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European Institutionalised Rail Partnership – Europe's Rail Joint Undertaking

Abstract: European partnerships are a key tool to support development and implementation of strategic research and innovation agendas. In the current financial perspective, partnerships are divided into three types: institutional, co-programmed and co-financed, depending on how they function. The article presents the principles and possibilities of obtaining funds for railway development from the EU perspective within the framework of the institutionalized European partnership: Europe's Rail Joint Undertaking. The status of a founding member was granted to PKP S.A., which formed a consortium of entities constituting a research and development ecosystem jointly carrying out research and innovation works in the field of railway. One of the entities of this ecosystem is the Railway Research Institute, which is currently implementing two projects: "Sustainable and green railway system" - *Rail4Earth* and "Delivering innovative rail services to revitalise capillary lines and regional rail services" - *FutuRe.*

Keywords: European rail partnership; Europe's Rail Joint Undertaking; Railway research and innovation; Research funding; Transport policy

Introduction

In 2020, the European Commission (EC) outlined its vision for the future of transport and mobility in Europe by adopting the "Sustainable and Smart Mobility Strategy" [2]. To help Europe become the world's first climate-neutral continent, the strategy calls for a 90% reduction in greenhouse gas emissions from transport by 2050 [1].

The primary objectives for mobility in Europe focus on making the transport system more sustainable, intelligent, and resilient to change and crises. The intermediate goals are set with key milestones for 2030, 2035, and 2050 and include:

- Zero-emission vehicles,
- Automated mobility,
- Expansion of high-speed rail traffic and rail freight transport,
- Creation of a comprehensive multimodal trans-European transport network.

Support for the transport sector is provided through reforms, policy strategies, and initiatives, which include legislative measures as well as non-legislative actions, such as research and innovation programs.

In the European Union (EU), stable and long-term funding for research and innovation (R&I) projects is provided through Framework Programs. The current framework program is Horizon Europe (HEU), covering the period 2021–2027, with the largest research and innovation budget in EU history—€95.5 billion [3].

A key tool within Horizon Europe for implementing the EU's political priorities is European partnerships. These partnerships bring together the European Commission (EC) and private and/or public partners to address Europe's most pressing challenges [4]. By integrating private and public entities, partnerships aim to avoid duplication of investments and reduce fragmentation in the EU research and innovation landscape.

Partnership participants may include:

