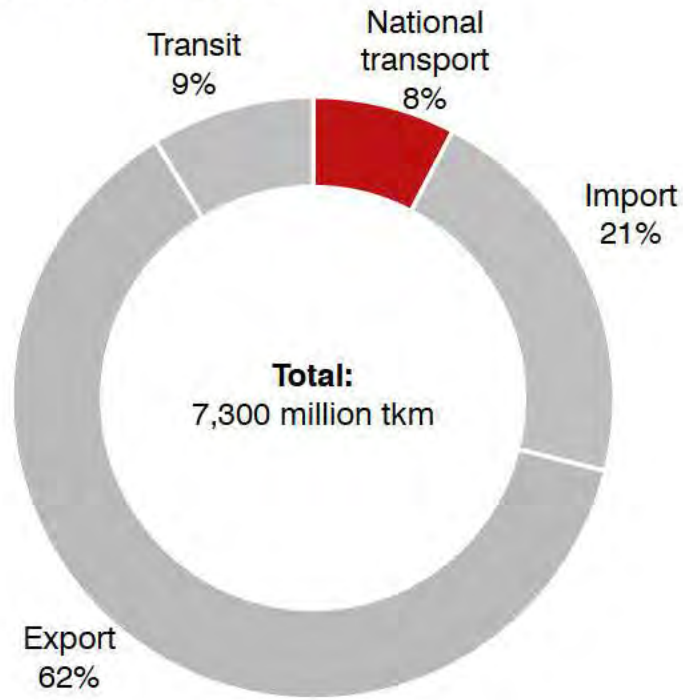
Market Structure

The Dutch rail freight market is comparatively small and very internationally orientated

Market shares rail freight operators in the Netherlands 2022 (tkm)



Market structure rail freight transport in the Netherlands 2022 (tkm)



- The Dutch rail freight market is **relatively small**. In 2022, it contributed less than 2% of the overall rail freight transport in Europe.
- Due to the size of the country and the importance of the port of Rotterdam, **international transport chains** are especially important. Less than 10% of all rail freight in the Netherlands is for domestic purposes.
- This is also reflected in the operator structure: **Dutch subsidiaries of German, French and Belgian rail operators dominate the market.**
- The biggest railway operator in the Netherlands is **DB Cargo Nederland**, which is the successor of former incumbent NS Cargo.

Source: SCI database

Between now and 2031, ProRail will introduce ERTMS BL 3 on seven mostly international sections

Source: ertms.nl

- ERTMS is already implemented on about 10 percent of the Dutch railway network. This includes the Betuwe line, the Rotterdam harbour line, the HSL-South line, the Hanze line and the Amsterdam - Utrecht section. These sections have ERTMS Level 2 Baseline 2, except for the Rotterdam harbour line, which is equipped with ERTMS Level 1.
- The railway sections that are foreseen for upgrade to ERTMS BL 3.6.0[1] are:
  - OV SAAL east, with the lines Weesp – Lelystad and Amsterdam – Weesp – Hilversum, without railway yard Amsterdam Central Station
  - Hoofddorp – Duivendrecht (including Schiphol)
  - Utrecht – Meteren (excluding the emplacement Utrecht)
  - Kijfhoek – Belgian border
  - Roosendaal – Den Bosch (including Zevenbergschen Hoek and Tilburg – Boxtel).
  - Meteren – Eindhoven
  - Eindhoven - Venlo
- In 2050, all trains and railway infrastructure in the Netherlands must be converted. Other member states of the EU are also installing ERTMS.

1: ERTMS BL 3.6.0 allows the operation of trains with ERTMS BL 3.4 on-board units installed

Methodological approach

Methodology and pre-requirements for impact assessment of rail freight forecast and other determining factors

1. Baseline

- Assessment of current supply and demand as baseline for demand development: Today's supply is reference point for further development.
- Assumption of equivalence between supply and demand: today's fleet meets today's rail transport demand.

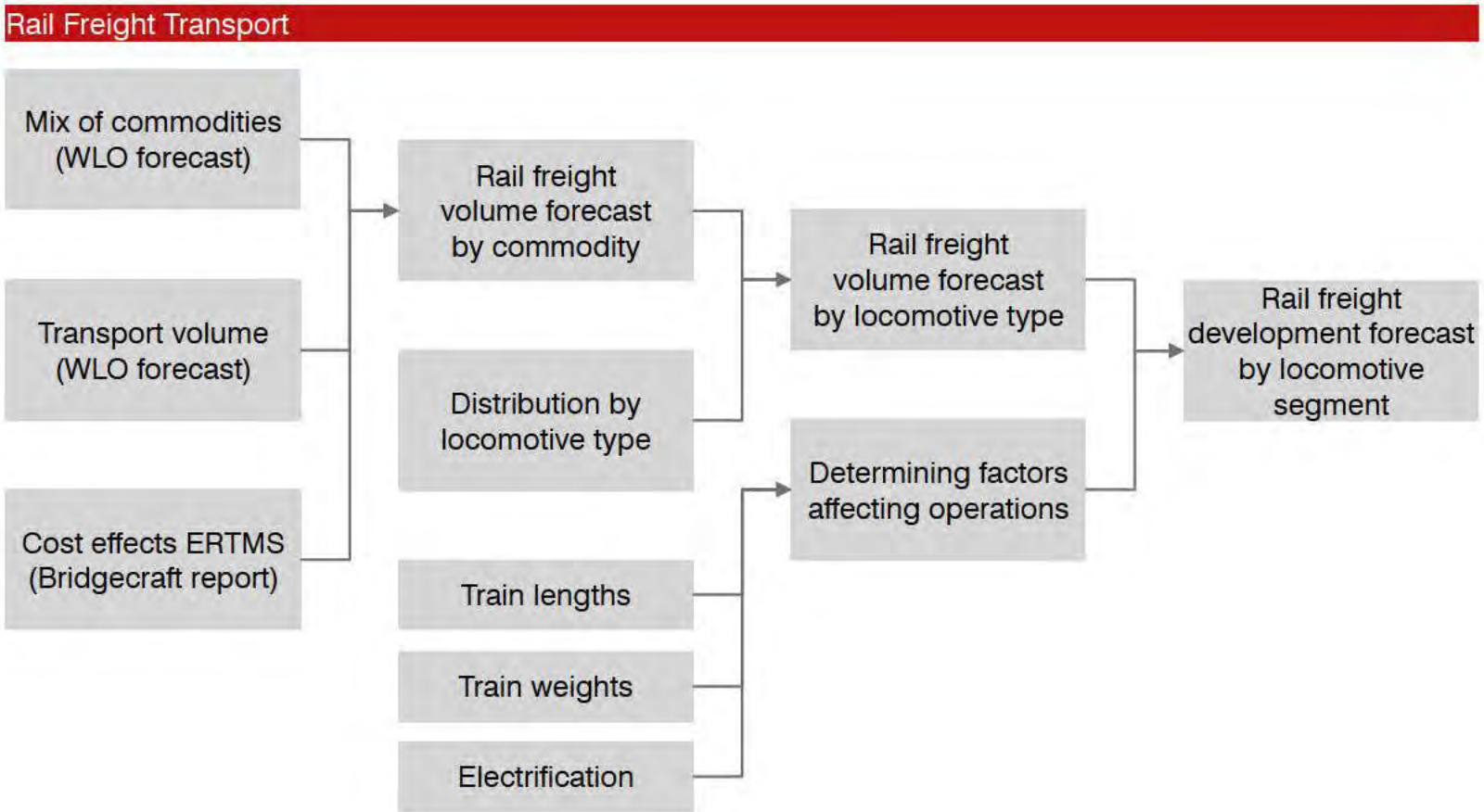
2. Influence of determining factors

- Pre-requisite from client: Transport growth based on WLO forecast.
- Identification of other determining factors.
- Trend analysis for individual determining factors.
- Quantification of influence on future demand.

3. Impact on demand

- Calculation of overall impact of influencing factors on future demand by commodity and train type.
- Assessment of effect on locomotive supply needed in 2030/2035.
- Provides input for calculation of required future locomotive fleet forecast.

Methodology rail freight transport forecast: Transport volume, mix of commodities and determining factors influence the future demand for locomotives

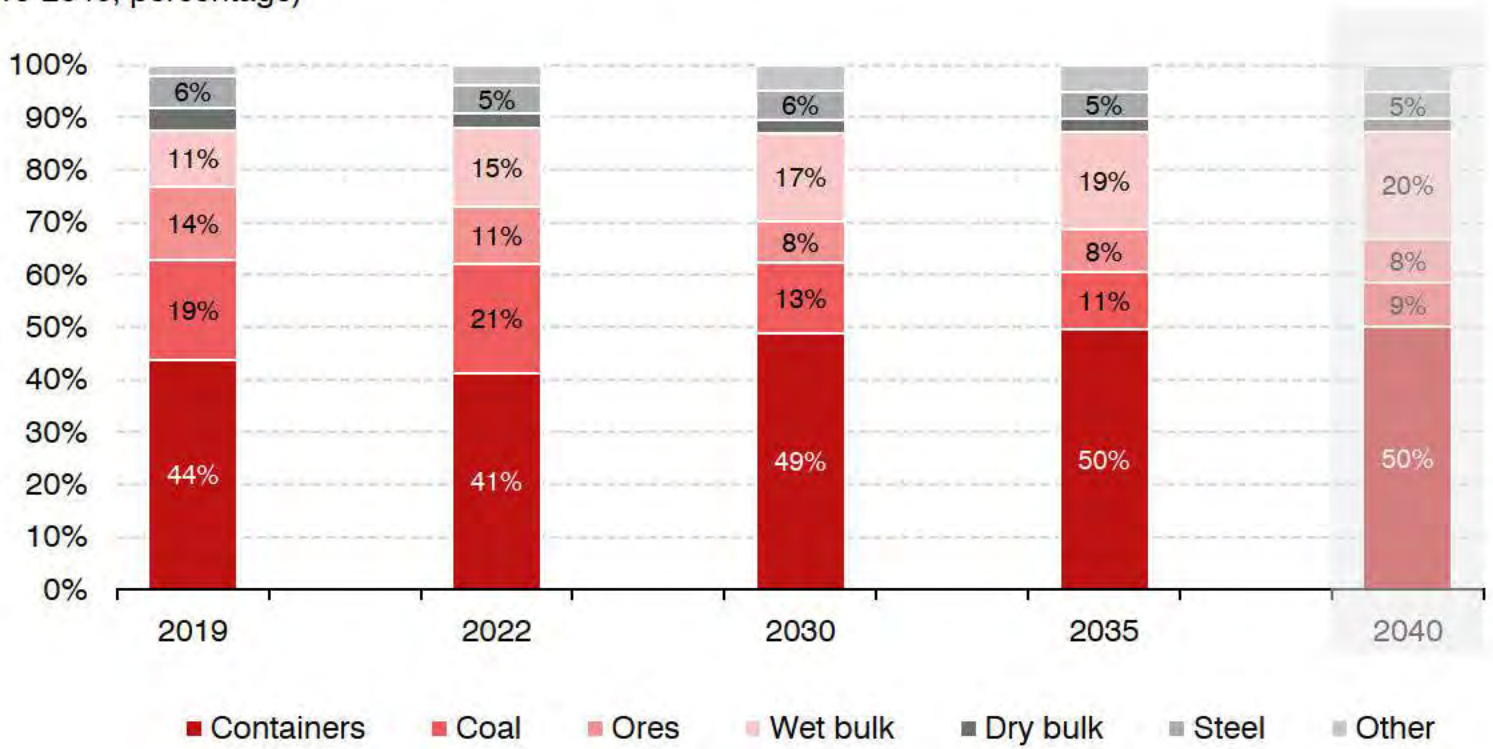


- The rail freight development forecast takes seven commodities and three locomotive segments into account.
- The result is based on three steps:
  - **Rail freight volume forecast by commodity:** Based on WLO Forecast of the Dutch government.
  - **Rail freight volume forecast by locomotive type:** Based on rail freight volume forecast by commodity and distribution by locomotive type based on ProRail transport matrix for rail freight.
  - **Rail freight development forecast by locomotive type:** Based on rail freight volume forecast by locomotive type and determining factors affecting operations (train length, train weights, electrification).
- The introduction of the Digital Automated Coupling (DAC) was investigated as a possible determining factor. However, due to the high uncertainty regarding the introduction, it was decided to exclude the effects.

Influence of determining factors

Mix of commodities: Containers and wet bulk will gain market shares in rail freight transport, while the market shares of coal and ores will decrease

Rail freight commodity shares in the Netherlands
(2019-2040, percentage)

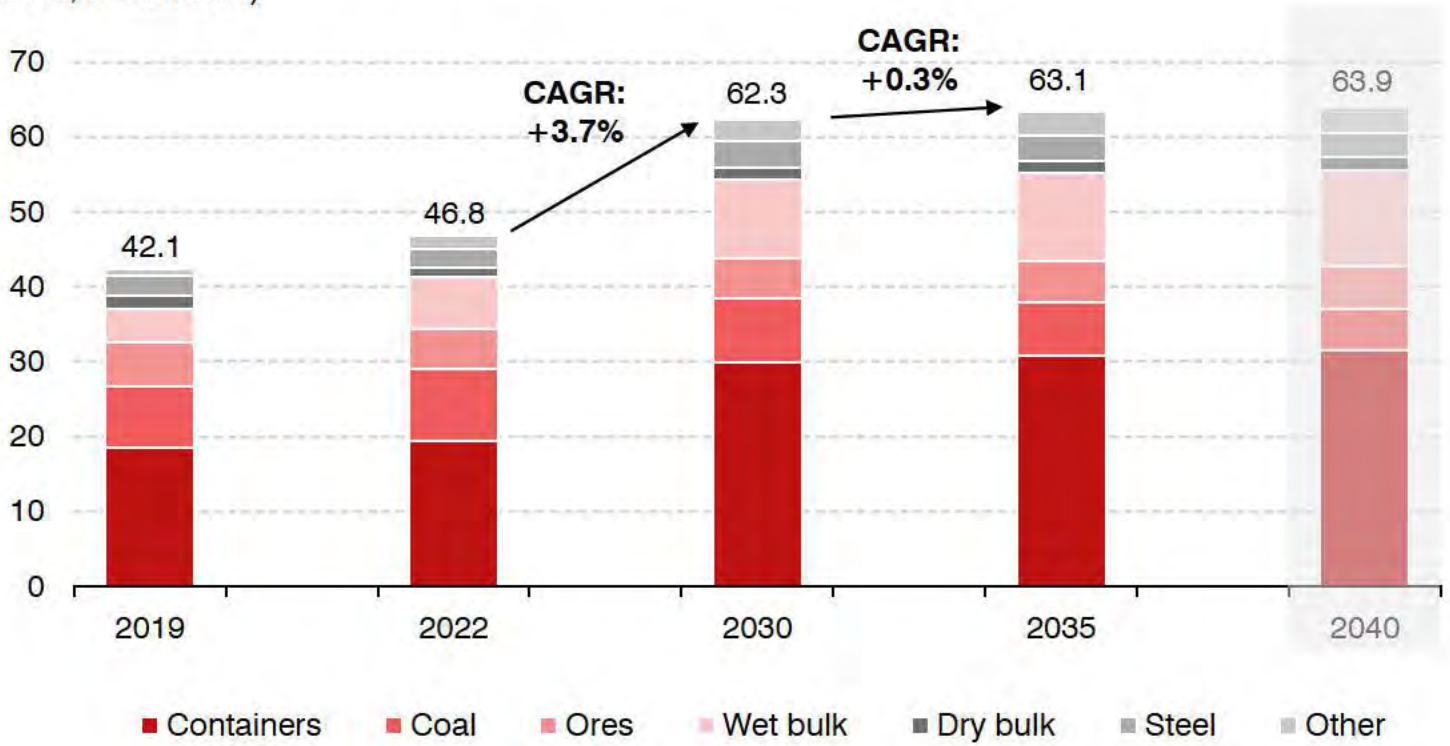


- Differentiation in seven goods types:
  - **Containers:** Maritime containers (mostly port hinterland), semi-trailers, swap bodies
  - **Coal:** Bulk transport of coal and biomass
  - **Ores:** Bulk transports of metal ores
  - **Wet bulk:** Liquids in tank waggons and tank containers, mostly chemicals
  - **Dry bulk:** Bulk transport of dry goods like lime and grain
  - **Steel:** Transport of steel products (coils, pipes, sheets etc.)
  - **Other:** All other transport goods
- The mix of goods is expected to shift further until 2030/2035. Containers and wet bulk are expected to grow in relative importance while coal and ores will lose out.
- Dry bulk, steel and other commodities will remain of lower significance for the overall rail freight transport demand.

Source: 2019/2022: ProRail; 2030/2040: WLO forecast; 2035: Calculation SCI Verkehr

Transport volume: WLO forecast foresees steep growth until 2030 and moderate growth between 2030 and 2035, while operators are less optimistic about growth rates

Rail freight commodity shares in the Netherlands
(2019-2040, million tons)



- The WLO High forecast assumes a compound annual growth rate (CAGR) of +3.7% between 2019 and 2030 and a CAGR of +0.3% between 2030 and 2035 for rail freight transport demand in the Netherlands.
- The operators reported changes since 2019 in the market that might affect rail freight market growth in the Netherlands:
  - Especially demand for coal, intermodal and wet bulk transports is currently seen as under pressure.
  - Rotterdam is perceived to be in competition with other ports regarding market share for these goods.

CAGR loco demand:	**2022 – 2030**	**2030 – 2035**
All locomotive types:	+ 3.7 %	+ 0.3 %

Source: 2019/2023: ProRail; 2030/2040: WLO forecast; 2035: Calculation SCI Verkehr

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Cost effects (1/2): Demand for rail freight transport services for containers, dry bulk and steel will be hit by cost increase due to ERTMS BL 3 introduction

Cost effects of ERTMS BL 3 introduction on rail freight volume in the Netherlands

Commodity	Growth WLO 2022-2030	Cost Effect 2030	Resulting Effective Growth
Containers	+54%	-8%	+43%
Coal	-10%	-2%	-12%
Ores	+2%	0%	+2%
Wet bulk	+49%	-2%	+46%
Dry bulk	+31%	-5%	+23%
Steel	+42%	-5%	+35%
Other	+59%	-2%	+56%
Total	**+33%**	**-5%**	**+27%**

Voices from the sector

"We will have to pay 10% more for locomotives with BL 3 upgrade without significant increase in operational parameters."

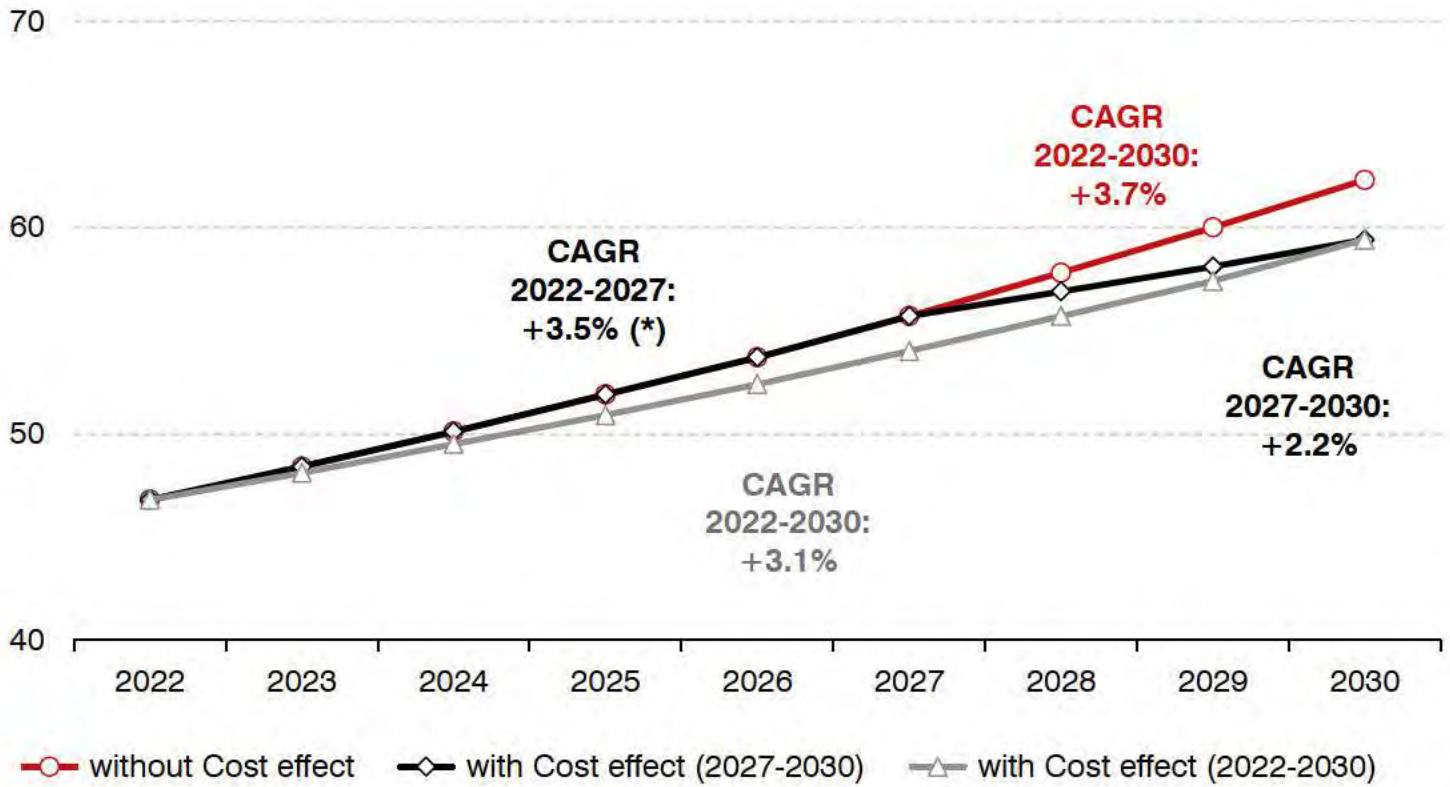
"The old locomotives are still needed. Therefore they have to be retrofitted to ERTMS BL 3."

- Due to the invest into new ERTMS on-board units (OBU) and/or new locomotives, rail freight transport services will increase in cost. These cost increases will dampen demand from shippers.
- The 2021 Bridgecraft report "Implementatie van ERTMS in het spoorgoederenvervoer" estimates the cost effects of the introduction of ERTMS BL 3 on demand for rail freight transport by commodity type:
  - **Containers:** - 8 % by 2030
  - **Coal:** - 2 % by 2030
  - **Ores:** 0 % by 2030
  - **Wet bulk:** - 2 % by 2030
  - **Dry bulk:** - 5 % by 2030
  - **Steel:** - 5 % by 2030
  - **Other:** - 2 % by 2030
- These cost effects were annualised and incorporated in the transport volume forecast.

Source: Report "Implementatie van ERTMS in het spoorgoederenvervoer"

Cost effects (2/2): The cost increase leads to a growth rate decrease between 2027 and 2030 that needs to be incorporated in the rail freight demand transport forecast

Comparison of transport growth for different scenarios (2022-2030, million tons)



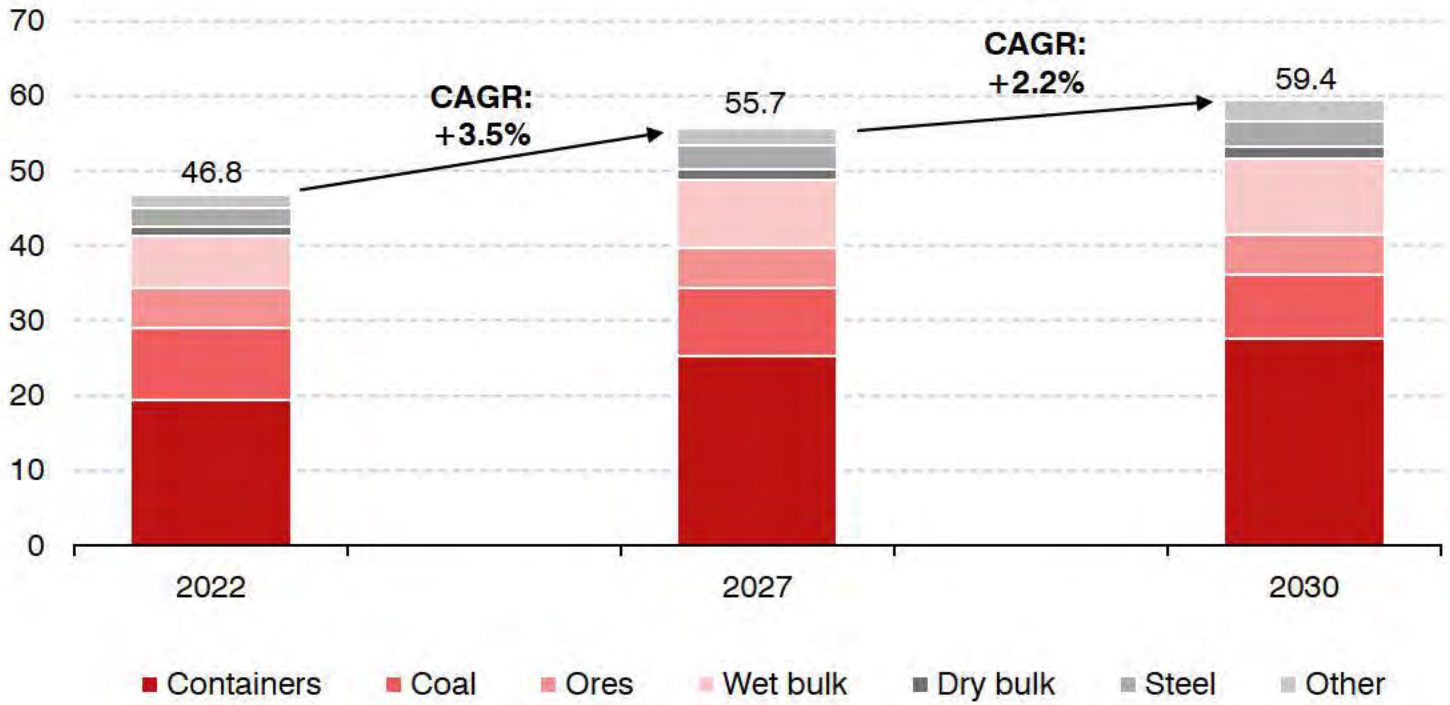
- As the cost effect will not come into effect before 2027, demand growth according to the WLO forecast will not be affected before that date. The annualised effect between 2027 and 2030 would lead to a reduced growth rate of +2.2% for this period.
- However, mathematically it is also possible by annualising the effect over the whole period between 2022 and 2030 (see graph). This would lead to a reduced growth rate of +3.1% for the period or -0.6% compared to the growth without the cost effect.
- As all other parameters do not change between 2022 and 2030, the second approach was used for the calculation of the effect on rail freight transport demand.

CAGR loco demand:	**2022 – 2030**	**2030 – 2035**
All locomotive types:	- 0.6 %	0.0 %

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)
(*) Note that the CAGR for 2022-2027 is below 3.7% due to mathematical effects of individual growth rates for each commodity.

Rail freight volume forecast by commodity: The cost effect decreases the WLO forecast volume for the year 2030 by 6%, affecting especially the growth of coal, container transport and dry bulk

Rail freight commodity shares in the Netherlands
(2019-2040, million tons)



- The cost effect will decrease the growth of rail freight transport volumes between 2027 and 2030 to +2.2% p.a.
- Therefore, the total rail freight transport volume in 2030 will be 59.4 million tons instead of 62.3 million tons without the cost effect, a decrease of over 6%.
- The most hit commodity groups will be coal, which will decrease by almost 50% more than without the cost effect, and containers and dry bulk, which lose half of their growth potential.

Source: 2019/2023: ProRail; 2030/2040: WLO forecast; 2035: Calculation SCI Verkehr

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Distribution by locomotive type (1/2): Analysis of rail freight traffic flows in the Netherlands

- Is the region accessible by electric mainline locomotive?
- What good types are transported from/to region?

# goederentreinen per HB 2022 (afgerond 50-tallen)		Naar														
		Amsterdam	Beverwijk	Blerick	Eijsden grens	Oldenzaal grens	Noord Nederland	Roosendaal grens	Rotterdam (incl. Kijfhoek)	Sittard	Sloe	Tilburg	Venlo grens	Zevenaar grens	Zwaluwe (Moerdijk)	Overig
Van	Amsterdam	X	100			150			300				200	800		200
	Beverwijk	250	X		250	50		50	250					200		<50
	Blerick			X					1.300	150				50		450
	Eijsden grens		250		X		100			300			<50			<50
	Oldenzaal grens	150	100			X	50	650	1.450		100	100			50	400
	Noord Nederland				100	50	X		200							50
	Roosendaal grens		50			650		X	950				1.550	850	100	150
	Rotterdam (incl. Kijfhoek)	300	400	1.300		1.450	200	800	X	400	500	250	4.250	11.300	1.000	1.000
	Sittard			150	350				250	X			650	50	100	600
	Sloe					150			350		X		650	150		<50
	Tilburg					100			250			X		250		50
	Venlo grens	200		600	<50			1.600	4.100	600	450		X		150	450
	Zevenaar grens	800	200	50				650	10.950	50	150	250		X	50	150
	Zwaluwe (Moerdijk)					50		100	900	100			150	50	X	100
	Overig	200	<50	450	<50	350	50	200	1.100	600	50	<50	300	100	100	X

Example:

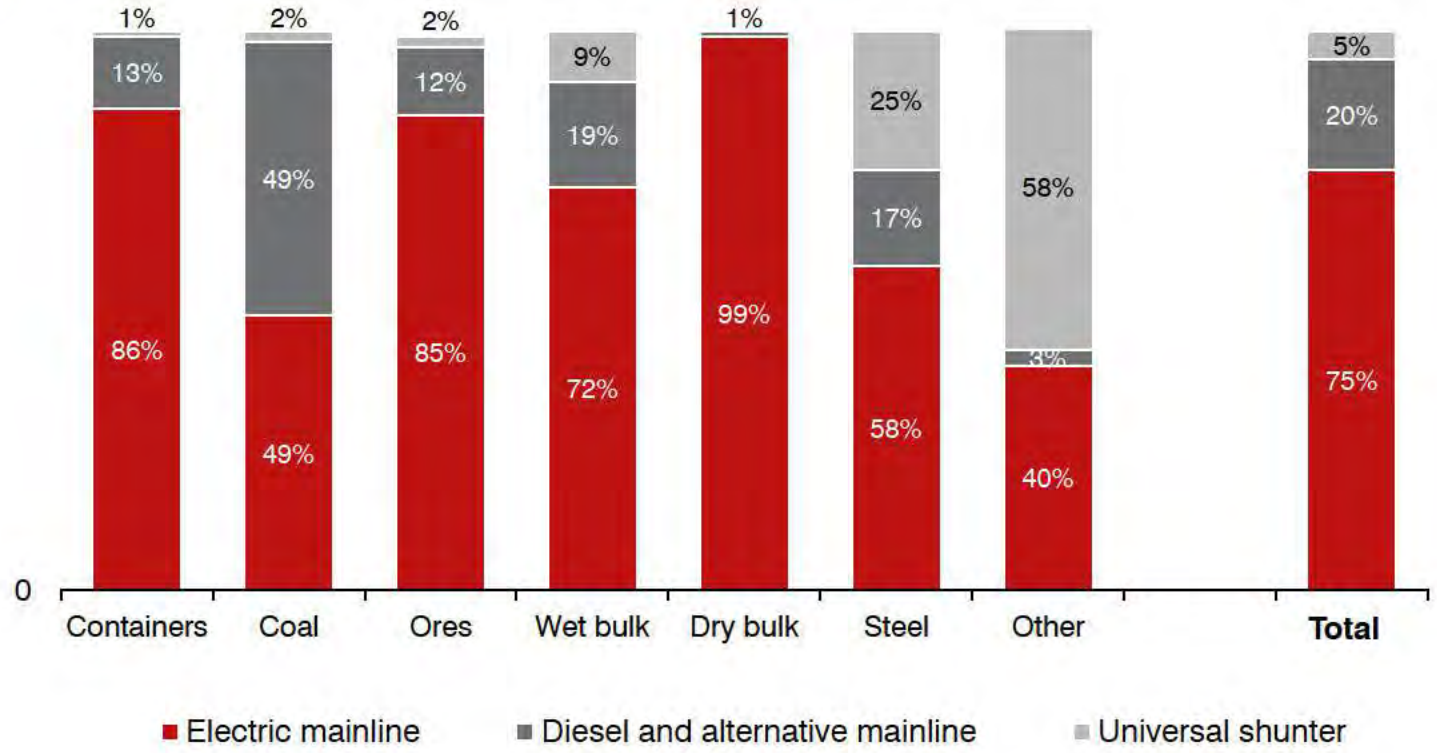
- Noord Nederland accessible mainly by diesel and alternative locomotives
- Mostly wet bulk
- **Assumption: 800 diesel mainline trains wet bulk / year**

Information from model trains from Bridgecraft report reflected and incorporated as well!

