ANNUAL ACTIVITY REPORT 2024

EXECUTIVE VIEW

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Manuscript completed in 2025.

Brussels: Europe's Rail Joint Undertaking, 2025.

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Europe's Rail

ANNUAL ACTIVITY REPORT 2024

EXECUTIVE VIEW

The Europe's Rail Joint Undertaking (EU-Rail) became the legal and universal successor of the Shift2Rail Joint Undertaking (S2R JU or S2R). Hence, EU-Rail has taken over the management of the S2R JU Research and Innovation Programme.

However, in this report, references may still be made to S2R Programme, S2R Other Members, S2R R&I, S2R Regulation, S2R JU, S2R etc. to identify all the activities and governance inherited by EU-Rail and related to the former S2R JU.

Contents

Foreword

The climate crisis is often used to advocate for a modern, resilient and reliable rail network. And with good reason! But modern railways offer advantages far beyond emissions reductions. They help us make more of our Single Market by strengthening economic ties across Europe. They make our supply chains more resilient. They reduce congestion on our roads. And together, these qualities make us more competitive as a continent.

In 2024, the Europe's Rail Joint Undertaking (EU-Rail) made impressive progress, laying the ground for the railways that Europeans want and need.

Publication of the first edition of the Standardisation and TSI Input Plan was also a major leap forward for the System Pillar. The plan provides a framework for technical interoperability, aligning it with the European Green Deal. It also strengthens links between EU R&I activities and the evolving technical regulatory framework.

I was pleased to see the EU-Rail Deployment Group come to life in 2024, created to accelerate the roll-out of innovative solutions across Europe's rail sector. By bridging the gap between research and deployment, the Group is ensuring that strategies for large-scale implementation are well coordinated. It will be a key driver in realising a Single European Railway Area.

Among the projects under way, 2024 also saw the launch of a call for expressions of interest in large-scale testing of Digital Automatic Coupling technology on 100 pre-deployment trains. This testing will generate valuable insights into operational performance and help prepare the ground for wider adoption in real-life conditions.

But perhaps what struck me most in 2024 was the way in which partners across the continent came together - industry, researchers and public bodies - to innovate and push boundaries. EU-Rail launched a Call for Expressions of Interest to attract new associated members, fostered synergies with the Smart Network and Services Joint Undertaking through a joint call, and joined forces with the SESAR, Clean Hydrogen, and Clean Aviation JUs at the Transport Research Arena 2024. It is this collaborative mindset that gives me confidence going forwards.

From advancing technologies like Digital Automatic Coupling and Future Radio Mobile Communication Systems, to fostering diversity through initiatives such as the Women in Rail Award, EU-Rail is laying the foundations for a more integrated and efficient rail system. Through partnerships, research, and development, the Joint Undertaking continues to position rail at the forefront of Europe's mobility strategy, driving progress toward the goals outlined in the European Green Deal.

Magda Kopczyńska,

Director-General for Mobility and Transport, European Commission

Europe’s Rail in 2024

2024 marked a year of transition as activities shifted fully towards the EU-Rail Programme. It was also an intense period for the team due to temporary assignments related to the ad interim transitions of both the Head of Programme and the Executive Director. Significant progress has been achieved as EU-Rail concluded the S2R Programme and broadly disseminated its results through a new catalogue of solutions and with coordinated participation at InnoTrans, with the European Commission, and the European Union Agency for Railways. A standout moment was the Connected Tram Live Demo from Oslo, part of the Europe’s Rail FP2-R2DATO project, which showcased the latest developments in tram connectivity and technology. This remote live tram operations demonstration, held in the presence of high-level participants, exemplified EU-Rail’s commitment to innovative rail solutions.

By the end of 2024, the EU-Rail R&I Programme had already engaged 361 participant entities across 27 countries. EU-Rail Membership has also been set for further expansion, with the Governing Board (GB) decision in June 2024 to launch a Call for Expressions of Interest for new Associated Members. This was supported by an updated version of the Multi-Annual Work Programme, which highlighted key technical gaps and the need for additional expertise.

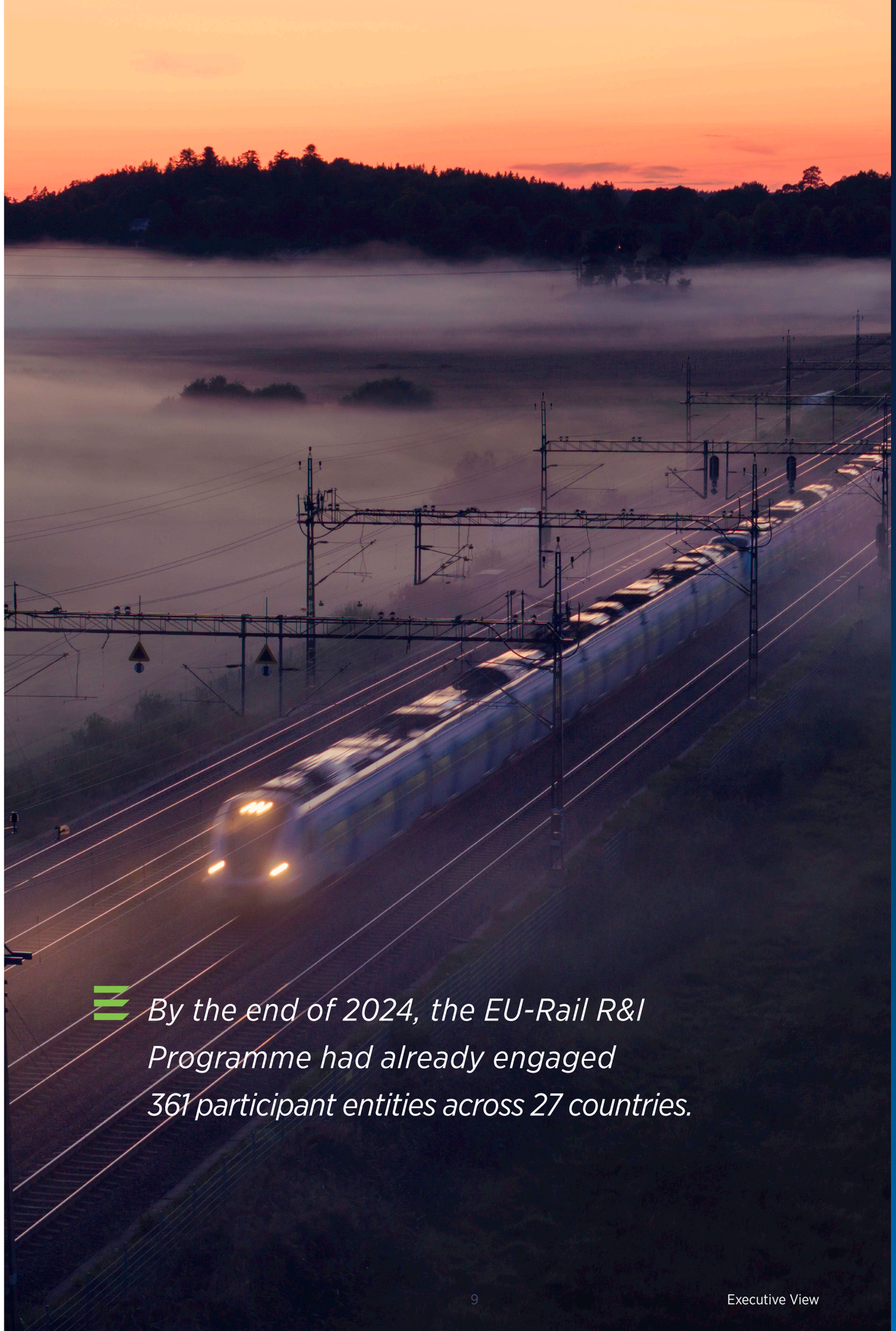
In 2024, a reflection process involving all EU-Rail Members on the future of the JU began. This activity will continue in 2025, providing insights to European decision-makers. Notably, this included the GB approval of the EU-Rail phasing-out plan in November 2024, as well as the draft **high-level paper** on future rail R&I within a policy-driven public-private partnership.

EU-Rail organised a successful side event “The Future of Rail Freight – see how it works in the 21st century!” during the Connecting Europe Days 2024, which featured live demonstrations of DAC technology at Train World in Brussels, under the Belgian Presidency of the Council of the European Union.

The year also marked the first joint participation of EU-Rail with the SESAR, Clean Hydrogen, and Clean Aviation JUs at the Transport Research Arena (TRA) 2024 in Dublin under the theme “Transport Transitions: Advancing Sustainable and Inclusive Mobility”, demonstrating a united approach to innovation in European transport. Additionally, EU-Rail facilitated the first high-speed train service from Brussels to Berlin to InnoTrans 2024, uniting all rail stakeholders and their associations to sponsor the journey, demonstrating unprecedented unity. At the European joint stand, EU-Rail showcased R&I demonstrations and standardised innovations.

EU-Rail became the first Joint Undertaking to sign two Grant Agreements based on joint topic calls and synergy Memoranda of Understandings – with SESAR JU for an optimised and harmonised exchange of traffic management information for passengers between rail and air and with SNS JU for testing the next EU rail communication system. These joint activities enhance cross-sector innovations and underscore the strategic importance of those activities supported by the European Union.

The next EU-Rail communication system is a key enabler of the EU-Rail Programme, building on activities previously performed within various organisations outside EU governance. **As of 2024, the sector and the Commission have entrusted EU-Rail to drive and ensure the rail system’s ability to embrace this new solution, with R&I through Innovation Pillar activities, with preparation for TSI updates under its System Pillar, and with migration planning and deployment recommendations under its Deployment Group.**



This cooperative work must be carried out alongside the European Union institutions and bodies for policy setting, including the EU Agency for Railways (ERA), the rail sector and in particular working with the organisations that have heavily invested in FRMCS [1], with the telecommunication sector, with the JU private Members contributing with additional in-kind activities, and with many other researchers contributing to the EU-Rail Programme under Horizon Europe.

The EU will continue to support the development of a comprehensive migration strategy to coordinate the deployment of Digital Automatic Coupling (DAC) technology, based on the R&I output of EU-Rail, reflecting its game-changing role for European rail freight in the 2023 Greening Freight Transport communication [2] of the European Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions.

In the same policy package, the Commission published a proposal for a "Regulation on the use of railway infrastructure capacity in the Single European Railway Area" [3]. This calls for rail Infrastructure managers to align and contribute, in particular in the areas of digitalisation of capacity and traffic management, with the work of the Europe's Rail Joint Undertaking.

The EU-Rail R&I activities are designed to deliver concrete solutions to global challenges, such as the climate change crisis, climate mitigation and adaptation, energy crises, and evolving competitiveness challenges. The JU Programme Office and its Members are well aware of the urgency and the importance of the work of our Integrated Programme, enabling an innovative solutions' life cycle, from exploratory research to pre-implementation and deployment.

The launch of the Research and Innovation activities of the EU-Rail Integrated Programme, building upon the results and success of the S2R Programmes, reflects the mission-oriented nature of the JU, building on openness and inclusiveness. **The Programme responds to the call of the Member States and European Parliament to deliver impact and added value to European citizens.** Synergies with the European Union, national, and regional programmes and partnerships shall provide opportunities to complement the actions across the rail ecosystem, including collaboration with ERRAC on complementary activities. Stakeholder relations, communication and dissemination of results will ensure the visibility and uptake of the progress achieved. Sound financial and risk management and compliance will support the Programme implementation throughout its life cycle.

The cohesion that EU-Rail has created within the European rail industry builds upon a small team of passionate professionals dedicated to delivering this new ambitious and Integrated Programme.

The Executive Director wishes to extend his gratitude to the EU-Rail Founding Members, the S2R Members, the EU-Rail staff, the Member States representatives and the observers for their collaboration and support during 2024, which made those significant achievements possible.

Giorgio Travaini,

Executive Director of the Europe's Rail Joint Undertaking

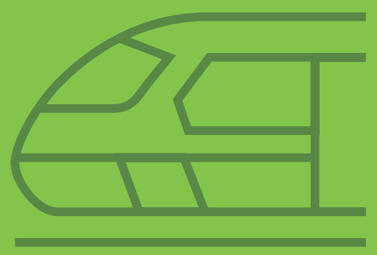
1 https://uic.org/rail-system/telecoms-signalling/frmcs
2 https://transport.ec.europa.eu/system/files/2023-07/COM_2023_440.pdf
3 https://transport.ec.europa.eu/system/files/2023-07/COM_2023_443_0.pdf

2024 in Figures

1 **Calls** launched in **2024**

€43 million
Total value of projects launched in 2024

€21.7 million
Funding awarded in 2024



99
Beneficiaries in funded projects

12
SME participations that were part of the evaluated proposals in the 2024 call

12
SME participations that were included in the proposals retained for funding

9
Grant agreements signed (stemming from the 2023 and 2024 Call for Proposals)

361
Total engaged unique participants by 2024

27
Total countries involved by 2024

Executive Summary

The R&I activities performed under the new EU-Rail Integrated Programme cover the innovative solutions' life cycle, from exploratory research to pre-implementation and deployment. These activities are designed to deliver the transformation of the rail sector, needed to respond to clients' needs, passengers, and supply chains. They aim not only to contribute to the objectives of the European Green Deal but also to address the energy crises and evolving competitiveness challenges.

