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IMPACT ASSESSMENT REPORT

Accompanying the document

**Proposal for a COUNCIL REGULATION establishing the Joint Undertakings under
Horizon Europe**

European Partnership for Transforming Europe's Rail System

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Glossary

<i>Term or acronym</i>	<i>Meaning or definition</i>
ATO	Automatic Train Operation
CEF	Connecting Europe Facility
CF	Cohesion Fund
DEP	Digital Europe Programme
EIT	European Institute of Innovation & Technology
ERA	European Union Agency for Railways
ERDF	European Regional Development Fund
ERRAC	European Rail Research Advisory Council
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FP	Framework Programme
GDP	Gross Domestic Product
IM	Infrastructure Manager
IP	Innovation Programme
JU	Joint Undertaking
KIC	Knowledge and Innovation Community
KPI	Key Performance Indicator
MAAP	Multi Annual Action Plan
MaaS	Mobility as a Service
OEM	Original Equipment Manufacturer
PRM	Person with Reduced Mobility

R&I	Research and Innovation
RSI	Rail Supply Industry
RU	Railway Undertaking
SDGs	United Nations Sustainable Development Goals
SERA	Single European Rail Area
SME	Small and Medium sized Enterprise
SRIA	Strategic Research and Innovation Agenda
S2R	Shift2Rail
TEN-T	Trans-European Transport Network
TRL	Technology Readiness Level
TFEU	Treaty on the Functioning of the European Union
TSI	Technical Specifications for Interoperability
UIC	International Union of Railways (Union Internationale des Chemins de Fer)

PART 1 - COMMON FOR ALL CANDIDATE INSTITUTIONALISED EUROPEAN PARTNERSHIPS

1. BACKGROUND AND CONTEXT TO EUROPEAN PARTNERSHIPS IN HORIZON EUROPE AND FOCUS OF THE IMPACT ASSESSMENT– WHAT IS DECIDED

[Note that the part dedicated to the Partnership on Transforming Europe’s rail system starts on page 26.]

1.1. Focus and objectives of the impact assessment

This impact assessment accompanies the Commission proposal for Institutionalised European Partnerships to be funded under Horizon Europe, the 2021-2027 Framework Programme for EU Research and Innovation (R&I).¹ It sets out to **help decide in a coordinated manner the right form of implementation for specific candidate initiatives** based on a common approach and methodology to individual assessments². It also provides an **horizontal perspective on the portfolio of candidate European Partnerships** to identify further efficiency and coherence gains for more impact.

European Partnerships are initiatives where the Union, together with private and/or public partners (such as industry, public bodies or foundations) commit to support jointly the development and implementation of an integrated programme of R&I activities. The rationale for establishing such initiatives is to achieve the objectives of Horizon Europe more effectively than what can be attained by other activities of the programme.³

Based on the Horizon Europe Regulation, European Partnerships may be set up using **three different forms**: “Co-funded”, “Co-programmed” and “Institutionalised”. The setting-up of **Institutionalised Partnerships** involves new EU legislation and the establishment of dedicated implementing structures based on Article 185 or 187 of the Treaty on the Functioning of the EU (TFEU). This requires an impact assessment to be performed.

The Horizon Europe Regulation defines **eight priority areas**, scoping the domains in which Institutionalised Partnerships could be proposed⁴. Across these priority areas, **13 initiatives** have been identified **as suitable candidate initiatives** for Institutionalised Partnerships because of their objectives and scope. This impact assessment aims to identify whether 12 of these initiatives⁵ need to be implemented through this form of implementation and would not deliver equally well with traditional calls of Horizon Europe or other lighter forms of European Partnerships under Horizon Europe. This means assessing whether each of these initiatives meets the necessity test set in the **selection criteria** for European Partnerships in the Horizon Europe Regulation, Annex III.

¹ Horizon Europe Regulation (common understanding), <https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf>

² Based on the European Commission Better Regulation framework (SWD (2017) 350) and supported by an external study coordinated by Technopolis Group (to be published in 2020).

³ For further details on these points, see below Section 1.2.2.

⁴ Set out in the Annex Va of the Horizon Europe Regulation (common understanding). <https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf>

⁵ Only 12 are subject to this impact assessment, as one initiative on High Performance Computing has already been subject to an impact assessment in 2017 (SEC(2018) 47).

This assessment is done **without any budgetary consideration**, as the overall budget of the Multiannual Financial Framework of the EU – and hence of Horizon Europe – for the next financing period is not known at this stage.⁶

1.2. The political and legal context

1.2.1. Shift in EU priorities and Horizon Europe framework

European priorities have evolved in the last decades, and reflect the social, economic, and environmental challenges for the EU in the face of global developments. In her Political Guidelines for the new European Commission 2019 – 2024⁷, the new Commission President put forward six overarching priorities, which reach well beyond 2024 in scope⁸. Together with the Sustainable Development Goals (SDGs), these priorities will shape future EU policy responses to the challenges Europe faces, and thus also give direction to EU research and innovation.

As part of the Multi-annual Financial Framework (MFF) 2021-27 the new EU Framework Programme for Research and Innovation **Horizon Europe will play a pivotal role for Europe to lead the social, economic, and environmental transitions needed to achieve these European policy priorities**. It will be more impact driven with a strong focus on delivering European added value, but also be more effective and efficient in its implementation.⁹ Horizon Europe finds its rationale in the daunting challenges that the EU is facing, which call for “*a radical new approach to developing and deploying new technologies and innovative solutions for citizens and the planet on a scale and at a speed never achieved before, and to adapting our policy and economic framework to turn global threats into new opportunities for our society and economy, citizens and businesses.*” While Horizon Europe continues the efforts of strengthening the scientific and technological bases of the Union and foster competitiveness, a more strategic and impact-based approach to EU R&I investment is taken. Consequently, the **objectives of Horizon Europe** highlight the need *to deliver on the Union strategic priorities and contribute to the realisation of EU objectives and policies, contribute to tackling global challenges, including the Sustainable Development Goals by following the principles of the Agenda 2030 and the Paris Agreement.*¹⁰

In this context, **at least 35 % of the expenditure from actions under the Horizon Europe Programme will have to contribute to climate action**. Furthermore, a **Strategic Plan** is co-designed with stakeholders to identify **key strategic orientations for R&I support** for 2021-2024 in line with the EU priorities. In the Orientations towards the first Strategic Plan

⁶ EU budget commitments to the European Partnership candidates can only be discussed and decided following the political agreement on the overall Multiannual Financial Framework and Horizon Europe budgetary envelopes. The level of EU contribution for individual partnerships should be determined once there are agreed objectives, and clear commitments from partners. Importantly, there is a ceiling to the partnership budgets in Pillar II of Horizon Europe (the legal proposal specifies that *the majority of the budget in pillar II shall be allocated to actions outside of European Partnerships*).