Source: ProRail Jaarrapport 2023; Report "Implementatie van ERTMS in het spoorgoederenvervoer"

Distribution by locomotive type (2/2): Transport flows, regional client structures and catenary availability influence operational use of locomotive types

Rail freight transport in the Netherlands by commodity and locomotive type
(2022, percentage)

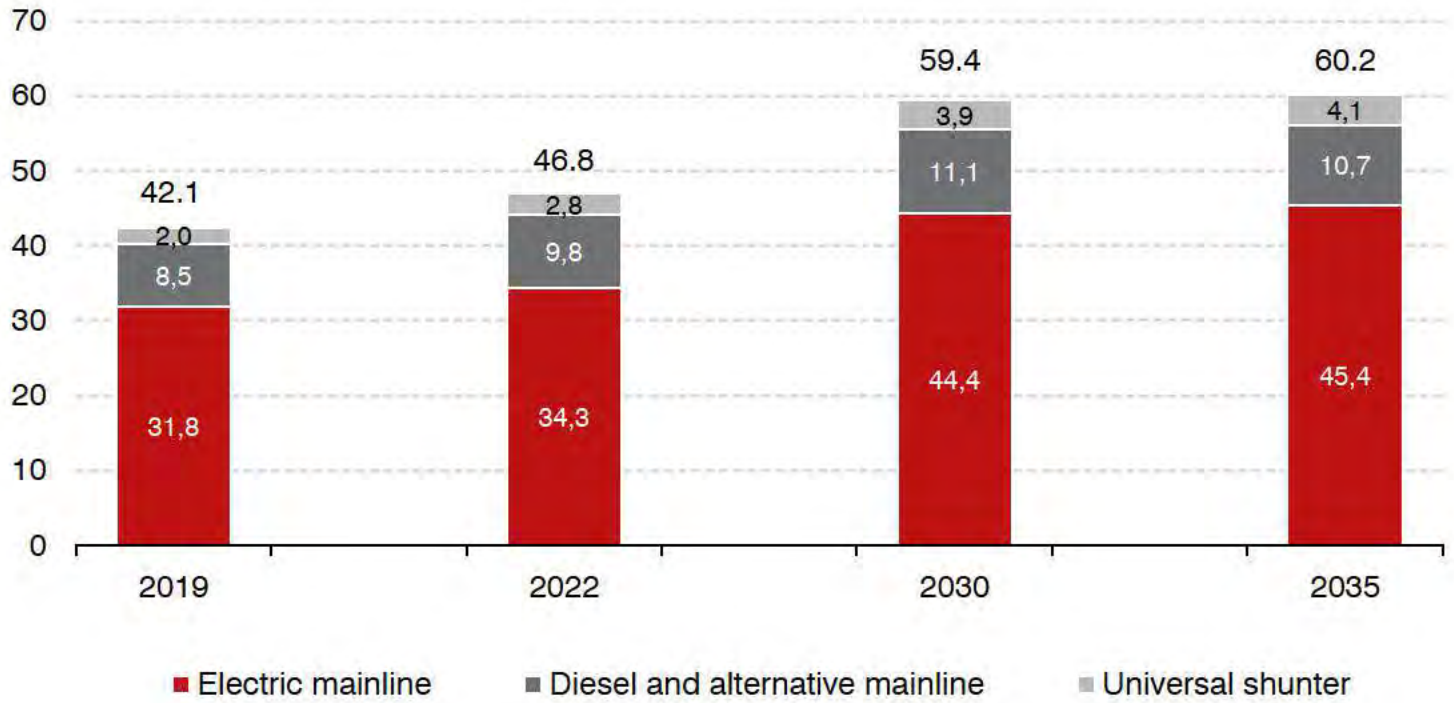


- The forecast differentiates three main locomotive types for rail freight transport:
  - **Electric mainline** locomotives are the backbone of rail freight operations and the most used locomotive type in the Netherlands.
  - **Diesel and alternative locomotives**, consisting of two sub-groups:
    - **Mainline** locomotives are mainly used for coal transport and to access lines without catenary. This category also includes hybrid locomotives.
    - **Universal shunter** locomotives can be used for mainline transport as well on short connections.

Source: ProRail; Report “Implementatie van ERTMS in het spoorgoederenvervoer”; SCI database

Rail freight volume forecast by locomotive type: Demand development different for each locomotive type, shaped by transported commodities

Rail freight transport in the Netherlands by locomotive type
(2019-2035, million tons)



- Due to the combination of growing transport demand, shifting mix of goods and operational profiles, demand developments differ by locomotive type:
  - **Electric mainline** demand will be growing.
  - **Diesel and alternative mainline** is growing until 2030 but declining afterwards until 2035.
  - **Universal shunter** have the highest growth rate, but from a relatively low starting point.

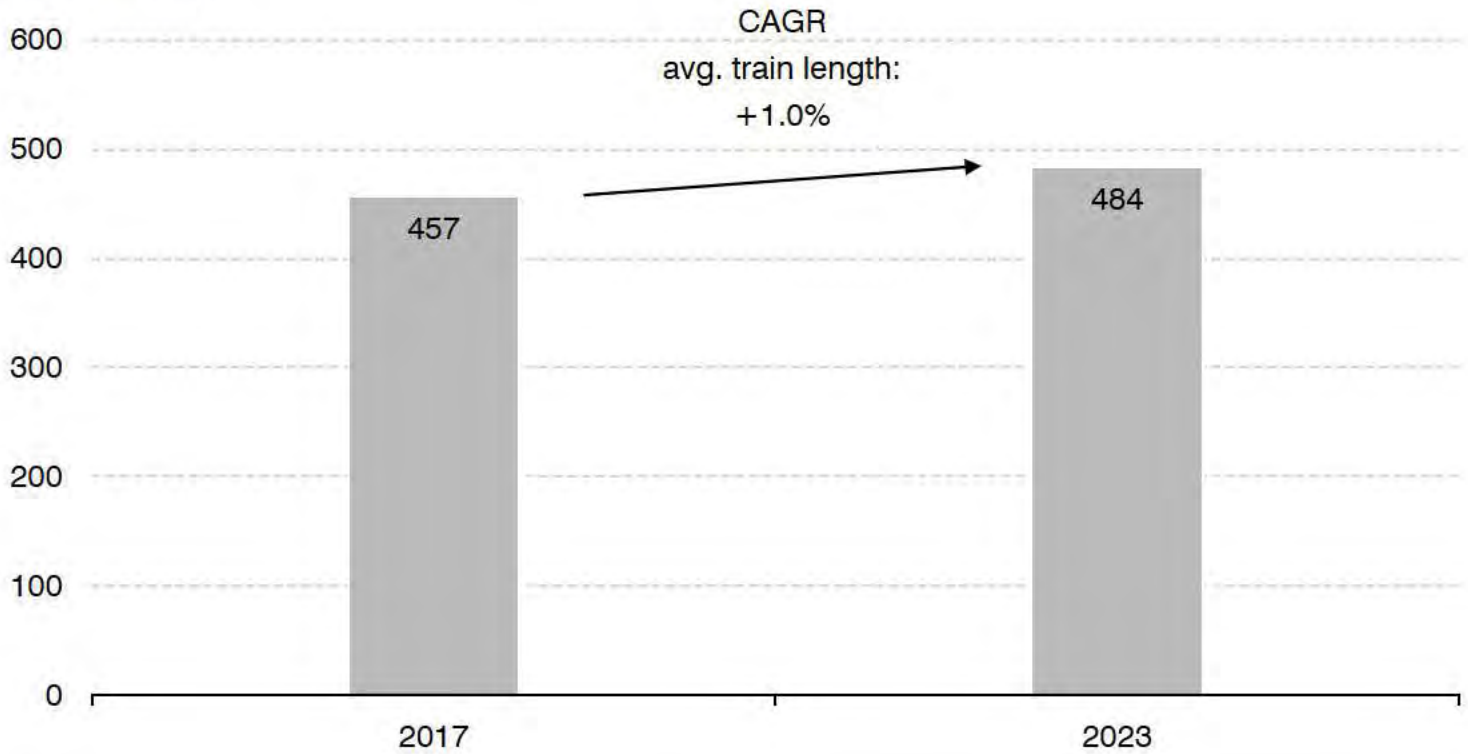
CAGR loco demand:	**2022 – 2030**	**2030 – 2035**
Electric mainline:	+ 3.3 %	+ 0.4 %
D&A mainline:	+ 1.6 %	- 0.8 %
Universal shunter:	+ 4.5%	+ 0.9 %

Source: SCI database

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Determining factor I – train length: Average train length will further increase, while additional 740 m train paths will become available for mainline operations after 2030

Average train length in the Netherlands
(2017-2023, meters)



- The average train length in the Netherlands is constantly growing, resulting in less demand for locomotives.
- For all locomotive types it was assumed that the trend will continue until 2035 (new average train length: 545 m), resulting in a declining demand for locomotives of -1.0% p.a.
- Additionally, it was assumed that one 740 m train path per hour is available between Kijfhoek – Venlo after 2030, resulting in an additional -0.5% p.a. for mainline locomotives only. The current maximum length on that route is 600 m.

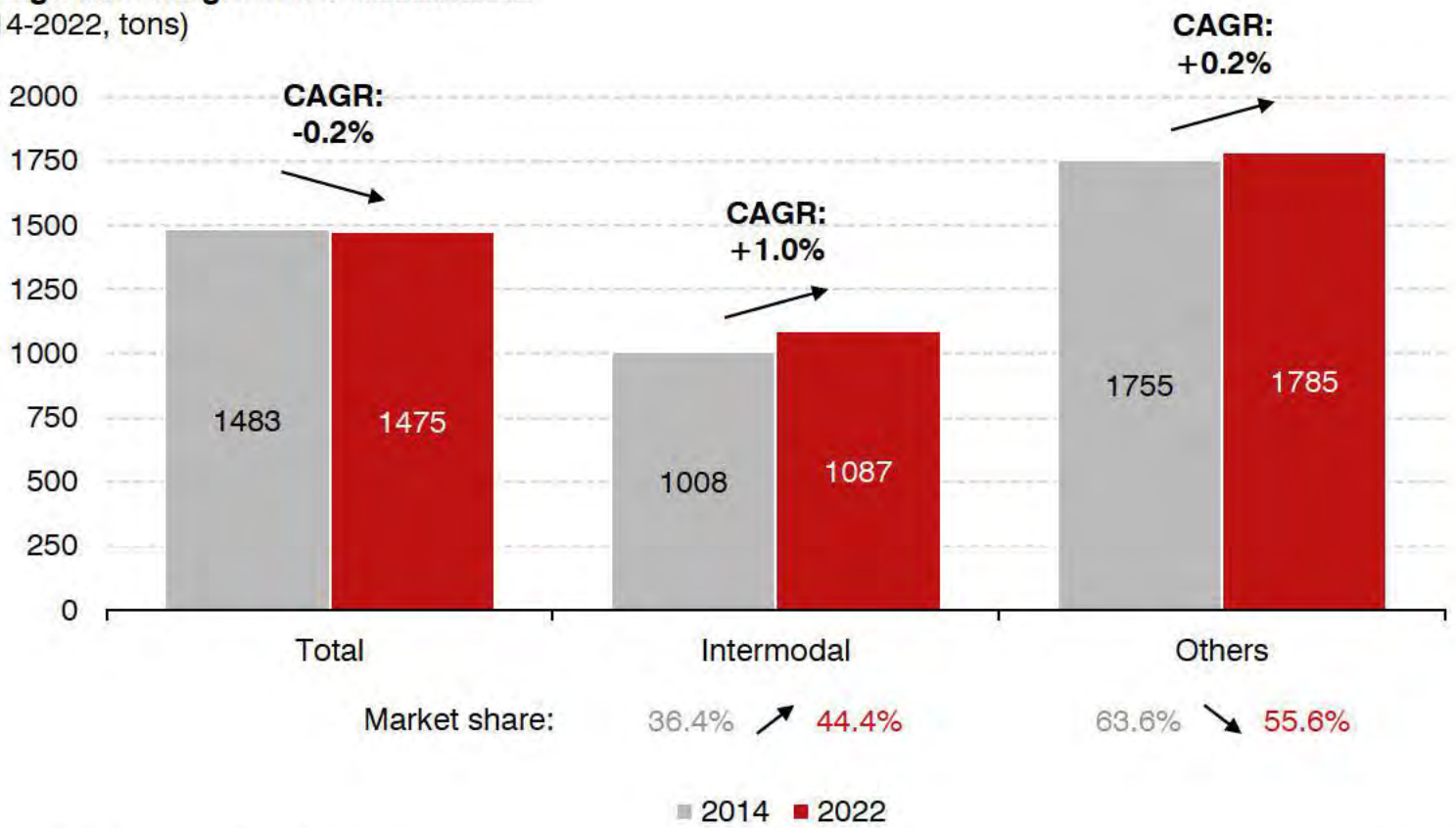
CAGR loco demand:	**2022 – 2030**	**2030 – 2035**
Electric mainline:	- 1.0 %	- 1.5 %
D&A mainline:	- 1.0 %	- 1.5 %
Universal shunter:	- 1.0 %	- 1.0 %

Source: ProRail Jaarrapport 2023, Mail from ProRail on 06.03.2024

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Determining factor II – train weights: Actual train weight increases, even if average train weight seems to decrease due to changing mix of goods

Average train weight in the Netherlands
(2014-2022, tons)



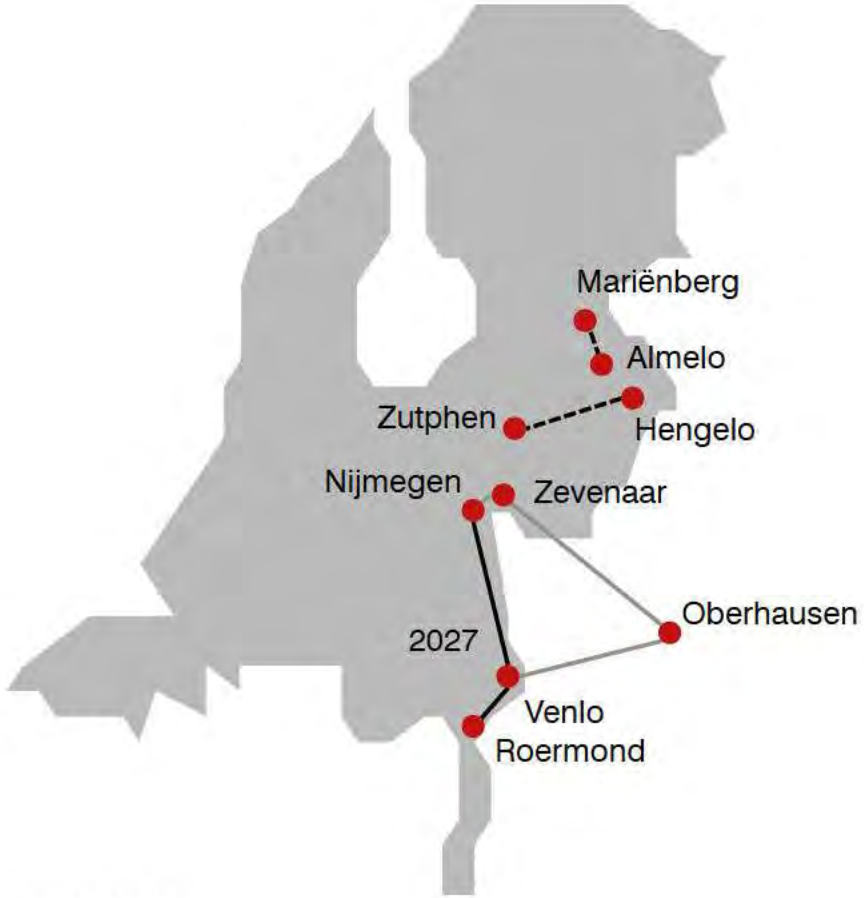
- The average train weight over all trains in the Netherlands is declining, which implies a growing demand for locomotives as more trains are needed for the same volume of goods.
- However, on a closer look, this is a mathematical artifact due to the changing composition of the train fleet: Both intermodal and other trains become heavier (i.e., more efficient), but because intermodal trains are significantly lighter than other trains, the overall average train weight declines.
- The share of heavy trains over 3,000 tons did not change between 2017 and 2023, implying that there is no change in demand for double traction etc.

CAGR loco demand:	**2022 – 2030**	**2030 – 2035**
Intermodal trains:	- 1.0 %	- 1.0 %
All other trains:	- 0.2 %	- 0.2 %

Source: ProRail Jaarrapport 2023, Eurostat

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Determining factor III – electrification: No impact expected due to high electrification rate and planned projects until 2035 without effects on rail freight locomotives



- Three significant electrification projects are currently planned in the Netherlands:
  - **Nijmegen – Venlo – Roermond** line. The project is scheduled to be finished in 2027.
  - **Zutphen – Hengelo** line. There is no project schedule yet.
  - **Almelo – Mariënberg** line. There is no project schedule yet.
- The Nijmegen – Venlo section is relevant for rail freight transport mainly as a possible detour during closings of the Zevenaar – Oberhausen railway line and for access to an intermodal terminal in Venlo, whereas Zutphen – Hengelo is part of the corridor from Rotterdam to the Oldenzaal/Bad Bentheim border crossing.
- However, the opening of the modernised lines will have no effect on the locomotive fleet as the signalling system is not modernised to ERTMS BL 3, thus preventing modern electric mainline locomotives from using the lines.

CAGR loco demand:	**2023 – 2030**	**2030 – 2035**
All locomotive types:	0.0 %	0.0 %

Source: SCI database

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Rail freight development forecast by locomotive type: The addition of transport growth by commodity type and productivity factors gives total demand growth for locomotives

Transport growth and productivity factors for rail freight transport in the Netherlands
(2022-2030, CAGR)

	Transport volume			Cost effect			Train length			Train weight			Electrification			**Total**		
	EML	DAML	US	EML	DAML	US	EML	DAML	US	EML	DAML	US	EML	DAML	US	**EML**	**DAML**	**US**
Containers	+5.5%	+5.5%	+5.5%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-0.8%	-0.8%	-0.8%	0.0%	0.0%	0.0%	**+2.7%**	**+2.7%**	**+2.7%**
Coal	-1.3%	-1.3%	-1.3%	-0.3%	-0.3%	-0.3%	-1.0%	-1.0%	-1.0%	-0.2%	-0.2%	-0.2%	0.0%	0.0%	0.0%	**-2.7%**	**-2.7%**	**-2.7%**
Ores	+0.3%	+0.3%	+0.3%	0.0%	0.0%	0.0%	-1.0%	-1.0%	-1.0%	-0.2%	-0.2%	-0.2%	0.0%	0.0%	0.0%	**-0.9%**	**-0.9%**	**-0.9%**
Wet bulk	+5.1%	+5.1%	+5.1%	-0.3%	-0.3%	-0.3%	-1.0%	-1.0%	-1.0%	-0.2%	-0.2%	-0.2%	0.0%	0.0%	0.0%	**+3.7%**	**+3.7%**	**+3.7%**
Dry bulk	+3.0%	+3.0%	0.0%	-0.6%	-0.6%	0.0%	-1.0%	-1.0%	0.0%	-0.2%	-0.2%	0.0%	0.0%	0.0%	0.0%	**+1.2%**	**+1.2%**	**0.0%**
Steel	+4.5%	+4.5%	+4.5%	-0.6%	-0.6%	-0.6%	-1.0%	-1.0%	-1.0%	-0.2%	-0.2%	-0.2%	0.0%	0.0%	0.0%	**+2.6%**	**+2.6%**	**+2.6%**
Other	+6.0%	+6.0%	+6.0%	-0.3%	-0.3%	-0.3%	-1.0%	-1.0%	-1.0%	-0.2%	-0.2%	-0.2%	0.0%	0.0%	0.0%	**+4.5%**	**+4.5%**	**+4.5%**
Total	+3.9%	+1.9%	+4.8%	-0.6%	-0.4%	-0.3%	-1.0%	-1.0%	-1.0%	-0.5%	-0.4%	-0.2%	0.0%	0.0%	0.0%	**+1.8%**	**+0.2%**	**+3.3%**

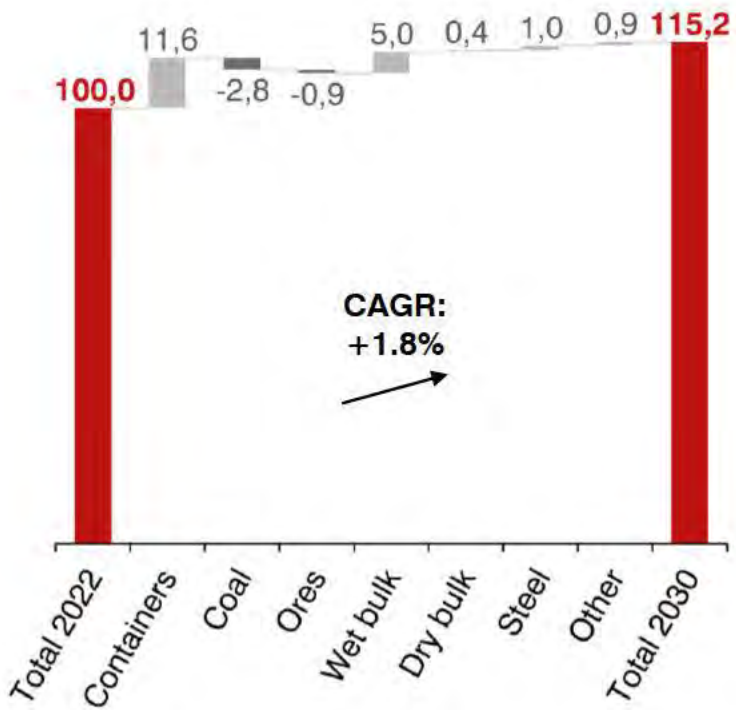
EML: Electric main line; DAML: Diesel an alternative mainline; US: Universal Shunter
CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Source: SCI Verkehr

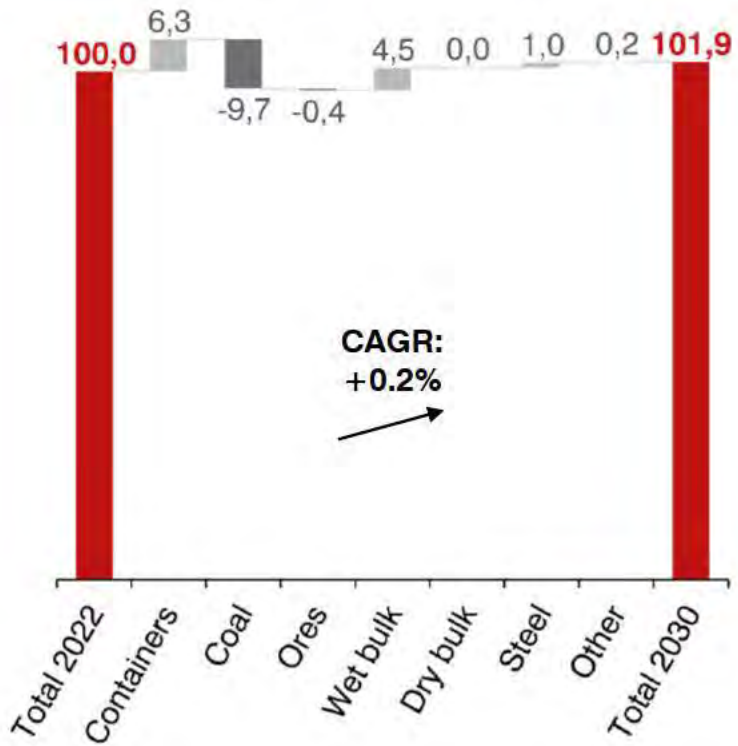
Results

Rail freight development forecast until 2030: Increased demand for electric mainline and universal shunter, while demand for diesel and alternative mainline remains stable

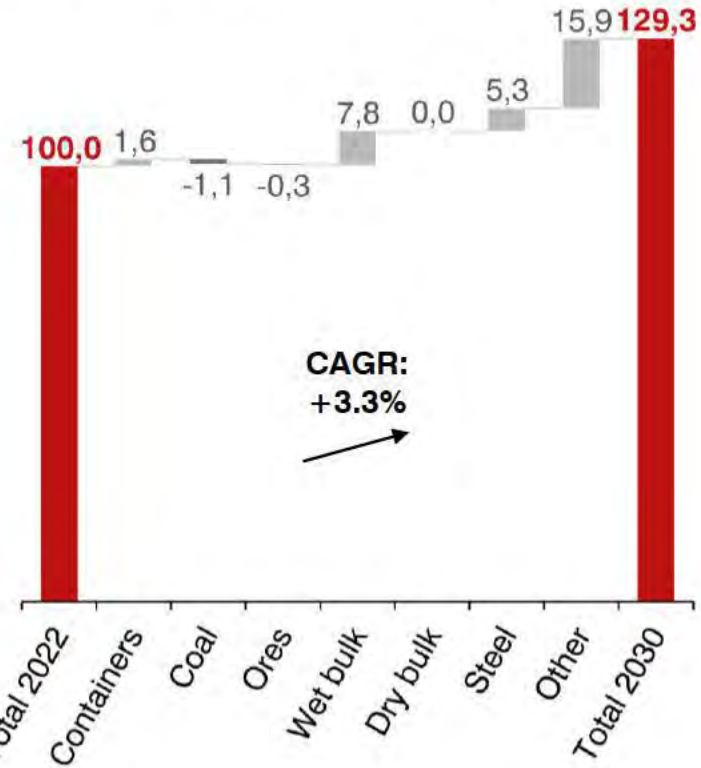
Change in demand for electric mainline locomotives (2022-2030, percentage points)



Change in demand for diesel and alt. mainline locomotives (2022-2030, percentage points)



Change in demand for universal shunting locomotives (2022-2030, percentage points)

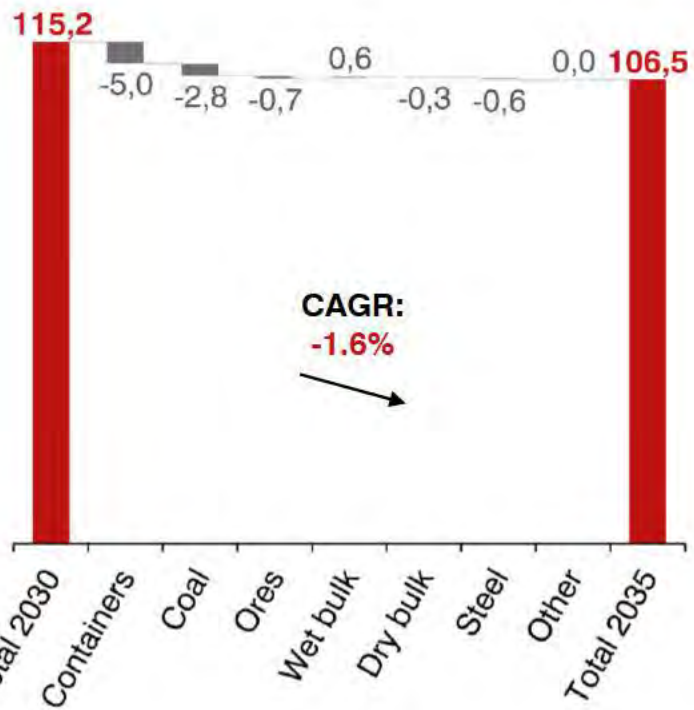


Source: SCI Verkehr

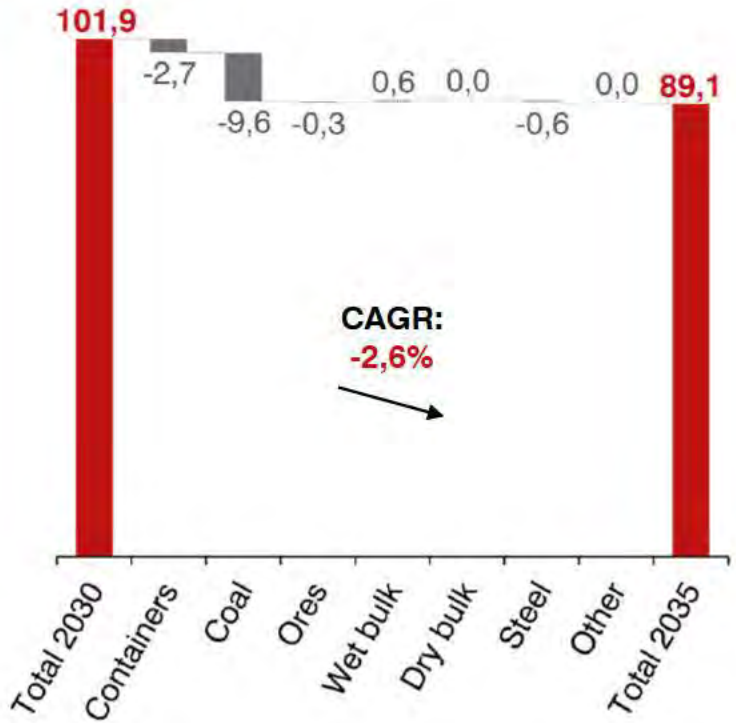
CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

Rail freight development forecast between 2030 and 2035: Demand decreases for locomotives compared to 2030 due to lower growth rate of transport volume and increased efficiency

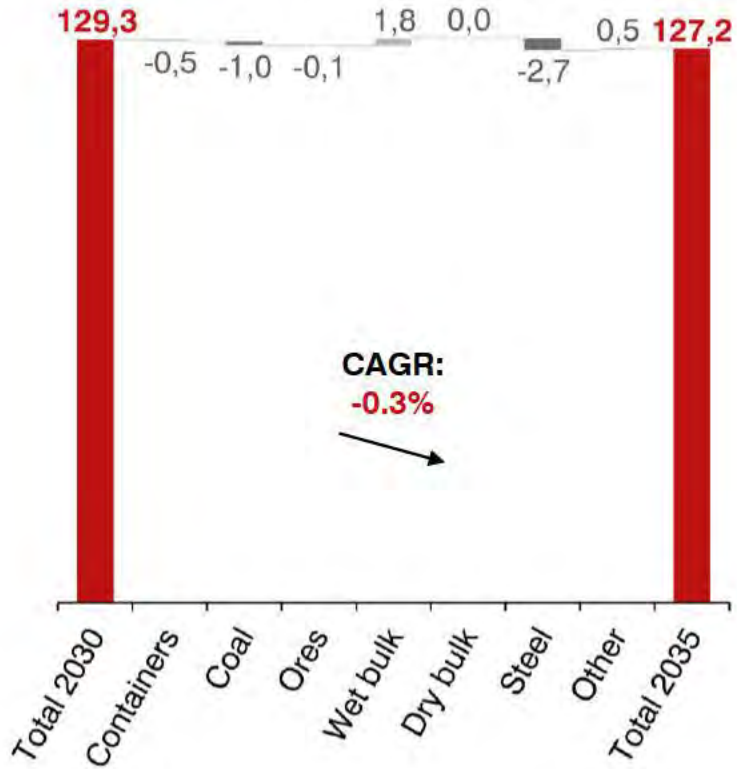
Change in demand for electric mainline locomotives (2030-2035, percentage points)



Change in demand for diesel and alt. mainline locomotives (2030-2035, percentage points)



Change in demand for universal shunting locomotives (2030-2035, percentage points)



Source: SCI Verkehr

CAGR: Compound Annual Growth Rate (average annual growth rate for a period of time)

SCI/Verkehr

3

ERTMS roadmap and ERTMS versions

ETCS on-board retrofit to Baseline 3 becomes necessary in the Netherlands but is quite complex

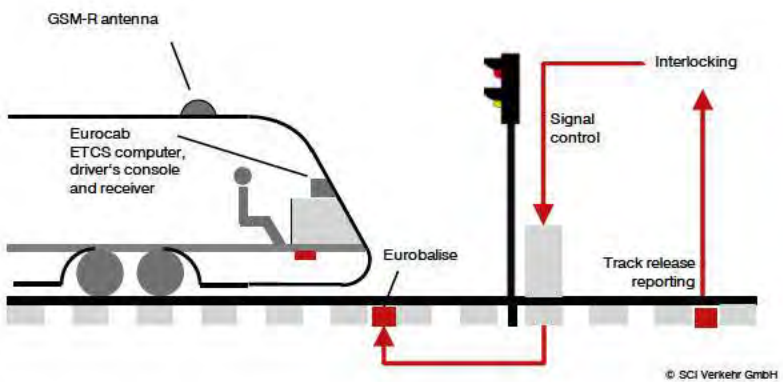
Each vehicle (sub)type requires a specific ETCS OBU version which makes retrofits very complex – the main challenge is not in the ETCS but rather in the connection to the TCMS and installed STM‘s

“It is not just the OBU, but also other components [like the TCMS] need to be considered.“

- ETCS OBU’s must be specifically developed for each vehicle type or subtype because of individually different interfaces to the TCMS and STM’s.
- ETCS retrofits are individual projects, there is no serial production.
- ETCS retrofit projects pose high demands and involve major risks due to their innovative nature.
  - The supplier is confronted with a high demand for personnel and bears the risk of successful completion.
  - The vehicle owner / operator is confronted with much coordination effort to initiate and implement the retrofit project.
- Retrofits (update or replacement) are only carried out at the customer's request, which is why the specific circumstances and contractual conditions play a decisive role.
  - Retrofits can only be carried out if the necessary funds are available. The specific source of funds (private / public funding) plays a subordinate role at best.
  - Retrofits are much more complicated when vehicles are used across borders, as the number of requirements to be met increases significantly.
  - A retrofit of shunting locomotives (limited to pure shunting operations) is easier to implement as, among other things, the calculation of braking curves is no longer necessary.