In 2024, the established System Pillar provided the first outputs, including:

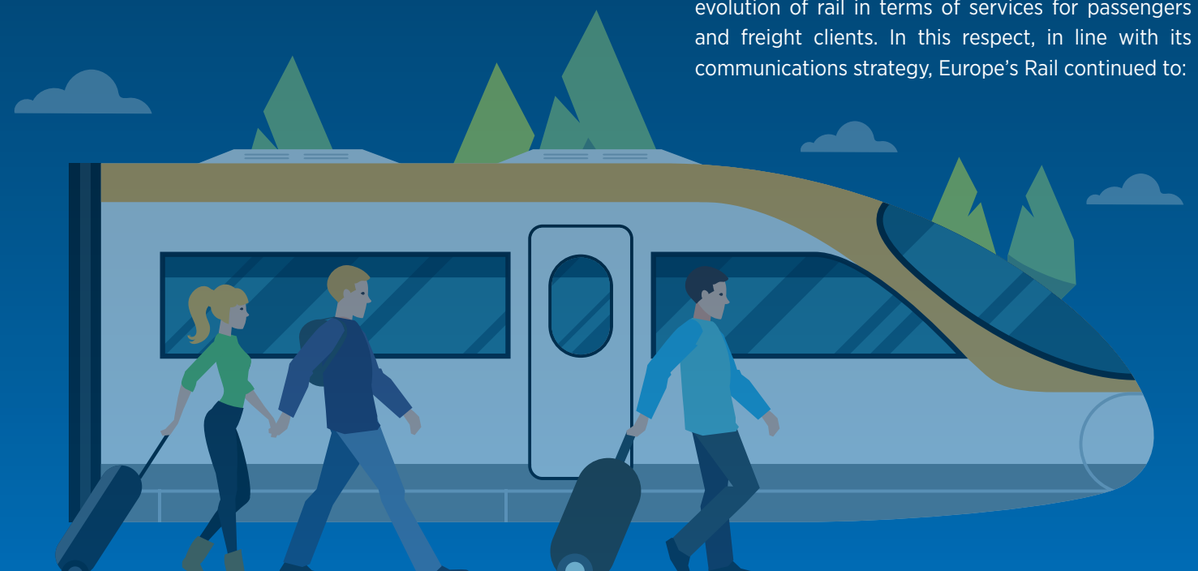
- Version 1 of Standardisation and TSI Input Plan – approved and published.
- Trackside Assets Specifications Update (TACS/ EULYNX Baseline 4 Release 3) – approved and published.
- Version 1 of CCS/TMS Data Model – approved and published.

Following the launch of the first six Flagship Projects in December 2022, within the Innovation Pillar 2024 there was a focus on continued monitoring of the activities and assessment of the results in view of fulfilling the main milestones, ahead of their conclusions in 2026. The results expected from this first wave of Flagship Projects will lay the foundation for future technological developments in the next phases of the programme.

Nine new Grant Agreements were signed for projects (stemming from the 2023 and 2024 Call for Proposals), of which three covered EU-Rail Flagship Areas: FA1 "Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers", in synergy with the Single European Sky ATM Research Joint Undertaking (SESAR 3 JU) on improving air and rail coordination; FA2 "Digital & Automated up to Autonomous Train Operations", in synergy with the European Smart Networks and Services Joint Undertaking (SNS JU) on testing and validating Version 2 of the FRMCS specifications; and FA7 "Innovation on new approaches for guided transport modes" on Hyperloop. While initially foreseen in 2024, the signature of a Grant Agreement in FA5, "Sustainable Competitive Digital Green Rail Freight Service", related to DAC, was postponed to Q1-2025. Additionally, in 2024 EU-Rail kick-started the second set of Exploratory Research activities with six new Grant Agreements, complementing the work of the FPs in often different areas of research and innovation within the EU-Rail Innovation Pillar.

Deployment activities remain central for EU-Rail. As such, the European DAC Delivery Programme, led by EU-Rail, has continued to unite the rail sector beyond the Membership, bridging the research work with innovation and supporting migration planning towards the deployment of a European DAC solution, built on open, transparent, and standardised specifications. In addition, the EU-Rail Deployment Group has been formally established withthe Future Railway Mobile Communication System (FRMCS) selected as the first topic to be addressed by the subgroup.

Beyond operational activities, 2024 marked the third year of implementation of Article 13 SBA, under which EU-Rail assumed the coordination of the Back Office Arrangement (BOA) Accounting Services. Another three BOAs led by other JUs were put into operation, in which EU-Rail also took a supporting role.



The year 2024 saw continued close collaboration between EU-Rail and:

- the European Railway Research Advisory Council (ERRAC);
- the European Union Agency for Railways (ERA);
- additional programmes, partnerships and other bodies, with the objective of establishing synergies that will result in coordinated and consistent activities, joint R&I projects, or administrative synergies, such as under the Back Office Arrangements with other JUs;
- different associations representing the key stakeholders of the rail sector and beyond;
- third-country programmes, in line with the policy priorities of the Commission and considering the key objective of the competitiveness of the European rail industry.

In 2024, EU-Rail continued conveying the message to European citizens that rail can answer their concerns about unsustainable and unreliable mobility options. The JU's key messages and events continued to reinforce the objectives of initiatives such as the European Green Deal, the Sustainable and Smart Mobility Strategy and the Digital Decade, as well as European competitiveness by disseminating R&I results and showing the future evolution of rail in terms of services for passengers and freight clients. In this respect, in line with its communications strategy, Europe's Rail continued to:

- showcase the innovative technological and operational solutions that result from the research and innovation activities, especially those ready for industrialisation and deployment, demonstrating tangible impact;
- raise awareness of the research and innovation activities engaging stakeholders at European level as well as in global events and conferences to promote EU-Rail's results, for example the successful collaboration with DG MOVE and ERA on the joint stand at InnoTrans 2024;
- enhance the partnership nature of the JU through communications and dissemination activities that will create opportunities for inclusiveness.

For this, it is worth noting that in 2024 the JU completely revamped its corporate website.

EU-Rail finalised its Phasing-Out Plan, approved by the Governing Board in November 2024 and highlighting the steps for the administrative closure of the Programme. There has been no preclusion of a possible continuation of the European Union investment in a potential successive partnership under the next EU Framework Programme, in accordance with the SBA. At the same time, it initiated a reflection on the future of rail R&I in the context of a policy-driven public-private partnership and published a draft **high-level paper on the topic**.

2024 also involved a significant effort from the Programme and Corporate Services teams to successfully close the final assessment and payment of the Shift2Rail Programme. Payment implementation reached 99.4% of the maximum available funding, which represents the successful financial implementation of the R&I Programme. The S2R Members validated EUR 25.6 million IKOP above the regulatory obligation and EUR 147.6 million IKAA above the regulatory obligation.

Mr Giorgio Travaini was appointed by the EU-Rail Governing Board as Executive Director of Europe's Rail Joint Undertaking on 22 May 2024, and Mr Vasileios Chatzigeorgiadis was recruited on 1 July 2024 as Head of Corporate Services.

S2R Programme Status

2024 marked the closing year for administrative and financial activities under the Innovation Programmes of Shift2Rail. 101 S2R Programme projects – awarded and signed since 2016 – were concluded and resulted in a total R&I value of EUR 764.3 million, including only the accepted payments. Additionally, 13 operational tenders implementing part of the Programme were closed. All technical demonstrators were finalised in 2023, and results already reported, demonstrating their results after 7–8 years of programme implementation since its launch, ahead of the S2R JU Programme implementation end date of 31 December 2024.

The work conducted within the S2R Programme was structured around five asset-specific Innovation Programmes (IPs), covering the different structural (technical) and functional (process) sub-systems of the rail system. These five IPs were supported by work in five cross-cutting areas (CCA), which tackled themes relevant to each of the projects and addressed the interactions between the IPs and the different sub-systems:

- **IP1:** Cost-efficient and Reliable Trains, including high-capacity trains and high-speed trains;
- **IP2:** Advanced Traffic Management & Control Systems;
- **IP3:** Cost-efficient, Sustainable and Reliable High-Capacity Infrastructure;
- **IP4:** IT Solutions for Attractive Railway Services;
- **IP5:** Technologies for Sustainable & Attractive European Freight.

In 2024, with the launch of its first **digital catalogue of solutions** on its website, EU-Rail put a fast and reliable overview of the results achieved by the S2R R&I Programme at the disposal of the wider audience and decision makers. It is an interactive platform that lets users explore various solutions elaborated and demonstrated by S2R projects. Filter options for beneficiaries and solution maturity are available, to help users navigate the different topics.

EU-Rail Programme Status

The EU-Rail Programme officially kicked off in 2022 and projects started in December. That same year, a framework was set up to enable regular collaboration between the System Pillar and Innovation Pillar as part of the Integrated Research and Innovation Programme. By 2023, this set up was fully up and running, making it possible for both pillars to actively exchange input and ideas based on a shared set of priorities and goals. The EU-Rail structure was then completed with the implementation of the Deployment Group.

At its core, the Integrated Programme aims to:

- help achieve the Single European Railway Area (SERA);
- ensure a fast transition to a more attractive, user-friendly, competitive, affordable, easy-to-maintain, efficient, and sustainable European rail system, integrated into the wider mobility system;
- support the development of a strong and globally competitive European rail industry.

DEPLOYMENT GROUP

SYSTEM PILLAR	CONTINUOUS EXCHANGE	**INNOVATION PILLAR** PILLAR
Single governance and coordination body		User-focused Research & Innovation
Functional system architecture		Flagship Projects
Unified operational concept		Large-scale demonstrations
Support SingleEuropean RailwaysArea		Exploratory, fundamental R&I

Common EU railway system view

Technological and operational solutions

DELIVER AN **INTEGRATED EUROPEAN RAILWAY NETWORK** BY DESIGN

DEVELOP A **UNIFIED OPERATIONAL CONCEPT AND A FUNCTIONAL SYSTEM ARCHITECTURE** FOR INTEGRATED EUROPEAN RAIL TRAFFIC AND CCS/AUTOMATION

DELIVER A **SUSTAINABLE AND RESILIENT RAIL SYSTEM**

DELIVER A **COMPETITIVE, GREEN RAIL FREIGHT** FULLY INTEGRATED INTO THE LOGISTICS VALUE CHAIN

DEVELOP A **STRONG AND GLOBALLY COMPETITIVE EUROPEAN RAIL INDUSTRY**

The System Pillar

The System Pillar is established under the Single Basic Act as a fundamental activity of EU-Rail, alongside the Innovation Pillar and Deployment Group.

The System Pillar provides governance, resources, and outputs to support a coherent and coordinated approach to the evolution of the rail system and the development of the system view, based on a formal functional system architecture to speed up innovation and deployment.

The System Pillar **tasks and domains** are:

- **Horizontal domains** – Engineering Environment Team (EET), Performance, Reliability, Availability, Maintainability and Safety (PRAMS), and Security;
- **Task 1:** Railway System;
- **Task 2:** Control-Command and Signalling (CCS);
- **Task 3:** Capacity Management System (CMS) and Traffic Management System (TMS);
- **Task 4:** Digital Automatic Coupling (DAC) and Full Digital Freight Train Operations (FDFTO) System Design;
- **Task 5:** Harmonised European Railway Diagnostics.

The scope and achievements of the System Pillar tasks and domains in 2024 were:

Horizontal domains and general deliverables

The horizontal domains deliver methods, tools and training for the whole System Pillar. Progress and results achieved in 2024:

- EU-Rail Standardisation and TSI Input Plan Version 1 approved, aligning the outputs of the EU-Rail programme with regulatory and standardisation bodies (including DG MOVE, ERA, standardisation bodies);
- A draft (Version 2) of the guidelines for implementing cybersecurity in rail was published, aiming to help in the railway-specific implementation of general cybersecurity principles, comprising:
  - Shared Cybersecurity Services Specification;
  - Secure Component Specification;
  - Secure Communication Specification;
  - Security Program Requirements.
- Version 3 of the System Engineering Management Plan (SEMP) has been developed, which includes the configuration and quality management plan, and the update of the existing.