⁷ https://ec.europa.eu/info/strategy/priorities-2019-2024_en

⁸ 1.A European Green Deal; An economy that works for people; A Europe fit for the Digital Age; Promoting our European way of life; A Stronger Europe in the World; and 6.A New push for European Democracy

⁹ EC (2018) *A Modern Budget for a Union that Protects, Empowers and Defends. The Multiannual Financial Framework for 2021-2027*. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2018) 321 final

¹⁰ Article 3, Common understanding regarding the proposal for Horizon Europe Framework Programme.

for Horizon Europe, the need to strategically prioritise and “*direct a substantial part of the funds towards the areas where we believe they will matter the most*” is emphasised. The Orientations specify, that actions under Pillar II of Horizon Europe “Global Challenges and European Industrial Competitiveness” will target only selected themes of especially high impact that significantly contribute to delivering on the political priorities of the Union. Most of the candidate European Partnerships fall under this Pillar.

1.2.2. *Key evolutions in the approach to partnerships in Horizon Europe*

Since their start in 1984 the successive set of Framework Programmes uses a variety of instruments and approaches to support R&I activities, address global challenges and industrial competitiveness. Collaborative, competition-based and excellence-driven R&I projects funded through Work Programmes are the most traditional and long-standing approach for implementation. Since 2002, available tools also include **partnerships**, whereby the Union together with private and/or public partners commit to jointly support the development and implementation of a R&I programme. These were introduced as part of creating the European Research Area (ERA) to align national strategies and overcome fragmentation of research effort towards an increased scientific, managerial and financial integration of European research and innovation. Interoperable and integrated national research systems would allow for better flows of knowledge, technology and people. Since then, the core activities of the partnerships consist of building critical mass mainly through collaborative projects, jointly developing visions, and setting strategic agendas.

As analysed in the **interim evaluation of Horizon 2020**¹¹, a considerable repertoire of partnership initiatives have been introduced over time, with 8 forms of implementation¹² and close to 120 partnership initiatives running under Horizon 2020 - without clear exit strategies and concerns about their degree of coherence, openness and transparency. Even if it is recognised that these initiatives allow setting long-term agendas, structuring R&I cooperation between otherwise dispersed actors, and leveraging additional investments, the evaluation points to the complexity generated by the proliferation of instruments and initiatives, and their insufficient contribution to policies at EU and national level.

¹¹ Interim evaluation of Horizon 2020, Commission Staff Working Document, SWD(2017)221 and 222

Interim evaluation of the Joint Undertakings operating under Horizon 2020 (Commission Staff Working Document, SWD(2017) 339); Evaluation of the Participation of the EU in research and development programmes undertaken by several Member States based on Article 185 of the TFEU, Commission Staff Working Document, SWD (2017)340)

¹² E.g. initiatives based on Article 187 (Joint Technology Initiatives), Article 185 TFEU, Contractual Public-Private Partnerships (cPPPs), Knowledge & Innovation Communities of the European Institute of Innovation & Technology (EIT-KICs), ERA-NETs, European Joint Programmes, and Joint Programming Initiatives.

Box 1 Key lessons from the interim evaluation of Horizon 2020 and R&I partnerships

- The **Horizon 2020 Interim Evaluation** concludes that the overall partnership landscape has become overly complex and fragmented. It identifies the need for rationalisation, improve their openness and transparency, and link them with future EU R&I missions and strategic priorities.

- The **Article 185 evaluation** finds that these public-public partnerships have scientific quality, global visibility and networking/structuring effects, but should in the future focus more on the achievement of policy impacts. From a systemic point of view, it found that the EU public-to-public cooperation (P2P) landscape has become crowded, with insufficient coherence.

- The **Article 187 evaluation** points out that Public-Private Partnership (PPP) activities need to be brought more in line with EU, national and regional policies, and calls for a revision of the Key Performance Indicators. As regards the **contractual PPPs (cPPPs)** their reviews identified challenges of coherence among cPPPs and the need to develop collaborations and synergies with other relevant initiatives and programmes at EU, national and regional level.

Over 80% of respondents to the Open Public Consultation (OPC) indicated that a significant contribution by future European Partnerships is 'fully needed' to achieve climate-related goals, to develop and effectively deploy technology, and for EU global competitiveness in specific sectors/domains. Views converged across all categories of respondents, including citizens, industry and academia.

The impact assessment of Horizon Europe identifies therefore the need to **rationalise the EU R&I funding landscape**, in particular with respect to partnerships, as well as to **re-orient partnerships towards more impact** and delivery on EU priorities. To address these concerns and to realise the higher ambition for European investments, Horizon Europe puts forward **a major simplification and reform for the Commission's policy on R&I partnerships**¹³. Reflecting its pronounced systemic nature aimed at contributing to EU-wide 'transformations' towards the sustainability objectives, Horizon Europe indeed intends to make a more effective use of these partnerships with a **more strategic, coherent and impact-driven approach**. Key related changes that apply to all forms of European Partnerships encapsulated in Horizon Regulation are summarised in the Box below.

¹³ Impact assessment of Horizon Europe, Commission Staff Working Document, SWD(2018)307.