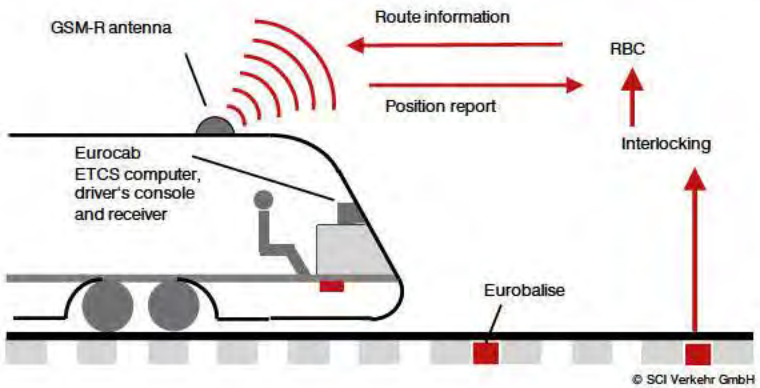
Public attention focuses mostly on the different ETCS Levels…

ETCS Level 1



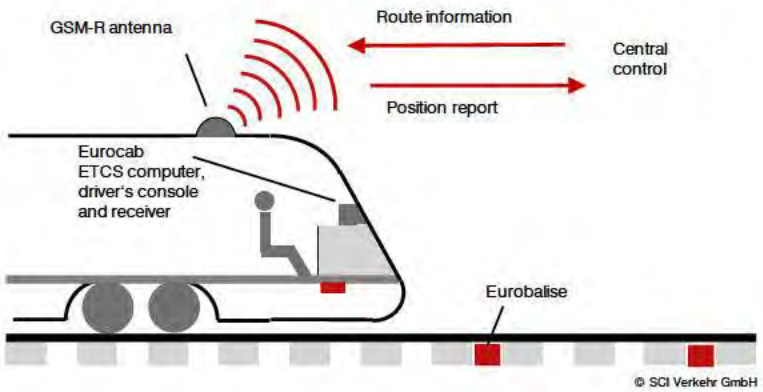
- Signal-controlled operation.
- Non-continuous transmission of data.
- The vehicle unit continuously monitors the speed and the braking curve.
- The information required by ETCS for driving permission (MA) is picked up from the LST components on the track.

ETCS Level 2



- Prerequisite: The railway infrastructure (interlocking) is suitable for connection to the ETCS Route Control Centre (RBC).
- The vehicle continuously communicates with the route (RBC) via GSM-R and thus receives its travel commands (MA).
- Signals are no longer necessary.

ETCS Level 3



- Distances between trains are fully automatised with radio control.
- Continuous line-clear authorisation is possible.
- Train headways come close to the principle of operation with absolute braking distance spacing ("moving block").

… but ignores that there are also different Baselines and System versions determining compatibility

X = Baseline
- Vehicles are downward compatible
- Infrastructure is **not** downward compatible

SRS system versions:
X.Y.Z

Example:
3.4.0

Y = Sub-version
- Compatibility between vehicles and infrastructure is downwards and upwards secured
- The higher the Sub-version, the more functions are included

! All system versions following 2.3.0d were developed to be backward and forward compatible.

! A vehicle must always be equipped with the highest ETCS version of the infrastructure that the vehicle is intended to be deployed on.

ETCS Baseline	SRS versions	Background
1	Class 1	Baseline 1 still contained various national specifications that limited interoperability
2	2.3.0	Baseline 2 was the first version that was deployed on a large scale, but it was prone to errors
	2.3.0d	
3	3.0.0	Baseline 3 inter alia solved the problem regarding the braking curves which appeared under Baseline 2 and provided further optimisation
	3.4.0	
	3.6.0	
4	4.0.0	Baseline 4 inter alia incorporates functionalities for ATO under GoA2

Figure adopted from: https://fahrweg.dbnetze.com

ERTMS Baselines and Sub-versions are continuously developed further – OBU supplier don't know the relevant standards and miss transparency about next regulatory steps incl. timeframe

- Legal basis:
  - 2012/88/EU
  - 2012/696/EU
- Applicable for new vehicles from 01.01.2015
- Permissible SRS versions: 2.3.0d, 3.0.0

- Legal basis: 2015/14/EU
- Also known as "Baseline 3 Maintenance Release 1"
- Applicable for new vehicles from 01.01.2018
- Permissible SRS versions: 2.3.0d, 3.4.0

- Legal basis: 2016/919/EU
- Also known as "Baseline 3 Maintenance Release 2"
- Applicable for new vehicles from 01.01.2019
- Permissible SRS versions: (2.3.0d), 3.4.0, 3.6.0

- Legal basis: 2023/1695/EU
- State-of-the-art SRS version
- Applicable for new vehicles probably from 01.01.2026 (or maybe 2030)
- Permissible SRS versions: 3.6.0, 4.0.0

There is a short-term need to equip rolling stock with ETCS Baseline 3 in NL and BE – in DE, FR and LU no such need exists currently because of different ETCS strategies

NL
- ETCS-only approach
- Current installations: ETCS L2 BL 2
- Goal: ETCS L2 BL 3 on the whole network by 2050

BE
- ETCS-only network from December 2025
- Current installation of BL 2 and BL 3, future focus on BL 3
- Goal: ETCS (L1 FS, L2 FS, L1 LS) on the whole network by the end of 2025

Short-term need to equip rolling stock with ETCS BL 3 in NL + BE

DE
- Dual wayside equipment approach
- BL 3 already installed, future focus on BL 3
- No comprehensive ETCS strategy
- ETCS-only on a few lines from 2028 (doubtful)

FR
- Dual wayside equipment approach
- Installation of BL 3 currently no topic
- No comprehensive ETCS strategy

LU
- ETCS-only network since 2018
- ETCS L1 BL 2 (2.3.0d) on the whole network
- No current plans for upgrade on BL 3

No short-term need to equip rolling stock with ETCS BL 3 in DE, FR + LU

Only very few OBU suppliers are really active in the market which shifts market power towards suppliers

Insufficiently documented interfaces to TCMS and STM‘s make ETCS retrofits a risky black box for OBU suppliers – it is mainly about the skilled personnel

“OBU development is a people, legacy and documentation business.“

“At the end of the day it’s a question of demand and supply – and of willingness to take risks.“

- OBU development is a people, legacy and documentation business
  - OBU development requires huge knowledge about vehicle programming, interfaces etc.
  - Beside the OBU, other components like the TCMS and STM must also be considered.
  - Strong dependency even from single persons in some cases
- The older the locomotive, the worse the documentation of the interfaces etc. This may lead to major expenses and high risk for the OBU manufacturer.
- In addition to the OBU, other components often must be replaced/updated during retrofits, which often makes retrofits very complex.

The ETCS OBU market is rather untransparent for vehicle owners / operators – this makes it hard to find a potential partner for retrofits and even harder to receive a (binding) offer

"As a vehicle operator we lack comprehensive / binding information from suppliers regarding timing and costs of ETCS retrofits."

- The market for ETCS retrofit is a supplier market in the economic sense. Thus, suppliers have limited incentive to actively promote their services or contact vehicle owners or operators
- Additionally, the market is rather untransparent: Concrete business plans / projects are only communicated by Alstom, but these also seem to be very dependent on the project business
- Thus, it is hard for vehicle owners / operators to find a suitable and willing supplier. It is also challenging to receive a binding offer from suppliers because of capacity restrictions
- These market characteristics must be considered in the design of funding programs.

Only very few suppliers provide ETCS OBU solutions due to high project risks and insufficient capacities – especially regarding skilled personnel

"We do have a capacity issue in the market for OBUs – Alstom alone will not serve the hole market and there is limited alternative at the moment."

"Companies that want to get a foothold in the market, will have to accept greater risk."

- Nearly all large vehicle manufacturers are also active in the market for ETCS OBU. However, very few suppliers are actually capable for projects.
  - Alstom currently is the undisputed market leader but will not be able to serve the whole market.
  - Siemens shows an opportunistic behavior as it focuses on equipment of its own new assets.
  - Stadler wants to enter the market and is thus willing to take risks (see i.a. TRAXX fleet).
  - CAF may become a relevant player in the Dutch market as it already knows the country (specifics) and maybe wants to promote its own system (AURIGA).
  - Thales is not regarded as a relevant player so far and in the foreseeable future.
- Skilled personnel is essential for successful ETCS OBU development and implementation.
  - Widespread capacity constraints leave suppliers room for opportunistic behaviour.
  - Focus on much built vehicle types (best chance to allocate fix costs, highest risk-reward ratio).
- Whether a supplier is active in retrofits is also dependent on its own product strategy.
- As Alstom is the only supplier to provide a class B system, this also affects market behavior of rivals.

The problematic situation in the ETCS market will not change fundamentally by 2030

Capacity constraints of the ETCS OBU suppliers will remain – current complex approval processes even exacerbate the situation

"If s.th. like OCORA should be implemented, it needs to be well managed, otherwise the suppliers will have big disadvantages and will eventually drop out."

Capacity constraints remain for established suppliers

- Current capacity constraints are expected to remain, because the suppliers either do not have the capabilities for capacity expansions and / or do not want to expand their capacities.
- Reasons may be a lack of skilled personnel, insufficient incentives / reasons of business strategy.

New suppliers are only entering the market to a limited extent

- New market entrants would be especially affected from the associated risks with ETCS retrofits and the dependency from skilled personnel.
- This will prevent most new suppliers from market entry.

OCORA generally interesting, but implementation until 2030 doubtful as of now

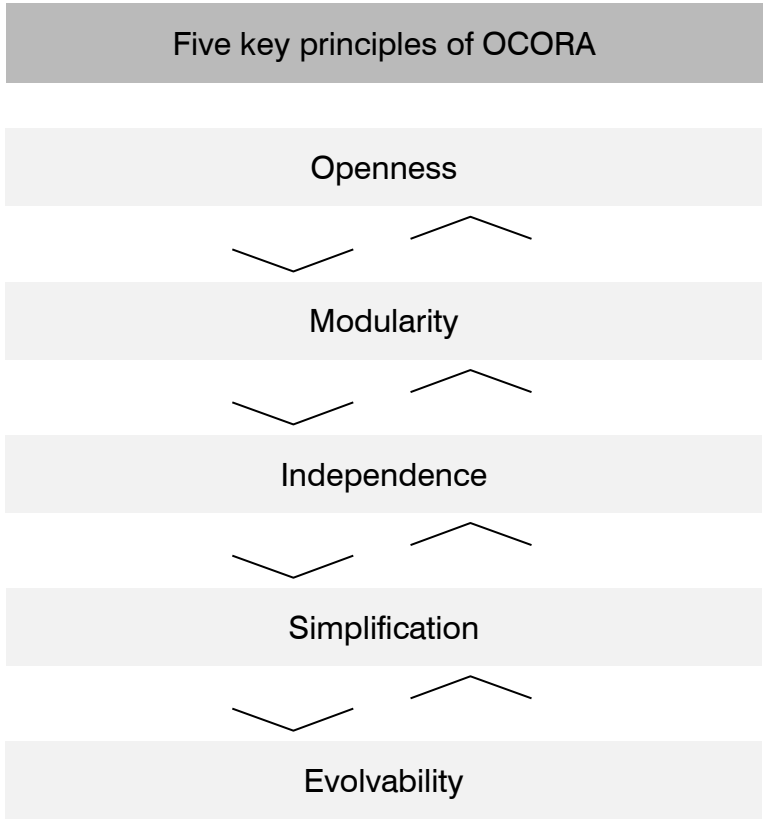
- A genuine platform solution with open interfaces must be very well managed.
- Otherwise, current suppliers will suffer major disadvantages, which will tend to lead to further restraint and less commitment.

Current approval processes pose a further challenge on the availability of ETCS OBU

- Beside the challenges on the supplier side, network operators / regulators need to make approval processes practicable and streamlined (limited resources available for certification and testing).
- This is necessary to avoid additional costs, efforts and delays in available ETCS BL3 locomotives.

OCORA initiative is aiming for a standardized CCS on-board solution published in successive releases

- OCORA initiative targets a comprehensive and coherent set of specification for a modular CCS On-board environment published through consecutive OCORA releases.
- The aim is to cut costs and boost efficiency by replacing legacy rail systems with adaptable digital modules.
- The initiative considers itself to be:
  - Open cooperation and set of public specifications and no organization
  - Focus for On-Board CCS and not for trackside
  - Result of the process is not a clear product, rather publications describing CCS On-board and including sector feedback
- The latest Release R5 defining the OCORA position for System-& Innovation-Pillar
- Four further publications are expected by the end of 2025, in parallel with the further development of the OCORA CCS-OB architecture and CCS-OB requirements and tender artefacts



Source: OCORA-BWS02-020 / v1.00 / 05.12.23 / Release R5, https://github.com/OCORA-Public/Publication

DB, SNCF, NS, ÖBB and SBB collaborate in the OCORA initiative to standardize the architecture and interfaces for ETCS on-board equipment

Current situation on ETCS On-board solutions

- On-board solutions are not built to standardized specifications
- Integration into existing vehicles are difficult
- Costly and time consuming to adapt or to upgrade:
  - In case of patching and error corrections in non-SIL and SIL areas (e.g. cyber- security patching);
  - In case of baseline upgrades (e.g. ETCS baseline 2 to 3);
  - In case of adaptation to new technologies (e.g. upgrade to FRMCS);
- No consideration of the different life cycle profiles of the various vehicle-based components
- Challenging to maintain (e.g. monitoring, diagnosis, configuration, and maintenance possibilities very limited – no remote functionality)

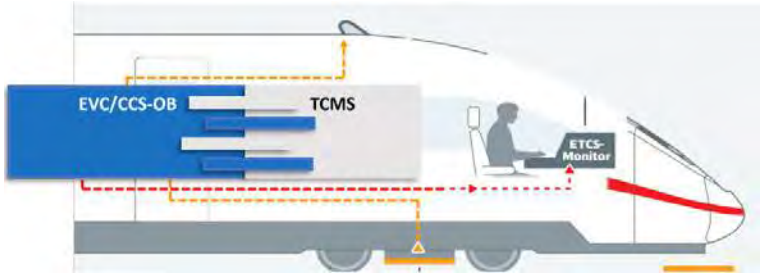
Open CCS On-board Reference Architecture (OCORA) initiative

- Initiative OCORA was founded by incumbents NS, SNCF, DB, SBB and ÖBB.
- OCORA aims to
  - Reduce life-cycle costs and
  - Facilitate the introduction of innovation and digital technologies beyond the current proprietary interfaces and
  - Establish a modular, upgradeable, reliable and secure CCS on-board architecture
- Latest OCORA release R5 in Dec 2023 describes CCS On-Board and includes feedback from the sector, in particular from the exchange with the EU Rail system pillar.

Source: OCORA-BWS02-020 / v1.00 / 05.12.23 / Release R5, https://github.com/OCORA-Public/Publication

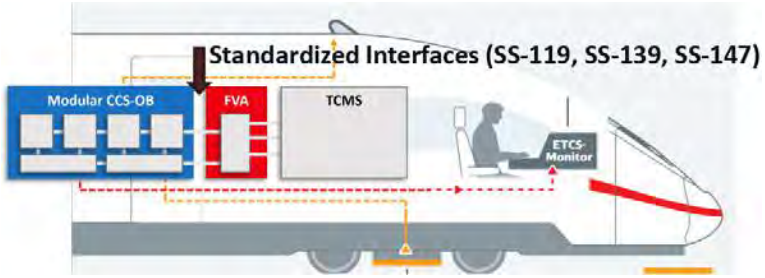
In the first step, migration is to realize via a functional vehicle adapter – in the long term, the TCMSs are compliant with the standardized interfaces via a next-gen Communication Network

Current situation



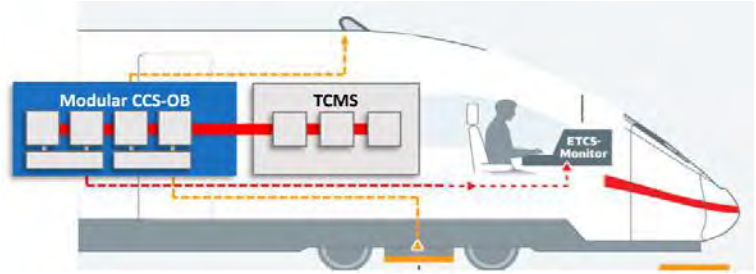
- **CCS consisting of an inseparable unit**
- EVC/CCS-OB closely integrated with Train Control Management System (TCMS)
- CCS-OB replacements requires understanding of manufacturer specific TCMS

1 OCORA Functional Vehicle Adapter



- **Modular, upgradeable CCS-OB architecture**
- CCS-OB communicates with TCMS via standardized interfaces (SS-119, SS-139, SS-147).
- Non-compliant TCMSs are adapted to the standardized interfaces through a Functional Vehicle Adapter.
- CCS-OB upgrades do not require a detailed understanding of the TCMS systems anymore

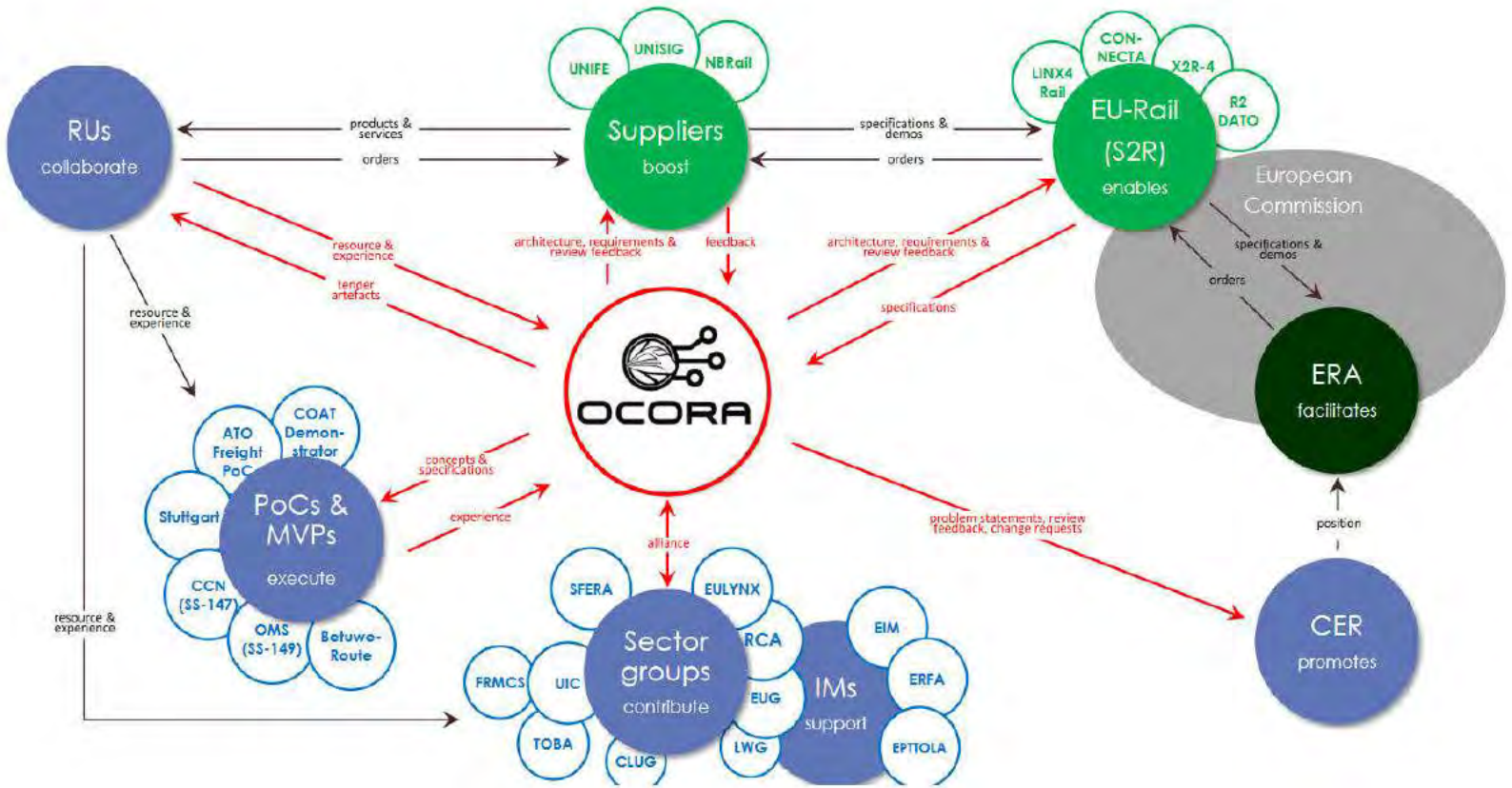
2 OCORA long term perspective



- **Comprehensive next-gen Communication Network** for connecting all train control and safety systems (TCMS and CCS).
- TCMSs are compliant with the standardized interfaces. The need for a FVA vanishes.
- Separation of Hardware and Software via Computing Platform.

Source: OCORA-BWS02-020 / v1.00 / 05.12.23 / Release R5, https://github.com/OCORA-Public/Publication

OCORA is a collaborative initiative involving a wide range of stakeholders from the railway sector and politics



- OCORA involves a large number of stakeholders (incl. policy makers) in the initiative
- This integration process includes the rail operators, the suppliers, the sector and the EU bodies
- In addition, specific projects are used to build up experience and receive feedback (e.g. Stuttgart 21 or the Betuweroute)
- The dialogue takes place in various work streams in which the respective stakeholders are involved

Source: OCORA-BWS02-020 / v1.00 / 05.12.23 / Release R5, https://github.com/OCORA-Public/Publication

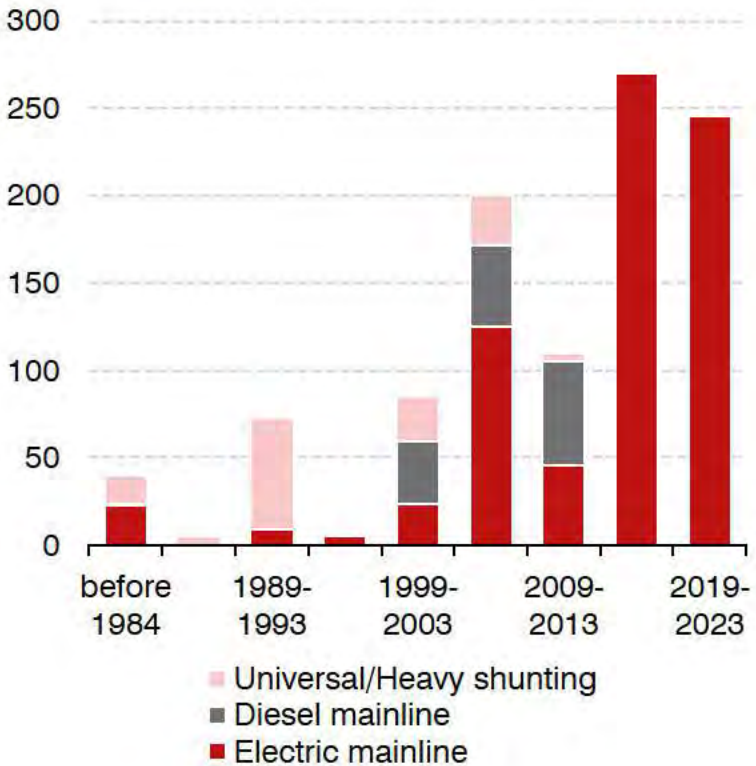
4

Freight locomotive fleet and forecast

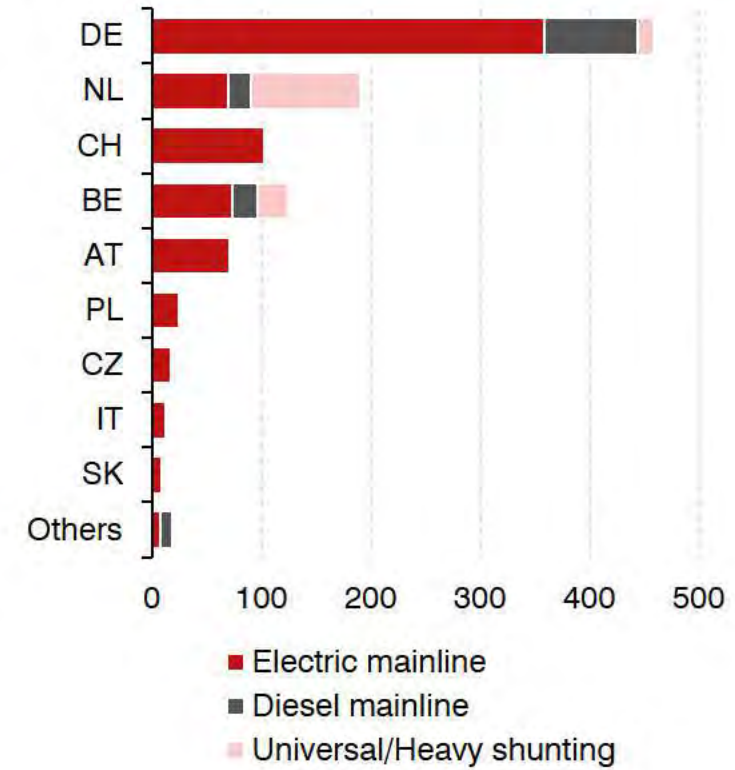
4.1 Fleet overview and methodology

SCI Verkehr identified 1,030 freight locomotives with Dutch homologation with an av. age of 14 years - 45% of the fleet is deployed by German based operators

Freight NL-locomotives age structure
(~1,030 units)



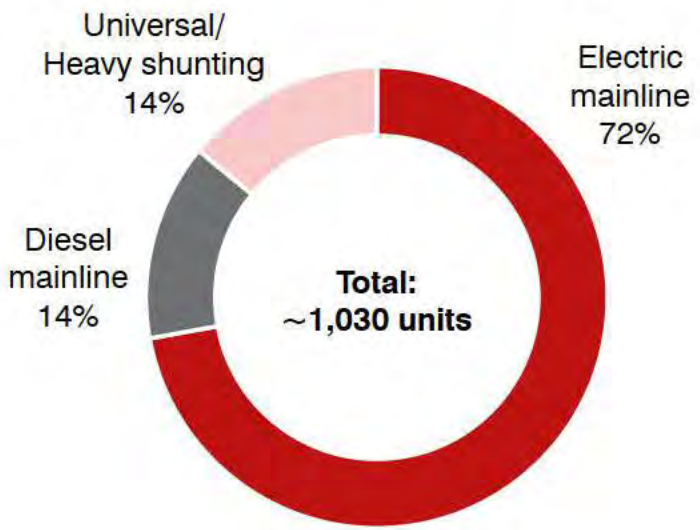
Freight NL-locomotives by operator country
(~1,030 units)



- <5% of the fleet was delivered before 1984
- The overall fleet has an average age of 14 years
  - Young fleet: ~50% of the fleet is ≤ 10 years old
  - Electric freight:10 years
  - Diesel freight: 18 years
  - Universal: 29 years
  - Heavy shunting: 40 years
- Operators of the four largest country markets (DE, NL, CH, BE) deploy ~85% of the total fleet
- It can be assumed that a certain share of the mainline fleet of locomotives with NL homologation does not reach the Netherlands in regular operation – for example Vectron MS and Traxx MS2 locomotives deployed by Eastern European operators such as CD Cargo, PKP Cargo or Lotos Kolej

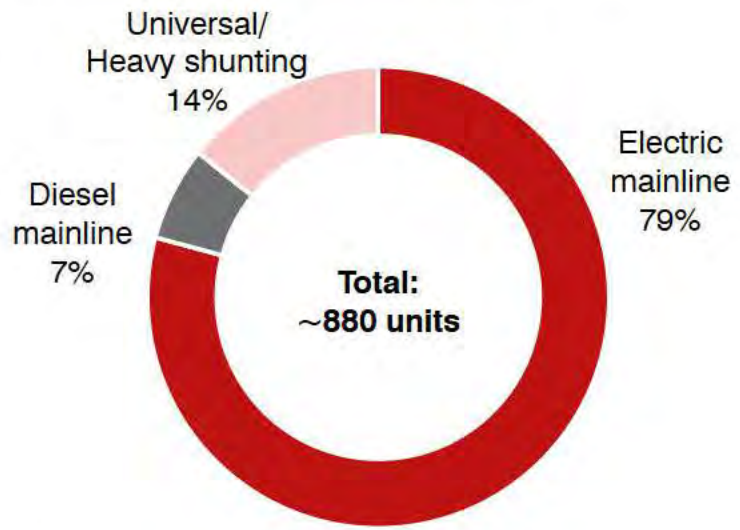
Out of the identified 1,030 freight locomotives with Dutch homologation, around 880 units (85%) are either equipped with ETCS or contracted for retrofit

Freight locomotives with NL homologation (units)



Besides the mainline locomotives, around 14% of the identified freight locomotives are deployed in the segments of heavy shunting and universal **and suited to run along the mainlines**

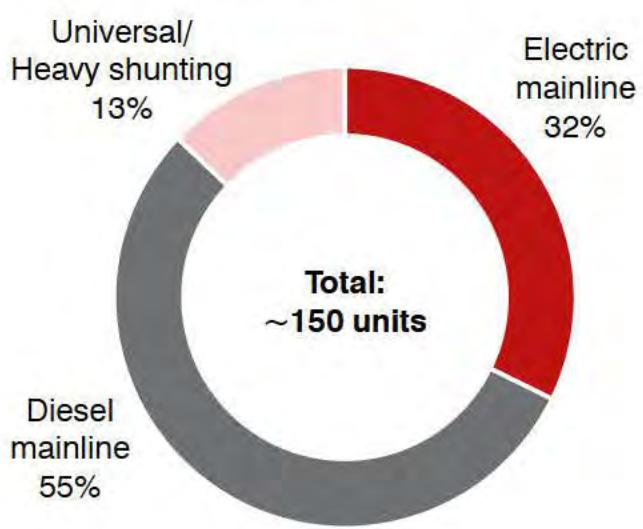
Freight locomotives with NL homologation <u>equipped with/contracted for ETCS</u> (units)