Task 1: EU Railway System

The main ambition for the Task 1 System Levels is to identify the necessary and important improvements in selected interaction processes (business, technical and operational) (for a better "to-be" architecture).

Progress and results achieved in 2024:

- Energy report on energy saving measures has been delivered. The report collects and assesses energy-saving approaches in all relevant sub-systems of the railway sector. This report contains a catalogue of solutions that have been trialled or used in the European rail sector, with a specific part for rail research programmes;
- Delivery of the remit deliverable "As-is (AI) Operational Architecture on the prioritised capabilities reflecting the differences between the countries";
- Reached conclusion of to-be (TB) architecture of "Manage Energy" and "Operate Train" capabilities within the remit deliverable "04-Operational analysis of TB architecture".

Task 2: CCS

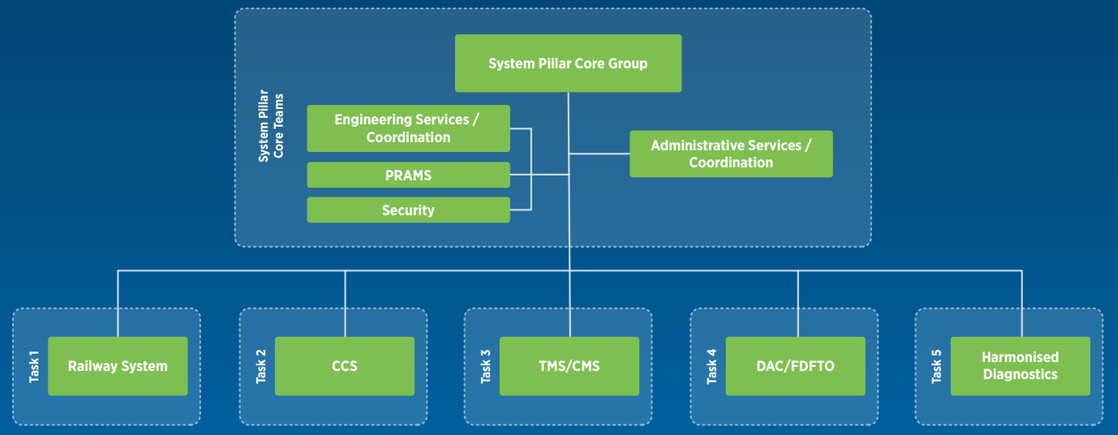
Task 2 develops the operational concept(s) and functional system architecture for a genuine integrated European CCS system, supported by a model-based systems architecting and engineering approach, beyond the current specifications in the CCS TSI, with much greater standardisation and much less variation than at present.

Task 2 is structured by domain teams:

- Cross-cutting activities:
  - The Operational Design Team;
  - The Architecture and Release Coordination Team;
  - The Migration and Roadmap Team.
- (Sub-)System Design activities:
  - The Traffic Control and Supervision Team;
  - The Trackside Assets Control and Supervision Team;
  - The Train Control and Supervision Team;
  - The Transversal CCS Components Team;
  - The Communications Team;
  - The Computing Environment Team.

Progress and results achieved in 2024:

- **Operational Design Domain:**
  - Collected operational requirements from the sector (RU, IM), derived from the CBO;
  - Concept capabilities finalised for 32 capabilities, including GoA2;
  - Preliminary operational risk analysis.
- **Migration Domain:**
  - Delivery of the remit deliverable "CCS features packages indivisible for deployment".
- **Traffic CS Domain:**
  - First input related to "Update of Standardisation & TSI Input plan for Traffic CS topics" has been provided.



- **Train CS Domain:**
  - Remit deliverable "Train CS logical architecture" finalised (initial Baseline 01);
  - Delivery of the remit deliverable "Update and more precisely specify Train CS System capabilities".
- **Computing Environment Domain:**
  - Delivery of "Computing Environment Operation concept – Operational Analysis".
- **Trackside Asset CS Domain:**
  - As part of the remit deliverable "Maintaining the specifications – update BL4R2", the EULYNX Baseline 4 Release 3 specification has been published jointly by EU-Rail SP/EULYNX. The primary focus of this release is to incorporate remaining feedback from the industry and reach a stable maturity level, ensuring full integration into the EU-Rail System Pillar.
- **Transversal Domain:**
  - Development of the CCS/TMS data model. This data model, based on the extended ERA ontology, is a standardised framework aimed at enabling seamless data exchange across railway systems. It specifies data structures that are critical for various railway functions such as engineering, asset management, operational plans, train protection, and automated train operations;
  - Delivery of the remit deliverables related to CCS/TMS diagnosis and configuration concepts.

Task 3: Traffic Management System/Capacity Management Design Team

Task 3 carries out the coordination and execution of the detailed design work for the lower System Levels 3, 4 and 5 for the Traffic Management System/Capacity Management System and defines detailed operational processes and requirements, functional system analysis and technical architecture. This domain is responsible for all planning activities including producing the operational plan and keeping it up to date. The two main areas of activities are Capacity Planning (CMS) and Capacity Production (TMS).

Progress and results achieved in 2024:

- Five variants for European TMS were proposed and analysed within the remit deliverable "Cross-border TMS & CMS". This activity aims to improve the management of the European Railway system especially for cross-border traffic, by determining the pros and cons of several (five) possible architecture models and their impact in different aspect;
- Several deliverables were produced related to system concept and system architecture:
  - Draft Specification for Topology Interface;
  - Draft for TAF TAP TSI Interface;
  - Draft for Legislative and Economic Issues;
  - Draft Specification for Incident Management System;
  - Logical Architecture Specification.
- Delivery of the remit deliverable "System Definition";
- Delivery of the remit deliverable "Interface between TMS and Traffic Control and Supervision System", aimed at aligning the Traffic CS and TMS joint interface.

Task 4: Digital Automatic Coupling (DAC)

Full Digital Freight Train Operations (FDFTO), as part of Task 4, covers all cross-cutting activities related to DAC/FDFTO (e.g., regarding operational procedures, architecture and interfaces to embed the on-board system, developed by FP5, into the overall railway system). It also manages the input to the Standardisation and TSI Input Plan (STIP) for DAC/FDFTO, and supports FP5 regarding authorisation strategy.

Progress and results achieved in 2024:

- Work regarding the European operational rulebook started during 2024. The rulebook work is based on the operational domain concepts and goes deeper to specify the CCS system and respective rulebook;
- Also, during 2024, work has been developed for three remit deliverables, "Operations Architecture related to FDFTO interfaces", "Possible further interfaces of DAC/FDFTO to the 'outside' world" and "Central Instance Management of data & software".

Task 5: Harmonised European Railways Diagnostics

The Harmonised European Railways Diagnostics (HERD) brings together representatives of data users and data providers from supplier industry, infrastructure managers (IM), railway undertakings (RU), and vehicle keepers (VK). The team members ensure strong alignment with the Innovation Pillar Flagship projects FP1, FP3 and FP5 as well as with the System Pillar Tasks 1, 2 and 4. This specific topic project was redefined as Task 5 HERD during 2024. This domain is responsible for designing a new standard procedure to harmonise European railway diagnostics. In this way, it will contribute to the creation of the Single European Railway Area (SERA).

Progress and results achieved in 2024:

- Two use cases for harmonised diagnostics were analysed within the activities associated to the remit deliverable, "Detailed elaboration/development of the framework/architecture and applying framework to a concrete example of use cases, measuring systems and parameters; output: harmonised measuring methods and parameters. Detailed elaboration of the framework/architecture":
  - Trackside Vehicle Monitoring (WTMS) use case, which consists of monitoring the condition of railway vehicle wheels using WTMS (Wayside Train Monitoring Systems);
  - On-Board Track Monitoring use case, which consists of monitoring the track quality using on-board measuring devices (on special and commercial vehicles).

The highlights among all 2024 the outcomes were:

- Publishing the Standardisation and TSI Input Plan V1;
- Publishing the Trackside Assets/EULYNX baseline 4 Release 3 specification;
- Publishing the EU-Rail CCS/TMS Data Model V1.

The Innovation Pillar

The Innovation Pillar is designed to deliver user-focused research, innovation and large-scale demonstrations. It is tasked to deliver operational and technological solutions with the necessary capabilities to transform the European rail system.

Its activities are structured in seven Flagship Areas, leading to large-scale demonstration as defined in the SBA and complemented by Transversal Topics which ensure the engineering integration of the Programme. In addition, new and disruptive ideas are continuously scouted in the form of Exploratory Research activities that challenge traditional approaches and practices, promote behaviour and organisational change, and thus help to accelerate the innovation, scientific knowledge generation and sharing, or integrating technological advances from other sectors into the railway system.

Progress in 2024

Nine new Grant Agreements were signed (stemming from the 2023 and 2024 Call for Proposals), of which three covered EU-Rail Flagship Areas:

- **FP1-TRAVEL WISE** project covers FA1, "Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers", in synergy with the Single European Sky ATM Research Joint Undertaking (SESAR 3 JU) and focusing on improving air and rail coordination;
- **FP2-MORANE-2** project covers FA2, "Digital & Automated up to Autonomous Train Operations", in synergy with the European Smart Networks and Services Joint Undertaking (SNS JU) with a focus on testing and validating Version 2 of the FRMCS specifications;
- **HYPER4RAIL** project covers FA7, "Innovation on new approaches for guided transport modes" with a focus on the Hyperloop system.

While initially foreseen in 2024, the signature of a Grant Agreement in FA5, "Sustainable Competitive Digital Green Rail Freight Service", related to DAC, was however postponed to Q1-2025 (FP5-DACTIVATE project).

Additionally, in 2024 EU-Rail kick-started the second wave of Exploratory Research activities with six new Grant Agreements (DACFIT, PhDs EU-Rail, XCROSS, SYMBIOSIS, NEXUS, QuieterRail), complementing the work of the FPs in often different areas of research and innovation of the EU-Rail Innovation Pillar.

Flagship Areas and Projects

In 2024, the Flagship Projects (FPs) responsible for undertaking the initial implementation of these Flagship Areas continued their activities. Building on the preparatory work done in 2023, all projects continued working on use cases, requirements and the development of specifications, as preparation for future prototype development ahead of testing in the second phase of these projects (foreseen from 2025 onwards). In parallel, active collaboration continued among all the FPs, as well as with the EU-Rail System Pillar.

FLAGSHIP AREA 1

Network Management Planning and Control & Mobility Management

The main objective of FA1 is to significantly improve flexibility, efficiency, resilience and capacity adaptation within the European rail network, while enabling the development and operation of a Single European Rail Area.

Currently, FA1 includes two flagship projects: **FP1-MOTIONAL** and **FP1-TRAVEL WISE**.

FP1-MOTIONAL, the first project under Flagship Area 1, started on 1 December 2022. Its aim is to pave the way towards a Single European Rail Area through the delivery of functional requirements, associated specifications, and operational and technological solutions to enable a future European Traffic Management and Capacity Management System that will make rail the backbone of a multimodal transport system for passenger and freight. Its scope also includes the Transversal Topics (TT), focusing on solutions for digital enablers across all flagship projects, such as Federated Rail Data Space, Digital Twin, Digital Asset Engineering and Conceptual Data Model.

This project is being delivered in two Workstreams (WS): WS1 addresses the solutions for planning and operations of rail services at the European level (Traffic Management System and Capacity Management System) and the integration of rail services with door-to-door mobility. WS2 covers the TT topics mentioned above. The summary of WS2 progress in 2024 can be found in the Digital Enablers – Transversal Topic TT section of this document.

Workstream 1

In 2024, Workstream 1.1 (Capacity Management) focused on developing the design, high-level requirements, and use cases for 28 demonstrations and associated use cases for the solutions to integrate national rail planning systems and processes developed by the project. This included cross-border planning, rolling stock planning, and timetable redesign to improve capacity management. The workstream also developed and implemented algorithms for long-term and short-term timetabling, train path optimisation, and decision support, leveraging feedback loops from ETCS Hybrid Train Detection, Automatic Train Operation, and C-DAS to enhance operational processes and on-time rail service performance.

Meanwhile, Workstream 1.2 (Traffic Management) developed the specifications for 31 demonstrations and related focusing on the real time integration of national Traffic Management Systems (TMS) and processes including cross-border traffic management, integration of TMS with yard and station management, energy management, and crew/rolling stock dispatching. It successfully completed TRL4 validation tests for prototypes addressing disruption management, planning support, and user-friendly Human-Machine Interfaces. Additionally, it developed algorithms and validation for 13 use cases focusing on real time convergence of planning and operations, linking TMS with ATO, in line with ERA vocabulary and CCS/TMS data models.