Box 2 Key features of the revised policy approach to R&I partnerships under Horizon Europe based on its impact assessment

- ✓ **Simpler architecture & toolbox** by streamlining 8 partnership instruments into 3 implementation forms (Co-Funded, Co-Programmed, Institutionalised), under the umbrella ‘European Partnerships’
- ✓ **More systematic and transparent approach** to selecting, implementing, monitoring, evaluating and phasing out all forms of partnerships (**criteria** for European Partnerships):
 - The selection of Partnerships is embedded in the strategic planning of Horizon Europe, thereby ensuring coherence with the EU priorities. The selection criteria require that partnerships are established with stronger ex-ante commitment and higher ambition.
 - The implementation criteria stipulate that initiatives adopt a systemic approach in achieving impacts, including broad engagement of stakeholders in agenda-setting and synergies with other relevant initiatives to promote the take-up of R&I results.
 - A harmonised monitoring & evaluation system will be implemented, and ensures that progress is analysed in the wider context of achieving Horizon Europe objectives and EU priorities.
 - All partnerships need to develop an exit strategy from Framework Programme funding. This new approach is underpinned by principles of openness, coherence and EU added value.
- ✓ **Reinforced impact orientation:**
 - Partnerships are established only if there is evidence they support achieving EU policy objectives more effectively than other Horizon Europe actions, by demonstrating a clear vision and targets (**directionality**) and corresponding long-term commitments from partners (**additionality**).
 - European Partnerships are expected to provide mechanisms – based on a concrete roadmap - to join up R&I efforts between a broad range of actors towards the development and uptake of innovative solutions in line with EU priorities, serving the economy and society, as well as scientific progress.
 - They are expected to develop close synergies with national and regional initiatives, acting as dynamic change agents, strengthening linkages within their respective ecosystems and along the value chains, as well as pooling resources and efforts towards the common EU objectives.

Under Horizon Europe, a ‘European Partnership’¹⁴ is defined as “*an initiative where the Union, prepared with early involvement of Member States and/or Associated Countries, together with private and/or public partners (such as industry, universities, research organisations, bodies with a public service mission at local, regional, national or international level or civil society organisations including foundations and NGOs), commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake.*”

The Regulation further specifies that European Partnerships shall adhere to the “*principles of Union added value, transparency, openness, impact within and for Europe, strong leverage effect on sufficient scale, long-term commitments of all the involved parties, flexibility in implementation, coherence, coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions.*”

1.3. Why should the EU act

1.3.1. Legal basis

Proposals for Institutionalised European Partnerships are based on:

- 1) Article 185 TFEU which allows the Union to make provision, in agreement with the Member States concerned, for participation in research and development

¹⁴ Article 8 and Annex III of the Horizon Europe Regulation (common understanding)

programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes; or

- 2) Article 187 TFEU according to which the Union may set up joint undertakings or any other structure necessary for the efficient execution of Union research, technological development and demonstration programmes.¹⁵

1.3.2. *Subsidiarity*

The EU should act only in areas where there is demonstrable advantage that the action at EU level is more effective than action taken at national, regional or local level. Research is a shared competence between the EU and its Member States according to the TFEU. Article 4 (3) specifies that in the areas of research, technological development and space, the EU can carry out specific activities, including defining and implementing programmes, without prejudice to the Member States' freedom to act in the same areas. The candidate initiatives focus on areas where there is a demonstrable value added in acting at the EU level due to the scale, speed and scope of the efforts needed for the EU to meet its long-term Treaty objectives and deliver on its strategic policy priorities and commitments. In addition, the proposed initiatives should be seen as complementary and reinforcing national and sub-national activities in the same area. Overall European Partnerships find their **rationale in addressing a set of systemic failures**¹⁶:

- Their primary function is to create a platform for a strengthened **collaboration** and knowledge exchange between various actors in the European R&I system and an enhanced **coordination** of strategic research agendas and/or R&I funding programmes. They aim to address **transformational failures** to better align agendas and policies of public and private funders, pool available resources, create critical mass, avoid unnecessary duplication of efforts, and leverage sufficiently large investments where needed but hardly achievable by single countries.
- The concentration of efforts and pooling of knowledge on common priorities to solve multi-faceted societal and economic challenges is at the core of these initiatives. Specifically, enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems are among the key objectives of these instruments. In the light of Horizon Europe, the aim is to **drive system transitions and transformations towards EU priorities**.
- Especially in fast-growing technologies and sectors such as ICT, there is a need to **react to emerging opportunities** and address systemic failures such as shortage in skills or critical mass or cross-sectoral cooperation along the value chains that would hamper attainment of future European leadership and/or strategic autonomy.
- They also aim to address **market failures** predominantly to enhancing industry investments thanks to the sharing of risks.