ETCS retrofit programmes (extract):

- **Alpha Trains**, 77 locomotives to BL 3.6
- **Railpool**, 73 Traxx MS2 to BL 3.6
- **Lineas**, 88 HDL77 to BL 3.4 (22 for NL)
- **DB Cargo**, DE 6400 to BL 3.6

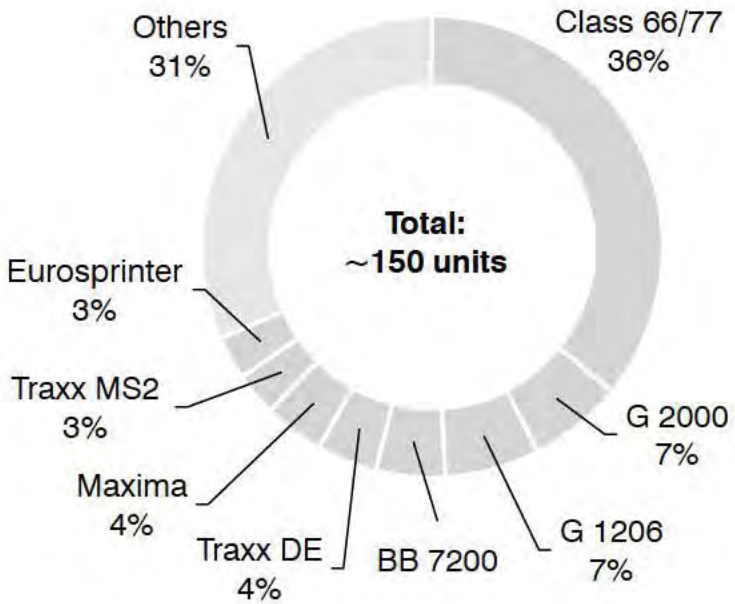
Freight locomotives with NL homologation <u>not equipped with ETCS</u> (units)



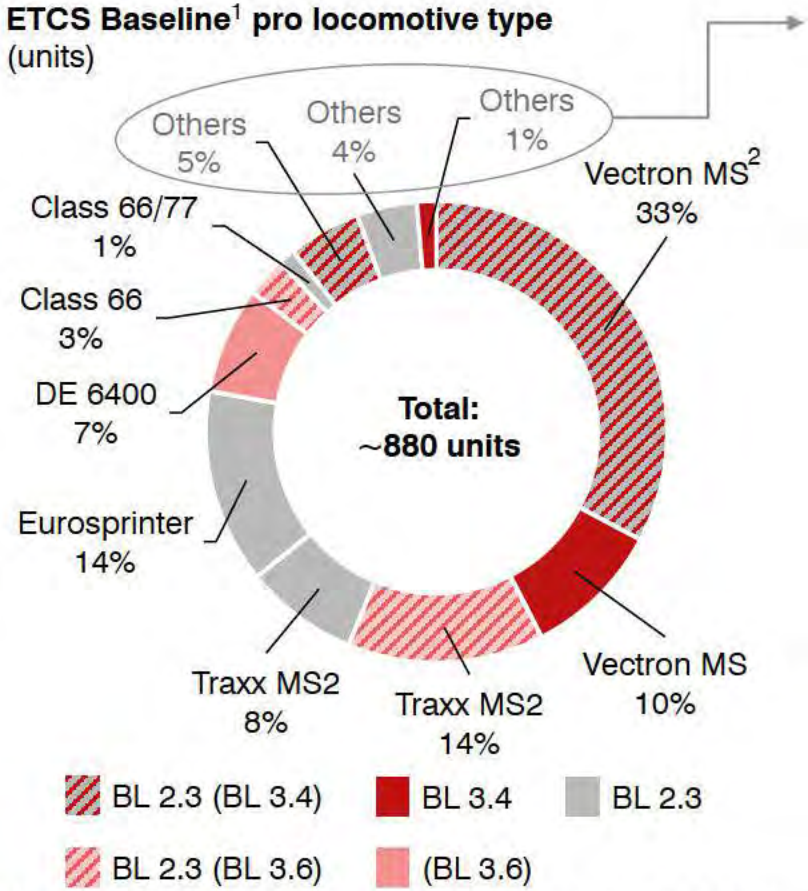
Majority of locomotives with NL homologation that are **currently not equipped with ETCS** are **diesel mainline assets**

Out of the identified 880 freight locomotives with Dutch homologation and ETCS installed/contracted, almost 75% are already equipped with or contracted for retrofit to Baseline 3.4 or 3.6

Freight locomotive type with NL homologation <u>not equipped ETCS</u> (units)



ETCS Baseline[1] pro locomotive type (units)



Segmentation of *Others*

- **BL 3.4.0 contracted** – HLD 77
- **BL 3.6.0 contracted** – G 2000, G 1206
- **BL 2.3.0** – Traxx DE, G 1206 (+BR 203 w/o ETCS)
- **BL 3.6.0** – Euro9000

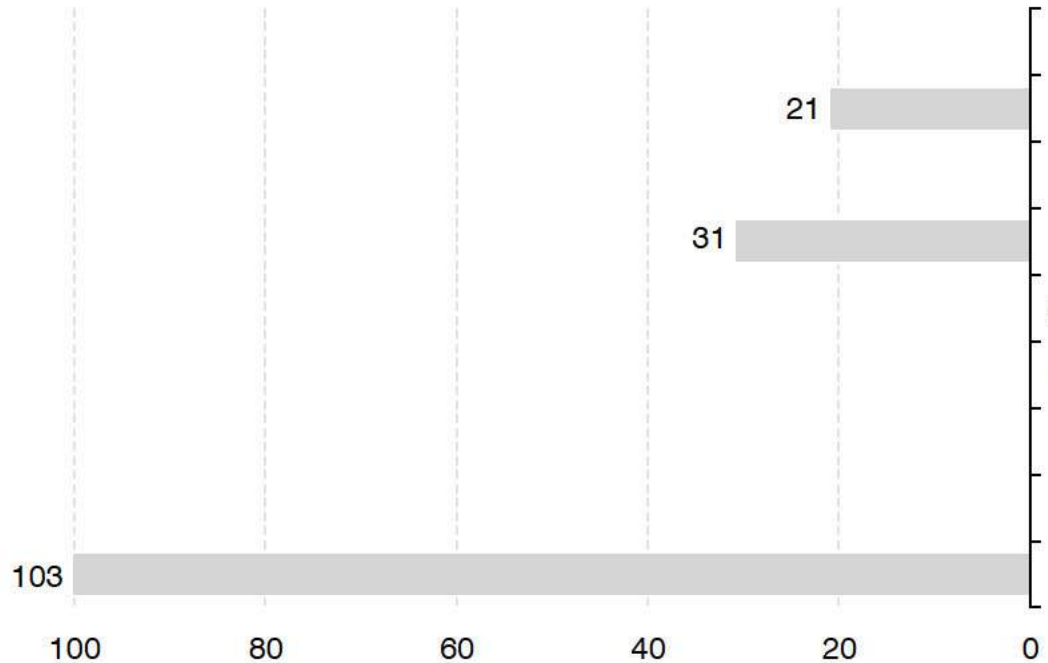
Recent retrofit/equipment projects

- **Alpha Trains** contracted Alstom/Bombardier for ETCS retrofitting to BL 3 of **77 locomotives** incl. NL homologations (55 x **Traxx MS2**, 8 x **G 1206**, 14 x **G 2000**) in 2021
- Alstom equipes **DE 6400** fleet of **DB Cargo** with ETCS BL3 for NL-BE transport (2021 contracted)
- **Railpool** contracted Bombardier for ETCS retrofitting to BL 3 of **73 Traxx MS2** in 2020
- **Lineas** equips **88 HLD 77** shunting locomotives with ETCS (2020 contracted)

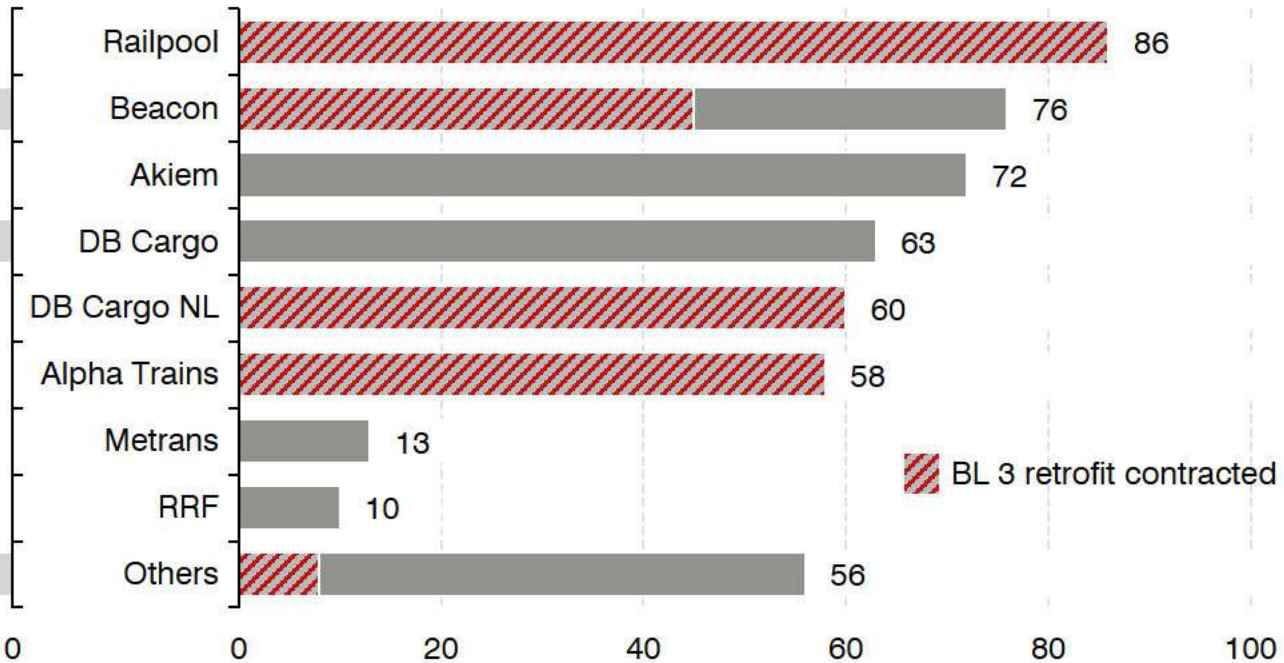
1: in brackets – retrofit contracted; 2: as of early 2024, a large fleet of Vectron MS locomotives is equipped with BL 2.3 – partly, a retrofit to BL 3.4 is contracted

Akiem and DB Cargo are top owners which do not have retrofit contracts for their NL fleets yet – from the observed fleet[1], around 30% of the locomotives are not equipped with ETCS

Freight NL-locomotives without ETCS by owner
(~150 units, % of the total fleet)



Freight NL-locomotives[1] ETCS equipped/contracted by owner
(~490 units, % of the total fleet)

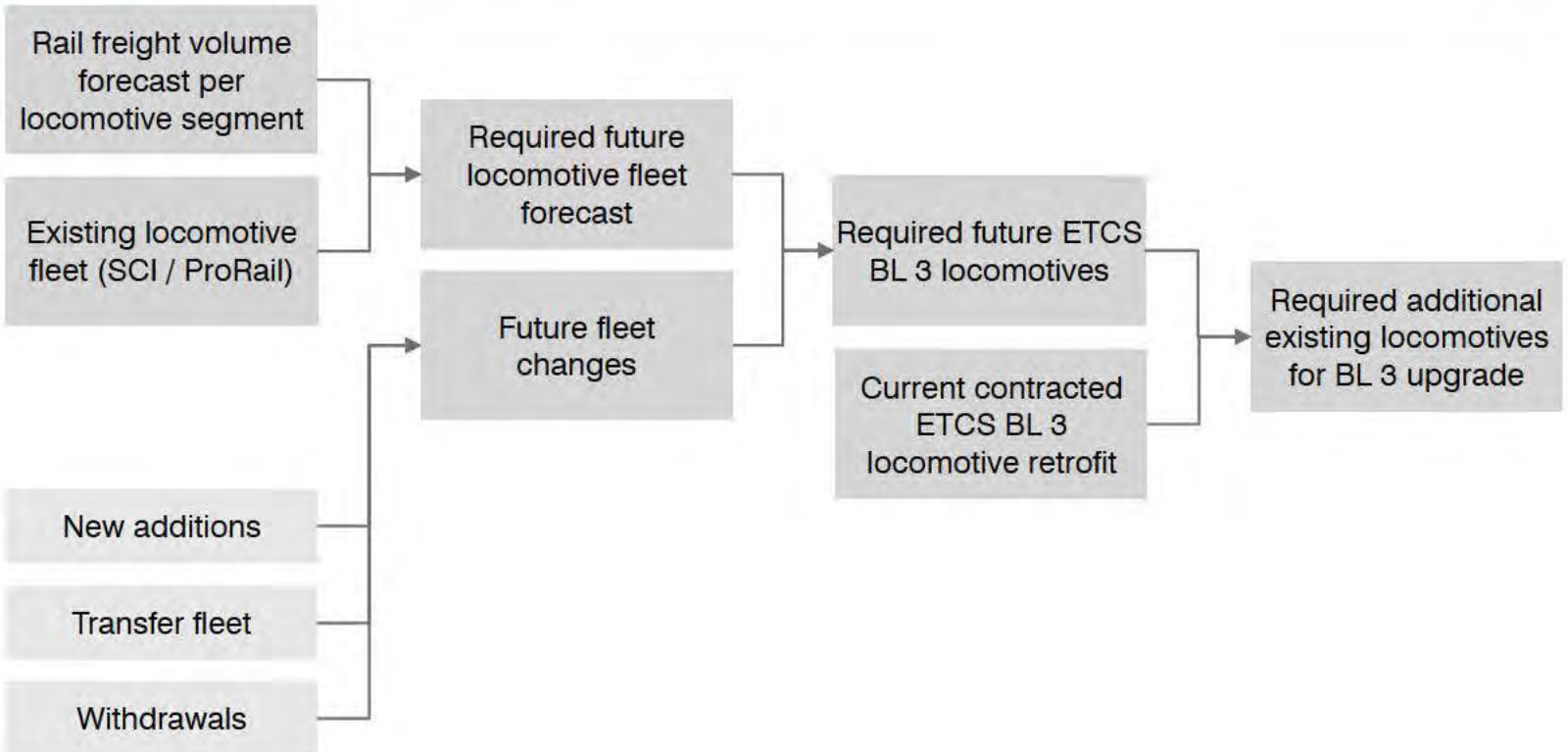


Among the top owners, only Akiem (ES64F4 and Traxx MS2) **as well as DB Cargo** (ES64F4) **do not have retrofit contracts closed for BL3 upgrades yet**

1: **Without Vectron MS and Euro9000**, as these assets are not in the programme scope

Forecast methodology: Rail freight locomotive ETCS BL 3 fleet

Rail Freight Locomotive ETCS BL 3 Fleet



- Forecast of the rail freight ETCS BL 3 locomotive fleet is based on the following:
  - **Rail freight volume forecast** per locomotive segment derived in the previous step
  - **Locomotive installed base** consisting of **existing and future** (fixed ordered) **fleets**, considering also **withdrawals** from the existing fleet (units that are not expected to be upgraded to BL 3 and will be gradually phased out in the observed period)
- In the next step, already **contracted BL 3 retrofit projects are regarded** and finally the **required additional fleet** of existing locomotives **for ETCS BL 3 upgrade** derived

The possibility of ETCS-only operation on BL3 lines in the Netherlands would enable access to Dutch corridors for important locomotive classes – SCI Verkehr takes this plan into account in its forecast

2023
ATB required

According to ProRail, a **new RIS** (Regeling Indienststelling Spoorvoertuigen) **will be published in July 2024**.

- The plan is to update the RIS, so that **the obligation to have ATB on board will be taken out**.
- The rolling stock will get admission for specific routes only, based on the compatibility of the rolling stock with the infrastructure.
- Any additional cost help for strandings will apply if the operator cannot run on ATB when it is needed.

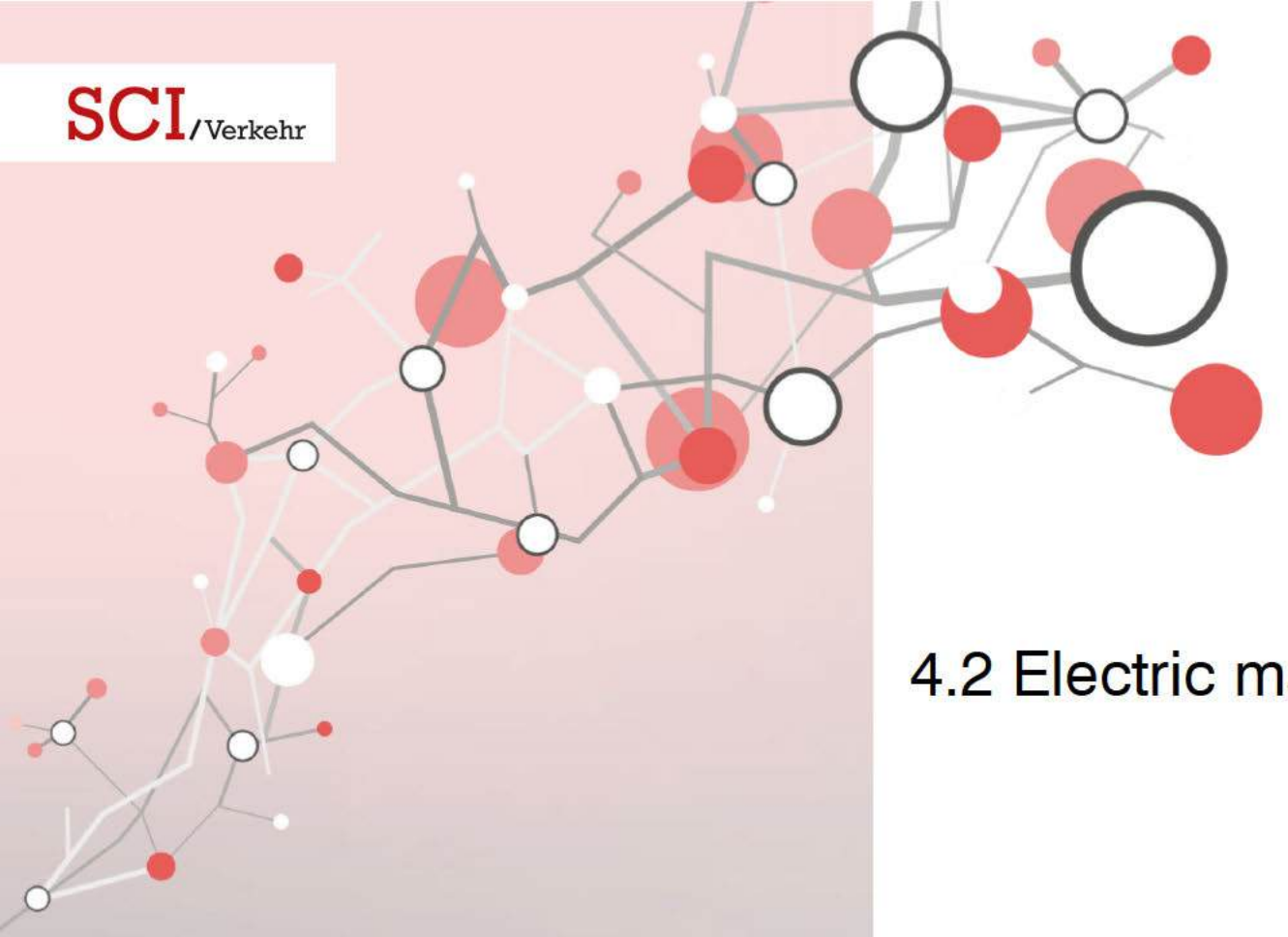
2030
ETCS-only operation on ETCS-lines

As of spring 2024, **locomotives** running along the Dutch mainline network **are required to have the national Class B system installed** (ATB or ATB NG)

2024
RIS-update

In its locomotive forecast, **SCI Verkehr assumes that ETCS-only operation is possible along ETCS-lines in 2030**

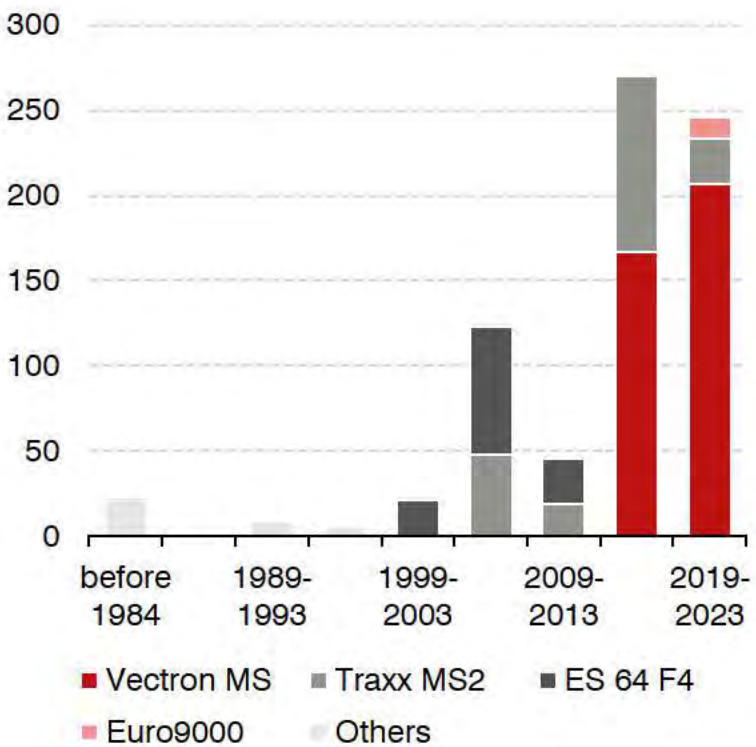
- E.g., a **Belgian-based operator will be able to reach Rotterdam** via an ERTMS BL3 L2 only-route with a locomotive having at least an ETCS BL 3.4.0 onboard unit **without having** the Dutch Class B system **ATB** or ATB NG **on board**
- **This will increase the locomotive supply on corridor lines** and is interesting especially for the modern asset types EuroDual and DE 18 SmartHybrid (both will come with ETCS but without ATB) and for the large fleet of ETCS-retrofitted Belgian HLD77 locomotives
- However, as this is also associated with costs, **first-in-class possibilities should be reviewed**



4.2 Electric mainline locomotives

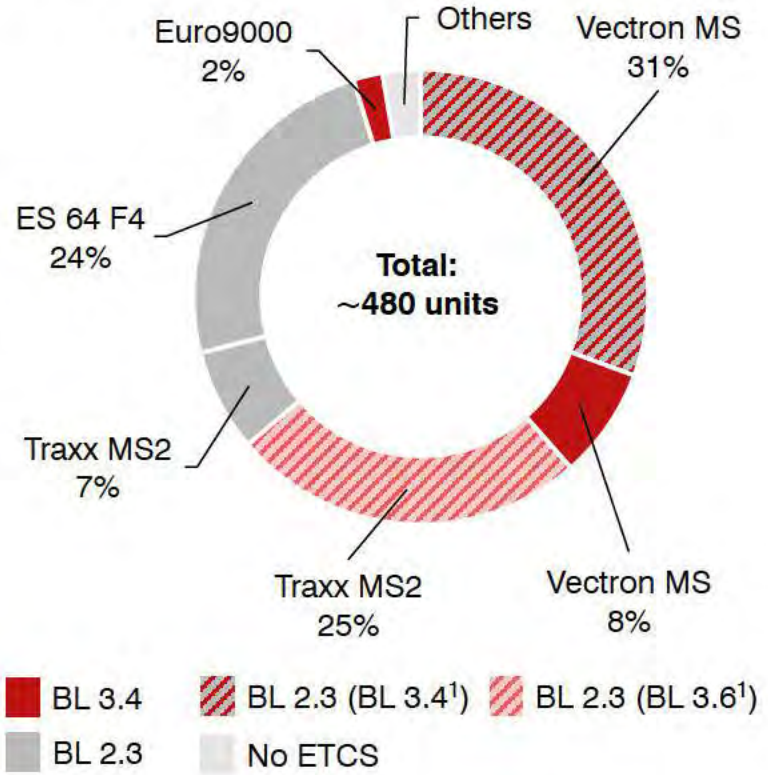
From ~750 electric mainline freight locomotives with NL homologation, ~500 units were identified as relevant for further analysis, which is comparable to ProRail's input fleet

Electric mainline freight NL-locomotives age structure (~750 units)



- Electric mainline freight fleet of NL-locomotives accounted for ~**750 units in 2023**
- From this total fleet, a fleet of **480 units is identified as the target fleet**, including:
  - **Vectron MS**: ~220 units (BL 3.4 equipped or BL 2.3 with partly contracts for BL 3.4 retrofit) estimated for deployment in NL as primary operation area. The rest of around 150 units with NL homologation not expected to reach NL in regular operation
  - **Traxx MS2**: ~120 units contracted for BL 3.6 upgrade (Railpool, Alpha Trains) and 35 units with BL 2.3 (e.g., Akiem, Metrans)
  - **ES64F4**: ~115 units with BL 2.3 (DB Cargo, Akiem, Beacon)
  - Small fleet of ~15 units still operating early 2024 without ETCS (e.g., Class 1700/1800).
- **Target fleet** is **comparable** with the input fleet provided by **ProRail**

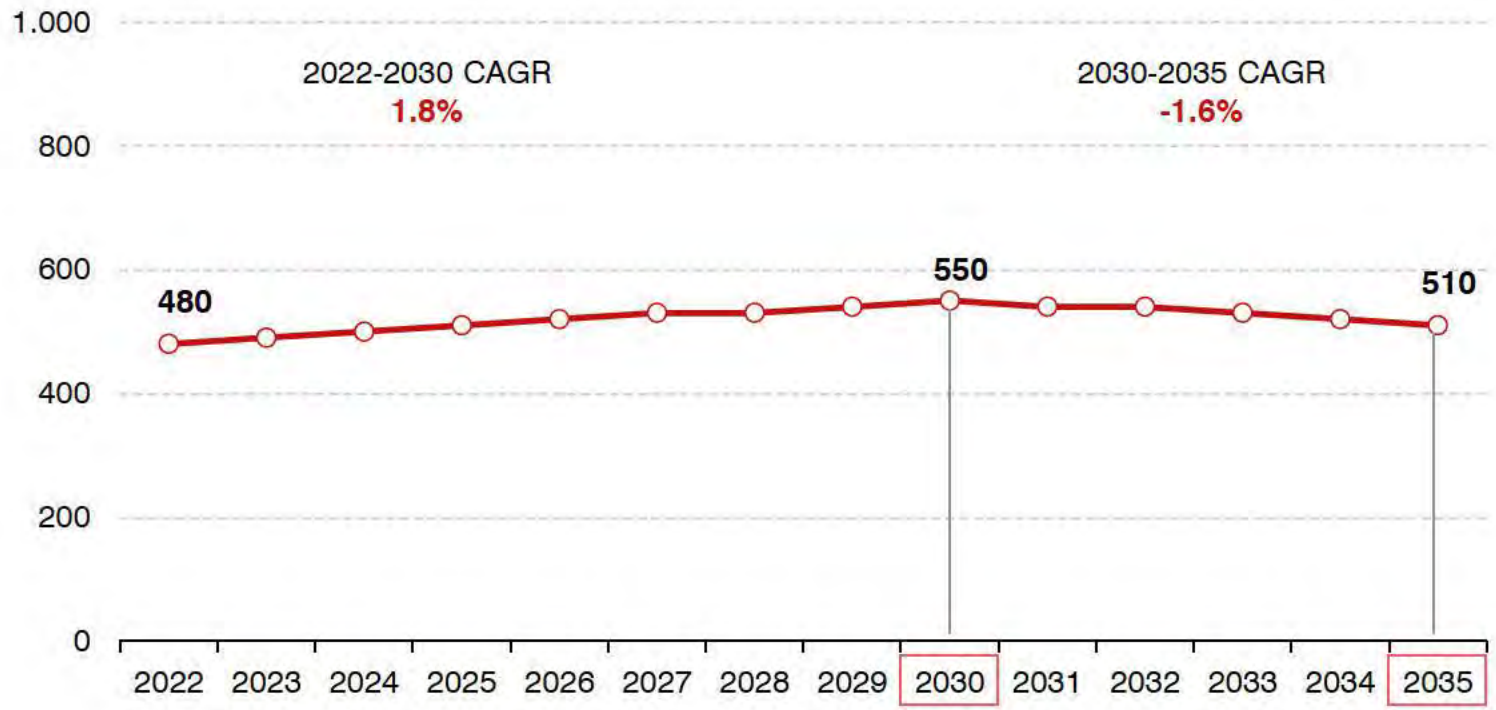
Electric mainline freight locomotive target fleet in 2022 (units)[2]



1: Retrofit contracted; 2: in line with the rail freight forecast, SCI Verkehr uses the year 2022 as the basis also for the locomotive forecast

Target fleet forecast is based on Bridgecraft report (WLO forecast), and locomotive efficiency factor derived by SCI Verkehr

Electric mainline freight locomotive target fleet forecast (units)

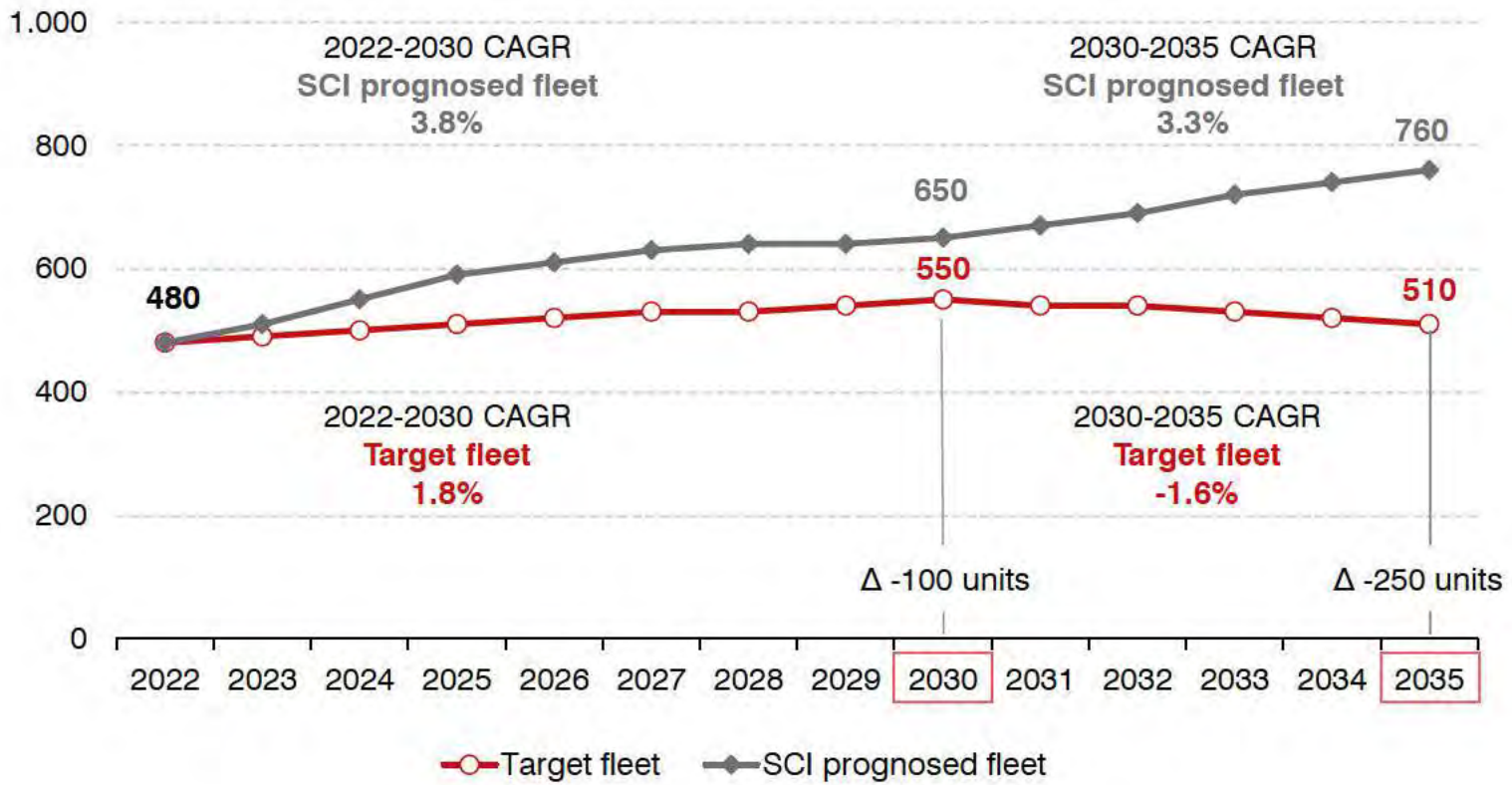


Development of the target fleet 2022-2035

- Target electric mainline freight locomotive fleet is derived from the transport volume forecast
- The following consideration regarding fleet development can be made:
  - Increase of ETCS BL 3.4 and BL 3.6 fleet due to new deliveries (Vectron MS, Euro9000, Traxx MS3)
  - Increase of ETCS BL 3.4 and BL 3.6 fleet due to the retrofit of the existing fleet (Vectron MS, Traxx MS2)
  - High order intake of Vectron MS and Traxx MS3 recently made by lessors (Railpool, ELL, Akiem, Alpha Trains) based on large framework contracts with manufacturers