In 2024, Workstream 1.3 finalised the development, implementation, and TRL4 validation of multimodal rail integration solutions, including seven platforms for 13 upcoming demonstrations. The solutions address challenges including ticketing, financial services, and disruption management, emphasising standardised interfaces like OJP and NeTEx for seamless platform communication, as well as passenger intermodal accessibility improvements, especially for those with reduced mobility. The latter includes mobile guidance through a MaaS app, seamless validation through facial recognition, and platform safety lighting. Additionally, demand forecasting tools using real time data were validated to optimise rail capacity and service connections, supported by a Digital Twin interface to optimise passenger guidance during disruptions.

In December 2024, the second FA1 flagship project formally kicked off. FP1-TRAVEL WISE is the first air-rail synergy project with SESAR Joint Undertaking, aiming to explore solutions for more efficient intermodal operations management and optimised passenger experience. Activities under this project are planned to ramp up in 2025.

FLAGSHIP AREA 2

Digital & Automated up to Autonomous Train Operations

FA2 will aim to deliver scalable automation in train operations with fully unattended train operations, including setting a train in motion, driving and stopping the train, opening and closing the doors, remote train control and recovery operations in the event of disruptions.

The objective of FA2 is to take the major opportunity offered by the digitalisation and automation of rail operations and to develop solutions expected to bring additional functionalities to control command and signalling.

This includes next generation Automatic Train Control (ATC), including Automated Train Operation (ATO), Grade of Automation (GoA) 4, building upon radio-based European Rail Traffic Management System (ERTMS) or above, representing the next evolution of the system, incorporating the latest technological advances, and with functionalities enabling full optimisation of performance in line with the Traffic Management improvements developed in FA1.

FA2 will aim to deliver scalable automation in train operations with fully unattended train operations, including setting a train in motion, driving and stopping the train, opening and closing the doors, remote train control and recovery operations in the event of disruptions.

In 2024, FA2 was implemented via Flagship Project 2 – R2DATO (FP2-R2DATO) launched in December 2022. In December 2024, FP2-MORANE-2, the EU-wide test campaign for the validation of FRMCS V2 also officially kicked off. A ramp-up of activities is expected in 2025.

The **Automation Processes Cluster (APC)** established a foundation for the upcoming implementation of the Technical Enablers. In 2024, the "remote operation of tram" demonstrator was finalised and showcased at InnoTrans, marking a successful step toward expanding remote driving use cases in both light rail and mainline railway operations, with an estimated 30% increase in staff productive hours. Additionally, the Train Control Monitoring System (TCMS) was integrated into the APC baseline work, including support for Next Generation TCMS focused on ATO and remote driving.

In 2024, the Optimised Headway Cluster (OHW) advanced work on Advanced Safe Train Positioning (ASTP), defining use cases and operational needs to enable more accurate train localisation (±5 m), reduced maintenance, and improved capacity. Furthermore, hazard analysis and functional architecture were delivered. Progress was also made on EGNOS integration through EGNOS4RAIL, with ESA and EUSPA delivering a preliminary system version. Specifications for Hybrid Train Detection (HTD) and Moving Block were completed, with implementation and simulations underway.

The **Digital Enabling Technologies Cluster** has progressed on the technical enabler linked to the modular platform. The requirements, architecture and specifications of the final modular platform have been delivered. The analysis and concept work are expected to further contribute to EU-Rail SP progress, supporting the domains in defining a suitable environment for modular platforms to be commissioned in the future. Furthermore, the activities for on-board communication resulted in the delivery of use cases and requirements for on-board communication networks. Also, a list of solution candidates was completed. For the digital register activities, a task force was set up. In full collaboration with the System Pillar, this task force completed the use cases and requirements on the digital register. Finally, Connectivity Development with a focus on ACS/Gigabit Train has evolved with respect to different use cases designed for the regional lines and with the design of a multi-connectivity platform. A first analysis was done for the prototype testing and an agreement on a common approach was reached.

Within the **Fast and Effective Deployment Cluster**, an outline of the business case has been completed. Several analysis steps have been started to quantify the ATO operational benefits analysis. For testing and validation, a common strategy and process for virtual certification of complete railway systems and functional upgrades is being defined. Furthermore, the requirements for a certification methodology were defined and approved.

In the **Innovative Operational Solutions Cluster**, the use case list and concept for autonomous route setting (AnRS) were defined. In addition, the architecture and interfaces for the virtual coupled train set (VCTS) were agreed. Furthermore, a set of test cases was defined for the technology development of short-range communications (SCR) and relative localisation (RL).

All **demonstrators** foreseen in FP2-R2DATO started the activities that align with the technical enablers and are needed for the demonstration. In 2024, three key demonstrators were advanced. The FP2-R2DATO Moving Block System defined its architecture and release plan, with testing set for a digital test field and a simulation environment. The remote tram demonstrator was completed and shown at InnoTrans 2024, focusing on automating depot operations via remote driving in collaboration with a Norwegian tram operator. The on-board platform demonstrator implemented and tested agreed user stories in a virtual environment, including FRMCS-related components.

FLAGSHIP AREA 3

Intelligent & Integrated Asset Management

Flagship Area 3 (FA3) is implemented by Flagship Project 3-IAM4RAIL (FP3) in the initial phase, and its main objective is to provide new innovative technical requirements, methods, solutions and services based on the latest leading-edge technologies to minimise asset life cycle costs or extend life cycles while meeting the safety needs and improving the reliability, availability and capacity of the railway system, addressing both infrastructure and rolling stock.

In 2024, **Sub-Area 1** on Wayside Monitoring and the Traffic Management System (TMS) made strong progress in design, deployment, and early testing, including initial data collection supporting the development of simulators and Digital Twins. Alignment with FA1 continued to define common methodologies and best practices regarding TMS and the Decision Support System. The Intelligent Asset Management System (IAMS) architecture for both use cases was finalised, with development and validation planned for 2025. Sensor installations in Spain and Italy enabled early demonstrators. In Italy, the platform monitors train transits and switch movements, with automated alerts for anomalies. In Spain, analysis of level crossing data produced a high-accuracy anomaly detection model. Some features were showcased at the FP3-IAM4RAIL Mid-Term Event in November. Additionally, the Obstacle Detection System for level crossings was successfully tested under simulated weather and object scenarios.

In 2024, **Sub-Area 2** on Rolling Stock Asset Management advanced the European Railway Checkpoints concept in coordination with FP5. Work focused on refining technology mapping, assessing functional goals, and starting data collection for on-board monitoring. Anomaly detection algorithms were developed for key sub-systems. New bogie sensing technologies were bench-tested, including trials with damaged components, and will be tested on track in 2025 in the Netherlands. Requirements for wayside monitoring were also defined. A method to certify Condition-Based Maintenance safety was developed and validated with two operators, confirming transferability and reducing certification time by up to four months.

In 2024, **Sub-Area 3** advanced in infrastructure asset management by developing decision-support tools, improving sensing technologies, and integrating multi-source data for better planning. Key achievements include developing intelligent sleepers and creating a geological risk network for real time embankment monitoring. Demonstrations and improvements will continue in 2025.

Meanwhile, **Sub-Area 4** advanced Railway Digital Twins by identifying real time data sources like CCTV feeds for station monitoring. A trash detection system was developed that tracks waste in real time, prioritises cleaning in high-traffic areas, and can detect hazardous materials such as broken glass. This system is expected to reduce cleaning costs by 20–25% and improve passenger satisfaction and safety by about 15%. Next steps include creating a dashboard for operators and a trash classification system for targeted responses. Additionally, Blockchain and

Virtual Certification Framework specifications were drafted, with use cases shared with FP1 and synergies explored with FP4 to support infrastructure certification and material traceability.

Finally, **Sub-Area 5** made key advances in sustainable railway assets, including eco-design and additive manufacturing for spare parts. A Digital Warehouse Strategy was launched, and new AM technologies are being tested. The robotic inspection platform showed promising results in navigation and detection, aiming to improve inspection accuracy by 25%. Development of exoskeletons and augmented reality tools also progressed, with full validation planned for 2025.

Sensor installations in Spain and Italy enabled early demonstrators. In Italy, the platform monitors train transits and switch movements, with automated alerts for anomalies. In Spain, analysis of level crossing data produced a high-accuracy anomaly detection model.

FLAGSHIP AREA 4

A Sustainable & Green Rail System

The main objective of Flagship Area 4 (FA4) is to provide new innovative products and services based on leading-edge technologies to minimise the overall energy consumption and environmental impact of the railway system, make the transportation mode healthier and more attractive, and provide resilience against climate change at a reduced total cost of ownership. In the first phase of the programme, FA4 is implemented via FP4-Rail4EARTH.

During 2024, progress has been made and valuable results have been achieved on the different topics within **Sub-Area 1**: key components of next-generation propulsion systems (including SiC-based power converters and transformers) were assembled and prepared for testing. On-board energy storage systems progressed across three demonstrators (two high-performance Battery Electric Multiple Units (BEMUs) and one for low traffic). Energy management studies helped evaluate autonomy, CO_2 emissions, and life cycle costs, showing potential for over 200 km range. A digital twin architecture and ageing tests on power semiconductors advanced virtual validation efforts. Lastly, hydrogen storage R&D continued with tests on both composite and metallic tank materials, each offering different benefits. A health monitoring system is being developed for commercial tank integration.

In 2024, **Sub-Area 2** advanced in several areas. The hydrogen refuelling station configuration was modelled, with hazard assessments and interface design initiated to align with international standards. Collaboration with projects like FP6-FutuRe and FCH2RAIL (a project funded by the Fuel Cells and Hydrogen 2 Joint Undertaking, now Clean Hydrogen Partnership) supported progress on interoperable refuelling processes and protocols. For energy hubs, simulation and validation showed that integrating energy storage systems (ESS) with renewables could save at least 12 MWh of energy daily. A pilot Urban Energy Hub was installed in Rotterdam. On the AC side, models for flexible traction substations and energy storage systems were developed, with co-simulations underway. A tool for managing AC/DC grids is also being built. Progress on the modular station included uploading the BIM of María Zambrano station into the Common Environment Platform, installing sensors, and simulating energy-efficient lighting scenarios.

Significant progress was also achieved in **Sub-Area 3** across standardisation, sustainability, noise mitigation, and circular economy. A preliminary list of 37 standards was identified for revision or development, covering charging infrastructure and on-board energy storage systems. A first methodology for system-level energy optimisation was also developed, based on defined use cases and performance criteria across operations, infrastructure, and rolling stock. As a continuation of the work done on adaptation to climate change, the analysis achieved in 2024 has highlighted the need to carry out vulnerability studies for all railway assets: rolling stock, infrastructure and stations. For the 15 key analysis results, a set of pedagogic presentations dedicated to FP4 partners have been developed, showing the main conclusions, what this allows, and a roadmap for 2025 and beyond.

In 2024, **Sub-Area 4** focused on advancing and introducing airless electromechanical systems, including braking systems, pantographs, and suspensions. Two airless brake prototypes underwent extensive wheel-rail testing and integration checks on a demo train. A first airless pantograph was designed, simulated, and had its regulation system tested, while simulation models for pantograph-catenary interaction were initiated. Development of the high-capacity independent rotating wheel (IRW) frame is ongoing, targeting TRL4. For eco-friendly HVAC systems, key technologies were selected. Additionally, initial high-accuracy numerical simulations for virtual aerodynamic certification and optimised roof and pantograph aerodynamics were completed, with results pending comparison.

Throughout 2024, **Sub-Area 5** prioritised improvements in ventilation and air quality management within railway settings. This involved evaluating ventilation concepts for contaminant removal and thermal comfort using a generic train compartment mock-up. Progress was made in air quality technology assessments, with harmonised evaluation criteria and refined weighting factors established. Two air quality measurement protocols were defined and tested: component level (L1) and mock-up level (L2), covering air treatment, surface treatment, and micro-sensors. Efforts also focused on developing a pre-standardised method to measure and report air quality in underground stations, supported by a thorough review of international regulations. Existing simulation tools for air quality prediction on covered platforms and tunnels were validated.

In 2024, **Sub-Area 6** made great progress on modular train interiors. They worked closely with aircraft suppliers and train operators to develop quick fasteners that make it easier and faster to reconfigure interiors. Sustainability was a big focus, with efforts to use recycled materials and designs for easy recycling. Two virtual train configurators were created: one aimed at customers and shown with mock-ups, and another for designers to test different options. A real train was restored to test how different fixings and materials perform in practice. They also defined key design principles to help make interiors safer and quicker to assemble and update. Lightweight insulation solutions were developed to keep passengers comfortable, and early work began on how modular designs affect acoustics. They looked into standardising fixing heights to avoid custom work and improve efficiency. On the hygiene side, a full-scale toilet mock-up was built for passenger feedback, and new ideas inspired by nature are being explored to improve cleanliness.