2. THE CANDIDATE EUROPEAN PARTNERSHIPS – WHAT NEEDS TO BE DECIDED

2.1. Portfolio of candidates for Institutionalised European Partnerships

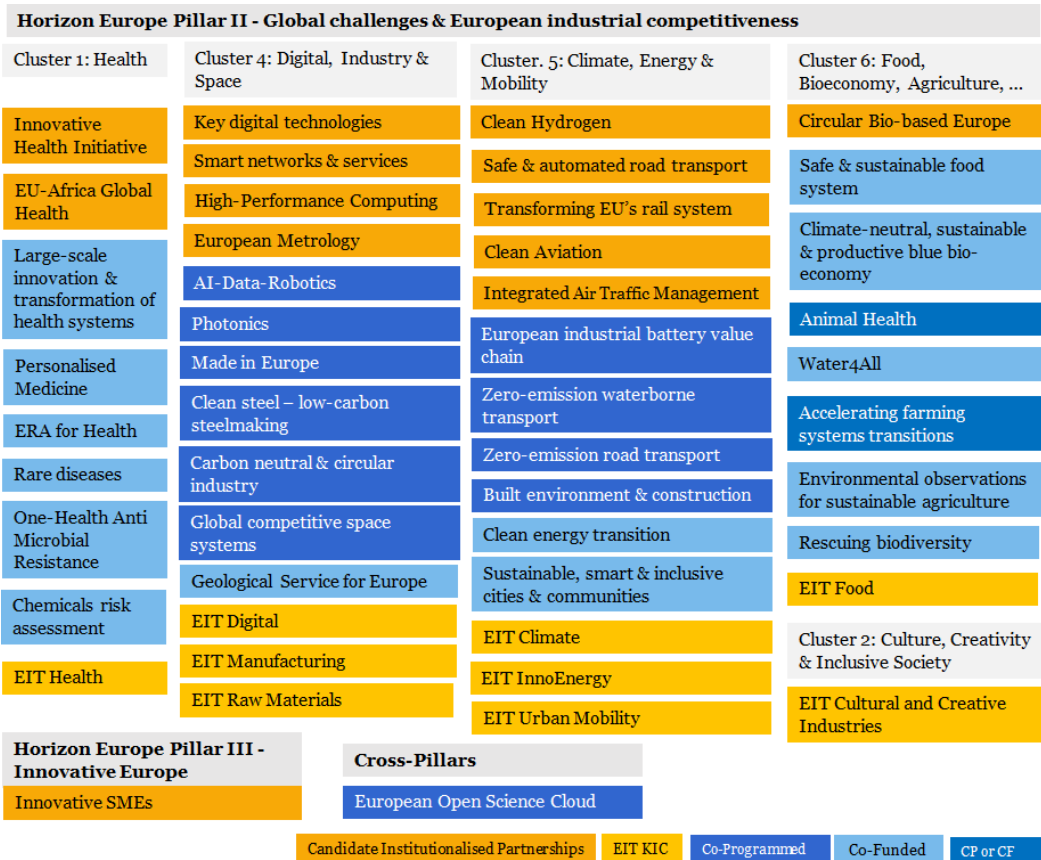
The new approach for more objective-driven and impactful European Partnerships is reflected in the way candidate Partnerships have been identified. It involved a co-design

¹⁵ Both Articles are under Title XIX of the TFEU - Research and Technological Development and Space.

¹⁶ The Interim Evaluation of Horizon 2020 and the impact assessment of Horizon Europe provide qualitative and quantitative evidence on these points. Sections 1 and 2 of each impact assessment on candidate European Partnerships include more detail on the necessity to act at EU level in specific thematic areas.

exercise aiming to better align these initiatives with societal needs and policy priorities, while broadening the range of actors involved. Taking into account the 8 areas for Institutionalised European Partnerships set out in the Horizon Europe Regulation¹⁷, a co-design exercise as part of the Strategic Planning process of Horizon Europe lead to the identification of **49 candidates for Co-funded, Co-programmed or Institutionalised European Partnerships**¹⁸. Out of these, **13 were identified as suitable candidate Institutionalised Partnerships because of their objectives and scope**¹⁹. Whilst the Co-Funded and Co-Programmed Partnerships are linked to the comitology procedure (including the adoption of the Strategic Plan and the Horizon Europe Work Programmes), Institutionalised Partnerships require the adoption of legislation and are subject to an impact assessment. The Figure below gives an overview of all candidate European Partnerships according to their primary relevance to Commission priorities for 2019-2024.

Figure 1 - Overview of the candidates for Co-Funded, Co-Programmed and Institutionalised European Partnerships according to Horizon Europe structure



Source: Technopolis group (2020)

There are only three partnerships for which implementation as an Institutionalised Partnership under Article 185 is an option, i.e. European Metrology, the EU-Africa Global Health partnership, and Innovative SMEs. Ten partnerships are candidates for

¹⁷ Horizon Europe Regulation (common understanding), Annex Va.
¹⁸ Shadow configuration of Strategic Programme Committee for Horizon Europe. The list of candidate European Partnerships is described in “Orientations towards the Strategic Plan of Horizon Europe” - Annex 7
¹⁹ Only 12 are subject to this impact assessment, as one initiative on High Performance Computing has already been subject to an impact assessment in 2017 (SEC(2018) 47)

Institutionalised Partnerships under Article 187. Overall the initiatives can be categorised into ‘*horizontal*’ partnerships and ‘*vertical*’ partnerships.

The ‘**horizontal**’ partnerships have a central position in the overall portfolio, as they are expected to develop methodologies and technologies for application in the other priority areas, ultimately supporting European strategic autonomy in these areas as well as technological sovereignty. These ‘horizontal’ partnerships are typically proposed as Institutionalised or Co-programmed Partnerships, in addition to a number of EIT KICs, they cover mainly the digital field in addition to space, creative industries and manufacturing, but also the initiative related to Innovative SMEs. ‘**Vertical**’ partnerships are focused on the needs and development of specific application areas, and are primarily expected to support enhanced environmental sustainability thereby addressing Green Deal related objectives. They also deliver on policies for more people centred economy, through improved wellbeing of EU citizen and the economy, like health related candidate European Partnerships.

2.2. Assessing the necessity of a European Partnership and possible options for implementation

Horizon Europe Regulation Article 8 stipulates that Institutionalised European Partnerships based on Article 185 and 187 TFEU *shall be implemented only where other parts of the Horizon Europe programme, including other forms of European Partnerships would not achieve the objectives or would not generate the necessary expected impacts, and if justified by a long-term perspective and high degree of integration.* At the core of this impact assessment is therefore the need to demonstrate that the impacts generated through a Partnership approach go beyond what could be achieved with traditional calls under the Framework Programme – the Baseline Option. Secondly, it needs to assess if using the Institutionalised form of a Partnership is justified for addressing the priority.