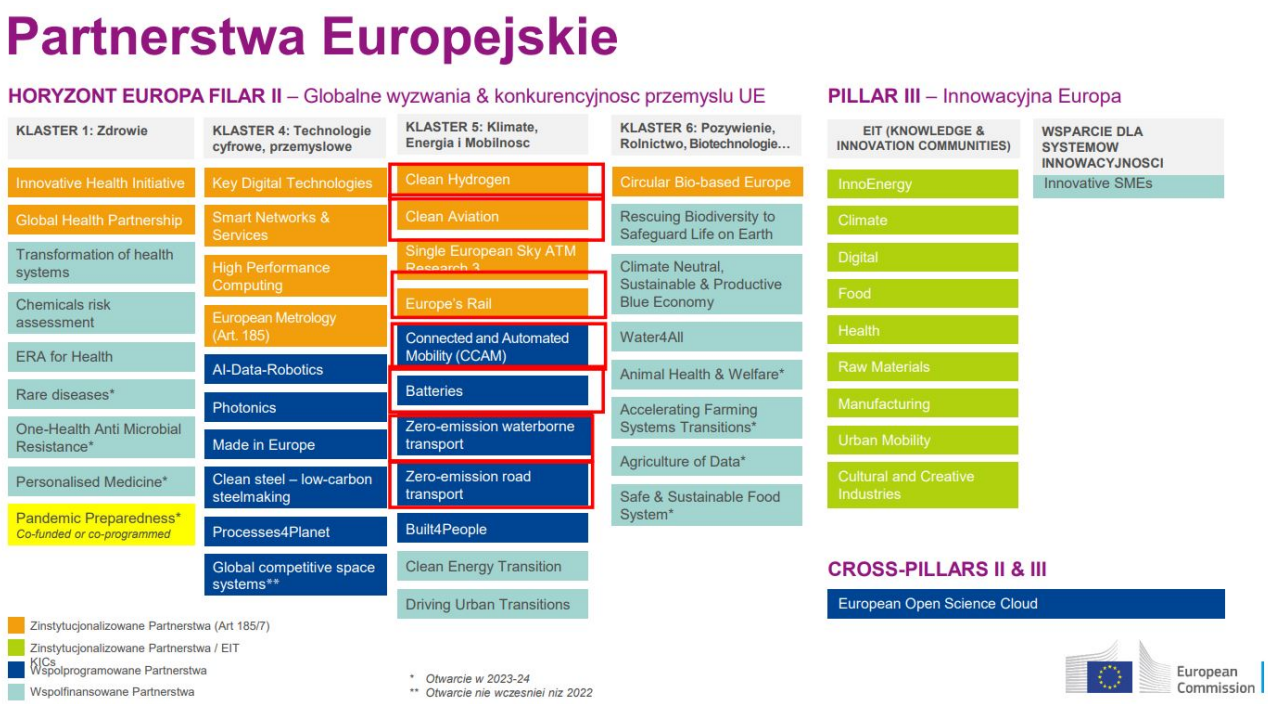
- Industry representatives,

- Universities,
- Research institutions,
- Small and large enterprises,
- Foundations and associations,
- Public administration authorities.

European partnerships are grouped into the following main thematic areas, which also represent the thematic clusters of Horizon Europe:

- Health,
- Digital technologies, industry, and space,
- Climate, energy, and mobility,
- Food, bioeconomy, natural resources, agriculture, and environment.

The wide range of European partnerships within different thematic areas of Horizon Europe is illustrated in Figure **1.**



1. Overview of European Partnerships in Horizon Europe.
Source: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021SC0035&rid=5

Types of Partnerships

European partnerships are categorized into three types based on their mode of operation [7]:

- Co-funded European Partnerships – These are public-public partnerships between the European Commission (EC) and national research funding agencies from EU Member States or associated countries. The partnership's budget consists of financial contributions from both the EC and national funding agencies. Open calls for proposals are launched from this joint budget, but participation is limited to stakeholders from countries whose funding agencies are part of the partnership.
- Co-programmed European Partnerships – These are public-private partnerships between the EC and industry associations in specific fields. Only members of the participating industry association can influence the topics of funding calls. However, participation in these calls is open to all legal entities, including those not affiliated with the partnership.

- Institutionalized European Partnerships – These public-private partnerships are established by a decision of the European Council and the European Parliament. Their budget consists of financial contributions from both the EC and private sector partners. Funding calls are open to all interested entities, while the partnership members develop and approve the research agenda.

Transport Partnerships under Horizon Europe

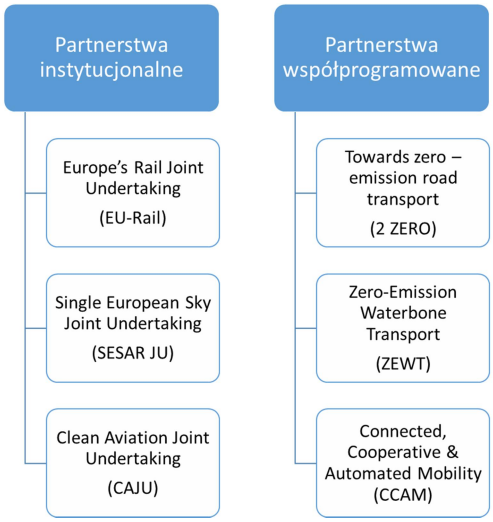
Under Horizon Europe (HEU), six transport-related partnerships have been established, as illustrated in Figure **2**.

Institutionalized Transport Partnerships:

- Europe's Rail Joint Undertaking (EU-Rail) – Established to drive research and innovation in the rail sector.
- Single European Sky Joint Undertaking (SESAR JU) – Focused on developing technological solutions for implementing a digital European airspace that will manage conventional aircraft, drones, and air taxis.
- Clean Aviation Joint Undertaking (CAJU) – Aimed at ensuring the long-term competitiveness of the European aviation industry through sustainable innovation.

Co-programmed Transport Partnerships:

- Towards Zero-Emission Road Transport (2ZERO) – Aims to accelerate the transition to zero-emission road mobility across Europe.
- Zero-Emission Waterborne Transport (ZEWT) – Focused on developing and testing zero-emission solutions for all types of waterborne transport (both inland and maritime).
- Connected, Cooperative & Automated Mobility (CCAM) – Designed to coordinate European research and innovation efforts to accelerate the deployment of innovative automated mobility technologies and services. Its goal is to establish Europe as a leader in safe and sustainable automated road transport.