FLAGSHIP AREA 5

Sustainable Competitive Digital Green Rail Freight Services

The objective of FA5, implemented via the FP5-TRANS4M-R in the first phase of the programme, is to make rail freight more attractive through increased capacity, e.g., with the DAC. FA5 has two clusters which are interlinked.

The first one is “Full Digital Rail Freight Operations” focused on substantially increasing the productivity, quality, and capacity of rail freight by applying digitalisation and automation to all possible operational functions and processes including innovative freight assets.

The second one, “Seamless Rail Freight”, is focused on important aspects to increase the efficiency of the immaterial (information/data) layer of transport and to gain time and save costs by ensuring a seamless environment in the long term combined with short/medium-term achievements and quick wins.

Workstream 1

In 2024, Workstream 1 progressed from analysis and architecture work to testing and validation. The reference freight system architecture was defined, covering physical and digital aspects. Functional and non-functional requirements advanced significantly, and testing plans were finalised.

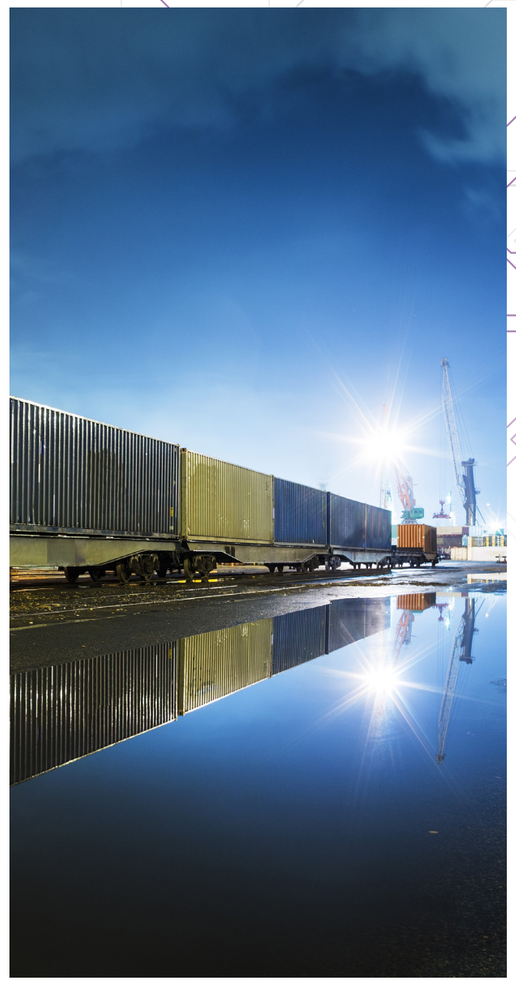
Field trials and prototype tests confirmed interoperability and supported the selection of e-coupler designs. The DAC commercial demonstrator train in Sweden successfully completed tests, providing key data on performance and life cycle costs in winter conditions.

Safety and IT security analysis for automated shunting operations were completed, with a preliminary SIL investigation supporting safe design. Collaborative efforts focused on design flexibility and operational efficiency.

Progress was made on innovative freight assets regarding loading/unloading efficiency and aerodynamics. At InnoTrans 2024, DAC interoperability and development progress were publicly demonstrated to stakeholders.

Workstream 2

While WS2 made significant progress in launching work for the Seamless Freight cluster, the focus has been on delivering key functional and technical specifications for the capacity management system, providing essential input for FA3. FA5 completed critical tasks supporting current and future development. Compared to 2023, 2024 saw a shift from planning and strategy toward detailed technical implementation and testing. The project advanced interoperability, improved operational procedures, and integrated advanced technologies across European rail freight, and has been driven by strong collaboration among work packages and stakeholders.



The project advanced interoperability, improved operational procedures, and integrated advanced technologies across European rail freight, and has been driven by strong collaboration among work packages and stakeholders.

FLAGSHIP AREA 6

Regional Rail Services/ Innovative Rail Services to Revitalise Capillary Lines

Flagship Area 6 (FA6) is dedicated to ensuring the long-term sustainability of regional railways by significantly reducing the Total Cost of Ownership (TCO), encompassing both operational and capital expenditures, while simultaneously enhancing service quality and operational safety.

The initiative aims to make rail transport a more attractive and preferred option by leveraging digitalisation, automation, and emerging technologies across signalling, trackside components, rolling stock, and customer information systems. In 2024, FA6 was implemented through the FP6-FutuRe project and achieved key milestones across its sub-areas.

Sub-Area 1 focuses on Regional Rail System Solutions and Architecture and developed specific requirements for regional lines based on feedback from the System Pillar and other Flagship Projects. These requirements serve as the starting point for demonstrator development and the beginning of safety verification activities. They will be revised and updated once all development, verification, and validation activities at different levels are complete. A KPI methodology was identified, including measurable criteria for each KPI and a preliminary qualitative justification of the technical enablers contributing to the expected KPIs. Safety analysis began from the defined architecture, with possible associated hazards identified.

Sub-Area 2 revised the specific requirements for regional lines. Feedback from the System Pillar and other Flagship Projects was considered. These requirements serve as the basis for demonstrator development and safety verification activities. These requirements will be updated after the conclusion of all development, verification, and validation activities.

In 2024, **Sub-Area 3** made great strides in finalising requirements and creating innovative wayside solutions aimed at cutting costs and boosting efficiency, with plans to demonstrate these improvements later on. Building on earlier Shift2Rail and other research projects, the team defined key requirements for wayside object controllers and obstacle detection systems, while also completing important safety and socio-economic studies. They worked out detailed specifications for the wireless interfaces of the Smart Wayside Object Controller at multi-modal level crossings, covering communication protocols from top to bottom. On top of that, they developed a flexible communications architecture to support the new FRMCS standard and affordable wireless options for regional lines, focusing on lowering costs, improving network performance, and opening up new possibilities for railway applications.

In 2024, **Sub-Area 4** focused on developing a comprehensive report addressing the regulatory and market needs of regional rail lines, including a detailed database of existing rolling stock, innovative technologies, and market pricing. The legal framework was analysed to identify potential adjustments for cost-effective regional train design. Mechanical architecture specifications were advanced with emphasis on mass reduction and material use, supported by modelling and performance studies of carbody and running gear. Work also included analysing multimodal hydrogen fuelling stations for various vehicles and refining the architecture for non-interoperable regional control command signalling, promoting minimal architecture, telecommunication-agnostic solutions, fewer wayside components, and cloud computing integration.

In 2024, **Sub-Area 5** focused on completing specifications to support the next implementation phase. Use cases were defined and refined, requirements set, acceptance criteria established, and test cases developed. Work included integrating demand responsive transport (DRT) into the multimodal trip planner, simulating DRT operations to optimise fleet size in rural areas, and supporting distributed trip planning with accessibility features. An interface between traffic management and passenger information systems was designed, with four use cases covering demand forecasts and timetable updates. Machine learning models were developed to forecast short- and long-term travel demand, improving efficiency and passenger experience by using data like journey requests and historical occupancy, aligned with FP1-MOTIONAL. Specifications for passenger congestion monitoring on regional lines were also created, combining data such as weather and passenger feedback to predict congestion and optimise train-to-platform allocation, reducing transfer times and station crowding.

The initiative aims to make rail transport a more attractive and preferred option by leveraging digitalisation, automation, and emerging technologies across signalling, trackside components, rolling stock, and customer information systems.

FLAGSHIP AREA 7

Innovation on New Approaches for Guided Transport Modes

Flagship Area 7 (FA7) focuses on exploring innovative, non-traditional, and high-speed guided transport systems. The goal is to integrate these new systems into existing rail networks to achieve socio-economic efficiency and sustainability across Europe. In 2024, the following projects contributed to this FA:

MaDe4Rail FA7

The **MaDe4Rail project** concluded in 2024 and aimed to explore non-traditional and emerging Maglev-derived Systems (MDS) and to evaluate the technical feasibility and effectiveness of introducing MDS in Europe. A roadmap for developing and implementing MDS in the European rail network has been created, outlining a step-by-step path toward commercial-ready solutions for both freight and passenger services. A risk analysis evaluated hazards associated with various MDS set ups like linear motors and magnetic or air levitation, proposing measures that reduced risks to acceptable levels. A gap analysis identified where new standards are needed and existing ones updated to support MDS components and operations. Potential MDS applications were selected based on market needs and technology readiness, with detailed technical and financial assessments, including cost-benefit analysis. Concepts for MDS vehicles and high-level prototype designs were developed, covering interfaces with infrastructure such as switches, power supply, and traffic management. This roadmap guides the future development of MDS technologies, focusing on overcoming key technical challenges and ensuring full interoperability with existing rail systems.

FA7 pods 4 RAIL

The **Pods4Rail project** aims to develop a concept for pods and pod carriers on railway to better adapt rail transport to user demand by providing higher flexibility and efficiency as well as offering on demand transport. In 2024, the existing safety framework was analysed, including relevant safety requirements across rail, road, and cable car standards due to the supermodal approach. Over 20 use cases were identified for both passenger and freight transport units, supported by surveys that informed a SWOT analysis of the autonomous pod system. Economic boundaries were estimated by comparing current transport costs, providing initial cost indicators for the pod system. A high-level functional requirements specification was developed, laying the groundwork for key components such as operation systems, ticketing, incident management, and transport units. Business case studies assessed the feasibility, costs, and benefits of various Pods4Rail use cases aimed at improving efficiency and sustainability. The system concept proposal included a structural design of transport units, HVAC power requirements, and energy transfer methods between pods and carriers. In the project's second half, coupling concepts were compared and interface definitions established to ensure interoperability between transport modes.

FA7 Hyper4Rail

On 1 December 2024, the **Hyper4Rail project**, entitled "A Giant Leap for Loop: Towards a Harmonised Implementable Hyperloop Concept," was launched. Bringing together 25 partners, the project aims to harmonise and develop a concept design for the hyperloop system (TRL 2), validate key sub-system technologies for transport in low-pressure environments (TRL 4), and create a common roadmap for integrating hyperloop technology into the Trans-European Network. The project held its kick-off meeting and launched a survey to gather input from end users and stakeholders on how the hyperloop system should operate.

Exploratory Research

Academics4Rail

The **Academics4Rail** project aims to build a stable and durable community of railway scientific researchers and academia to share and exchange scientific knowledge with Europe's Rail, as well as to enable a network of PhDs (with academia teaming up with industry).

In 2024, in the framework of building European rail scientific excellence, the project has delivered a tool for mapping national rail research themes and funds. An infographic to summarise all the findings, contributing to the project's broader dissemination efforts, will soon be developed. Progress has also been made regarding the establishment of a scientific observatory for Europe's Rail. Finally, the development of an overarching assessment framework that will support an evidence-based assessment methodology of how Europe's Rail's activities are delivering against its aims and objectives is under development.

All six PhD positions that were filled in 2023 are advancing, and the researchers are now finding the right journals to submit the ongoing work.

InBridge4EU

The **InBridge4EU** project addresses unresolved issues in current railway infrastructure standards, focusing on improving the dynamic interface between railway bridges and rolling stock. During 2024, the project made strong progress in defining Dynamic Train Categories (DTCs) for train-bridge compatibility, using dynamic data and statistical analysis to support compatibility checks and speed limits. The Linear Inverse Regression method was preferred over spectral methods, and over 520 bridges were analysed with shared numerical models. Research on dynamic amplification (φ˝) using Swedish track data showed dependencies on span, speed, and track quality. Damping studies across 90 bridges confirmed the effectiveness of the estimation methods and the conservatism of the current normative damping curves. Furthermore, full-scale tests and shake table experiments validated Discrete Element Method simulations related to ballast stability, and a new algorithm suggested that safety factors below two may be suitable for existing ballasted bridges.

LEADER 2030

LEADER 2030 aims to address the future availability of raw materials and components for EU-Rail innovations by 2030. In 2024, the project completed an analysis of comparable industrial sectors including aerospace, defence, automotive and clean energy to identify resilience patterns relevant to the railway sector. Findings revealed that all sectors faced major supply disruptions due to unexpected events and that innovation-driven developments often introduced further challenges. Additionally, the analysis of the EU-Rail Master Plan and Multi-Annual Work Programme (MAWP) (aimed at identifying the components needed to deliver each target innovation) was nearly completed. Finally, the project coordinator, Ms Veronica Elena Bocci (ERCI/DITECFER), was awarded the "Women in Rail Award 2024" in the "Research and Innovation" category, jointly presented by EU-Rail, the European Commission, CER, EIM, ALE, and UNIFE and recognising her outstanding contributions to rail technology and innovation through the "LEADER 2030" project.