For all candidate Institutionalised European Partnerships the options considered in this impact assessment are the same, i.e.:

- Option 0 – Baseline option – Traditional calls under the Framework Programme
- Option 1 – Co-programmed European Partnership
- Option 2 – Co-funded European Partnership
- Option 3 – Institutionalised Partnership
 - Sub-option 3a Institutionalised Partnerships based on Art 185 TFEU
 - Sub-option 3b Institutionalised Partnerships based on Art 187 TFEU

2.2.1. Option 0 - Baseline option – Traditional calls

Under this option, strategic programming for R&I in the priority area will be done through the mainstream channels of Horizon Europe. The related priorities will be implemented through **traditional calls** of Horizon Europe covering a range of actions, mainly R&I and/or innovation actions but also coordination and support actions, prizes or procurement. Most actions involve consortia of public and/or private actors in ad hoc combinations, while some actions are single actor (mono-beneficiary). There will be no dedicated implementation structure and no support other than what is foreseen in the related Horizon Europe Work Programme. This means that discontinuation costs/benefits of predecessor initiatives should be factored in for capturing the baseline situation when relevant.

Under this option, strategic planning mechanisms in the Framework Programme will allow for a high level of flexibility in the ability of traditional calls to respond to particular needs over time, building upon additional input in co-creation from stakeholders and programme

committees involving Member States. The Union contribution to addressing the priority covers the full duration of the initiative, during the lifetime of Horizon Europe. Without a formal EU partnership mechanism, it is less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual commitments and contributions outside their participation in funded projects.

2.2.2. *European Partnerships*

Under this set of options, three different forms of implementation are assessed: Co-funded, Co-Programmed, Institutionalised European Partnerships. These have **commonalities that cannot serve as a distinguishing factor in the impact assessment process**. They are all based on agreed objectives and expected impacts and underpinned by Strategic Research and Innovation Agendas / roadmaps that are shared and committed to by all partners in the partnership. They all have to follow the same set of criteria along their lifecycle, as defined in the Horizon Europe Regulation (Annex III), including ex ante commitment from partners to mobilise and contribute resources and investments. The Union contribution is defined for the full duration of the initiative for all European Partnerships. The Horizon Europe legal act introduces few additional requirements for Institutionalised Partnerships, e.g. the need for long-term perspective, strong integration of R&I agendas, and financial contributions.

Figure 2 - Key differences in preparation and implementation of European Partnerships

Type	Legal form	Implementation
Co-Programmed	Contractual arrangement / MoU	Division of labour , whereby Union contribution is implemented through Framework programme and partners' contributions under their responsibility.
Co-Funded	Grant Agreement	Union provides co-funding for an integrated programme with distributed implementation by entities managing and/or funding national research and innovation programmes
Institutionalised based on Article 185/187 TFEU	Basic act (Council regulation, Decision by European Parliament and Council)	Integrated programme with centralised implementation

The main differences between the different forms of European Partnerships are in their preparation and in the way they function, as well as in the overall impact they can trigger. The Co-Programmed form is assessed as the simplest, and the Institutionalised the most complex to prepare and implement. The functionalities of the different form of Partnerships – compared to the baseline option – are presented in Figure 3. They relate to the types of actors Partnerships can involve and their degree of openness, the types of activities they can perform and their degree of flexibility, the degree of commitment of partners and the priority setting system, and their ability to work with their external environment (coherence), etc. These key distinguishing factors will be at the basis of the comparison of each option to determine their overall capacity to deliver what is needed at a minimised cost.

Figure 3 Overview of the functionalities provided by each form of European Partnerships, compared to the traditional calls of Horizon Europe (baseline)

Baseline: Horizon Europe calls	Option 1: Co-Programmed	Option 2: Co-Funded	Option 3a: Institutionalised Art 185	Option 3b: Institutionalised Art 187
Type and composition of actors (including openness and roles)				
<p><u>Partners:</u> N.A., no common set of actors that engage in planning and implementation</p> <p><u>Priority setting:</u> open to all, part of Horizon Europe Strategic planning</p> <p><u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules</p>	<p><u>Partners:</u> Suitable for all types: private and/or public partners, foundations</p> <p><u>Priority setting:</u> Driven by partners, open stakeholder consultation, MS in comitology</p> <p><u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules</p>	<p><u>Partners:</u> core of national funding bodies or government-mental research organisations</p> <p><u>Priority setting:</u> Driven by partners, open stakeholder consultation</p> <p><u>Participation in R&I activities:</u> limited, according to national rules of partner countries</p>	<p><u>Partners:</u> National funding bodies or governmental research organisation</p> <p><u>Priority setting:</u> Driven by partners, open stakeholder consultation</p> <p><u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules, but possible derogations</p>	<p><u>Partners:</u> Suitable for all types: private and/or public partners, foundations</p> <p><u>Priority setting:</u> Driven by partners, open stakeholder consultation</p> <p><u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules, but possible derogations</p>
Type and range of activities (including additionality and level of integration)				
<p><u>Activities:</u> Horizon Europe standards that allow broad range of individual actions</p> <p><u>Additionality:</u> no additional activities and investments outside the funded projects</p> <p><u>Limitations:</u> No systemic approach beyond individual actions</p>	<p><u>Activities:</u> Horizon Europe standard actions that allow broad range of individual actions, support to market, regulatory or policy/ societal uptake</p> <p><u>Additionality:</u> Activities/investments of partners, National funding</p> <p><u>Limitations:</u> Limited systemic approach beyond individual actions</p>	<p><u>Activities:</u> Broad, according to rules/programmes of participating States, State-aid rules, support to regulatory or policy/ societal uptake</p> <p><u>Additionality:</u> National funding</p> <p><u>Limitations:</u> Scale & scope depend on participating programmes, often smaller in scale</p>	<p><u>Activities:</u> Horizon Europe standards that allow broad range of individual actions, support to regulatory or policy/societal uptake, possibility to systemic approach</p> <p><u>Additionality:</u> National funding</p>	<p><u>Activities:</u> Horizon Europe standards that allow broad range of individual actions, support to regulatory or policy/societal uptake, possibility to systemic approach (portfolios of projects, scaling up of results, synergies with other funds).</p> <p><u>Additionality:</u> Activities/investments of partners/ national funding</p>
Priority-setting process and directionality				
<p><u>Priority setting:</u> Strategic Plan and annual work programmes, covering max. 4 years.</p> <p><u>Limitations:</u> Fully taking into account existing or to be developed SRIA/ roadmap</p>	<p><u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution</p> <p>Input to FP annual work programme drafted by partners, finalised by EC (comitology)</p> <p>Objectives & commitments set in contractual arrangement</p>	<p><u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution</p> <p>Annual work programme drafted by partners, approved by EC</p> <p>Objectives & commitments set in Grant Agreement</p>	<p><u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution</p> <p>Annual work programme drafted by partners, approved by EC</p> <p>Objectives & commitments set in legal act</p>	<p><u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution</p> <p>Annual work programme drafted by partners, approved by EC (veto-right in governance)</p> <p>Objectives & commitments set in legal act</p>
Coherence: internal (Horizon Europe) & external (other Union programmes, national programmes, industrial strategies)				
<p><u>Internal:</u> Coherence between different parts of the FP Annual Work programme can be ensured by EC</p> <p><u>External:</u> Limited for other Union programmes, no synergies with national/regional programmes &</p>	<p><u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC</p> <p><u>External:</u> Limited synergies with other Union programmes & industrial strategies. If MS participate, with national/ regional</p>	<p><u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC</p> <p><u>External:</u> Synergies with national/ regional programmes & activities</p>	<p><u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC</p> <p><u>External:</u> Synergies with national/ regional programmes & activities</p>	<p><u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC</p> <p><u>External:</u> Synergies with other Union programmes and industrial strategies</p> <p>If MS participate, with national/ regional</p>