2. Types of transport partnerships in HEU

Source: own study based on: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/climate-energy-and-mobility_en

European Railway Partnerships

In 2014, for the first time in the history of EU Framework Programs, a public-private partnership entirely dedicated to rail transport was established—Shift2Rail Joint Undertaking (Shift2Rail) [5].

Between 2014 and 2020, the EU allocated €450 million for rail research and innovation, while an additional €470 million came from private sector entities, which co-founded the partnership alongside the EU.

Shift2Rail focused on large-scale, well-coordinated research, development, and innovation projects, aimed at adapting rail transport to 21st-century challenges.

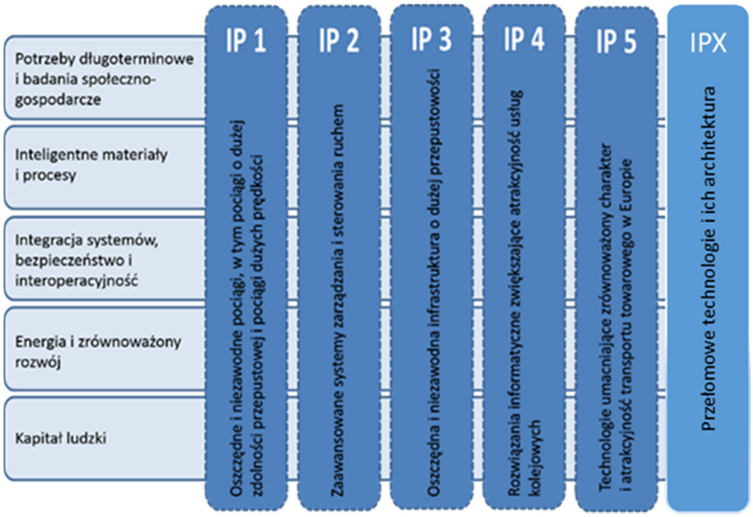
Key Research Areas of Shift2Rail

The scope of Shift2Rail was divided into six main thematic areas, known as "Innovation Programs" (IP) [8, 9]:

1. IP1 – Passenger Rolling Stock: Research and development of modern, efficient, and comfortable passenger trains.
2. IP2 – Traffic Management: Advanced rail traffic control and automation systems.
3. IP3 – Railway Infrastructure: Enhancing railway tracks, stations, and network resilience.
4. IP4 – IT Solutions for Rail Services: Development of digital platforms for railway operations and passenger services.
5. IP5 – Freight Transport: Innovations in rail freight logistics and operations.
6. IPX – Disruptive Technologies: Research on next-generation technologies with the potential to revolutionize rail transport.

Alongside these Innovation Programs (IP), additional cross-cutting areas and topics were included to address issues relevant to all projects and facilitate synergies between different IPs.

The thematic areas of Shift2Rail are illustrated in Figure **3**.



3. Innovation Programs and Cross-cutting Issues Shift2Rail
Source: own study, based on: Wieloletni Plan Pracy Shift2Rail dostępny na http://shift2rail.org/wp-content/uploads/2013/07/MAAP-5nal_5nal.pdf

Continuation of Shift2Rail: EU-Rail

In the current financial perspective under Horizon Europe (HEU), Shift2Rail has been succeeded by Europe's Rail Joint Undertaking (EU-Rail). This public-private partnership officially commenced operations on December 1, 2021, with an estimated total budget of €1.2 billion over its 10-year duration [4].

The primary goal of EU-Rail is to accelerate research and development in innovative rail technologies and operational solutions, ultimately leading to the creation of a highly efficient, flexible, sustainable, reliable, and integrated European railway network for both passenger and freight transport.

Objectives of EU-Rail

The partnership aims to:

- Adapt to evolving customer needs,
- Increase transport system efficiency and rail network capacity,
- Reduce railway maintenance and operational costs,
- Promote more sustainable transport solutions,
- Ensure a harmonized approach to industry adaptation,
- Strengthen the role of rail in European transport and travel,
- Enhance the competitiveness of European railway manufacturers and suppliers [6].

Characteristics of Europe's Rail Joint Undertaking

EU-Rail focuses on digital innovation and automation, driving a radical transformation of the railway system that is crucial for achieving the goals of the European Green Deal. By enhancing competitiveness, it aims to support Europe's leadership in railway technology.