Based on very large orders of electric locomotives for corridors incl. NL, several ETCS retrofit projects or plans and low withdrawal activity of the young fleet, SCI Verkehr expects a stronger fleet growth

Electric mainline freight locomotive fleet forecast (units)



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Target fleet / SCI prognosed fleet discrepancy

- SCI prognosed fleet is based on the relevant firm orders, retrofit contracts and estimation regarding withdrawals (e.g., no unit w/o ETCS BL 3.4 operable on the main lines after 2030)
- Target fleet is derived on the base of prognosed transport volume in tonnes dedicated to asset type (i.e., electric ML freight locomotives)

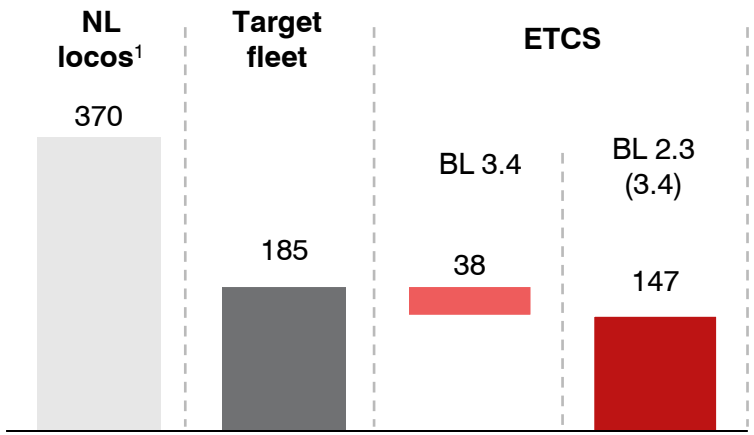
Vectron MS: SCI Verkehr recommends extending BL3 subsidies also for the existing fleet that is out of the program scope to secure long-term operability of the largest fleet in focus in the Dutch market

Siemens
Vectron MS

Technical data	
Years of delivery	2014-
Deliveries (total / NL)	890 / 370
Operational area	Mainline freight and PAX
Traction system	15 kV / 25 kV 50 Hz AC 1.5 kV / 3 kV DC
Power output (kW)	6,400
Starting traction effort (kN)	300-350
Vmax (km/h)	160 / 200
Axle load (t)	22.0-22.5
Homologation (planned)	AT, BE, BG, CH, CZ, DE, HR, HU, IT, NL, NO, PL, RO, RS, SE, SK, SI, TR (FR, LU)

1: All locomotives with NL-homologation

Target fleet 2022			
Owner	**Operator**	**BL 3.4**	**BL 2.3 (3.4 contracted)**
Various (incl. Railpool, Akiem)	Various (incl. SBB Cargo, boxXpress)	38	-
Various (incl. Beacon, SüdL., ELL, Alpha Trains, BLS Cargo, DB Cargo, ÖBB)	Various (incl. SBB Cargo, LTE, TX, DB Cargo, ÖBB BLS Cargo, RFO)	-	147
Total		**38**	**147**



SCI Verkehr recommends extending subsidies for BL 3.4 retrofit also for the existing fleet of Vectron MS

- The asset is very popular among operators and the **most widespread** locomotive **type in focus**
- The modern locomotive is the most demanded corridor asset in Continental Europe – several assets are operating, and a large number is on order with BL 3.4 as of spring 2024 – however, **most existing assets are equipped with BL 2.3 only** – some retrofit contracts exist, but to secure overall operability of the fleet in NL, BL 3.4 retrofits should be supported monetarily

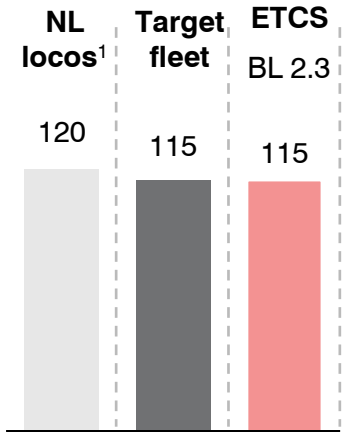
Eurosprinter: Beacon is likely to retrofit (first-in-class asset), but other retrofits is rather uncertain - DBC should be approached to check subsidy-options (risk of modal shift in NL if DB ends operations)

Siemens
Eurosprinter

Technical data	
Years of delivery	2003-2010
Deliveries (total / NL)	400 / 120
Operational area	Mainline freight
Traction system	15 kV / 25 kV 50 Hz AC 1.5 kV / 3 kV DC
Power output (kW)	6,400
Starting traction effort (kN)	300
Vmax (km/h)	140
Axle load (t)	21.5
Homologation	DE, AT, CH, IT, NL, SE, PL, CZ, SK, SI, HR

1: All locomotives with NL-homologation

Target fleet		
Owner	**Operator**	**BL 2.3**
DB Cargo	DB Cargo	63
Akiem	TX Logistik, Ecco Rail, LTE, ...	29
Beacon	SBB Cargo, Ecco Rail, NRV, ...	28
Total		**120**



Large mid-aged fleet with importance for Dutch rail freight transports – first positive signs for retrofits but no contract as of spring 2024

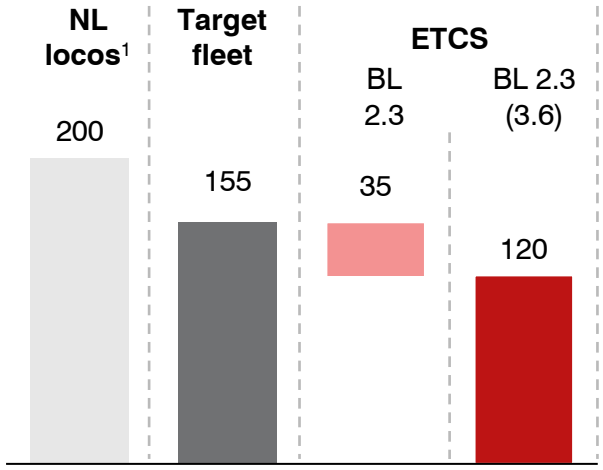
- **Beacon**: hosts a first-in-class locomotive (ex MRCE) – this supports SCI Verkehr's expectation that Beacon will retrofit its fleet with BL 3.4
- **DB Cargo**: SCI Verkehr recommends ProRail to put a focus on DB to check possibilities for fleet admission in first-in-class and series subsidies program – DB is an important player in NL (50% market share in terms of tkm) and operates at an attractive price (risk of modal shift if DB must end transports – *"business not profitable with new Vectrons"*)
- **Akiem**: plans are rather uncertain ("*Akiem is generally planning to equip these locomotives with ETCS BL 3 but so far, it is not contracted*") – SCI Verkehr does not consider an ETCS upgrade of the assets in its forecast as part of a cautious approach

Traxx MS2: large leasing fleet that will be retrofitted with BL 3.6 – Alpha Trains and Railpool with fixed contracts, Akiem intends a retrofit as well and hosts a large fleet currently deployed in passenger

Alstom
Traxx MS2

Technical data	
Years of delivery	2004-2020
Deliveries (total / NL)	490 / 200
Operational area	Mainline freight and PAX
Traction system	15 kV / 25 kV 50 Hz AC 1.5 kV / 3 kV DC
Power output (kW)	5,600
Starting traction effort (kN)	300
Vmax (km/h)	140
Axle load (t)	21.25
Homologation (planned)	DE, AT, BE, CH, FR, IT, LU, NL, PL, CZ, HU, SK (SI)

Target fleet			
Owner	**Operator**	**BL 2.3**	**BL 3.6 contracted**
Railpool	Lineas, RTB Cargo, Crossrail, ...	14	85
Akiem	HSL Logistik, METRANS, DB Cargo BE, ...	21	-
Alpha Trains	Crossrail, Medway BE, DB Cargo NL, ...	-	35
Total		**35**	**120**



Large fleet of widespread locomotive type operating in NL – lessors will retrofit MS2 fleet

- **Railpool**: contract to retrofit >70 units to BL 3.6, further units of the fleet with NL approval expected to be retrofitted as well
- **Akiem**: retrofit with BL 3.6 not yet contracted but certainly planned before 2030; 50 additional Traxx MS2 in ownership that is currently deployed in Dutch rail passenger service can be seen as additional potential[2]
- **Alpha Trains**: the 2021-contract with Alstom to retrofit 77 locomotives to BL 3 includes Traxx MS2 locomotives as well (partly operated in passenger as of spring 2024 and therefore not considered in the forecast)

1: All locomotives with NL-homologation; 2: as part of a cautious approach, these passenger assets are not part of the SCI fleet forecast

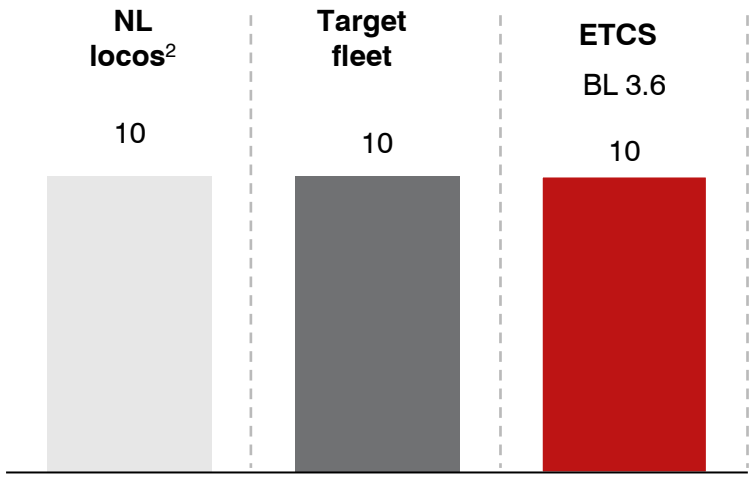
Euro9000: powerful 6-axle heavy mainline asset for operation along DACHINLB freight corridor, equipped with ETCS BL 3.6 – relevant newbuild asset both along electrified and non-electrified lines

Stadler
Euro9000

Technical data	
Years of delivery	2023-
Deliveries (total / NL)	10[1] / 10
Operational area	Heavy mainline freight
Traction system	15 kV / 25 kV 50 Hz AC 1.5 kV / 3 kV DC + Last-mile diesel engines
Power output (kW)	9,000 1,900 (LM diesel)
Starting traction effort (kN)	500
Vmax (km/h)	120
Axle load (t)	20
Homologation (planned)	DE, AT,CH, NL, BE (IT, FR, PL, CZ, SK, HU, SI, HR, RO, BG, RS, MK, GR)

Target fleet		
Owner	**Operator**	**BL 3.6**
ELP	HSL Logistik, RFO, RTB Cargo, ...	10 (30 on order)
Alpha Trains	-	- (12 on order)
Total		**10 (42 on order)**

- Powerful 6-axle asset for operation along the DACHINLB freight corridor, partly regarded as a competitor to diesel/alternative locomotives due to the strong diesel traction available (last-mile engines)

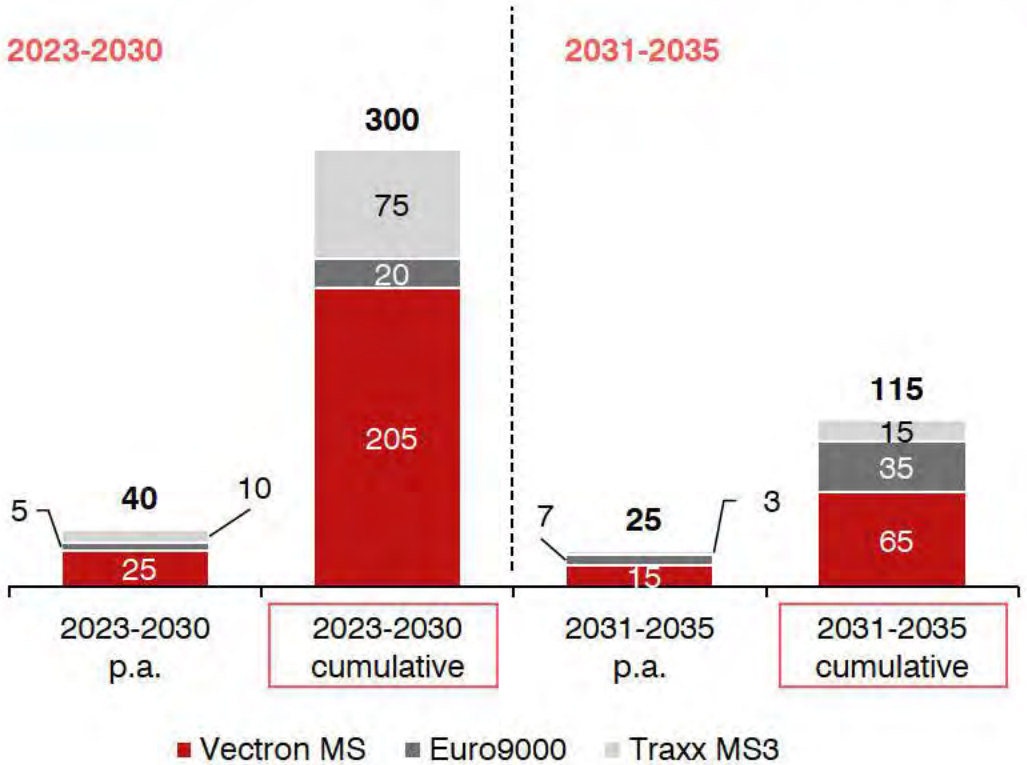


- **ELP**: as of spring 2024, lessor European Loc Pool ordered a total of 40 Euro900 locomotives – the first units of the high-priced asset are already in service
- **Alpha Trains**: 12 units ordered in 2023 for delivery in 2025/26, planned to be offered to German operators
- Expected to **replace part of the Class 66 locomotives** on the relevant lines

1: additional ~40 units currently on order; 2: all locomotives with NL-homologation

Around 300 locomotives ordered and will enter the market up to 2030, i.e., around 40 units annually – Up to 2035, additional 115 units expected to be procured

Electric mainline freight locomotive fleet – new additions (ETCS BL 3)
(units)



Locomotives on order (2024-2030)

Vectron MS (extract)

- Railpool: Framework contract for up to 100 units signed in 2022, with initial call-off for 70 locomotives
- SüdLeasing: 20 Vectron MS with Xload package ordered in 2022
- Akiem, Alpha Trains, ELL: Further fleet additions based on framework contracts with Siemens
- TX Logistik: 20 NL-units ordered in 2023 (out of 40 units ordered in total)
- Beacon (MRCE's order): 14 A10 versions ordered in 2022
- Medway BE: 15 units ordered in 2023

Traxx MS3

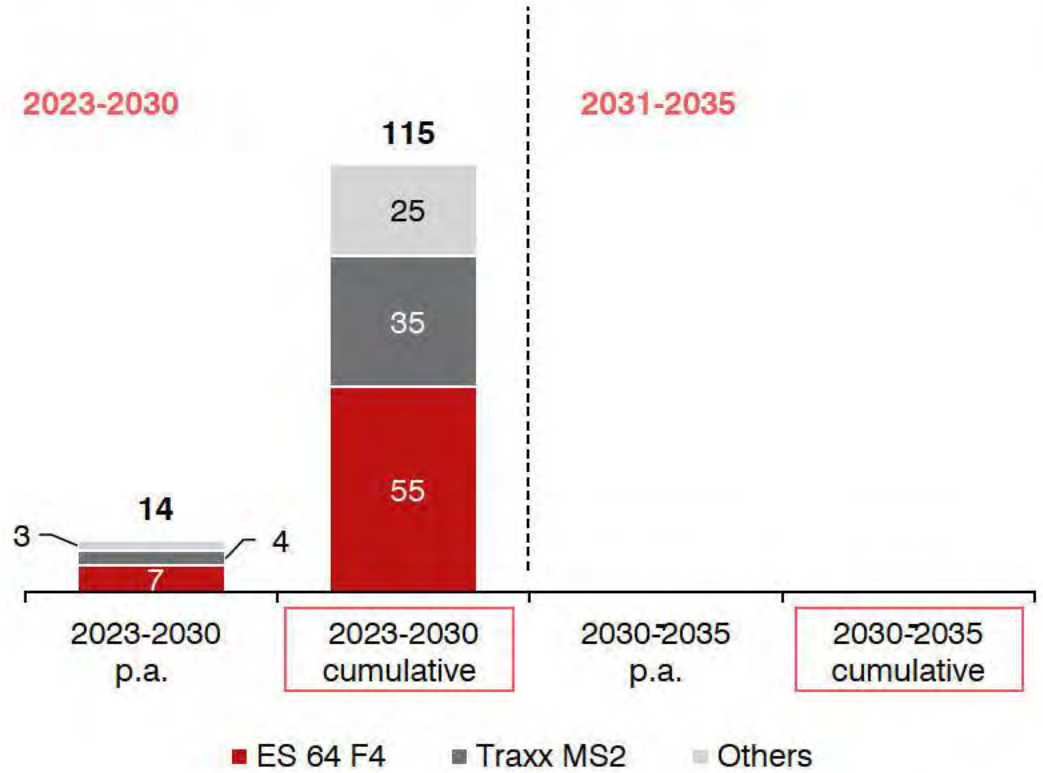
- Akiem's contract for up to 100 Traxx MS3 locomotives (with Atlas ETCS) signed in 2023, with initial call-off for 65 units

Euro9000

- ELP's units – the last call-off from the framework contract with Stadler (up to 100 units, including EuroDual as well) took place early 2024 for 10 units

Around 100 locomotives are expected to be withdrawn from the Dutch market up to 2030 when ETCS BL 3 becomes necessary – this fleet is neither contracted nor expected for ETCS retrofit

Electric mainline freight locomotive fleet – withdrawals[1]
(units)



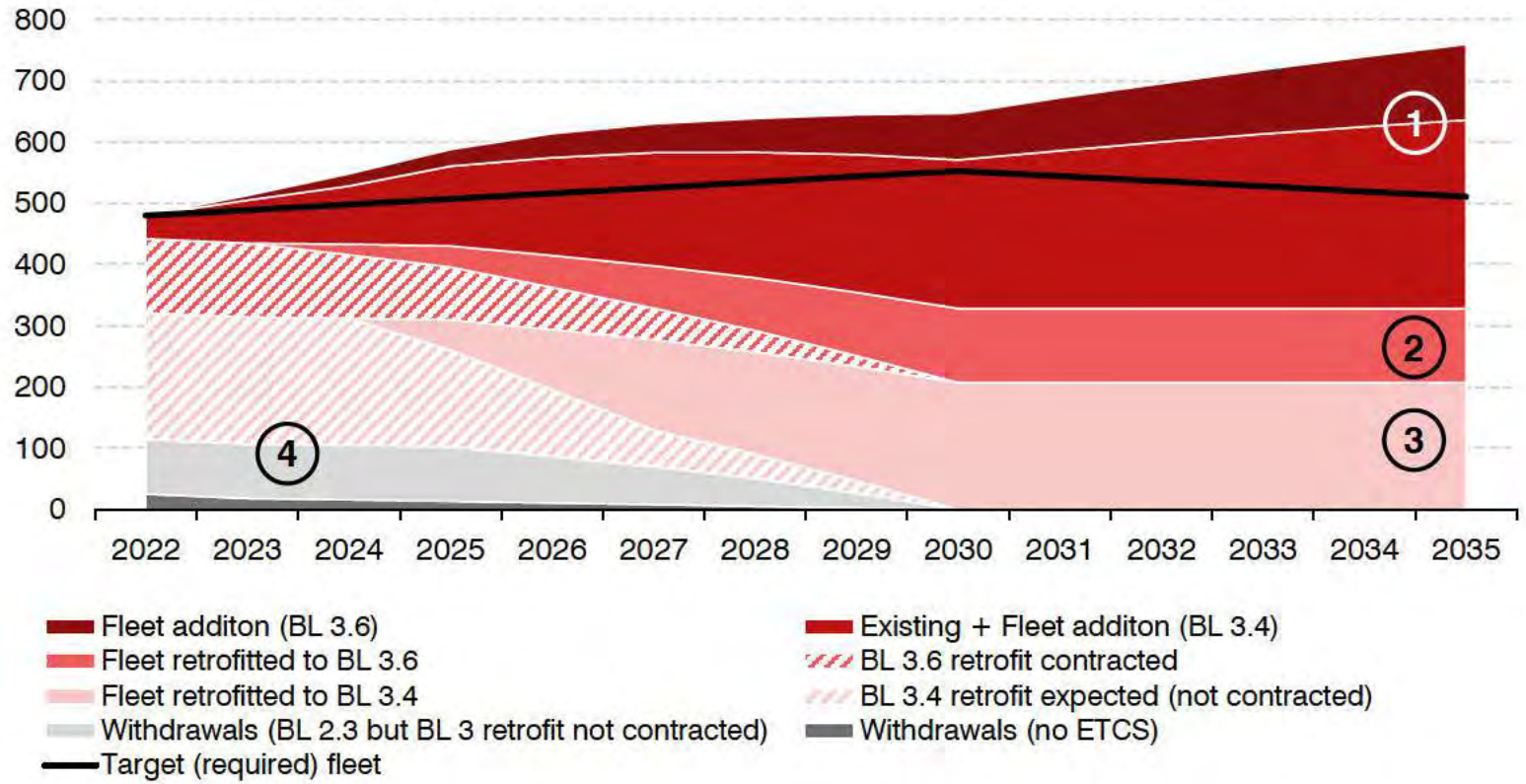
Withdrawals from the Dutch market

- **ES 64 F4**: part of the fleet of BL 2.3 units is expected to be withdrawn (e.g., assets in ownership of Akiem)
- **Traxx MS2**: BL 2.3 units not contracted for retrofit, e.g. Metrans
- **Others**: Locomotives **w/o ETCS** (Class 1700/1800, 101, Traxx AC2, etc.)
- These assets are not contracted/expected to be upgraded to BL 3.4 or BL 3.6 and SCI Verkehr expects that they will not be deployed in the Dutch market after 2030 due to lack of economical feasibility for an upgrade and high number of new additions that will enter the market in this timeframe

1: Most of the Traxx MS2 locomotives expected for withdrawals do not have NL-BE-+ homologation

Contracted as well as expected ETCS retrofit projects accompanied by new fleet additions will be able to cover the demand for ETCS BL 3 assets up to 2030

ETCS electric mainline freight locomotive fleet SCI Verkehr prognose and target fleet[1] (units)

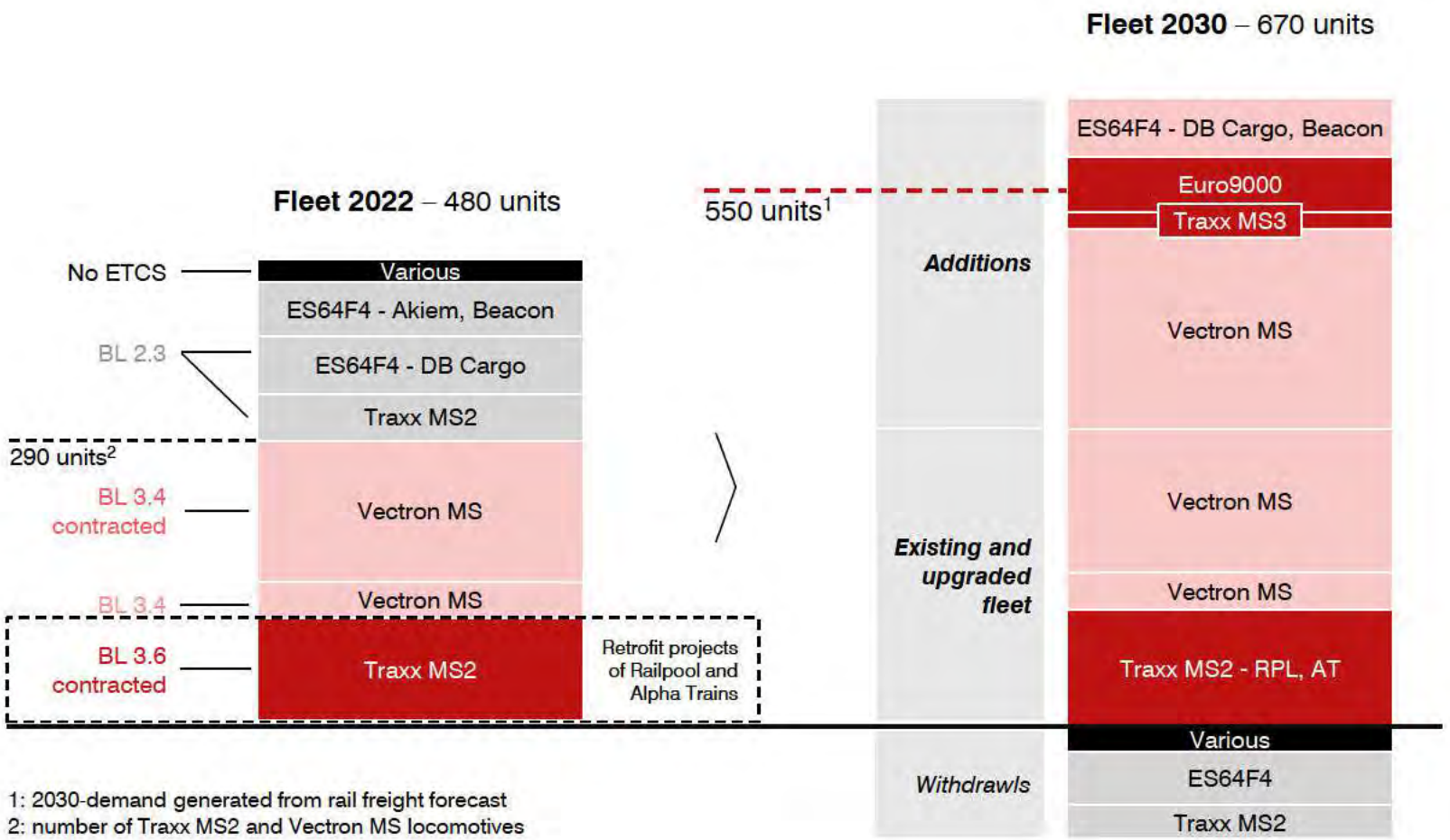


1: Derived on the base of prognosed transport volume in tonnes dedicated to asset type

1. Fleet of existing **BL 3.4** (**Vectron MS**) and new additions of BL 3.4 (Vectron MS) and **BL 3.6** (**Traxx MS3, Euro9000**) – the fleet is forecasted to reach **~320 units in 2030**
2. Assets contracted for **BL 3.6 retrofit** (**Traxx MS2**, ~120 units) – estimated to be retrofitted until 2030
3. SCI Verkehr expects the **older Vectron MS** (BL 2.3) and **parts of the Eurosprinter** fleet (BL 2.3) gradually to be **retrofitted to BL 3.4** until 2030 – these assets are mostly not contracted as of spring 2024
4. **Fleet of BL 2.3 assets** (ES64F4, Traxx MS2) that is **neither contracted for BL 3.4/3.6 retrofit nor expected** – expected gradually to be replaced with retrofitted or new assets

Target fleet[1] is smaller than the SCI Verkehr forecasted fleet and takes different trend – not the entire SCI forecasted fleet will be needed to cover demand for ETCS locomotives in NL

SCI Verkehr forecasts sufficiently large ETCS-only fleet in 2030 – the assets will be significantly more expensive than today's fleet



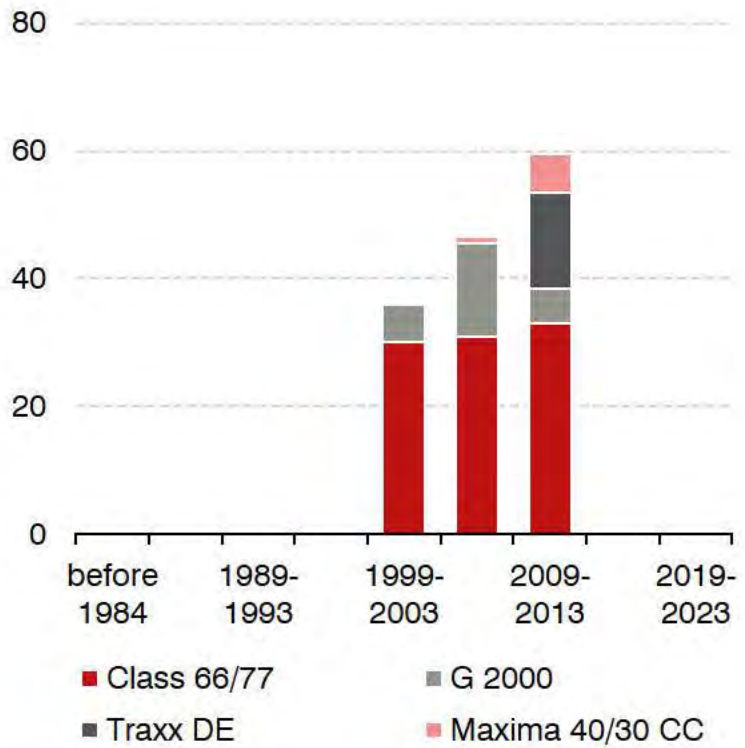
1: 2030-demand generated from rail freight forecast
2: number of Traxx MS2 and Vectron MS locomotives

- **Forecasted** electric freight mainline **fleet** for 2030 **is more than sufficiently large** to meet the rail freight demand
- The **future fleet will differ** from the current fleet **in economic and technical parameters**
  - New locomotive types like the powerful 6-axle Euro9000 and the Traxx MS3 with last mile-module will provide **an increase in efficiency**
  - The high-powered multi-system locomotives, equipped ETCS-BL 3.4 and higher, are **significantly higher priced** than most of today's operating assets
- OBU-supplier **Alstom is the crucial player** in achieving a sufficiently large ETCS-fleet for 2030