Baseline: Horizon Europe calls	Option 1: Co-Programmed	Option 2: Co-Funded	Option 3a: Institutionalised Art 185	Option 3b: Institutionalised Art 187
activities	programmes & activities			programmes & activities

2.2.2.1. Option 1 - Co-programmed European Partnership

This form of European Partnership is **based upon a Memorandum of Understanding or a Contractual Arrangement** signed by the Commission and the private and/or public partners. Private partners are represented by industry associations, which also support the daily management of the partnership. This type of partnership would allow for a large degree of flexibility for the activities, partners and priorities to continuously evolve. The commitments of partners are political efforts described in the contractual arrangement and the contributions from partners are provided in kind more than financially. The priorities for the calls, proposed by the Partnership's members for integration in the Horizon Europe's Work Programmes, are subject to further input from Member States (comitology) and Commission services. The Union contribution is implemented within the executive agency managing Horizon Europe calls for research and innovation projects proposals. The full array of Horizon Europe instruments can be used, ranging from research and innovation (RIA) types of actions to coordination and support actions (CSA) and including grants, prizes, and procurement.

2.2.2.2. Option 2 – Co-funded European Partnership

The Co-funded European Partnership is **based on a Grant Agreement** between the Commission and a consortium of partners, resulting from a specific call in the Horizon Europe Work Programme. This form of implementation only allows to address public partners at its core. Typically these provide co-funding to a common programme of activities established and/or implemented by entities managing and/or funding national R&I programmes. The recipients of the EU co-funding implement the initiative under their responsibility, with national funding/resources pooled to implement the programme with co-funding from the Union. The expectation is that these entities would cover most if not all EU Member States. Calls and evaluations would be organised centrally, beneficiaries in selected projects would be funded at national level, following national funding rules.

2.2.2.3. Option 3 – Institutionalised European Partnership

This type of Partnership is the most complex and high-effort arrangement, and requires meeting additional requirements. Institutionalised European Partnership are **based on a Council Regulation (Article 187 TFEU or a Decision by the European Parliament and Council (Article 185 TFEU)** and are implemented by dedicated structures created for that purpose. These regulatory needs limit the flexibility for a change in the core objectives, partners, and/or commitments as these would require amending legislation.

The basic rationale for this type of partnership is the need for a strong integration of R&I agendas in the private and/or public sectors in the EU in order to address a strategic challenge. It is therefore necessary to demonstrate that other forms of implementation would not achieve the objectives or would not generate the necessary expected impacts, and that a long-term perspective and high degree of integration is needed. For both Article 187 and 185 initiatives, contributions from partners can be in the form of financial and in-kind contributions. Eligibility for participation and funding follows by default the rules of Horizon Europe, unless a derogation is introduced in the basic act.

Option 3a - Institutionalised Partnerships based on Article 185 TFEU

Article 185 of the TFEU allows the Union to participate in programmes jointly undertaken by Member States and limits therefore the scope to **public partners** which are Member States and Associated Third Countries. This type of Institutionalised Partnership aims therefore at reaching the greatest possible impact through the integration of national and EU funding, aligning national strategies in order to optimise the use of public resources and overcome fragmentation of the public research effort. It brings together R&I governance bodies of most if not all EU Member States (legal requirement: at least 40% of Member States) as well as Associated Third Countries that designate a legal entity (Dedicated Implementation Structure) of their choice for the implementation. By default, participation of non-associated Third Countries is not foreseen. Such participation is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement.

Option 3b - Institutionalised Partnerships based on Article 187 TFEU

Article 187 of the TFEU allows the Union to set up joint undertakings or any other structure necessary for the efficient execution of EU research, technological development and demonstration programmes. This type of Institutionalised Partnership brings together a stable set of **public and private partners** with a strong commitment to taking a more integrated approach and requires the set-up of a dedicated legal entity (Union body, Joint Undertaking (JU)) that carries full responsibility for the management of the Partnership and implementation of the calls. Different configurations are possible:

- Partnerships focused on creating strategic industrial partnerships where, most often, the partner organisations are represented by one or more industry associations, or in some cases individual private partners;
- Partnerships coordinating national ministries, public funding agencies, and governmental research organisations in the Member States and Associated Countries;
- Or a combination of the two: the so-called tripartite model.

Participation of non-associated Third Countries is only possible if foreseen in the basic act and subject to conclusion of an international agreement.