DACcord

As a support action, **DACcord** coordinated efforts related to the European DAC Delivery Programme (EDDP). The project refined and further developed the DAC migration roadmap, aligning it with the multi-annual work programme and collaborating closely with all EDDP work areas and stakeholders. This included integrating related EU-Rail projects and coordinating timing aspects such as milestones, key deliverables, required interactions, and resource availability. The project also progressed in executing and managing the DAC migration roadmap alongside EDDP Stakeholder Management. A key achievement was the development of the revised DAC General Master Plan 02, which incorporates recent developments and interfaces with FP5-TRANS4M-R and the EU-Rail System Pillar, and includes a large-scale testing phase for DAC pioneer trains prior to full-scale rollout.

RAIL4CITIES

The **RAIL4CITIES** project aims to transform railway stations into promoters of sustainable cities. It focuses on developing a new operational model (SCP model) and deploying it across five European living labs, each targeting different aspects of station transformation. In 2024, after 18 months of operation, the project has successfully published a first iteration of the methodology, with the introduction of a new operational model for stations. Moreover, the project has delivered the detailed roll-out methodology linked to the SCP model for Living Labs, testing and refining it in real-world scenarios, and providing an impact assessment and recommendations for refining the SCP model in subsequent work to be performed.

ESEP4Freight

The main goal of the **ESEP4Freight** project is to create a web platform that shows all available rail freight services across Europe on an interactive map. This easy-to-use tool will give users access to open, high-quality information, making it simpler to choose rail freight and encouraging more goods to be transported by train. In 2024, the project has achieved the identification of KPIs, an assessment of emerging technologies and modal share analysis and data collection, specifications for the implementation of blockchain technologies and smart contracts, as well as the analysis of the current contractual and legal framework, with recommendations for improvement.

EXPLORATORY RESEARCH

Projects starting in 2024

SYMBIOSIS

Launched in 2024, the **SYMBIOSIS** project brings together experts from different fields to focus on biodiversity. It aligns with the United Nations' vision for responsible land use and supports the European Green Deal. The project aims to create a community where people working in transport infrastructure, energy, and biodiversity can collaborate.

The project successfully initiated its activities in 2024, organising a kick-off meeting that facilitated open dialogue among consortium members and external stakeholders. Additionally, data collection for Environmental Impact Assessment case studies from 2021–2024 has commenced and efforts are being made to evaluate the inclusion of raw data from previous project surveys to avoid duplication.

QuieterRail

The main goal of **QuieterRail** project is to introduce a step change in predicting and mapping railway noise and vibration, acceptance testing of rolling stock and promoting cost-effective noise mitigation.

Following the kick-off meeting, progress was made in key areas such as gathering input data for modelling, defining squeal noise measurement set ups, and improving transposition methods. A survey on new propulsion technologies was carried out, alongside evaluations of on-board roughness and rail grinding. Track optimisation identified Advisory Board members and proposed ground vibration models. Work also began on a hybrid ground vibration prediction tool, developing a cloud-based app to replace the earlier desktop version.

XCROSS

The main goal of the **XCROSS** project is to enhance the monitoring and inspection of railway crossing surface profiles.

The XCROSS project has successfully initiated its activities in 2024, setting a strong foundation for its objectives. The kick-off meeting and first workshop (technical discussions about practical welding and grinding of railway turnouts) facilitated technical knowledge exchange and stakeholder engagement. The consortium is well-positioned to advance its mission of improving railway crossing maintenance and life cycle cost management in the coming months.

PhDs EU-Rail

The **PhDs EU-Rail** project aims to foster collaboration and innovation in the European railway sector by consolidating a scientific community and conducting research through 10 PhD positions. The project aligns with the goals of the EU-Rail Joint Undertaking (EU-Rail) and industry partners.

The PhDs EU-Rail project has progressed as planned in 2024. The first achievement was the appointment of 10 PhD candidates who started their preliminary research activities. Simultaneously, a guidebook for current and future PhD students in railway research was finalised, covering key topics and aiming to provide comprehensive guidance and support to PhD students, making this project a significant and impactful contribution to the field.

DACFIT

The main objective of **DACFIT** is to provide a detailed and quantitative analysis of vehicle data, including a thorough assessment of retrofitting processes. It also evaluates the capacity and infrastructure of European workshops to support retrofitting, with the aim of developing a comprehensive and integrated retrofitting strategy and plan.

Since the start, the project has focused on several key areas related to the quantitative and technical analysis of vehicle data, the detailed examination of retrofitting processes, and the evaluation of European workshop infrastructure for retrofitting with the goal of developing a comprehensive retrofitting strategy. The project has already organised a workshop to conduct an installation test of DACs from four different manufacturers.

NEXUS

The main objectives of **NEXUS** are to establish an innovation benchmark and provide guidance towards a transformative future for European metros, with a focus on optimisation and adaptability to passenger demands.

The project successfully initiated its activities in the last quarter of 2024, organising the kick-off meeting and a General Assembly. Additionally, the project developed the surveys for passengers and metro operators that will be used to gather requirements for the future models for metro adaptability analysis, a train control feasibility study, and AI and data science implementation in metro operation.

TRANSVERSAL TOPIC (TT)

Digital Enablers

The goal of "Digital Enablers" is to introduce new digital capabilities across EU-Rail Work Programme destinations to support railway industry operations through the following solutions, delivered under the FP1-MOTIONAL project:

- **A Conceptual Data Model (CDM)**, as an extension of previous ERA and Shift2Rail's LinX4Rail project work on a standardised rail model and ontology.
- **A Digital Twin (DT)** run-time environment and reusable, digital model units to enable the virtual representation of rail sub-systems supporting their validation and interoperability assessments.
- **Solutions to support Digital Assets Engineering** processes including the analysis of maintenance activities such as preventative maintenance and root cause fault detection.
- **A Federated Rail Data Space Sandpit** to enable cyber secure rail data exchange.

In 2024, the CDM team performed an analysis of the relevant use cases from all flagship projects to identify new conceptual needs for the CDM while finalising the CDM extension for rail infrastructure and rolling stock modelling.

The Digital Twin team delivered the preparation and implementation of the DT run-time environment and the coordination and compilation of FA use cases based on technical, strategic, and interaction criteria. Examples of such use cases include ERTMS (European Rail Traffic Management System) DT, failure analysis of point machines, fault detection in rail infrastructure, virtual certification of rolling stock, and ATO (Automatic Train Operation) operational pre-assessments. Development began on runtime environments for these demonstrations to enable modular, interoperable Digital Twins.

In 2024, the Digital Asset Engineering team progressed with deep learning for object extraction, updated a number of engineering rules, and the BIM (Building Information Modelling) data development platform reached its alpha version for web development. Work has progressed on identifying the guidelines and standards for acquiring, updating and developing BIM/AIM (Asset Information Model) data and models.

The Federated Rail Data Space team implemented the Sandbox environment and performed preliminary tests for static data transfer. The team also developed an IDSA-compatible (International Data Spaces Association) mock-up app store and started the deployment of Data Space Connectors in preparation for the upcoming demonstrations, while the collection and analysis of use cases continued throughout the year. The preferred options for the Rail Data Space governance model were also identified during 2024.

TT achievements were also showcased at InnoTrans 2024, including Digital Twin simulations integrated with the Rail Data Space Sandbox demonstrations highlighting track condition monitoring via Infrastructure Manager data through an app store. Two public town hall presentations were also held in 2024 to share progress and encourage engagement.

Deployment Group

As per Article 97 of the Single Basic Act, the Deployment Group is tasked to advise the Governing Board on the market uptake of rail innovation developed in EU-Rail and to support the deployment of innovative solutions. The main objective of the Deployment Group is to analyse how to strengthen the capability of the sector to sustainably contribute and accelerate rail innovation to reach the market. It focuses on various aspects to make recommendations to the different actors of the system on the deployment of innovative solutions that require high levels of coordination.

During 2024, following the Governing Board Decision No 11/2023 EU-Rail organised and finished the set up of the High-Level Deployment Group.

The first three meetings in 2024 were informal, due to the fact that the Commission had not taken the final decision on the composition. The Group was formalised in November 2024.

A kick-off meeting took place, followed by two meetings on procedures and the first topic (FRMCS). During these meetings, Rules of Procedure (RoP), a communication plan and rules for appointing subgroups were discussed and informally decided. Formal decisions will be taken in the first – now formal – meeting of 2025.

It was agreed that FRMCS would be the first topic of focus for a dedicated subgroup. This group discussed and set its remits and working plan. Five informal meetings of the FRMCS subgroup were held in 2024.

Additionally, three working groups were initiated: (1), Technology WG, (2), Legal and Finance WG, (3), Migration and Alignment WG.

The main objective of the Deployment Group is to analyse how to strengthen the capability of the sector to sustainably contribute and accelerate rail innovation to reach the market.

The European DAC Delivery Programme (EDDP) under the leadership of EU-Rail

In July 2020, the Governing Board of the JU endorsed the creation of the EDDP proposed by the ED, reflecting the request of the railway sector. Building upon the outcomes achieved in S2R's freight-related R&I activities (IP 5), this Programme brings together the broader rail sector beyond the JU Membership to bridge the research work with innovation.

It includes migration planning, towards the deployment of a European DAC solution, built on open and transparent standard specifications. This activity constitutes a major step forward of the digital rail freight, enabling new operations and services that will contribute to meeting the expectations of the Sustainable and Smart Mobility Strategy of the European Commission.

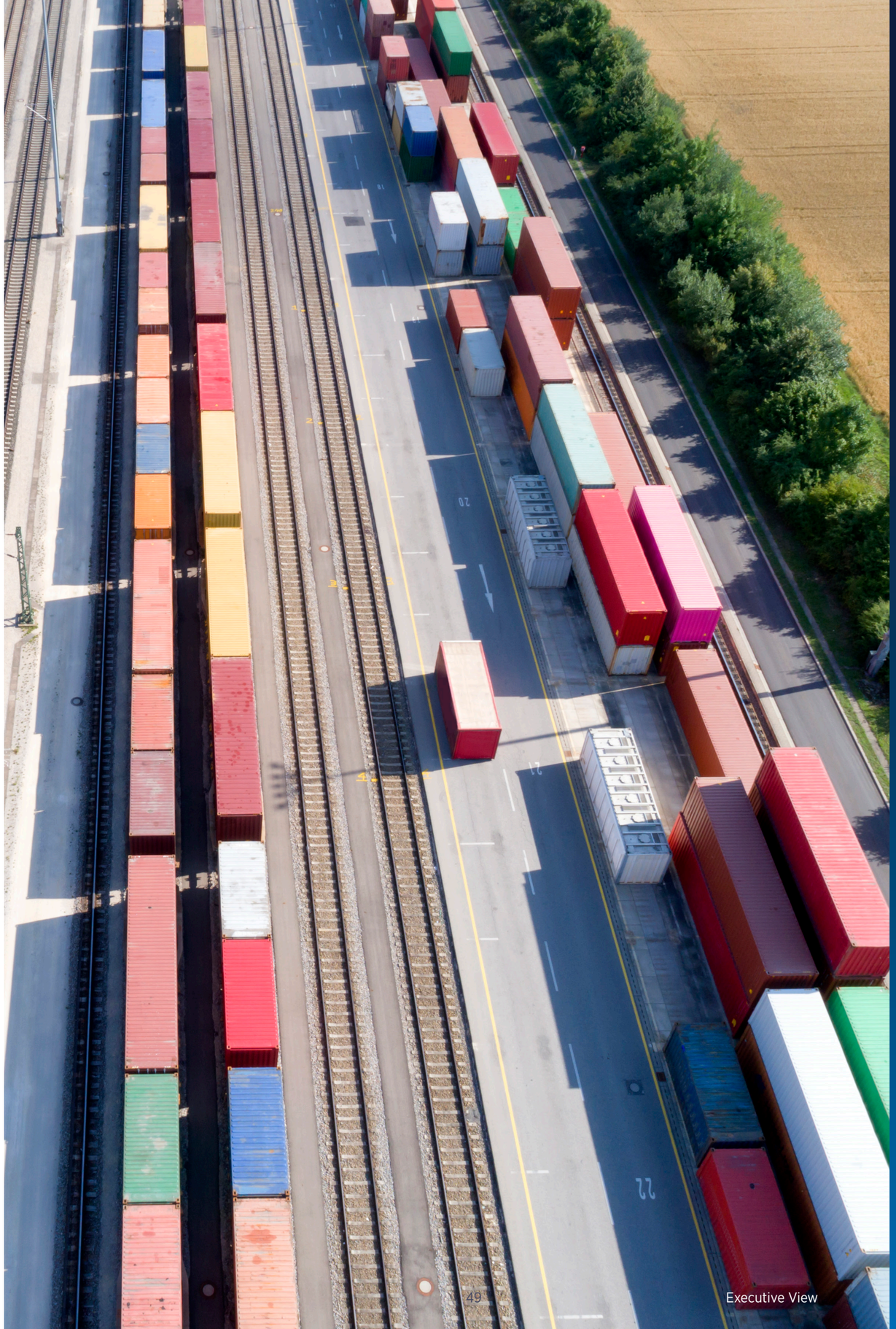
The EDDP, as an independently managed delivery programme, integrates the relevant results from the projects linked to Europe's Rail JU FA5 activities, such as FP5-TRANS4M-R, FP5-DACtiVate and DACFIT, on European rail freight.