4.3 Diesel/alternative mainline locomotives

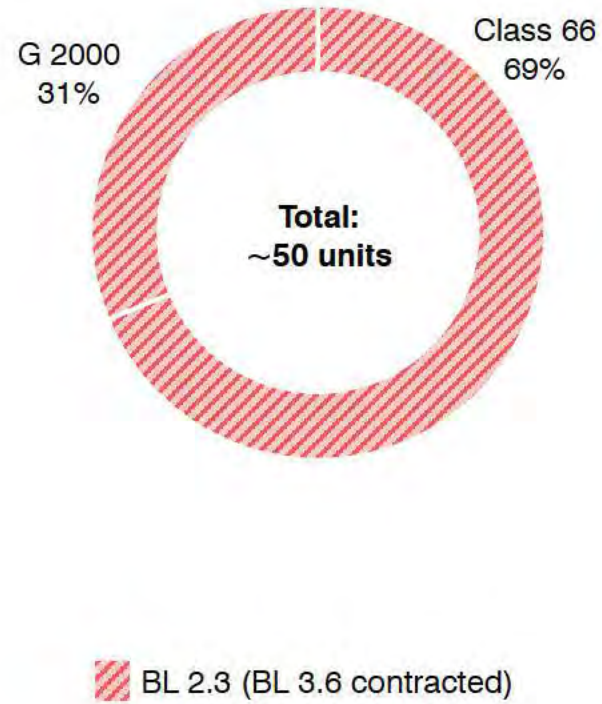
From ~140 diesel mainline freight NL-locomotives, ~50 units were identified as relevant for further analysis, which is comparable to ProRail's input fleet

Diesel mainline freight NL-locomotives
age structure (~140 units)



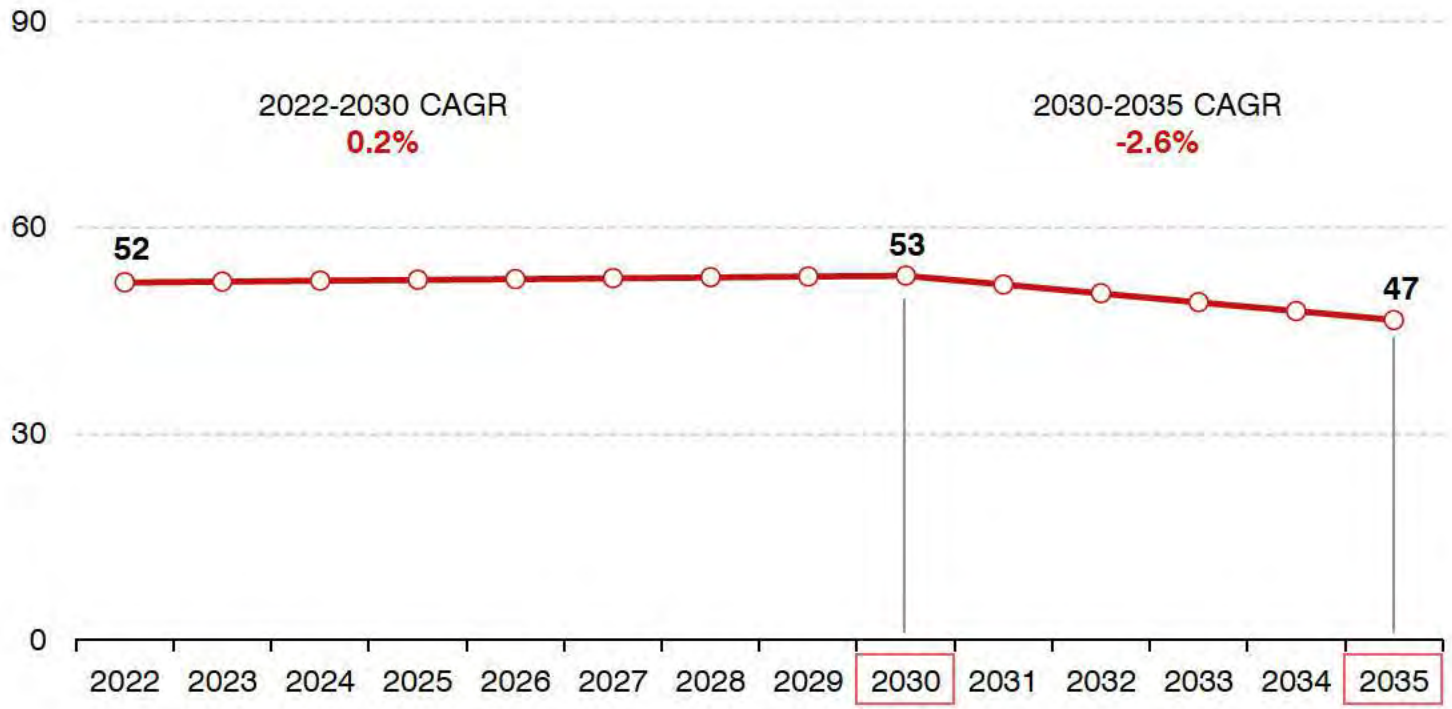
- Diesel mainline freight fleet of NL-locomotives accounted for ~**140 units in 2023**
- Large fleet of **Class 66/77** with NL-homologation that are not operated in NL
- **Withdrawals, i.e., not part of ProRail's scope**:
  - Part of the Traxx DE locomotive fleet
  - Voith Maxima 40/30 CC
- According to **ProRail's input**, **Class 66** locomotives will be retrofitted with **BL 3.6**
- **Target fleet** is therefore **comparable** with the input fleet provided by **ProRail**

Diesel mainline freight locomotive
target fleet in 2022 (units)



Target fleet forecast is based on Bridgecraft report (WLO forecast), and locomotive efficiency factor derived by SCI Verkehr

Diesel mainline freight locomotive target fleet forecast (units)

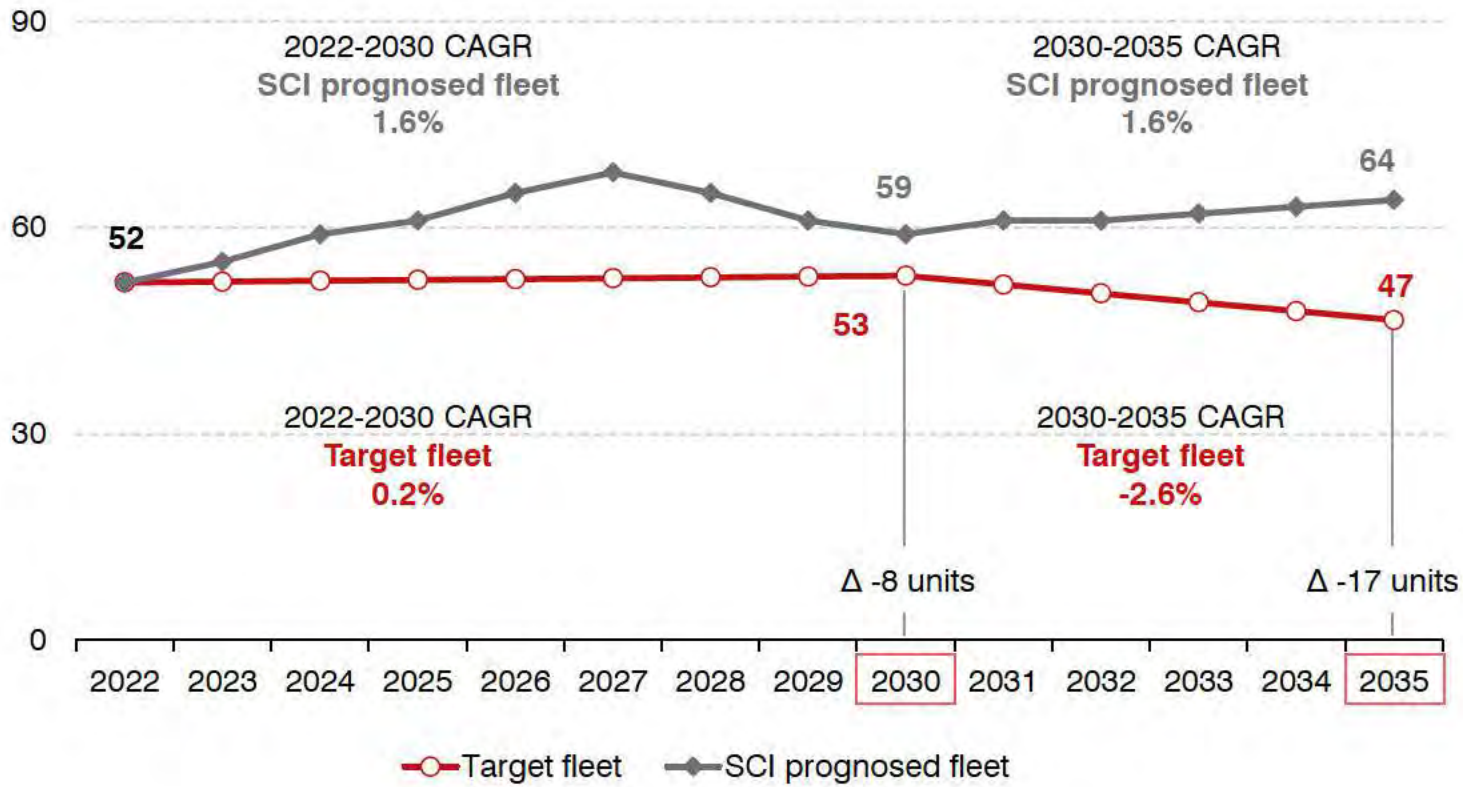


Development of the target fleet 2022-2035

- Target diesel mainline freight locomotive fleet is derived from the transport volume forecast
- The following consideration regarding fleet development can be made:
  - No new additions within the segment of pure diesel locomotives are expected
  - Only increase is due to Euro9000 electric multi-system locomotive to the market – high-powered asset, equipped also with 1,900 kW diesel traction, expected partly to overtake tasks currently done by diesel fleet
  - Existing ETCS BL 2.3 fleet contracted for retrofit to BL 3.6 (Beacon's Class 66, Alpha Trains' G 2000)
  - Gradual withdrawal of the BL 2.3 fleet that is not expected to be retrofitted (remaining Beacon's and Crossrail's Class 66 and Traxx DE) and units w/o ETCS (Akiem's Class 77 which will be transferred to UK)

From starting 52 units (2022), the target fleet will almost not change in terms of fleet size until 2030 and even slightly decrease until 2035

Diesel mainline freight locomotive target fleet forecast (units)



Development of the target fleet 2022-2035

- No new additions within the segment of diesel locomotives are expected
- Only increase is due to the Euro9000 electric multi-system locomotive to the market
- Existing ETCS BL 2.3 fleet contracted for retrofit to BL 3.6 (Beacon's Class 66, Alpha Trains' G2000)
- Gradual withdrawal of the fleet equipped with BL 2.3 and not expected to be retrofitted

Target fleet / SCI prognosed fleet discrepancy

- SCI prognosed fleet is based on the current installed base and market entry of the Euro9000, as well as expected withdrawal of obsolete assets (w/o ETCS, not contracted)
- Target fleet is derived on the base of prognosed transport volume in tonnes dedicated to asset type (i.e., diesel ML freight locomotives)

Class 66/77 locomotive: Beacon contracted a large part of its Class 66 fleet for BL 3.6 retrofit and will mainly contribute to securing locomotive capacity for heavy haul services in NL beyond 2030

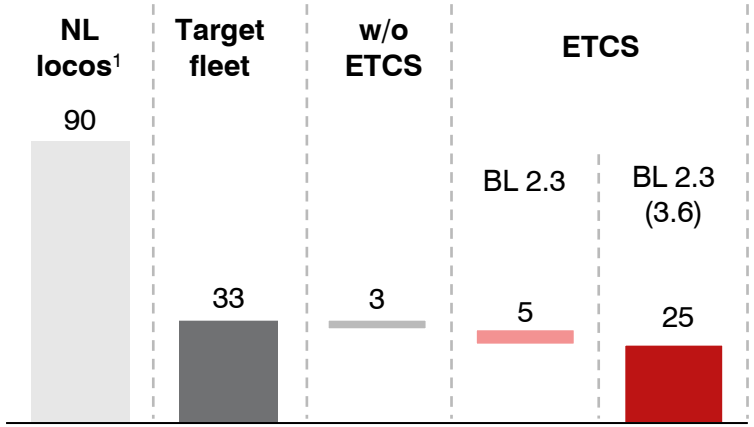
EMD
Class 66/77

Technical data	
Years of delivery	2003-2016
Deliveries (total / NL)	600 / 90
Operational area	Heavy mainline freight
Traction system	Diesel
Power output (kW)	2,420
Starting traction effort (kN)	409
Vmax (km/h)	120
Axle load (t)	21
Homologation	BE, DE, DK, FR, UK, LU, NL, NO, PL, SE, RO

1: All locomotives with NL-homologation

Target fleet

Owner	**Operator**	**w/o ETCS**	**BL 2.3**	**BL 2.3 (3.6 contracted)**
Beacon	Various (e.g., Freightliner DE, Crossrail, RTB Cargo, Railtraxx)	-	2	25
Crossrail	Crossrail	-	3	-
Akiem	Captrain Benelux, ITL	3	-	-
Total		**3**	**5**	**25**



- Around 30 units estimated for deployment in NL as primary operation area
- **Akiem**: Class 77 without ETCS not expected for retrofit (will go to the UK market)
- **Beacon**: large part of the Class 66 fleet already contracted for upgrade to BL 3.6

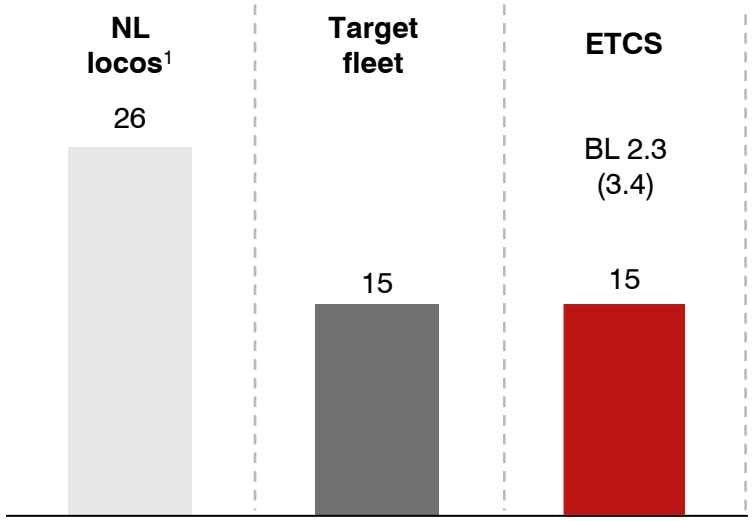
G 2000 locomotive: lessor Alpha Trains contracted a fleet of 15 G2000 locomotives in operation in the Netherlands for BL 3.6 retrofit

Vossloh
G 2000

Technical data	
Years of delivery	2000-2010
Deliveries (total / NL)	83 / 26
Operational area	Mainline freight
Traction system	Diesel
Power output (kW)	2,240
Starting traction effort (kN)	283
Vmax (km/h)	140
Axle load (t)	21.9-22.5
Homologation	NL, BE, FR, DE, AT, SE

1: All locomotives with NL-homologation

Target fleet		
Owner	**Operator**	**BL 2.3 (3.6 contracted)**
Alpha Trains	Lineas NL, Rail Force One, RRF, ...	15
Total		**15**



- Around 15 units estimated for deployment in NL as primary operation area
- **Alpha Trains**: The 2021-contract with Alstom/ Bombardier for retrofit of 77 locomotives to BL 3.6 includes G 2000 locomotives as well – the G2000 locomotive is an attractive asset for rail freight operators in terms of leasing rates but SCI Verkehr expects that Alpha Trains will also have to increase its pricing following the BL 3.6 retrofit

EuroDual locomotive: powerful dual mode locomotive not equipped with Dutch ATB system, but implementing the possibility of ETCS-only operation could enlarge heavy haul locomotive potential

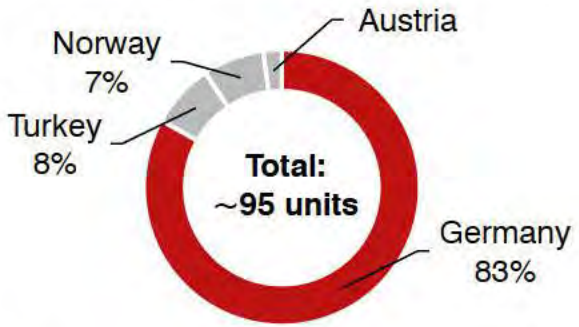
Stadler
EuroDual

Technical data	
Years of delivery	2019-
Deliveries (total / NL)	95 / -
Operational area	Heavy mainline freight
Traction system	Electric (AC) - diesel
Power output (kW)	7,000 (e), 2,800 (d)
Starting traction effort (kN)	500
Vmax (km/h)	120
Axle load (t)	21
Homologation (planned)	DE, AT, SE, NO, TR, RS (NL[1], BG, RO, SI, HR, ME, MK, GR)

Installed base

Owner	Operator	Units
ELP	DB Cargo, HHPI, MEG, ...	65
DAL	HVLE	11
Various	Various	19
Total		**95**

Operator country 2023 (units)



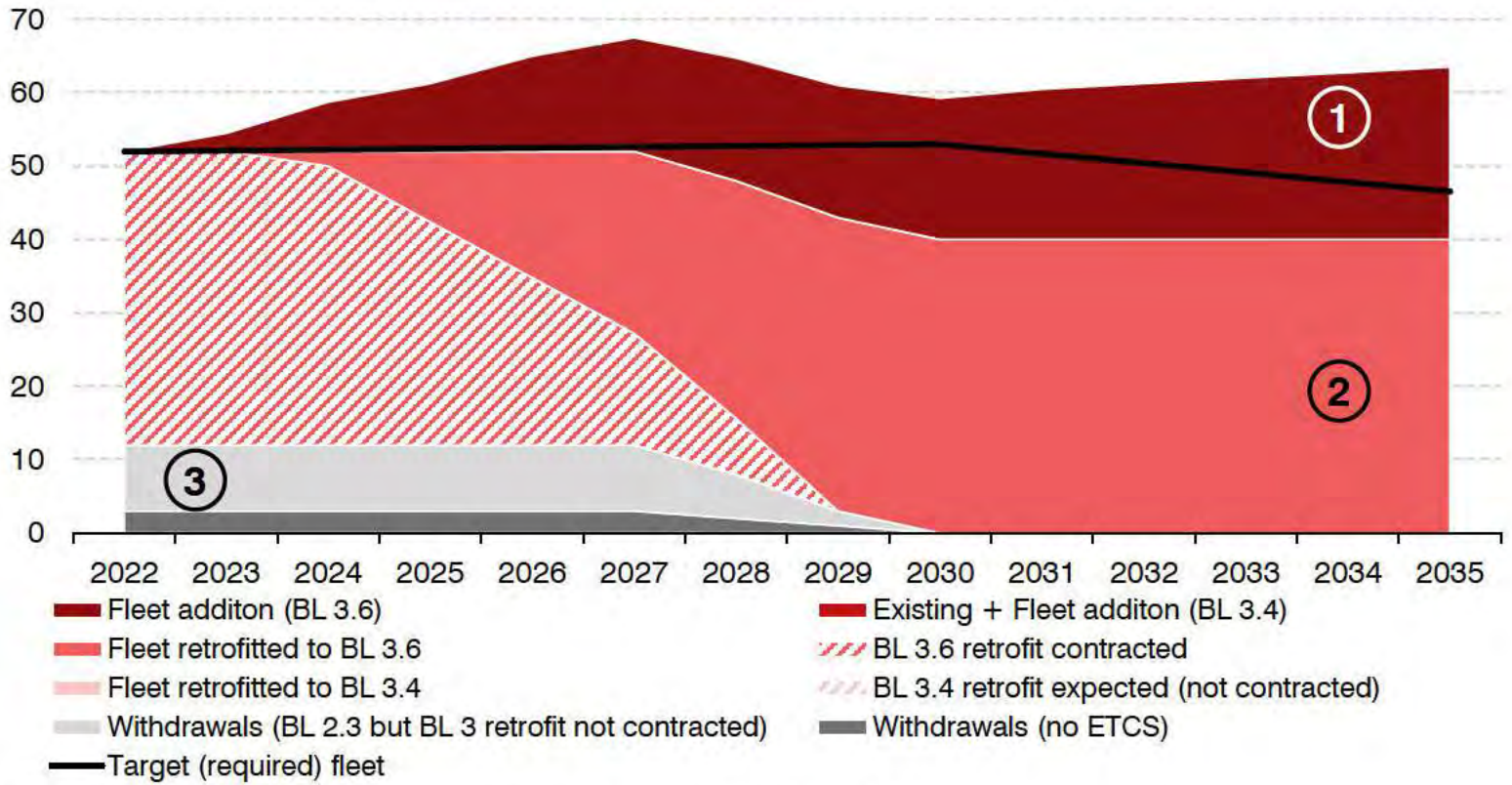
A dual-mode asset combining electric and diesel traction (diesel engine fulfilling highest EU emission standard) and currently the only 6-axle alternative drive asset available to operators in Continental Europe

- Lessor ELP intends to authorize its DE/AT-homologated EuroDual locomotives for the **Betuwe route** already up to 2025 such that the asset will be able to **operate along this line with ETCS-only (without the Dutch ATB system)** – the EuroDual could be able to operate the Kijfhoek area as well in such a scenario
- This could be interesting for German/Austrian EuroDual operators and has the **potential to increase the available fleet** in the heavy haul segment **significantly** – **ProRail is recommended to further support the initiative of ETCS-only operation in the Netherlands**. However, as this is also associated with initial costs, ProRail should **review a first-in-class subsidy** also for the EuroDual locomotive.
- For ETCS-only operation on other Dutch lines, the EuroDual could operate in diesel-only mode.[2]

1: Planned only for the Betuweroute (25 kV 50 Hz, equipped with ETCS); 2: as it is not equipped with DC-traction

Both the Euro9000 and the EuroDual would be needed to cover the demand for catenary-free ETCS BL 3 assets up to 2030 – the 2023-operating fleet is not sufficiently large due to expected withdrawals

ETCS diesel mainline freight locomotive fleet prognose (units)



1: Derived on the base of prognosed transport volume in tonnes dedicated to asset type

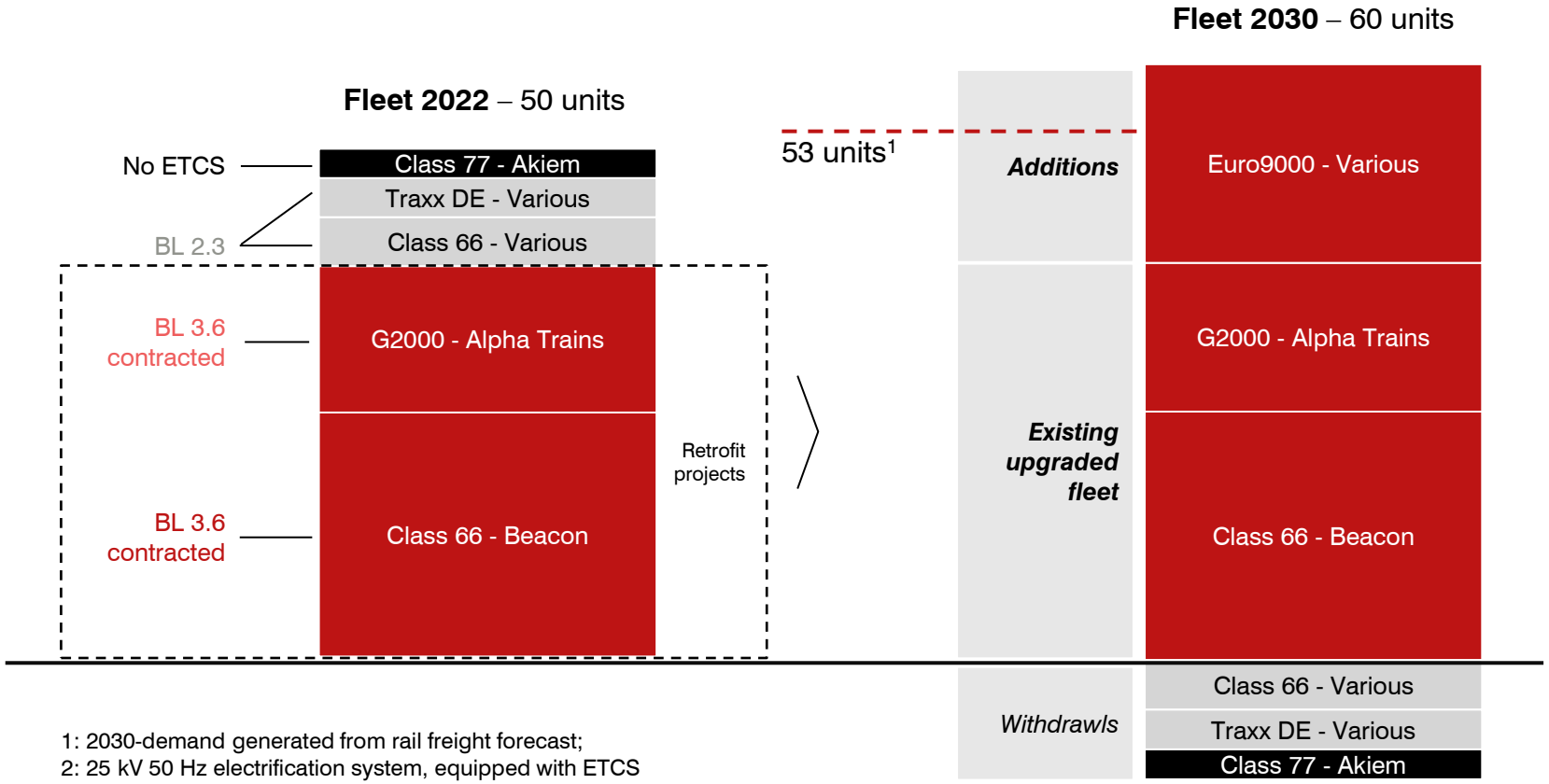
1. New additions with **BL 3.6** (**Euro9000**) – the fleet is forecasted to reach **~20 units in 2030** and **~25 in 2035**

2. Fleet of lessors Beacon Rail and Alpha Trains contracted for **ETCS BL 3.6** (**G 2000**, ~15 units, and **Class 66**, ~25 units) retrofit – 4 years estimated retrofit duration, 2025-2030

3. Fleet **currently not contracted for BL 3 retrofit**, **~10 units** in 2023 – expected **gradually to be replaced with retrofitted/new assets**, to fully extent **until 2029**

The target (required) fleet[1] is smaller than the SCI Verkehr forecasted fleet and takes different trend, but: both the Euro9000 and the EuroDual would be needed to cover the demand for catenary-free ETCS BL 3 assets up to 2030 – the 2023-operating fleet is not sufficiently large due to expected withdrawals

Freight mainline services via non-electrified lines – SCI Verkehr forecasts sufficiently large ETCS-only fleet in 2030 but new Euro9000 locomotives are needed to cover the demand



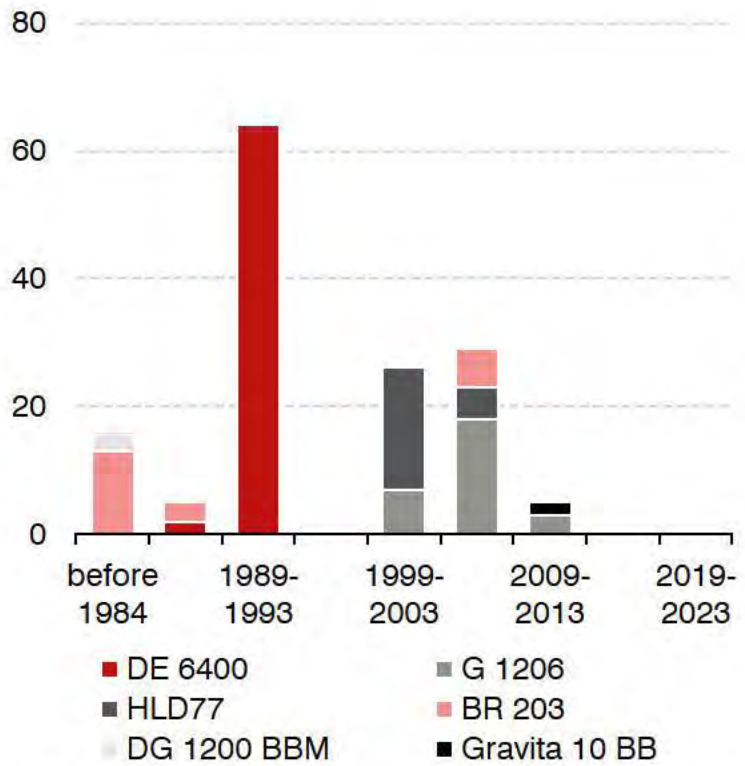
- **Forecasted** freight mainline **fleet** to operate today's diesel-hauled mainline traffic **is sufficiently large** to meet the rail freight demand in 2030
  - Already contracted **retrofit projects** of Beacon and Alpha Trains **will build a solid basis** of future fleet
  - Moreover, SCI Verkehr dedicated **25%** of the forecasted fleet of 6-axle electric-hybrid **Euro9000** (1,900 kw Stage V diesel power) to the segment
  - **Universal locomotives** could also support in serving this demand when operating **in double traction**
- Additionally, **EuroDual** is planned to be authorised for the **Betuwe route**[1] already up to 2025 and will then be able to run on this line with **ETCS-only** as well as through **Kijfhoek** yard from 2030. For NL-operation, the EuroDual could be then also deployed in **diesel mode** (not equipped with DC-traction) and with ETCS-only.
- Hence, the EuroDual is expected to take over some services that are today run with pure diesel assets.