2.3. Overview of the methodology adopted for the impact assessment

The methodology for each impact assessment is based on the Commission Better Regulation Guidelines²⁰ to evaluate and compare options with regards to their **efficiency, effectiveness and coherence**. This also integrates **key selection criteria for European Partnerships**.

Box 2 Summary of European Partnerships selection criteria²¹

- **Effectiveness** in achieving the related objectives and impacts of the Programme;
- **Coherence** and synergies of the European Partnership within the EU R&I landscape;
- **Transparency & openness** as regards the identification of priorities and objectives and the involvement of partners & stakeholders from the entire value chain, backgrounds & disciplines;
- Ex-ante demonstration of **additionality** and **directionality**;
- Ex-ante demonstration of the partners' **long term commitment**.

²⁰ European Commission (2017), Better Regulation Guidelines (SWD (2017) 350)

²¹ For a comprehensive overview of the selection criteria for European Partnerships, see Annex 6.

2.3.1. Overview of the methodologies employed

In terms of **methods and evidence used**, the impact assessments draw on an external study covering all candidate Institutionalised European Partnerships in parallel to ensure a high level of coherence and comparability of analysis, in addition to an horizontal analysis.²² For all initiatives, the understanding of the overall context of the candidate institutionalised European Partnerships relied on desk research, including among others the lessons learned from previous partnerships. This was complemented by the analysis of a range of quantitative and qualitative evidence, including evaluations of past and ongoing initiatives; foresight studies; statistical analyses of Framework Programmes application and participation data, and Community Innovation Survey data; analyses of science, technology and innovation indicators; reviews of academic literature; sectoral competitiveness studies and expert hearings. The analyses included a portfolio analysis, a stakeholder and social network analysis in order to profile the actors involved as well as their co-operation patterns, and an assessment of the partnerships' outputs (bibliometrics and patent analysis). A cost modelling exercise was performed in order to feed into the efficiency assessments of the partnership options, as described below. Public consultations (both open and targeted) supported the comparative assessment of the policy options. For each initiative, up to 50 relevant stakeholders were interviewed by the external contractor (policymakers, business including SMEs and business associations, research institutes and universities, and civil organisations, among others). In addition, the analysis was informed by the results of the Open Public Consultation run between September and November 2019, the consultation of Member States through the Strategic Programme Committee and the online feedback received on the Inception Impact Assessments of the set of initiatives.

A more detailed description of the methodology and evidence base that were mobilised, completed by thematic specific methodologies, is provided in Annexes 4 and 6.

2.3.2. Method for identifying the preferred option

The first step of the assessments consisted in scoping the problems that the initiatives are expected to solve given the overall economic, technological, scientific and social context, including the lessons to be learned from past and ongoing partnerships on what worked well and less well. This supported the identification of the objectives of the initiative in the medium and long term with the underlying intervention logic – showing how to get there.

Given the focus of the impact assessment on comparing different forms of implementation, the Better Regulation framework has then been adapted to introduce “**key functionalities needed**” - making the transition between the definition of the objectives and what would be crucial to achieve them *in terms of implementation*. The identification of “key functionalities needed” for each initiative as an additional step in the impact assessment is based on the distinguishing factors between the different options (see Section 2.2.1). In practical terms, each option is assessed on the basis of the degree to which it would allow for the key needed functionalities to be covered, as regards e.g. the type and composition of actors that can be involved (‘openness’), the range of activities that can be performed (including additionality and level of integration), the level of directionality and integration of R&I strategies; the possibilities offered for coherence and synergies with other components of Horizon Europe, including other Partnerships (internal coherence), and the coherence with the wider policy environments, including with the relevant regulatory and standardisation framework

²² Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Study for the European Commission, DG Research & Innovation

(external coherence). This approach guides the identification of discarded options while allowing at the same time a structured comparison of the options not only as regards their effectiveness, efficiency and coherence, but also against a set of other key selection criteria for European Partnerships (openness, transparency, directionality)²³.

In line with the Better Regulation Framework, the assessment of the effectiveness, efficiency and coherence of each option is made compared to the baseline. Therefore, for each of these aspects the performance of using traditional calls under Horizon Europe is first estimated and scored 0 to serve as a reference point. This includes the discontinuation costs/benefits of existing implementation structures when relevant. The policy options are then scored compared to the baseline with a + and – system with a two-point scale, to show a slightly or highly additional/lower performance compared to the baseline. A scoring of 0 of a policy option means that it would deliver as much as the baseline option.

On the basis of the evidence collected, the intervention logic of each initiative and the key functionalities needed, the impact assessments first evaluate the **effectiveness** of the various policy options to deliver on their objectives. To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into ‘expected impacts’ - how success would look like -, differentiating between scientific, economic/ technological, and societal (including environmental) impacts. Each impact assessment considers to which extent the different policy options provides the ‘key functionalities needed’ to achieve the intended objectives. The effectiveness assessment does not use a compound score but shows how the options would deliver on the different types of expected impacts. This is done to increase transparency and accuracy in the assessment of options²⁴.

A similar approach is followed to evaluate the coherence of options with the overarching objectives of the EU’s R&I policy, and distinguishes between **internal** and **external coherence**. Specifically, internal coherence covers the consistency of the activities that could be implemented with the rest of Horizon Europe, including European Partnerships (any type). External coherence refers to the potential for synergies and/or complementarities (including risks of overlaps/gaps) of the initiative with its external environment, including with other programmes under the MFF 2021-27, but also the framework conditions at European, national or regional level (incl. regulatory aspects, standardisation).

To compare the expected costs and benefits of each option (**efficiency**), the thematic impact assessments broadly follow a cost-effectiveness approach²⁵ to establish to which extent the intended objectives can be achieved for a given cost. A preliminary step in this process is to obtain a measure of the expected costs of the policy options, to be used in the thematic assessments. As the options correspond to different implementation modes, relevant cost categories generally include the costs of setting-up and running an initiative. For instance, set-up costs includes items such as the preparation of a European Partnership proposal and the preparation of an implementation structure. The running costs include the annual work programme preparation costs. Where a Partnership already exists, discontinuation costs and

²³ The criterion on the ex-ante demonstration of partners’ long term commitment depends on a series of factors that are unknown at this stage, and thus fall outside the scope of the analysis.