On the public side, the European Union (EU), represented by the European Commission (EC), is a core member. On the private side, leading European railway companies, manufacturers, and service providers act as founding members of the initiative.

A total of 25 founding members of EU-Rail have been identified and are presented in Figure **4**.

4. EU-Rail members other than the EU
Source: own study based on: https://rail-research.europa.eu/about-europes-rail/europes-rail-ju-members/

Affiliated Entities in EU-Rail

Each of the 25 founding members of EU-Rail serves as a leader for affiliated entities—third-party organizations linked to beneficiaries as defined by Article 187 of the EU Financial Regulation 2018/1046 [4].

These affiliated entities participate in the EU-Rail partnership under similar rights and obligations as direct beneficiaries. This includes:

- Obligation to carry out tasks within the project,
- Right to allocate costs and request financial contributions.

As part of their participation in EU-Rail, the founding members, on behalf of themselves and their affiliated entities, confirmed their commitment to financial contributions. The funding level for research and innovation (R&I) activities under the partnership covers 60% of eligible costs.

Flagship Areas of Europe's Rail Joint Undertaking

The research and innovation activities within EU-Rail are categorized into seven key Flagship Areas (FA), along with cross-cutting actions, as illustrated in Figure **5**.

5. Europe's Rail JU flagship areas
Source: own study based on: https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf [dostęp: 06.04.2023]

According to the assumptions of the Multiannual Action Plan, projects implemented under EU-Rail should contribute to the development of the entire railway system and ensure interoperability and standardization of adopted solutions [6, 10]. The flagship areas indicate the main directions for the implementation of research, innovation, and deployment tasks in the railway sector in the coming years. The most important of these include: efficiency in railway traffic management, including cross-border operations; punctuality and optimization of railway traffic; digital train communication systems; automation of train control; efficiency in the operation of low-traffic lines; development of diagnostic and monitoring systems for the technical condition of infrastructure objects and vehicles; optimization of energy supply for traction and non-traction systems; possibilities for using hydrogen to power traction vehicles, as well as battery-powered traction units equipped with energy storage; systems for automating shunting processes, including automatic coupling of vehicles and train formation; automatic coupler constructions (DAC), automated brake testing systems, and technical condition monitoring of wagons.

Participation of the Polish side in Europe's Rail JU

Polish State Railways S.A. (PKP) has obtained the status of Founding Member of EU-Rail JU. In 2022, PKP established a consortium of entities, known as a research and development ecosystem, that declared their willingness to undertake joint activities within international research and development projects of the "Horizon Europe" program. This ecosystem includes both entities providing transport-related services, companies cooperating with the railway sector, and scientific institutions from across the country. The established research and development environment provides a unique opportunity for each participant to achieve their objectives. Through activities in EU-Rail, they can develop innovations and modern technological solutions, gaining experience and knowledge from partners across Europe. It is also an opportunity to promote Polish technical thought and showcase the capabilities and potential of Polish science on the international stage. The ecosystem around PKP S.A. includes the following entities collaborating within EU-Rail:

- AGH University of Science and Technology
- Central Communication Port sp. z o.o.
- Infrabyte sp. z o.o.
- Road and Bridge Research Institute (POLTRIN network)
- Electrotechnical Institute (Łukasiewicz Research Network)
- Railway Institute (POLTRIN network)
- Institute of Mechanized Construction and Rock Mining (Łukasiewicz Research Network)
- Institute of Innovative Technologies EMAG (Łukasiewicz Research Network)
- Łódź Metropolitan Railway sp. z o.o.
- Ignacy Mościcki State Vocational University in Ciechanów
- PKP Energetyka S.A.
- PKP Informatyka sp. z o.o.
- Poznan University of Technology
- Poznań Institute of Technology (Łukasiewicz Research Network)
- International Union of Railways (UIC)
- Jarosław Dąbrowski Military University of Technology in Warsaw.

Entities from the ecosystem were involved in developing assumptions for the scope of work planned in flagship areas during the preparation of the Multiannual Work Plan in the third and fourth quarters of 2021. On March 10, 2022, the European Commission announced the first call under Europe's Rail, where PKP represented the entire ecosystem by participating in discussions and coordinating activities from a formal standpoint. The competition was open to all stakeholders and was not limited to founding members.