1: 2030-demand generated from rail freight forecast;
2: 25 kV 50 Hz electrification system, equipped with ETCS

4.4 Universal / Shunting locomotives

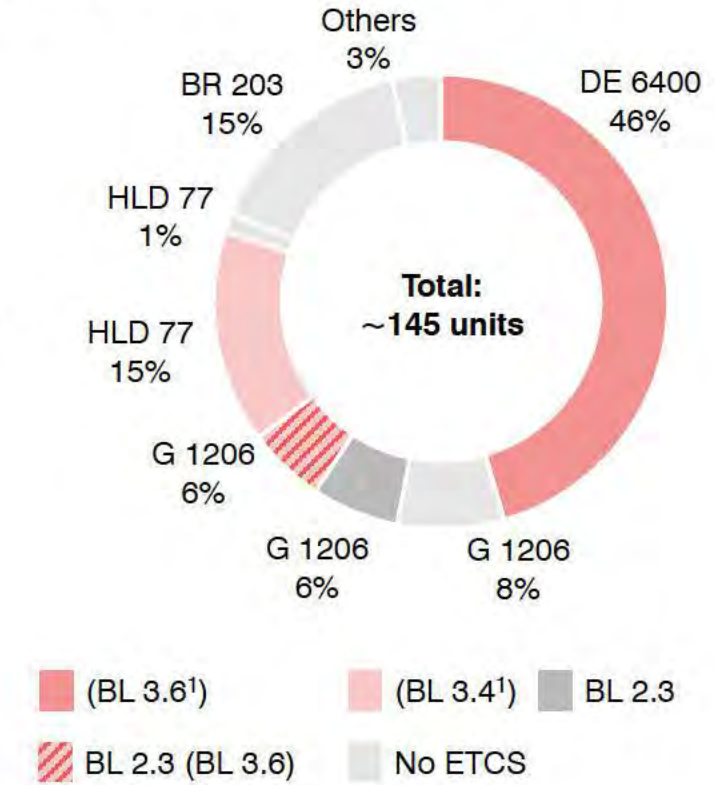
Around 145 units identified as relevant for further analysis, comparable to ProRail's input fleet

Universal/shunting NL-locomotives
age structure (~145 units)



- Universal/shunting locomotive fleet of NL-locomotives accounted for ~**145 units in 2023**
- Entire fleet is assumed to be operated in the Netherlands, resulting in **target fleet accounting for 145 units**.
- According to the **ProRail's input**, **DE 6400** locomotives will be retrofitted with **BL 3.6**
- **Target fleet** is **comparable** with the input fleet provided by **ProRail**

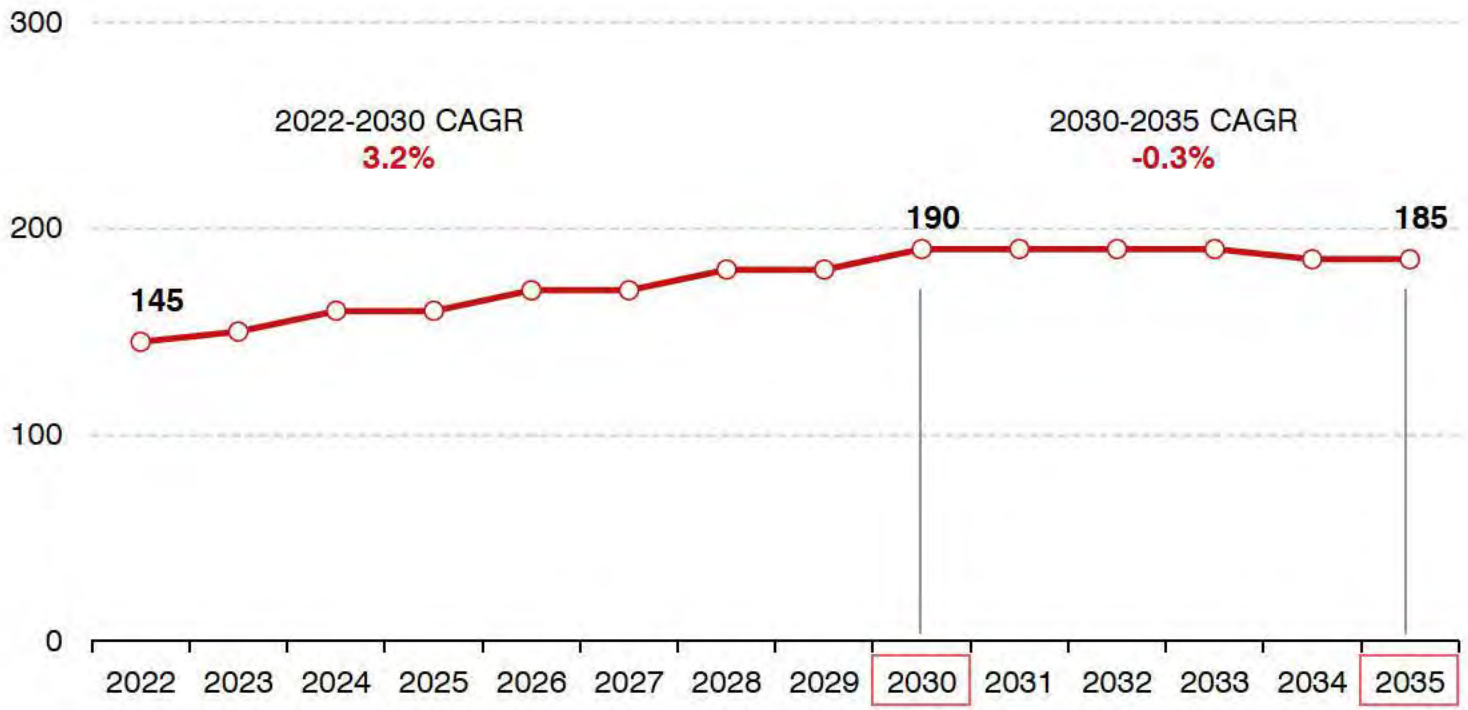
Universal/shunting locomotive
target fleet in 2023 (units)



1: Retrofit contracted

Target fleet forecast is based on Bridgecraft report (WLO forecast), and locomotive efficiency factor derived by SCI Verkehr

Universal/shunting locomotive target fleet forecast (units)

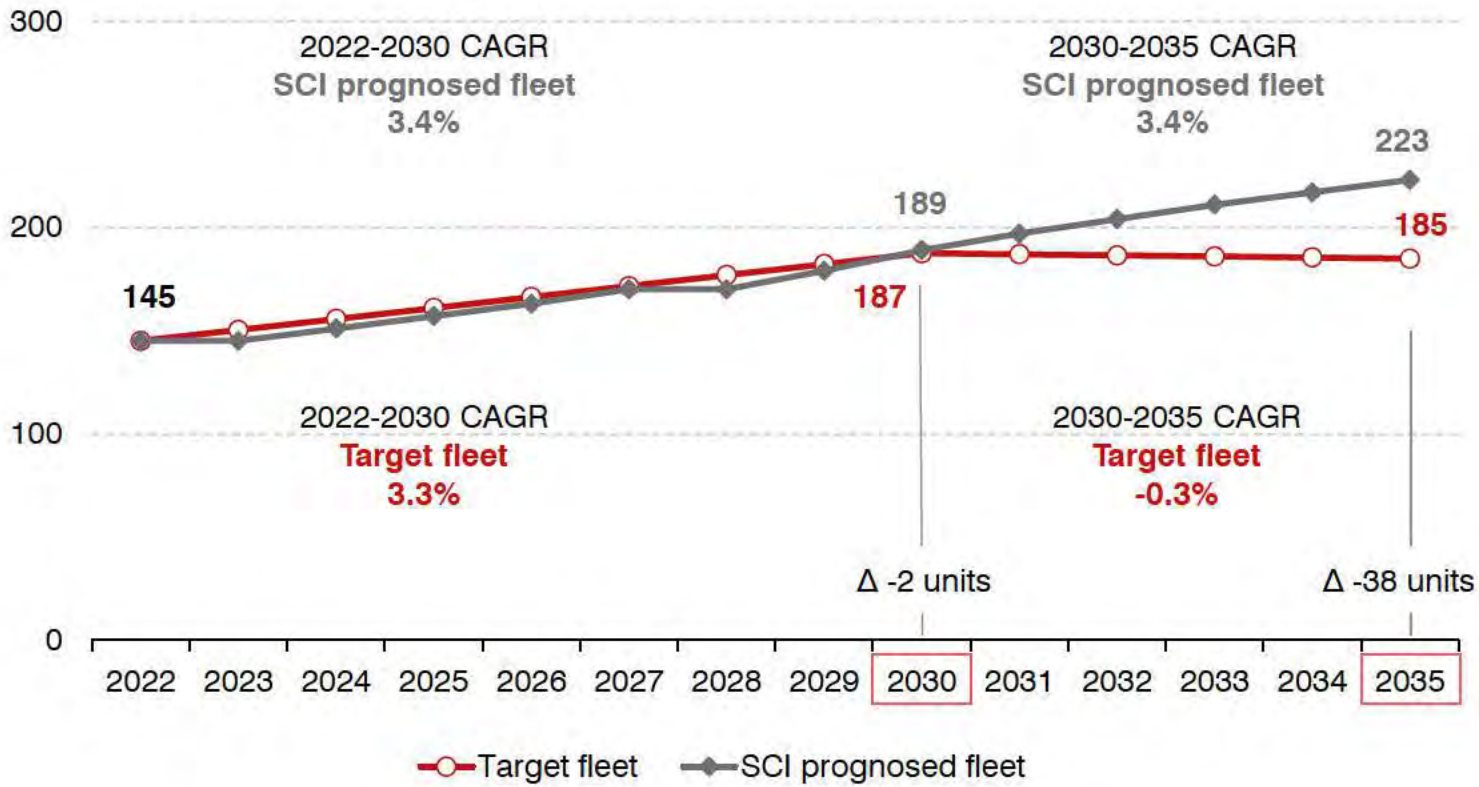


Development of the target fleet 2022-2035

- Target universal/shunting locomotive fleet is derived from the transport volume forecast
- The following consideration regarding fleet development can be made:
  - Existing fleet contracted for BL 3.6 retrofit (DE6400 from DB Cargo NL, G1206 from Alpha Trains)
  - Existing fleet contracted for BL 3.4 retrofit (HLD 77 from Beacon and SNCB)
  - ETCS BL 3.6 fleet additions (Modula EBB/EDD and Alstom's Traxx Shunter in the long-term)
  - ETCS BL 3.4 fleet additions (DE 18 SmartHybrid)

From starting 145 units (2022), target fleet to account ~190 units in 2030 and ~185 units in 2035

Universal/shunting locomotive fleet forecast (units)



Development of the target fleet 2022-2035

- Existing fleet contracted for BL 3.6 retrofit (DE6400 from DB Cargo NL, G1206 from Alpha Trains)
- Existing fleet contracted for BL 3.4 retrofit (HLD 77 from Beacon and SNCB)
- ETCS BL 3.6 fleet additions (Modula EBB/EDD and Alstom's Traxx Shunter in the long-term)
- ETCS BL 3.4 fleet additions (DE 18 SmartHybrid)

Target fleet / SCI prognosed fleet discrepancy

- SCI prognosed fleet is based on the relevant firm orders, retrofit contracts and estimation regarding withdrawals (e.g., no unit w/o ETCS BL 3.4 operable on the main lines after 2030)
- Target fleet is derived on the base of prognosed transport volume in tonnes dedicated to asset type (i.e., universal/shunting locomotives)

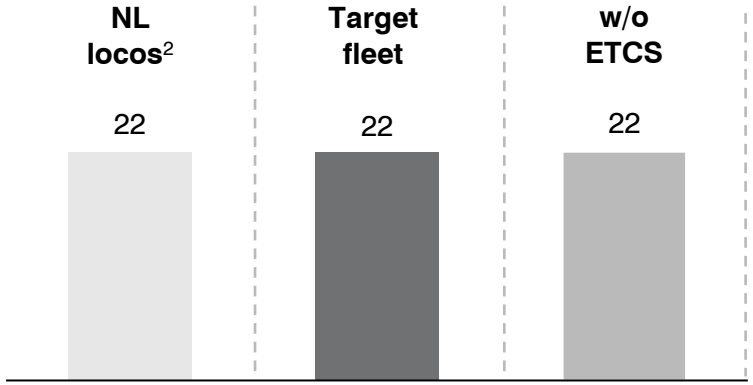
BR 203 locomotive: not contracted for ETCS BL 3 retrofit, expected to be withdrawn from the overall target fleet and remain deployed within closed networks that do not require ETCS

LKM/LEW/Alstom
BR 203 (V100)

Technical data	
Years of delivery	1966-1985[1]
Deliveries (total / NL)	1,145 (V100) / 22
Operational area	Heavy shunting / light ML
Traction system	Diesel
Power output (kW)	1,385
Starting traction effort (kN)	227
Vmax (km/h)	100
Axle load (t)	16
Homologation	DE, FR, NL

Target fleet

Owner	**Operator**	**No ETCS**	**BL 3 contracted**
RRF	RRF	11	-
Captrain Benelux	Captrain Benelux	4	-
Volker Rail Materieel	Volker Rail Materieel	4	-
Spitzke	Spitzke	3	-
Total		**22**	**-**



- No unit contracted for ETCS BL 3 retrofit – the **series is not sufficiently distributed in terms on fleet size and too outdated in terms of performance**
- Fleet homologated for the Netherlands is expected to be withdrawn from the overall target fleet, but **to remain deployed within closed networks (yards)** where no ETCS is required **from 2030 on**

1: Original V100 series, conversion to BR 203 took place in 2000-16 by Alstom; 2: All locomotives with NL-homologation

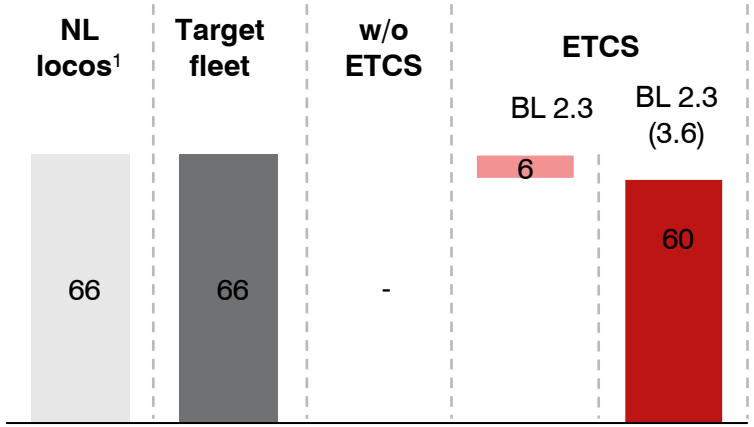
DE 6400 locomotive: 90% of the target fleet is already contracted for BL 3 retrofit – SCI Verkehr expects that the remaining companies will follow DB Cargo NL and will also retrofit their assets

MaK (Vossloh)
DE 6400

Technical data	
Years of delivery	1998-1994
Deliveries (total / NL)	120 / 66
Operational area	Heavy shunting / light ML
Traction system	Diesel
Power output (kW)	1,180
Starting traction effort (kN)	290
Vmax (km/h)	120
Axle load (t)	20
Homologation	NL, BE, PL, FR, NO

1: All locomotives with NL-homologation

Target fleet				
Owner	**Operator**	**No ETCS**	**BL 2.3**	**no ETCS (BL 3.6 contracted)**
DB Cargo NL	DB Cargo NL	-	-	60
Railtraxx	Railtraxx	-	4	-
LTE	LTE	-	2	-
Total		**-**	**6**	**60**



- **DB Cargo NL**: Signed contract with Alstom in 2021 for DE 6400 fleet ETCS retrofit (BL 3.6) for services in the Netherlands and Belgium
- The rest of the target fleet no contracts for BL 3.6 known so far but SCI Verkehr expects that retrofits to BL 3.6 could follow

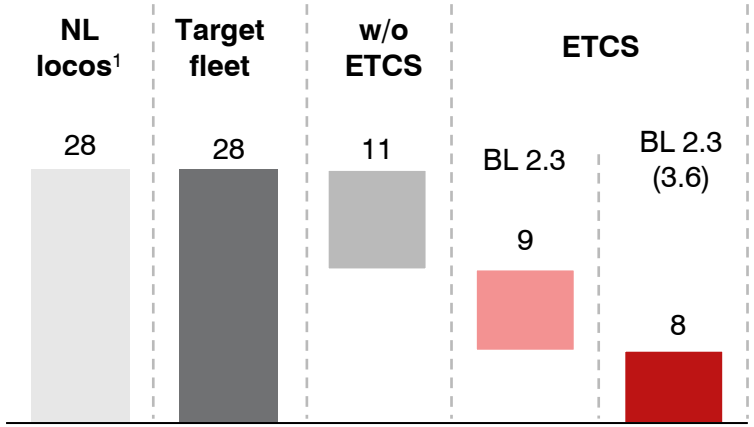
G 1206 locomotive: Alpha Trains units are contracted for BL 3.6 retrofit but SCI Verkehr also expects lessor RIVE to retrofit their G 1206 locomotives operating in the Netherlands

MaK (Vossloh)
G 1206

Technical data	
Years of delivery	1997-2017
Deliveries (total / NL)	323 / 28
Operational area	Heavy shunting / light ML
Traction system	Diesel
Power output (kW)	1,500
Starting traction effort (kN)	291
Vmax (km/h)	100
Axle load (t)	21.0-22.5
Homologation	AT, BE, CH, DE, IT, FR, LU, NL, SE, ES

1: All locomotives with NL-homologation

Target fleet				
Owner	**Operator**	**No ETCS**	**BL 2.3**	**BL 2.3 (BL 3.6 contracted)**
RIVE/Paribus	Lineas NL, RFO, ...	4	9	-
Alpha Trains	LTE, Captrain, Freightliner, ...	-	-	8
Others	Strukton Groep, ...	7	-	-
Total		**11**	**9**	**8**



- **Alpha Trains**: the 2021-contract with Alstom/Bombardier for retrofit of 77 locomotives to BL 3.6 includes G 1206 locomotives as well
- The rest of the target fleet is not contracted for retrofit so far but SCI Verkehr expects lessor RIVE/Paribus to also target a ETCS BL 3.6 retrofit for their Dutch operating assets

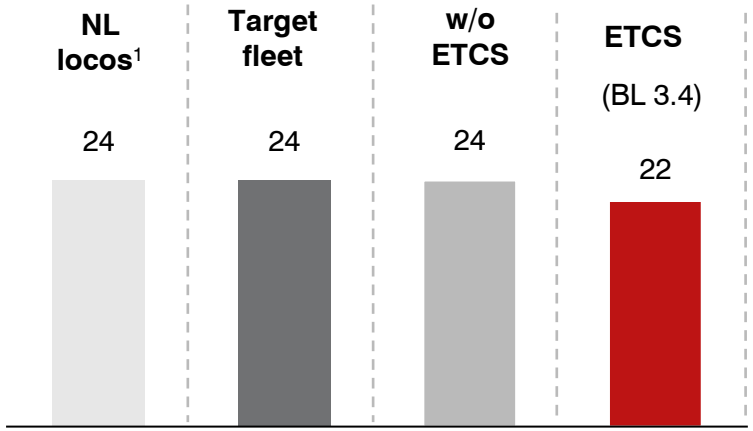
HLD 77 locomotive: Belgian incumbent Lineas will receive around 20 ETCS retrofitted HLD 77 with NL-homologation in ownership of Beacon – huge potential in Belgian assets with ETCS-only operation

Vossloh
HLD 77

Technical data	
Years of delivery	1995-2005
Deliveries (total / NL)	170 / 24
Operational area	Heavy shunting / light ML
Traction system	Diesel
Power output (kW)	1,150
Starting traction effort (kN)	265
Vmax (km/h)	100
Axle load (t)	22.5
Homologation	DE, NL, BE

1: All locomotives with NL-homologation

Target fleet			
Owner	**Operator**	**No ETCS**	**no ETCS (BL 3.4 contracted)**
Beacon	Lineas	-	20
SNCB Technics	SNCB Technics	-	2
Infrabel	Infrabel	2	-
Total		**2**	**22**



- **Beacon/Lineas**: ETCS retrofit program for 88 units signed in 2020 (incl. 20 assets with NL homologation)
- Hence, there will be a **large fleet of HLD 77 locomotives in Belgium that will be equipped with ETCS** – this fleet could serve as **further potential** in terms of ETCS-only operation
- A first-in-class-subsidy could be interesting as the Belgian locomotives could operate the border line to NL via ETCS-only

DE 18 locomotive: SCI Verkehr recommends to include the DE18 SmartHybrid to the first-in-class programme to increase the supply on BL3 ETCS-only corridor lines

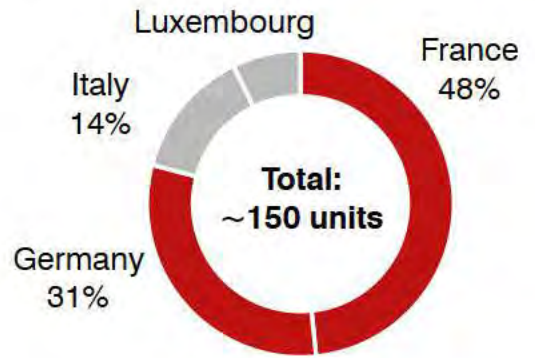
Vossloh
DE 18

Technical data	
Years of delivery	2012-
Deliveries (total / NL)	150 (80 on order[1]) / -
Operational area	Heavy shunting / ML
Traction system	Diesel / Diesel-battery
Power output (kW)	1,800
Starting traction effort (kN)	291
Vmax (km/h)	120
Axle load (t)	20.0-22.5
Homologation (planned)	DE, AT, FR, IT, LU (BE, SE, NO)

Installed base

Owner	Operator	Units
Akiem	SNCF Infra	44
Nexrail	CFL Cargo, Europorte, ...	29
Beacon	Locon, Régiorail , ...	9
Others	Eiffage, Rhein Cargo, DB Cargo, ...	70
Total		**150**

Operator country (units)



➔ A powerful and flexible diesel universal locomotive and the most delivered asset in recent years in the universal segment with Stage V emission standards - recent product evolution: **DE 18 Smarthybrid**

- The DE18 is not NL-homologated, but the **SmartHybrid** version ordered by **Nexrail** will feature the **Belgian homologation incl. ETCS** - the DE 18 **SmartHybrid will remain the most modern universal locomotive** with a powerful diesel engine in the BENELUX market and **production will continue**; the flexible asset can take over light to medium mainline operations at speed up to 120 km/h
- SCI Verkehr recommends to **include the DE18 SH to the first-in-class programme** to increase the supply on BL3 ETCS-only corridor lines as (Belgian) operators would then be able to offer transports in the Netherlands as well – **however**: such a non-ATB asset would not be able to operate on the regional (non-ETCS BL3) lines – **universals with ATB** (like the G1206, DE6400) **will remain necessary** in the long-term

1: Including 30 DE 18 SmartHybrid alternative drive (diesel-battery) models ordered by lessor Nexrail

Modula EBB/EDD locomotive: the latest Vossloh's platform of alternative drive universal locomotives for operation in the Netherlands and Germany that will feature Siemens' Trainguard train control

Vossloh
Modula EBB/EDD

Technical data	
Years of delivery	2024- (EBB) / 2026- (EDD)
Deliveries (total / NL)	- (44 ordered) / 23
Operational area	Heavy shunting / ML
Traction system	Electric-battery (EBB) Electric-diesel (EDD)
Power output (kW)	2,500 (e), 500 (b), 960 (d)
Starting traction effort (kN)	300
Vmax (km/h)	120
Axle load (t)	21.0-22.5
Homologation (planned)	EBB: (DE, NL) EDD: (DE)

Ordered units

Type	Owner	Operator	Units
EBB	RIVE	RTB Cargo, ...	20[3]
	RFO	RFO	2
EDD	Railpool	Various	~20-25[4]
	Schweerbau	Schweerbau	1
Total			**~45**

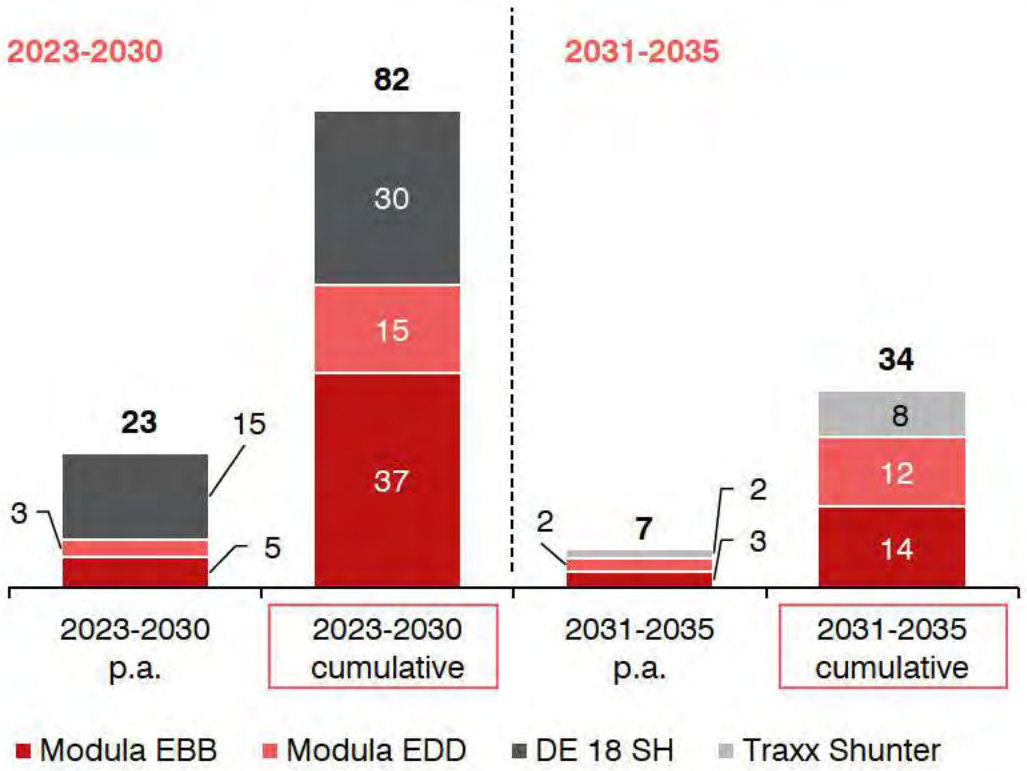
➔ The latest locomotive platform by Vossloh consisting of alternative drive locomotives, with high level of component standardisation and different locomotive configurations available (electric-battery-diesel)

- New platform, ordered mainly by leasing companies RIVE and Railpool (~95% of the on-order fleet)
- Attractive assets regrading environmental consideration (alternative drive), but costly
- Innovative locomotives that can operate on main lines with and without catenary
- ETCS-ready and will feature new Siemens' Trainguard communication-based train control

1: Including 30 DE 18 SmartHybrid alternative drive (diesel-battery) models ordered by lessor Nexrail; 2: All locomotives with NL-homologation; 3: 50 units in total in the framework contract; 4: 45 Modula EBB/EDD ordered, exact share is unclear – SCI Verkehr expects the variants to have a 50%-50% share

Around 80 locomotives ordered and will enter the market up to 2030, i.e., up to 25 units annually – Up to 2035, additional ~35 units potentially to be delivered

Universal/shunting locomotive fleet – new additions (ETCS BL 3)
(units)



Locomotives on order (2024-2030)

Modula EBB

- In 2021, RIVE/Northrail signed a framework agreement with Vossloh for delivery of up to 50 units, initially calling-off 10 for operation in Germany and the Netherlands. Later, ten more units were called-off
- Dutch operator Rail Force One ordered 2 units for operation in the port of Rotterdam in 2021

Modula EDD

- In October 2023, Railpool ordered a total of 45 Modula locomotives (EDD and BDD versions), with delivery scheduled from 2026
- In 2022, order for 1 Modula EDD was made from a German rail infrastructure construction company Schweerbau (the launch EDD-client)

DE 18 SmartHybrid

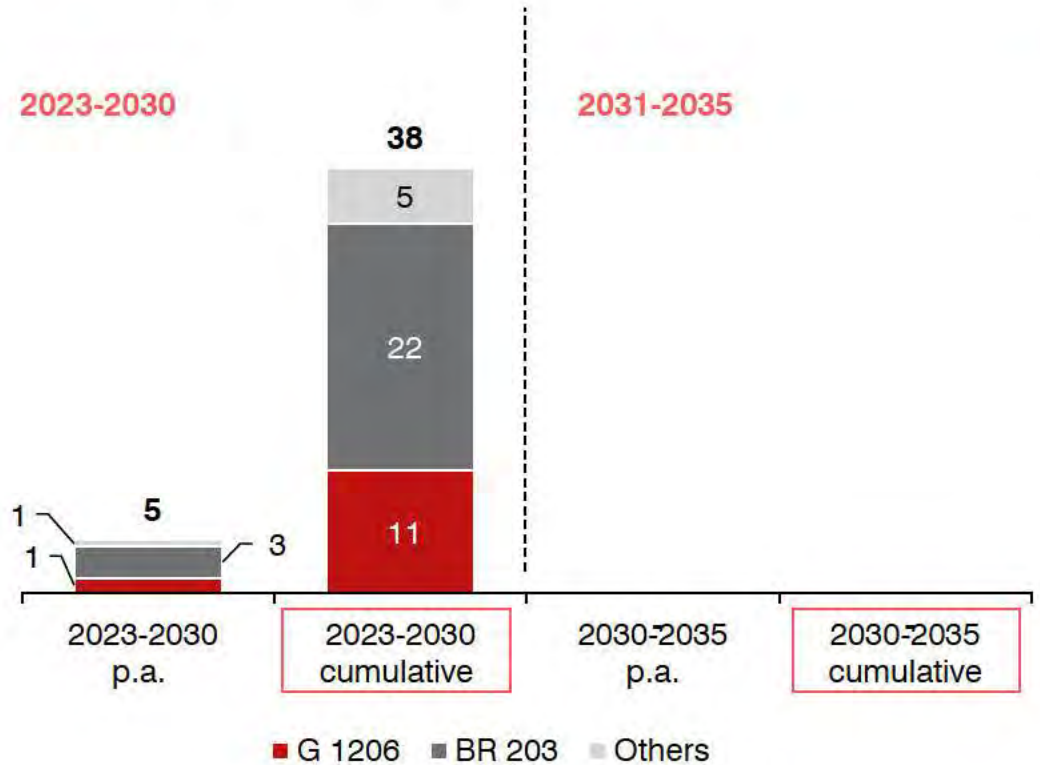
- Leasing company Nexrail signed a framework agreement with Vossloh for 50 units in 2021, initially calling-off 30.

Additional assets

- In mid-2023, Alstom presented the **Traxx Shunter** platform as a successor of its Prima H4 locomotive (with a different technical setup). No order has been made yet, but SCI Verkehr expects some units might be placed on the target country markets after 2030.