In 2024, several meetings continued with the ERA DAC Topical Working Group and national NSAs with the aim of agreeing a DAC specification that could be adopted in future TSI, supporting harmonisation all across the EU rail network.

Throughout the year, the DACcord Coordination and Support Action continued to support the running of the EDDP. The refined EDDP programme planning as a basis for an exhaustive risk management was delivered and the permanent coordination with FP5-TRANS4M-R was ensured via regular reports in the EDDP boards. Regular alignment meetings were held between the different bodies and in coordination with the EU-Rail JU. This work supported the ongoing execution and management of the DAC General Master Plan. It further worked on the DAC migration roadmap and on EDDP Stakeholder Management.

An updated DAC cost-benefit analysis (CBA) was coordinated in EDDP and led by the European Commission. This led to the creation of a task force on Intermodal Traffic with stakeholders from Intermodal and EDDP to better reflect Intermodal aspects in the CBA. This task force continuously interacted with all other DACcord Work Packages and with FP5-TRANS4M-R. The activities on regular cross-coordination of the works of the EDDP, FP5-TRANS4M-R and EU-Rail System Pillar (Task 4) continued throughout 2024.

Furthermore, the DACFIT project supported the work of the migration roadmap update, especially on the collection of the European vehicle fleet data. In collaboration with FP5-TRANS4M-R project, DACFIT set up three so called EU-Rail "sounding boards". The results of these sounding boards were reported to the EDDP programme board and used for evaluation by the FP5-TRANS4M-R project.



Communication Activities

In 2024, the majority of the communication activities focused on organising and participating in events, streamlining dissemination activities, and promoting the outputs of the EU-Rail Flagship and Exploratory Research Projects. EU Rail also prioritised maintaining an active network of stakeholders who engage regularly in joint activities with the JU.

The JU participated in nearly 58 events across Europe and beyond. A key milestone from 2024 was InnoTrans, where EU-Rail, the European Commission and the European Union Agency for Railways, co-hosted the "Europe for Rail" stand, showcasing over 20 rail innovations from the EU-Rail Research and Innovation Programme. The programme included a VIP event at the EU stand with CEOs, Members of the European Parliament, and government representatives, highlighting cutting-edge rail technologies. To mark EU Rail's presence at InnoTrans, a dedicated high-speed train transported over 300 high-level stakeholders from Brussels to Berlin on 23 September, hosting conferences and workshops en route as a symbol of the commitment of the rail community to a sustainable means of transport.

EU-Rail participated in Transport Research Arena (TRA) 2024, sharing a stand with Clean Hydrogen JU, Clean Aviation JU, and SESAR 3 JU, emphasising synergies in transport research and innovation. EU-Rail's team and projects actively contributed through technical, strategic, and Young Scientists awards as part of the TRA Visions Competition.

Alongside the key events, the JU reinforced its engagement with the presidencies of the Council of the European Union, with a particular focus on the Belgian Presidency. In collaboration with the Belgian Transport Ministry, the European Commission, and EU-Rail, the JU co-hosted a high-level event during the Connecting Europe Days.

Relations with the European Parliament remained regular, with the JU contributing to several TRAN Committee activities. Relations were further strengthened via the European Startup Prize for Mobility, an EU startup acceleration programme supported by EU-Rail.

EU-Rail also organised important initiatives such as the "Women in Rail" award to recognise outstanding contributions in the sector, in collaboration with DG MOVE, ERA, ALE, CER, EIM, and UNIFE. The initiative featured three distinct prizes, awarded following a rigorous jury evaluation. The winners were honoured during a formal ceremony at InnoTrans in Berlin.

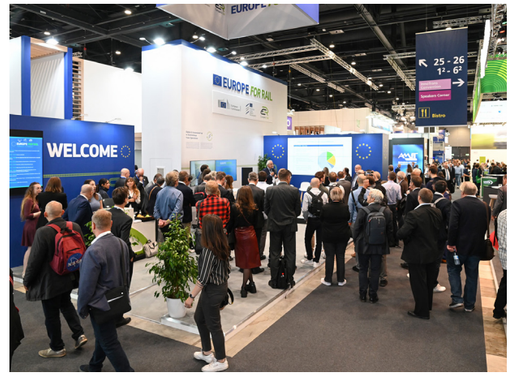
Promoting the 2024 Calls for Proposals remained a key focus of the communication activities. In 2024 one Call for Proposals was launched and widely promoted through website, newsletter, social media channels and through events and this promotional content was successfully re-shared by EU-Rail Founding Members, the European Commission and partners as well as reported in the press. Additionally, the Info Day was further promoted by the Horizon Europe National Contact Points Network, including the organisation of regional info days. To further leverage on the synergies offered by the collaboration, a joint communication campaign was launched, including a social media campaign and visual materials. In 2024, EU-Rail also maintained its long-term matchmaking platform encouraging interested applicants to find like-minded experts, exchange ideas and schedule meetings.

The JU completed a two-phase corporate website revamp: Enhancements included an improved navigation system based on user feedback, a new landing page, updated templates, an upgraded visual identity, improved plug-ins for events and news, and the launch of a fully digital Solutions Catalogue highlighting key success stories from both the Shift2Rail and Europe's Rail programmes.

Ongoing close collaboration with the European Union Agency for Railways (ERA), the European Railway Research Advisory Council (ERRAC), and other International and European organisations and associations ensured continuous and constructive exchanges with other EU bodies and agencies.

58

events the JU participated in, across Europe and beyond.



Other Activities

2024 has seen the JU further continue its significant progress towards delivering the EU-Rail Programmes.

The EU-Rail Staff Establishment Plan was adopted by the GB on 1 March 2023 and covers the EU-Rail activities of 2024 from the perspective of resources and needs.

In November 2024, the GB adopted the Staff Establishment Plan for 2025–2026 which includes three staff members of the Back Office Arrangements. This unit provides accounting services for all Joint Undertakings. According to the Staff Establishment Plan applicable to 2024, EU-Rail was expected to have 32 staff members including two Seconded National Experts. Following the revision of the Multi-Annual Framework with a reduction of the Horizon Europe amount, as well as the signature of the association agreement with the UK, one CA position was converted from a position funded by the EU to funding by third countries. This change, applicable as of 2025, had no impact on the total number of EU-Rail staff members. Additionally, an extra TA post was added, financed from external revenue.

In 2024, the JU experienced three staff member departures and the vacant posts were progressively filled. To fill temporary gaps or long-term absences, the JU also relied on external competencies and expertise to achieve its operational activities, as well as temporarily outsourcing some administrative tasks.

With regard to communication and dissemination activities, the JU continued to support activities of the Europe's Rail Joint Undertaking, with a particular focus on the continued promotion of the S2R Programme, bringing as much visibility as possible to the results of its R&I activities while also raising awareness of the Europe's Rail Programme, Calls for Proposals, System and Innovation Pillars, and newly established Deployment Group.

2024 marked the conclusion of the Shift2Rail projects. Particular focus was also placed on the promotion of the objectives and outputs of the EU-Rail Flagship Projects. Furthermore, project results were disseminated through its social media channels as well as at various events with Europe's Rail participation, such as the InnoTrans 2024, The Connecting Europe Days 2024 and the Transport Research Arena (TRA).

In addition to the efforts on stakeholder involvement, the JU further continued improving its internal organisation to provide continuous support to its members and beneficiaries. Efforts were made to further implement the internal control framework and to strengthen risk assessment and management. The JU also cooperated with different stakeholders engaged in audit activities, such as the European Court of Auditors, the Internal Audit Service of the Commission, the Common Audit Service of DG RTD (despite no longer supporting EU-Rail in performing the ex-post activities and EU-Rail having launched in 2024 two ex-post reviews following CAS indication of selection for the Horizon Europe indicators) or the external auditors auditing the Annual Accounts of the JU. All of these activities have contributed to continuously assuring the sound financial management of EU funds managed by the Joint Undertaking.

Moreover, the EU-Rail Horizon Europe Control Strategy for grants was updated in 2024 to reflect this change. In 2024, the JU submitted a follow-up report to the European Parliament's observations in its resolution related to the decision on discharge regarding the implementation of the JU's budget for the 2022 financial year. In this follow-up report, the JU explained how it addressed or intends to address these observations in the upcoming period. More specifically, it explained how EU-Rail contributes to the EU goals related to transport (e.g., a zero-emission, silent rail system and climate resilient infrastructure; an integrated European railway network which is more attractive, affordable and easy-to-maintain, etc.).

In response to some HR-related concerns that were raised by the Parliament, the JU explained the objective conditions in which it operates, and the feasible actions that it took in that area. At the same time, the JU explained its opposed view on the conclusions drawn by the European Court of Auditors on the implementation of a structured risk-based approach to ex-ante controls and has further clarified the risk control strategy that was implemented. Furthermore, the JU has provided additional details on the actions taken to address the observations on the presentation of the programme funding in the annual accounts and the budget implementation.

In conclusion, thanks to the commitment of both the JU Members and the Programme Office, 2024 has seen the JU further continue its significant progress towards delivering the EU-Rail Programmes. The following sections of this 2024 CAAR present the achievements, risks and opportunities in detail, as well as the developments pertaining to the JU during the past year.

Flagship Projects

Topic Code	Topic Description	Project value € M	Partners Involved	Duration
HORIZON-ER-JU-2022-FA1- TT-01	Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers	92.6	90	46 months
HORIZON-ER-JU-2022-FA2-01	Digital & Automated up to Autonomous Train Operations	160.8	77	42 months
HORIZON-ER-JU-2022-FA3-01	Intelligent & Integrated asset management	108.7	97	48 months
HORIZON-ER-JU-2022-FA4-01	A sustainable and green rail system	95.1	73	48 months
HORIZON-ER-JU-2022-FA5-01	Sustainable Competitive Digital Green Rail Freight Services	103	78	54 months
HORIZON-ER-JU-2022-FA6-01	Regional rail services/Innovative rail services to revitalise capillary lines	33.5	52	48 months
HORIZON-ER-JU-2023-FA1-SESAR	EU-Rail – SESAR ynergy: integrated air and rail network backbone for a sustainable and energy-efficient multimodal transport system	6.8	37	36 months
HORIZON-ER-JU-2024-FA2-SNS	EU-Rail – SNS synergy: digital & automated testing and operational validation of the next eu rail communication system	19.1	43	34 months
HORIZON-ER-JU-2024-FA5	Digital Automatic Coupler – testing to support dac authorisation, mix and match for dac coupler head and draft gear interchangeability and dac hybrid coupler fitting solutions	9.9	21	25 months

Other Projects

Topic Code	Topic Description	Project value € M	Partners Involved	Duration
HORIZON-ER-JU-2022- FA7-01	Conceptual development of Automated Multi-Modal Mobility-Systems (“Moving Infrastructures”)	4.6	15	30 months
HORIZON-ER-JU-2022- ExpIR-01	New Railway station concept for green and socially inclusive smart cities	0.9	11	24 months
HORIZON-ER-JU-2022-ExpIR-02	Bridge Dynamics	1	12	36 months
HORIZON-ER-JU-2022-ExpIR-03	European Shift Enabler Portal for Freight	1.3	9	24 months
HORIZON-ER-JU-2022-ExpIR-04	Building a community of railway scientific researchers and academia for ERJU and enabling a network of PhDs (academia teaming with industry)	1.9	25	42 months
HORIZON-ER-JU-2022-ExpIR-06	European value chains for rail supply	0.7	4	30 months
HORIZON-ER-JU-2022-ExpIR-07	DAC migration roadmap towards deployment	1.5	6	36 months
HORIZON-ER-JU-2022-FA7-02	**Maglev-Derived Systems for Rail - CLOSED**	**2.6**	**16**	**15 months**
HORIZON-ER-JU-2023-EXPLR-01	Noise and vibrations	4.5	16	36 months
HORIZON-ER-JU-2023-EXPLR-02	Future Metro Systems	3.6	13	24 months
HORIZON-ER-JU-2023-EXPLR-03	Biodiversity	3	22	36 months
HORIZON-ER-JU-2023-EXPLR-04	Disruptive Assets Management and solutions, including urban use cases	2.7	10	30 months
HORIZON-ER-JU-2023-EXPLR-05	Extending the rail network of PHDs	2	15	36 months
ORIZON-ER-JU-2023-EXPLR-06	DAC fleet retrofitting and retrofit capacity plan	1.9	8	24 months
HORIZON-ER-JU-2024-FA7	Hyperloop – Roadmap towards industrialisation and harmonised implementable concept	2.6	27	24 months