Participation of the Railway Institute in Europe's Rail projects

In the first EU-Rail partnership competition, the Railway Institute (IK), as an affiliated entity of PKP, joined the implementation of two flagship projects (FP):

- FP4 – Sustainable and Green Rail Systems, given the acronym Rail4Earth
- FP6 – Delivering Innovative Rail Services to Revitalize Capillary Lines and Regional Rail Services, under the acronym FutuRe.

The FP4 project is being implemented from December 1, 2022, to November 30, 2026. The project activities focus on pro-ecological solutions at railway stations, the development of modular construction, and the use of circular economy principles. A crucial aspect developed under FA4 is the design and application of digital representation of station buildings in a virtual environment. Additionally, FA4 includes work on holistic energy management solutions for both traction power supply and station buildings, as well as

developing a universal hydrogen refueling interface with appropriate safety standards and the shortest possible refueling time.

IK participates in tasks related to hydrogen refueling stations, including safety analyses for hydrogen-powered rolling stock refueling stations, hydrogen storage, hydrogen refueling station operations, and the refueling process itself. IK is also involved in energy-related aspects, such as analyzing the impact of renewable energy sources (RES) on power quality and reliability, selecting optimal power supply system parameters based on substation load characteristics and climatic conditions, and determining energy storage system parameters for RES-based power supply systems.

The FA6 project is being implemented from December 1, 2022, to November 30, 2026. The overall goal of the project is to ensure the long-term profitability of regional railways by reducing total maintenance and operational costs while offering high-quality services and operational safety. The project tasks include developing a tool to ensure interoperability and coherence between railways and urban environments through the Smart Transit Oriented Development (STOD) model, leveraging station and surrounding area service correlations to enhance the attractiveness of small stations on regional lines, increasing railway transport attractiveness by integrating last-mile transport services with railway stations on regional lines, and defining requirements for a lightweight rail vehicle for passenger transport on non-electrified low-traffic lines.

The activities undertaken by PKP, along with entities from the research and development ecosystem in the FutuRe flagship project, primarily focus on analyzing and developing a model for transport services tailored to small railway stations located on capillary lines, as well as providing additional services related to local transport. Moreover, thanks to the involvement of IK, it is possible to participate in the initial technical requirements for a lightweight rail vehicle with small capacity, intended for servicing non-electrified regional railway lines.

Summary

To enhance the effectiveness of financing research and innovation activities by pursuing clearly defined goals, the EU has launched European partnerships, which are categorized into three types based on their operational mode: institutional partnerships, co-programmed partnerships, and co-funded partnerships. Participation in European partnerships provides the opportunity to address socially significant issues while benefiting from additional funding and the expertise of international partners. Being part of EU partnerships increases visibility, which can lead to long-term collaboration with other entities and offers a unique chance to influence the definition of competition topics announced within the partnerships. On the other hand, it requires the payment of a membership fee and often involves significant own contributions toward achieving the partnership's objectives.

The EU-Rail public-private partnership, established in 2022, aims to strengthen the position of rail transport in Europe and improve the quality of services provided. It continues the work of Shift2Rail from Horizon 2020. Due to the high required own contributions for achieving EU-Rail's objectives, obtaining founding member status was challenging for individual stakeholders. Sixteen entities from Poland, led by PKP S.A., created a research and development ecosystem to jointly apply for participation in research and innovation activities within the European institutional rail partnership under Horizon Europe (HEU). EU-Rail's scope of work covers various aspects related to passenger and freight transport, as well as services supporting rail transport operations. All these efforts are aimed at ensuring rail interoperability and supporting the harmonization and standardization of developed solutions.
As a result of the first EU-Rail competition, the Railway Institute secured two EU projects: the Rail4Earth project under FA4 and the FutuRe project under FA6. Since December 2022,

the Railway Institute has been implementing both projects as an associated entity of PKP S.A. In the Rail4Earth project, the Institute is engaged in safety analyses for hydrogen-powered rolling stock refueling stations, including hydrogen storage, hydrogen refueling station loading, and the refueling process itself. Additionally, the Institute is involved in the project's energy management segment, focusing on improving energy management, increasing energy flexibility, and enhancing the resilience of smart electrical grids.

In the FutuRe project, the Railway Institute contributes to defining functional requirements for a lightweight rail vehicle for secondary lines, developing design guidelines based on transport demand, and establishing principles for cost reduction and increased efficiency in the maintenance and operation of regional lines. The projects are scheduled to be completed by the end of November 2026.

Source materials

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