Around 40 locomotives are expected to be withdrawn from the Dutch market up to 2030, mostly units without ETCS and without retrofit contracts

Universal/shunting locomotive fleet – withdrawals[1]
(units)



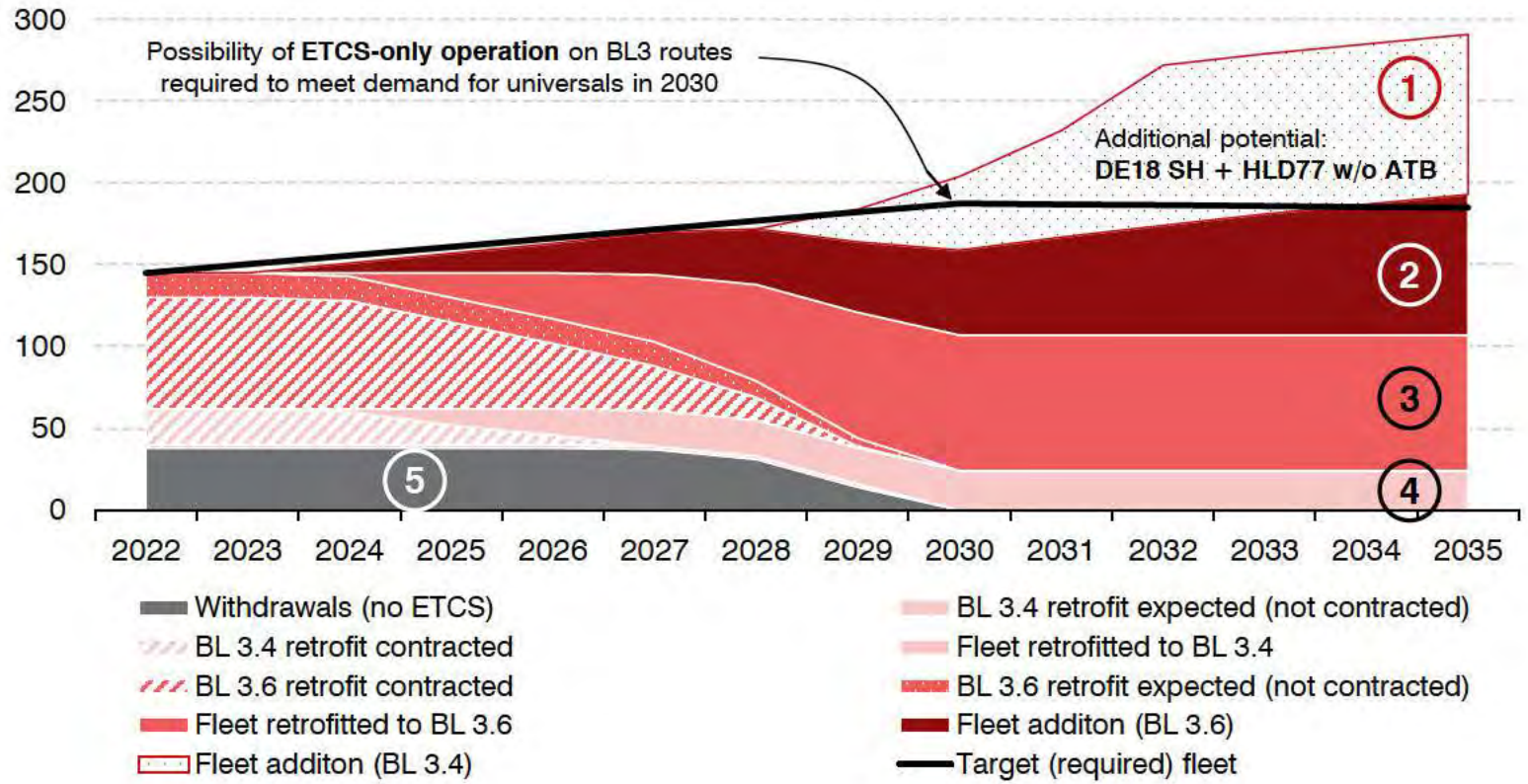
Withdrawals from the Dutch market

- **G 1206**: BL 2.3 units owned by RIVE/Northrail and units without ETCS owned by e.g., RIVE/Northrail and Strukton Groep
- **BR 203**: units without ETCS owned by e.g., RRF and Volker Rail Materieel
- **Others**: units without ETCS (DG 1200 BBM, Gravita 10 BB) owned by e.g., Strukton Groep and RIVE/Northrail

1: Most of the Traxx MS2 locomotives expected for withdrawals do not have NL-BE-+ homologation

Universal fleet in 2030 will be sufficiently large to meet the demand under the assumption that ETCS-only operation will be possible on BL 3 corridor lines to increase the locomotive supply

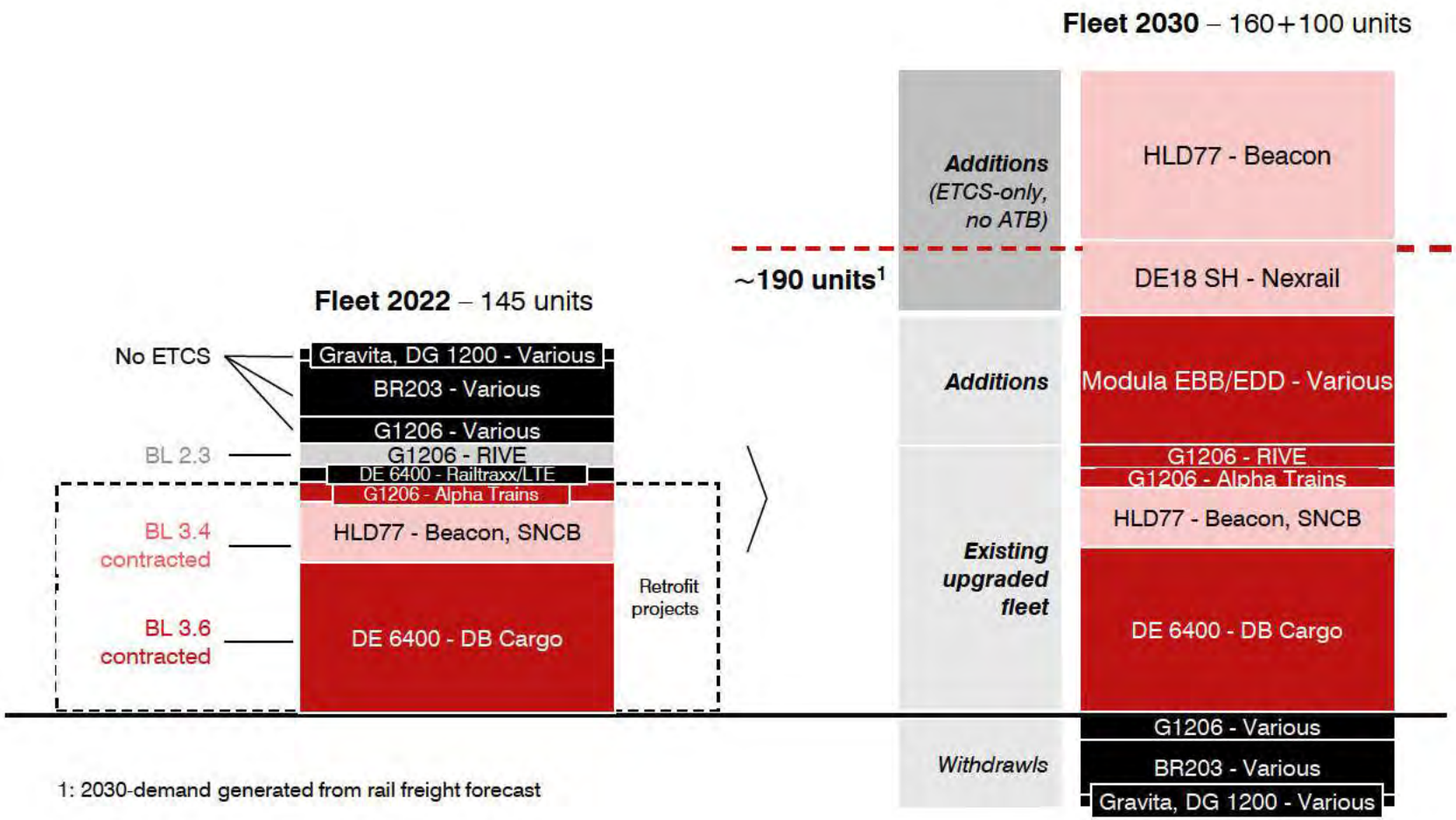
Universal/shunting locomotive fleet prognose (units)



1. Belgian **DE18 SH and HLD77** (BL 3.4) w/o Dutch ATB can increase supply along corridor lines – **prerequisite**: **ETCS-only** operations are possible in 2030
2. New **Modula** assets (in the long-term new universal locomotives like the Traxx shunter as well) will enter the market with **BL 3.6**
3. A large fleet of **DE 6400** (mainly **DB Cargo**) **and Alpha Trains' G1206 fleet** will be **retrofitted to BL 3.6**
4. **HLD77 with** Dutch **ATB** on board will be retrofitted with **BL 3.4** (mainly for **Lineas**)
5. Mainly outdated **BR203** locomotives **will leave the fleet** that is able to operate along the Dutch mainline – "behind the fence"-operation likely beyond 2030

Universal fleet in 2030 will be sufficiently large to meet the demand under the assumption that ETCS-only operation will be possible on BL 3 corridor lines to increase the locomotive supply

Freight universal services operated by mid-cab locomotives – SCI Verkehr forecasts sufficiently large ETCS-only fleet in 2030 under the assumption that ATB will not be required on ETCS-only lines



- **Forecasted** diesel and alternative drive mid-cab locomotive fleet **is sufficiently large** to meet the rail freight demand in 2030 (**190 units required**) …
- … under the assumption that the Class B system **ATB will no longer be required** on Dutch ETCS-only lines such that DE18 SH and further HLD77 can enter the Netherlands on these lines
  - Already contracted **retrofit projects** of HLD 77 (Beacon) and DE 6400 (DB Cargo) **will build a solid basis** of the future fleet
  - **DE18 SmartHybrid** locomotives and the remaining fleet of **HLD 77** (both assets without Dutch Class B system but **with ETCS** BL 3.4 on-board unit in 2030) would be able to operate

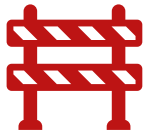
1: 2030-demand generated from rail freight forecast

SCI/Verkehr

5

Barriers

Possible barriers that impede and hinder the development of a suitable fleet for the Netherlands



Barriers

Transport market & operations

1. Weaker transport volume development: Current market situation different from 2019 and less favourable for growth
2. Loss of transport volume due to higher production costs: The necessary investment in rolling stock for ERTMS BL 3 will potentially lead to loss of clients due to higher production costs
3. Capacity restraints on upgraded ERTMS lines: Communication loss events and restrictive braking curves affect the capacity of ERTMS-equipped infrastructure

ETCS on-board retrofit

1. Problematic market characteristics and a monopolistic market structure cause economic risks
2. Rapid technological development and missing standardization cause uncertainty
3. Capacity restraints on upgraded ERTMS lines: Communication loss events and restrictive braking curves affect the capacity of ERTMS-equipped infrastructure
4. ETCS installation doesn’t make sense for vehicle owners/operators which causes financing problems

Locomotive supply

1. The commercial risk for ETCS retrofitting for a relatively small market is still high, despite generally attractive subsidy program in the Netherlands
2. ETCS-OBU suppliers cannot meet their timetables for the ETCS upgrade and capacity for testing and homologation is limited as well
3. Large number of different stakeholders with different interests prevent rapid adjustments to general framework conditions

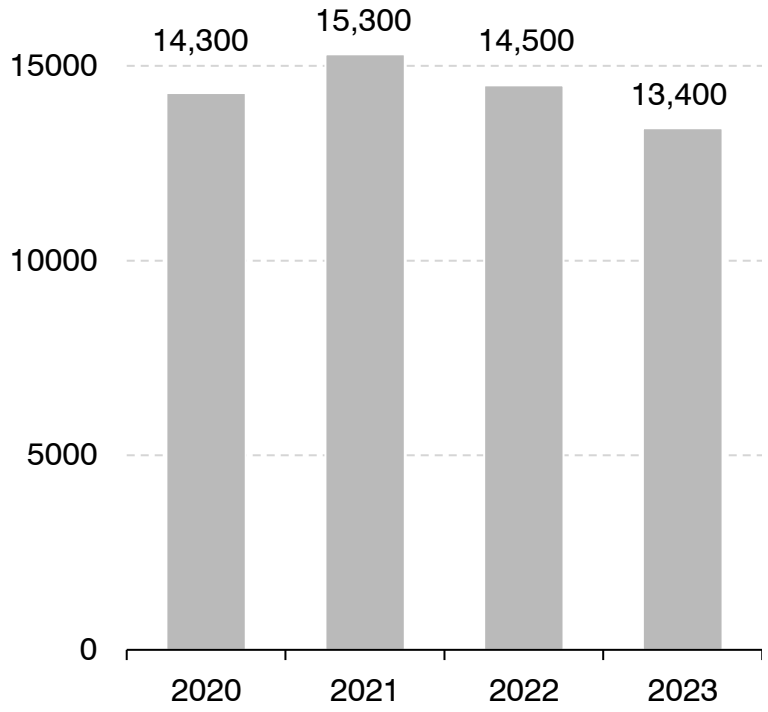
Rail freight: Risk of weaker transport volume development as current market situation is different from 2019 and less favourable for growth

Maritime News, 04.04.2024:

"In the first three months of the year, the Port of Rotterdam, recognised as Europe's leading seaport, experienced a slight decrease in activity, reporting a 1.5% drop in throughput compared to the previous quarter."

- The operators are more cautious about the future development of rail freight volume, especially on the Dutch market.
- Some operators expected the chemical industry (which contributes most of the **wet bulk** demand) to enter a prolonged downturn as a result from the higher energy prices after the start of the war in Ukraine.
- The experts agreed on a relatively quick phase out of **coal** transport in the near future due to lacking demand.
- While the current downturn in **container** transport was attributed by the operators to the current market situation, they see the Port of Rotterdam in competition with other North Range ports which could impact further growth of container transhipment.

Container throughput Port of Rotterdam
(2020-2023, 1,000 TEU)



Source: Port of Rotterdam

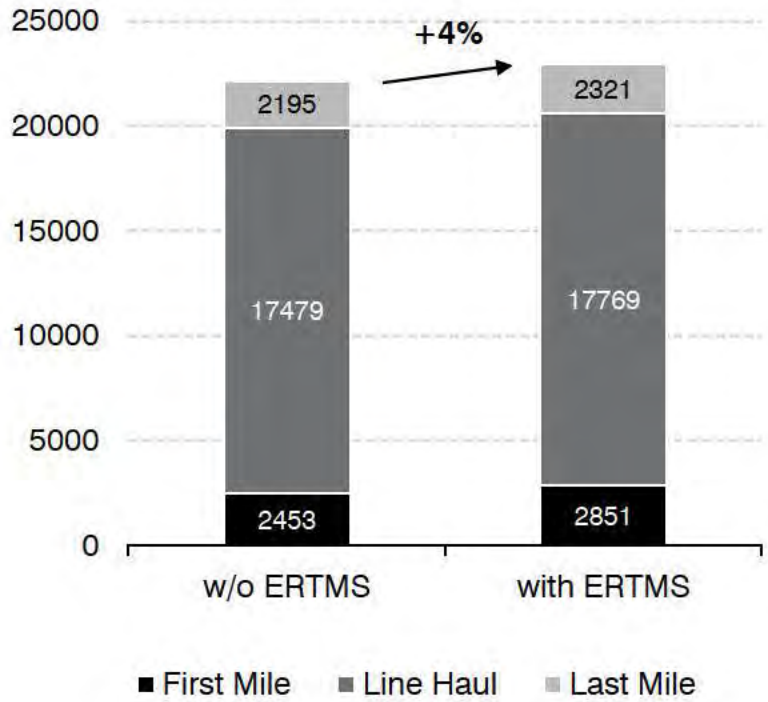
Rail freight: Loss of transport volume due to higher production costs: The necessary investment in rolling stock for ERTMS BL 3 will potentially lead to loss of clients due to higher production costs

Railway operator:

„My clients will see a cost increase if I have to use a more expensive asset for the same services as before.“

- The necessary investments for the ERTMS upgrade will lead to higher production costs, which will affect the willingness of clients to use rail freight transport in the Netherlands.
- This study already reflects the cost effect as given in 2021 Bridgecraft report “Implementatie van ERTMS in het spoorgoederenvervoer”. However, the effect could be potentially bigger if shipper choose to prefer other rail freight corridors over the Netherlands due to the higher costs.
- The Dutch government needs to ensure that the funding meets the necessary investment costs to guarantee that operators’ clients do not opt for rail corridors outside of the Netherlands. The currently discussed compensation of EUR 280 million for higher operation costs after 2030 are a step into that direction.

Average costs for rail freight transport with and without ERTMS BL 3 (in EUR)



Source: Bridgecraft report “Implementatie van ERTMS in het spoorgoederenvervoer”

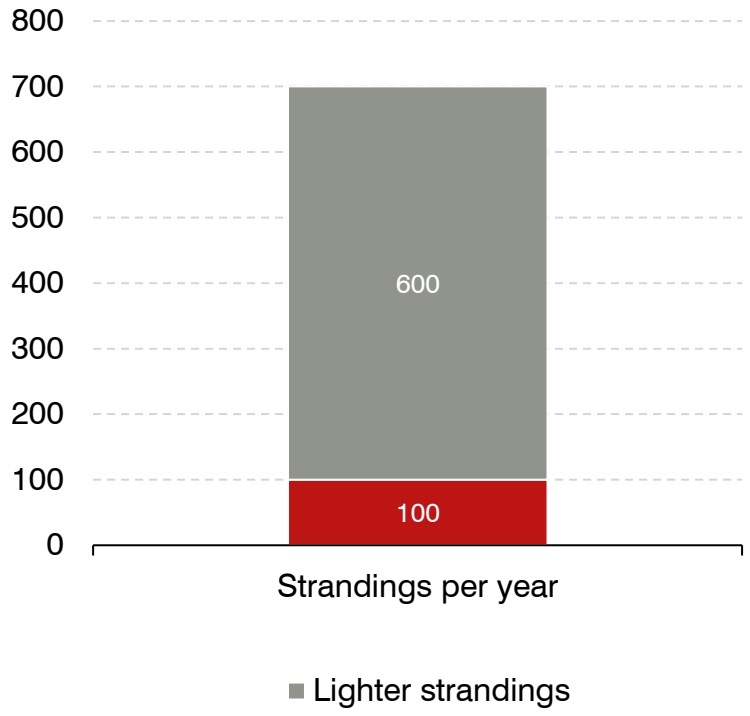
Rail freight: Capacity restraints on upgraded ERTMS lines are an issue – communication loss events and restrictive braking curves affect the capacity of ERTMS-equipped infrastructure

Railway operator:

„Ten years after the introduction on the Betuwe line there are still 60 to 70 stranding incidents per month. Our train drivers are experts by now how to deal with that situation, but it's always a minimum of 10 minutes of time loss per incident."

- The upgrade to ERTMS BL 3 adds the risk for technical problems as components or software on the locomotives might by incompatible with components/software of the infrastructure. This is highlighted by the ongoing issues with "strandings" (i.e. loss of communications between locomotive and infrastructure) on the Betuwe line and can lead to instability in the timetable, especially if the issue is wide-spread.
- The braking curve used for ERTMS operations can lead to forced breaking or reduced speed in certain conditions (e.g., approach of pre-signal showing stop signal, downhill run on ramps), reducing the available capacity on the infrastructure.
- Combined with the expected growth for rail freight transport this might cause a bottleneck of available train paths for the growing demand for rail freight transport.

Expected number of additional strandings in the Netherlands per year with ERTMS BL 3.2



Source: Expert interviews, Bridgecraft report "Implementatie van ERTMS in het spoorgoederenvervoer"

ETCS-OBU supply: Problematic market characteristics and a monopolistic market structure cause economic risks

Challenge

Due to the product and market characteristics, there is a high risk for suppliers and vehicle owners / operators to engage in ETCS OBU development

Barriers

- Each vehicle (sub)type requires a specific ETCS OBU version and therefore requires customized project execution
- Interfaces to TCMS and STM's are often insufficiently documented
- The market for ETCS OBU has a monopolistic structure with Alstom being the undisputed leader
- Unforeseeable risks of ETCS retrofit projects for OBU suppliers
- Even including funding, project risk often too high on owner / operator side

Possible solution approaches

- Outlook: The product and market characteristics are not expected to change significantly until 2030
- Solution approaches:
  - Creation of incentives to improve documentation in the context of subsidized retrofits
  - Expansion of state subsidy programs to include a risk reduction component

ETCS-OBU supply: Rapid technological development and missing standardization cause uncertainty

Challenge

Rapid and continuous ETCS development creates uncertainty for all stakeholders

Barriers

- Interfaces to TCMS and STM‘s are specific for each manufacturer of even vehicle type
- ETCS OBU are not built to standardized specifications
- ETCS Baselines and Sub-versions are continuously developed further
- ETCS wayside equipment strategies are often delayed or adapted by infrastructure managers
- A genuine platform solution with open interfaces (i.e., OCORA) will not evolve without political coordination

Possible solution approaches

- Outlook: Non-standardized specifications will remain, and a genuine platform solution will have no realistic chance of implementation by 2030
- Solution approaches:
  - Freezing the applicable ETCS baselines for a certain period of time
  - Establishing reliability and predictability regarding infrastructure equipment

ETCS-OBU supply: A high dependency on skilled personnel causes capacity constraints

Challenge

ETCS OBU development and installation is challenging and labour-intensive which leads to capacity constraints

Barriers

- There is a high dependency on / a lack of skilled personnel for ETCS OBU development
- Insufficient capacities for R&D of OBU suppliers
- Insufficient workshop capacities
- The market structure is untransparent for owners / operators

Possible solution approaches

- Outlook: Capacity constraints will remain for established suppliers and new suppliers are only entering the market to a limited extent
- Solution approaches:
  - Support for training and further education programs including industry-wide exchange
  - Promoting the market entry of new providers
  - Support for measures to increase market transparency

ETCS-OBU supply: ETCS installation doesn't make sense for vehicle owners/operators which causes financing problems

Challenge

As ETCS OBU installation does not pay off for vehicle owners / operators, public funding is required

Barriers

- ETCS OBU installation does not pay off economically for owners / operators
- Funding schemes are insufficient and / or application requirements are too high

Possible solution approaches

- Outlook: It can be expected that ETCS OBU installation will remain to not pay off for vehicle owners / operators
- Solution approaches:
  - Adapt funding schemes to better address challenges

Locomotive supply: The commercial risk for ETCS retrofitting for a relatively small market is still high, despite generally attractive subsidy program in the Netherlands

Rolling stock lessor:

„The Netherlands is a small country. We are happy to invest in new locos and to help secure operation in the ETCS era, but any project needs to be profitable. I will not take a commercial risk in these projects."

Rolling stock lessor:

„The ERTMS program in the Netherlands is already better coordinated than in other countries as routes and assets are considered in parallel."

Barriers

- Despite good funding support, the commercial risks are still high, as a lot of time (human resources), capacity and capital has to be invested. Alstom is acting as a monopolist and does not offering reliable contract options for smaller series.
- Especially for locomotives that are in high demand, such as diesel universal and heavy shunters, and which can still be operated without ETCS in countries such as Germany (e.g. G1206), retrofitting is of little interest, as these locos can also be leased out otherwise for attractive rates.
- The railway industry is in a rather difficult economic situation. Sufficient funds for investment and qualified personnel are often in tight supply.

Possible solution approaches

- The ERTMS funding was generally positively assessed by the dialogue partners because it goes far beyond the activities of the EU.
- The subsidy scheme **must mitigate the commercial risks** as much as possible and in particular promote:
  - **ETCS only operation** on the corridors with locomotives from abroad. As these locomotives are not yet able to run in the NL, they do not yet benefit from the current subsidy scheme.

Locomotive supply: ETCS-OBU suppliers cannot meet their timetables for the ETCS upgrade and capacity for testing and homologation is limited as well

Rolling stock lessor:

„The upgrade of TRAXX MS2 with BL 3.6.0 will be hopefully possible for 2030."

Rolling stock lessor:

„Final acceptance from infrastructure managers is an important question as well to meet the tight schedule. It is possible that the limited capacity by the infrastructure managers could be the crucial point that this goal cannot be achieved."

Barriers

- There is a very high order backlog for ETCS refits and manufacturers are concentrating on the large series in order to be able to serve the most important customers. There is no capacity for smaller customers or platforms.
- In addition to the limited capacities of the OBU-industry, market participants highlight the capacities of the notified bodies and infrastructure managers as threat.
- Workshop capacities for refit are partly limited:
  - Individual workshops such as Alstom BV (DE 6400, Class 66 ETCS refit) are very busy due to the ETCS conversion and therefore have less capacity for other maintenance services.
  - In general, however, there is sufficient capacity on the market for locomotive maintenance and for the ETCS refit,

Possible solution approaches

- Support **new market participants** for ETCS-OBU supply like the Signalling Company.
- Development of a **strategy** and a binding implementation schedule with all relevant market participants with a strong focus on **testing and homologation capacities.**
- If at all possible, **simplify the homologation effort and ESC testing**, which is very complex in the Netherlands, in order to reduce the time required for approval.
- Building the **necessary capacities and procedures** to put all vehicles into operation on time especially for vehicles with BL 3.4 ETCS equipment, which must be approved by the end of 2029.

Locomotive supply: Large number of different stakeholders with different interests prevent rapid adjustments to general framework conditions

Rolling stock lessor:

„ProRail should not start equipping any lines with ETCS earlier than planned on the infrastructure side!“

Rolling stock lessor:

„AERRL is asking the European Commission/ERA to allow instead of BL 4, BL 3.4 with FRCMS compatibility. What would be next is, that AERRL is requesting an ‘ETCS-plateau’ with a limit of BL 3.6.0 and not starting the scheme of BL 4. This would significantly reduce the high utilisation at manufacturers.

Barriers

- The innovation cycles and refit cycles for ETCS are shorter than the available capacities.
- Infrastructure upgrades are optimised, and vehicles must follow.
- Vehicle owners cannot keep up with the equipment and retrofitting of ETCS.
- Problematic situation will not change in the next ETCS upgrade cycle if there are no structural changes

Possible solution approaches

- Ensure a **reliable schedule** with sufficient advance schedule (based on infrastructure planning) for the industry and operators and generally equalise it in a longer term.
  - This also applies for ETCS rollout plans
  - **ETCS BL 3.6 lines and connected rolling stock require a significant lead time!**
- Long-term adjustment of capacities and refit cycles and support initiatives which limit the need for new ETCS versions and equalise schedule for ETCS refits.

SCOPE OF WORK

1. Forecast freight locomotive fleet development 2025-2035 – Scope of work

Subject of the analysis

SCI Verkehr will provide a forecast, about how the **locomotive fleet used for freight transport in the Netherlands will** develop from 2025 to 2035 including the following items:

- What types of locomotives will be in use?
- How many locomotives will be used (quantity)?
- Which kind of safety systems are installed?

Approach

- SCI Verkehr determines the locomotive fleet currently in use in the Netherlands rail freight transport (operators in the Netherlands) and the rail freight locomotive fleet that is regularly used from operators outside the Netherlands (e.g. German and Belgium rail freight operators) to run freight trains inside the Netherlands. The fleet consists of shunting and universal locomotives (e.g. G1206, Modula), diesel mainline locomotive (e.g. Class 66) and electric mainline locomotives including corridor locomotives (e.g. TRAXX MS, Vectron MS). The main indicator for this is a valid licence for the locomotives, as it is not possible to clearly identify which locomotives are actually used regularly in the Netherlands rail freight transport.
- For this analysis, SCI Verkehr uses public sources and its own SCI database as a source for this and supplements this information with the installed train protection systems. The equipment with safety systems can be given as an estimate / expert input since no concrete plans / tenders are published for the entire time. Based on this fleet analysis, SCI Verkehr calculates a forecast for the required future locomotive fleet for freight trains by using several parameters like useful life, equipment with safety systems (ETCS) and the ability for modifications, changes in transport demand, etc. As source for the expected future transport development, SCI Verkehr relies on the data provide by **ProRail**/**Bridgecraft.**

Results

- As a result, SCI Verkehr provides a current fleet and a qualitative and quantitative fleet forecast as overview with quantities per year from 2025 to 2035.

2. Roadmap of the ERTMS-OBU suppliers – scope of work

Subject of the analysis

SCI Verkehr will analyse the **roadmaps of the ERTMS-OBU** (on-board-unit) suppliers including the identification which version with which functionality will be available in the period under review.

Approach

- SCI Verkehr will identify the three main supplier of ETCS OBU (like Alstom, Siemens and Thales/ Hitachi) and the relevant smaller/local suppliers that are relevant for the future development of ETCS equipment in the Netherlands. SCI Verkehr suggests focussing this analysis on the activities on the main suppliers.
- The processing of this question is carried out with a desktop research analysis and with the realisation of expert interviews in the industry. In this working package SCI Verkehr and ProRail needs to be in a close exchange to carry out the relevant interviews and to get access to the relevant decision makers in the supplier landscape.

Results

- As a result, SCI Verkehr provides a current fleet and a qualitative and quantitative fleet forecast as overview with quantities per year from 2025 to 2035.

3. Availability of ERTMS versions for relevant locomotive types

Subject of the analysis

To answer the question, **which ERTMS version will be available on which type of locomotive** and when the installation of the relevant systems will take place.

Approach

- The processing of this question is also carried out with a desktop research analysis and with the realisation of expert interviews in the industry.
- In addition, SCI Verkehr will analyse past ETCS-configuration projects to assess the expected road map for the future installation and migration of the new ETCS-OBU systems.
- For existing locomotive types, that are no longer being delivered, SCI Verkehr assesses around 5 to 7 locomotive types (e.g. Class 66, G1206, DE6400, ES64F4) to assess their refurbishment potential (based on quantities still in use in the years under consideration).

Results

- The result of this working package is a **concrete assessment of the availability of ETCS-OBU solutions** for the main existing locomotive platforms and the determination of the probable equipment level of these main locomotive platforms with ETCS-OBU during the forecast period.

4. Determining factors that influence the number of required locomotives per migration step

Subject of the analysis

Definition of the determining factors **that influence the number of required locomotives per migration step**, such as 740-meter train length, the use of double traction for very heavy freight trains, electrification of railway lines, autonomous fleet developments (inflow, outflow), the introduction of new locomotive types approved for use in the Netherlands, and possible other deployment models.

Approach

- SCI Verkehr develops an overview of the expected operational, infrastructural and product-specific potential for change and evaluates the effects on the possible demand for locomotives. This work package requires close co-operation with ProRail, especially in the area of operational and infrastructural improvement potentials.
- To this purpose, SCI Verkehr **conducts interviews** with approx. three relevant operators and some additional lessors in order to better assess the optimisation potential.

Results

- SCI Verkehr determine the main factors that influence the required locomotives per migration step and their influence on the future loc fleet mix. SCI Verkehr will separate the following drivers:
  - **Infrastructure** based drivers: Train length of 740m and electrification of railway lines.
  - **Operation** and fleet-based drivers: Use of double traction for very heavy freight trains and e.g. passenger locomotives being available for freight when not used in passenger contracts (e.g. Traxx locomotives HSL Zuid). Autonomous fleet developments (inflow, outflow).
  - **Product related drivers:** Expected developments in the locomotive technology like introduction of more powerful mainline assets (e.g., Stadler Euro9000) or the increasing availability of alternative drive locomotives (e.g., Vossloh Modula).

5. Identification of barriers that impede and hinder the development of a suitable fleet for NL

Subject of the analysis

SCI Verkehr identifies **barriers that impede and hinder the development of a suitable fleet for NL.** This analysis will include a proposal for effective measures to overcome these barriers (what, who, when)?

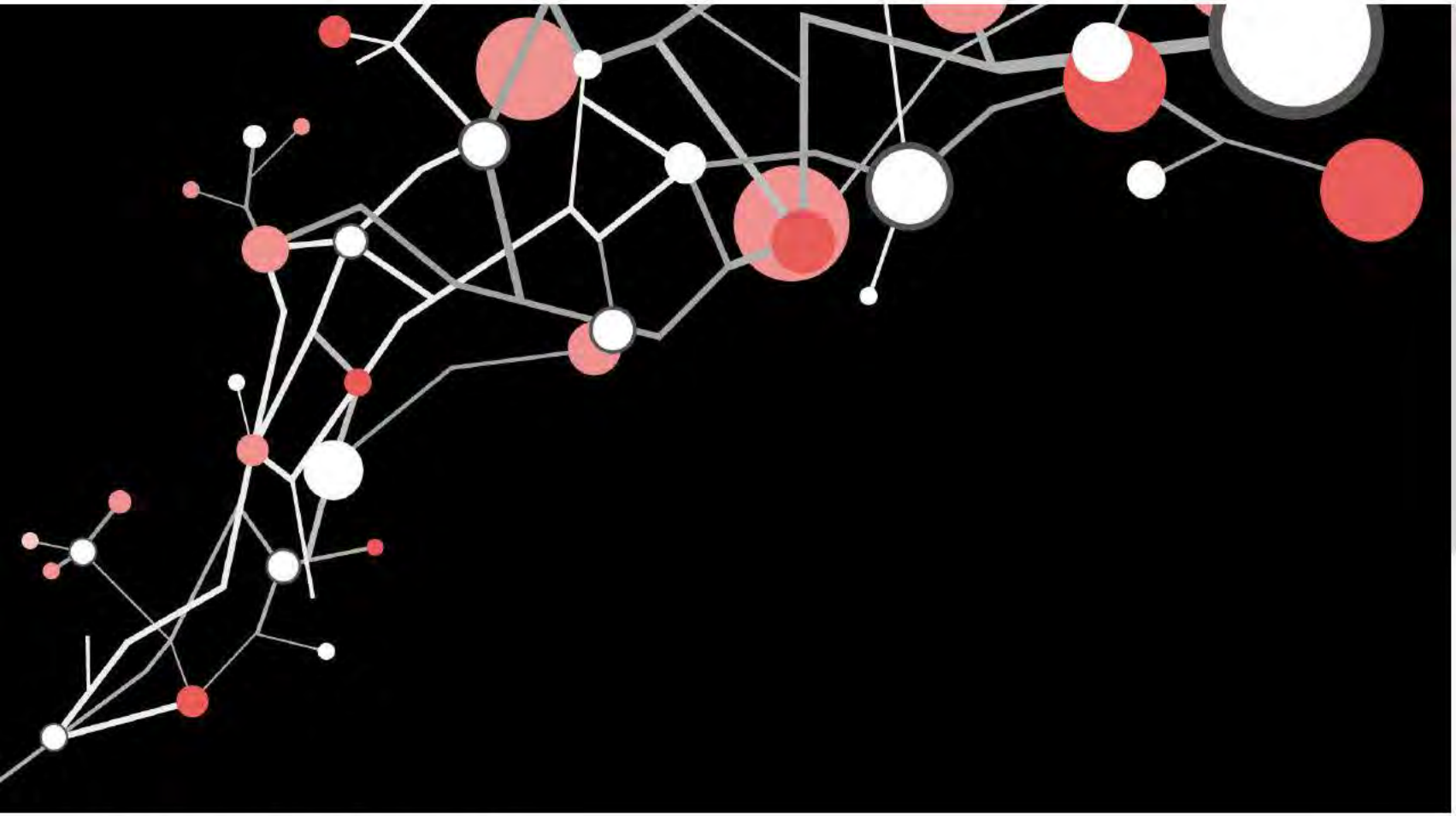
Approach

- SCI Verkehr will perform a **high-level analysis** of potential barriers and based on the results of the previous work packages and the deductions made as well as the expert discussions.
- This analysis will be in close cooperation with the client ProRail. SCI Verkehr intends to provide a broader overview of which we select together with ProRail **3-5 key topics** for a more detailed view.

Results

The results will be presented in a high-level presentation document with approx. one slide per defined potential barrier.

Contact



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