Europe's Rail Overview

Name	Europe's Rail Joint Undertaking – as of 30/11/2021 (hereinafter "EU-Rail").
Objectives [4]	EU-Rail is an autonomous body with its own legal personality. It is an institutional European partnership as per Article 187 of the Treaty on the Functioning of the European Union dedicated to managing and coordinating mission-oriented R&I activities for a major transformation in rail systems in Europe. The general objectives of EU-Rail are to: a. contribute towards the achievement of the Single European Railway Area; b. ensure a fast transition to more attractive, user-friendly, competitive, affordable, easy-to-maintain, efficient and sustainable European rail system, integrated into the wider mobility system; c. support the development of a strong and globally competitive European rail industry. The main task of EU-Rail is to deliver a high-capacity integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure and services, aiming to achieve faster uptake and deployment of projects and innovations.
Legal basis	Article 187 of the Treaty on the Functioning of the European Union. [5] The founding legal Act of EU-Rail is the Council Regulation (EU) 2021/2085 [6] of 19 November 2021, which entered into force on 30 November 2021, establishing the Joint Undertakings under Horizon Europe (hereafter the "Single Basic Act" or the "SBA"). By means of the SBA, the EU-Rail was established and became the legal and universal successor of the former S2R JU, which it replaced and succeeded as of that date. In addition, in its first meeting, the EU-Rail Governing Board approved the list of decisions adopted by the S2R JU that will continue to apply for EU-Rail in accordance with Article 174(12) of the SBA. [7]

Executive Director (ED)	Mr Giorgio Travaini, appointed ED as of 22 May 2024. [8]	
Governing Board of EU-Rail	***European Commission (EC) members:***	
	• Ms Magda Kopczynska, DG MOVE	
	EC alternates:	
	• DG MOVE	Mr Kristian Schmidt
	• DG RTD	Ms Rosalinde Van Der Vlies
	Industry members:	
	• ADIF	Mr Luis Fernando López
	• ALSTOM	Mr Richard French
	• ANGELRAIL consortium led by MER MEC	Mr Francesco Inzirillo
	• AŽD	Mr Vladimir Kampik
	• CAF	Mr Jorge De Castro
	• CEIT	Mr Juan Melendez
	• ČD	Mr Jan Ilík
	• DEUTSCHE BAHN	Ms Jasmin Bigdon
	• DLR	Mr Michael Meyer zu Hörste
	• eSGR JV	Ms Noemi Jimenez Redondo
	• Faiveley Transport	Mr Paolo Pagliero
	• Ferrovie dello Stato Italiane	Ms Andrea Volponi
	• HITACHI RAIL STS	Ms Antonella Trombetta
	• INDRA-TALGO	Mr Jose Miguel Rubio Sanchez
	• Jernbanedirektorate	Mr Preben Saethre
	• KNORR-BREMSE	Mr Hans-Christian Hilse
	• ÖBB	Mr Mark Topal Goekceli
	• PKP	Mr Jancewicz Zbigniew
	• ProRail-NS Groep	Mr Julien Cayet
	• SIEMENS	Mr Roland Edel
	• SNCF	Mr Christophe Cheron
	• Strukton	Mr Tjark de Vries
	• THALES	Mr Amaury Jourdan
	• TRAFIKVERKET	Mr Bo Olsson
	• Voestalpine Railway Systems	Mr Franz Sodia

4 The key objectives pertaining to the S2R Programme, pursued by the former Shift2Rail Joint Undertaking, and inherited by its successor – EU-Rail, are the following:
- a 50% reduction of the life cycle cost of the railway transport system (i.e. costs of building, operating, maintaining and renewing infrastructure and rolling stock);
- a 100% increase in the capacity of the railway transport system;
- a 50% increase in the reliability and punctuality of rail services (measured as a 50% decrease in unreliability and late arrivals).

5 **https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12016E187**

6 **OJ L 427, 30.11.2021**

7 **EU-Rail GB Decision n° 02/2021**

8 Based on the **EU-Rail GB Decision n° 07/2024**.

Governing Board of EU-Rail	***Industry alternates:***	
	• ADIF	Mr David-Ibán Villalmanzo Resusta
	• ALSTOM	Mr Michael Haddad
	• ANGELRAIL consortium led by MER MEC	Mr Vincenzo Scarnera
	• AŽD	Mr Michal Pavel
	• CAF	Mr Imanol Iturrioz Villalba
	• CEIT	Mr Jaizki Mendizabal
	• ČD	Mr Petr Jindra
	• DEUTSCHE BAHN	Mr Manuel Lianos
	• DLR	no alternate
	• eSGR JV	Mr Jose Solis Hernandez Mr Celestino Martinez
	• Faiveley Transport	Mr Matteo Frea
	• Ferrovie dello Stato Italiane	Mr Davide Pifferi
	• HITACHI RAIL STS	Mr Carlo Crovetto
	• INDRA-TALGO	Mr Alfredo Gonzalez Moreno Ms Leyre Merle Carrera
	• Jernbanedirektorate	Mr Pal Midtlien Danielsen
	• KNORR-BREMSE	Mr Martin Ertl
	• ÖBB	Ms Flora Strohmeier
	• PKP	no alternate
	• ProRail-NS Groep	Mr Tijmen Voet
	• SIEMENS	Mr Lars Deiterding - Mr Ralf Kaminsky
	• SNCF	Mr Gilles Quesnel
	• Strukton	Mr Henk Samson
	• THALES	Mr Mounir El Said
	• TRAFIKVERKET	Mr Christer Lofving Dr Anders Carolin
	• Voestalpine Railway Systems	Mr Uwe Ossberger
	Other participants:	
	• EU-Rail	Mr Giorgio Travaini, Executive Director
	Observers:	
	• ERA	Mr Pio Guido Ms Ana Gigantino Ms Ny Tiana Tournier
	• ERRAC	Dr Marion Berbineau - Mr Artur Fojud
	• Scientific Committee (SC)	Ms Angela Di Febbraro
	• State's Representative Group (SRG)	Mr Miroslav Haltuf
Other bodies	• System Pillar Steering Group • Deployment Group • States Representatives Group (SRG) • Scientific Steering Group (SSG)	
Number of staff	29 posts as at year-end 2024 [9]	

9 The full staffing as per the JU's Staff Establishment Plan comprises 32 posts, out of which three posts were vacant at year-end 2024.

Total budget 2024

At the year-end 2024, the JU had implemented 99.9% of its commitment appropriations made available in its active budget (Titles 1 to 4) and 69.9% for the total budget (Titles 1 to 5). The payment appropriations were implemented up to 87.9% (85.2% in 2023) of the active funds (or 64.3% of implementation when compared to the full JU budget (including Title 5). The active budget relates to the Titles 1 to 4, while the total budget includes the Title 5 of the unused appropriations.

By means of the GB Decision 16/2023 of 5 December, the EU-Rail Governing Board adopted the initial Annual Work Programme and Budget for 2024.

There were two amendments to this initial Decision adopted during 2024 that had an impact on the budget.

- ***Amendment number 1:*** This amendment recognised and balanced (Revenue and Expenditure) unused appropriations of the S2R Programme operational expenditure due in relation to the previous budgetary years, in accordance with EU-Rail Financial Rules Article 6.5. EUR 32.9 million in payment appropriations were entered in the Budget for the last year of the S2R Programme execution in order to pay S2R Programme grants interim and final payments.
- ***Amendment number 2:*** The Executive Director proposed to the Governing Board a second amendment of the Budget in order to adapt both commitment and payment appropriations per line considering the evolution of budget needs, payment budget forecast expected until year-end, lower than planned, in particular for staff expenditure and associated costs (turnover in 2024), as well as to ensure the financing of the 2nd wave call of Flagship Projects under the WP 2025-2026.

As a result, the budget as finally adopted amounted to:

- Commitment appropriations: EUR 114.5 million
- Payment appropriations: EUR 120.8 million

Budget implementation	The implementation rate of the active operational budget in commitment appropriations was 99.9% and 87.9% in payment appropriations (85.2% in 2023). In 2024, an important portion of payment appropriations was used for the second pre-financing of the grants resulting from the calls for proposals for 2023 and 2024. **Commitment appropriations total consumption of the active budget: EUR 80.1 million is 99.9%, while the consumption percentage on the total budget is 69.9%.** Further breakdown by Titles in EUR and in % of total, excluding unused appropriations: Title 1 – EUR 3.3 million – 99.5% Title 2 – EUR 1.7 million – 99% Title 3 - 4 – EUR 75 million – 100% **Payment appropriations total consumption of the active budget: EUR 77.7 million is 87.9% while the consumption percentage on the total budget is 64.3%.** Further breakdown by Titles in EUR and in % of total, excluding unused appropriations: Title 1 – EUR 3.3 million – 88.6% Title 2 – EUR 1.8 million – 85.9% Title 3 - 4 – EUR 72.6 million – 87.9% The reported implementation also includes payments to the Expert Evaluators which are managed by the REA Services. In 2024, the third instalment of the grant agreements derived from the first call of 2022 and the award of six Flagship Projects have been covered with complementary budget (commitment appropriations). For the Shift2Rail Programme, the year 2024 mainly entailed ensuring the closure of the ongoing payments. By the end of 2021, the JU had signed 101 grant agreements in total since its autonomy in 2016. The R&I activities total value, including those accepted for payment in grants within the Programme, has reached EUR 764.8 million (including Lighthouse Projects as part of the S2R initiative), of which EUR 628.7 million performed by the S2R Members with a funding made available by the JU to Members and non-Members up to of EUR 349.9 million. At the end of 2024, all of the 101 S2R projects and 32 operational contracts implementing part of the Programme were closed.
Grants/ Tenders	The value of nine signed grants in 2024 resulting from the 2023 and 2024 Call for Proposals corresponds to EUR 34.4 million of funding by EU-Rail. In 2024, contracts/orders (legal commitments) amounting to EUR 13.5 million were signed, of which EUR 11.09 million resulted from operational procurements and EUR 2.41 million from administrative procurements.
Strategic Research & Innovation Agenda	In the context of EU-Rail, as defined in the SBA, the “Strategic Research and Innovation Agenda” (SRIA) represents the document covering the duration of Horizon Europe that identifies the key priorities and the essential technologies and innovations required to achieve the objectives of the JU. In accordance with SBA Article 86(5), the SRIA of EU-Rail is constituted by its Master Plan. [10]

Call implementation	• Number of calls launched in 2024: 1 • Number of proposals submitted: 3 • Number of evaluated proposals: 3 • Number of proposals retained for funding: 3
Participation, including SMEs	Total number of beneficiaries, affiliated entities and associated partners retained for funding in projects from the call 2024–01 only: 891 • 14% of which are SMEs, receiving 17% of total EU funding provided by EU-Rail, 100% of the SMEs that participated in the call were retained for funding. • 69% of which are private for-profit companies, receiving 72% of total EU funding provided by EU-Rail. • 10% of which are non-EU entities, receiving 2% of total EU funding provided by EU-Rail. 13 SME participations were part of the evaluated proposals in the 2024–01 call of which all of them were included in the proposals retained for funding.

10 https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

Europe's Rail

Founding Members

adif
ALSTOM
mermec AN ANGEL COMPANY
ŽD
CAF
ceit MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
CD
DB
DLR
Faiveley Transport A Wabtec Company
eSGR European Smart Green Rail
FERROVIE DELLO STATO ITALIANE
HITACHI Inspire the Next
Indra Talgo
Jernbane-direktoratet
KNORR-BREMSE
ÖBB
PKP POLSKIE KOLEJE PAŃSTWOWE Spółka Akcyjna
ProRail
SIEMENS
SNCF
Strukton Rail
THALES Together • Safer • Everywhere
RAILWAY SYSTEMS by voestalpine
TRAFIKVERKET

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