²⁴ In the thematic impact assessments, scores are justified in a detailed manner to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation is provided of why certain scores were given to specific impacts, and why one option scores better or worse than others.

²⁵ For further details, see Better Regulation Toolbox # 57.

cost-savings are also taken into account²⁶. The table below provides an overview of the cost categories used in the impact assessment and a qualitative scoring of their intensity when compared to the baseline option (traditional calls). Providing a monetised value for these average static costs would have been misleading, because of the different features and needs of each candidate initiative.²⁷ The table shows the overall administrative, operational and coordination costs of the various options. These costs are then put into context in the impact assessments to reflect the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution (cost-efficiency):

- The costs related to the baseline scenario (traditional calls under Horizon Europe) are pre-dominantly the costs of implementing the respective Union contribution via calls and project, managed by the executive agencies (around 4%, efficiency of 96% for the overall investment).
- For a Co-Programmed partnership the costs of preparation and implementation increase only marginally compared to the baseline (<1%), but lead to an additional R&I investment of at least the same amount than the Union contribution²⁸ (efficiency of 98% for the overall investment).
- For a Co-Funded partnership the additional R&I investment by Member States accounts for 2,3 times the Union contribution²⁹. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the national programmes, can be estimated at 6% of the Union contribution (efficiency of 98% related to the overall investment).
- For an Article 185 initiative the additional R&I investment by Member States is equal to the Union contribution³⁰. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 7% of the Union contribution (efficiency of 96% related to the overall investment).
- For an Article 187 initiative the additional R&I investment by partners is equal to the Union contribution³¹. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 9% of the Union contribution (efficiency of 94% related to the overall investment).

²⁶ These costs are not monetised. While monetised cost figures are available for existing European Partnerships, they widely differ between each case, thus limiting meaningful comparability. Moreover, they are not readily applicable for new candidate initiatives. Instead, the analysis uses a static, common model of average real costs as a means to show the order of magnitude of efforts and reveal the principal differences between the options. Discontinuation costs will bear winding down and social discontinuation costs and vary depending on e.g. the number of full-time-equivalent (FTEs) staff concerned, the type of contract (staff category and duration) and applicable rules on termination (e.g. contracts under Belgian law or other). If buildings are being rented, the cost of rental termination also apply. As rental contracts are normally tied to the expected duration of the current initiatives, these termination costs are likely to be very limited. In parallel, there would also be financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. This is developed further in the individual efficiency assessments.

²⁷ A complete presentation of the methodology developed to assess costs as well as the sources used is described in the external study supporting this impact assessment (Technopolis Group, 2020).

²⁸ Minimum contributions from partners equal to the Union contribution

²⁹ Based on the default funding rate for programme co-fund actions of 30%, partners contribute with 70% of the total investment.

³⁰ Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.

³¹ Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.

Figure 4 - Intensity of additional costs compared with Horizon Europe Calls (for Partners, stakeholders, public and EU)

Cost items	Baseline: traditional calls	Option 1: Co-programmed	Option 2 Co-funded	Option 3a - Art. 185	Option 3b -Art. 187
Preparation and set-up costs					
Preparation of a partnership proposal (partners and EC)	0		↑↑		
Set-up of a dedicated implementation structure		0		Existing: ↑ New: ↑↑	Existing: ↑↑ New: ↑↑↑
Preparation of the SRIA / roadmap	0		↑↑		
Ex-ante Impact Assessment for partnership		0		↑↑↑	
Preparation of EC proposal and negotiation		0		↑↑↑	
Running costs (Annual cycle of implementation)					
Annual Work Programme preparation	0		↑		
Call and project implementation	0	0 In case of MS contributions: ↑	↑	↑	↑
Cost to applicants	Comparable, unless there are strong arguments of major differences in oversubscription				
Partners costs not covered by the above	0	↑	0	↑	↑
Additional EC costs (e.g. supervision)	0	↑	↑	↑	↑↑
Winding down costs					
EC		0			↑↑↑
Partners	0	↑	0	↑	↑

Notes: 0: no additional costs, as compared with the baseline; ↑: minor additional costs, as compared with the baseline; ↑↑: medium additional costs, as compared with the baseline; ↑↑↑: higher costs, as compared with the baseline.

The cost categories estimated for the common model are then used to develop a scorecard analysis and further refine the assessment of options for each of the 12 candidate Institutionalised Partnerships. Specifically, the scores related to the set-up and implementation costs are used in the thematic impact assessments to consider the scale of the expected benefits and thereby allow a simple “value for money” analysis (**cost-effectiveness**)³². In carrying out the scoring of options, the results of fieldwork, desk research and stakeholder consultation undertaken and taken into account.

For the **identification of the preferred option**, the scorecard analysis builds a hierarchy of the options by individual criterion and overall in order to identify a single preferred policy option or in case of an inconclusive comparison of options, a number of ‘retained’ options or hybrid. This exercise supports the systematic appraisal of alternative options across multiple types of monetary, non-monetary and qualitative dimensions. It also allows for easy visualisation of the pros and cons of each option. Each option is attributed a score of the adjudged performance against each criterion with the three broad appraisal dimensions of effectiveness, efficiency and coherence.

As a last step, the alignment of the preferred option with key criteria for the selection of European Partnerships is described, reflecting the outcomes of the ‘**necessity test**’.³³ The

³² More details on the methodology can be found in Annex 24.

³³ Certain aspects of the selection criteria will be further addressed/ developed at later stages, notably in the context of preparing basic acts (e.g. Openness and Transparency; Coherence and Synergies), in the Strategic Research and Innovation Agendas (e.g. Directionality and Additionality), and by collecting formal commitments (Ex-ante demonstration of partners’ long-term commitment).

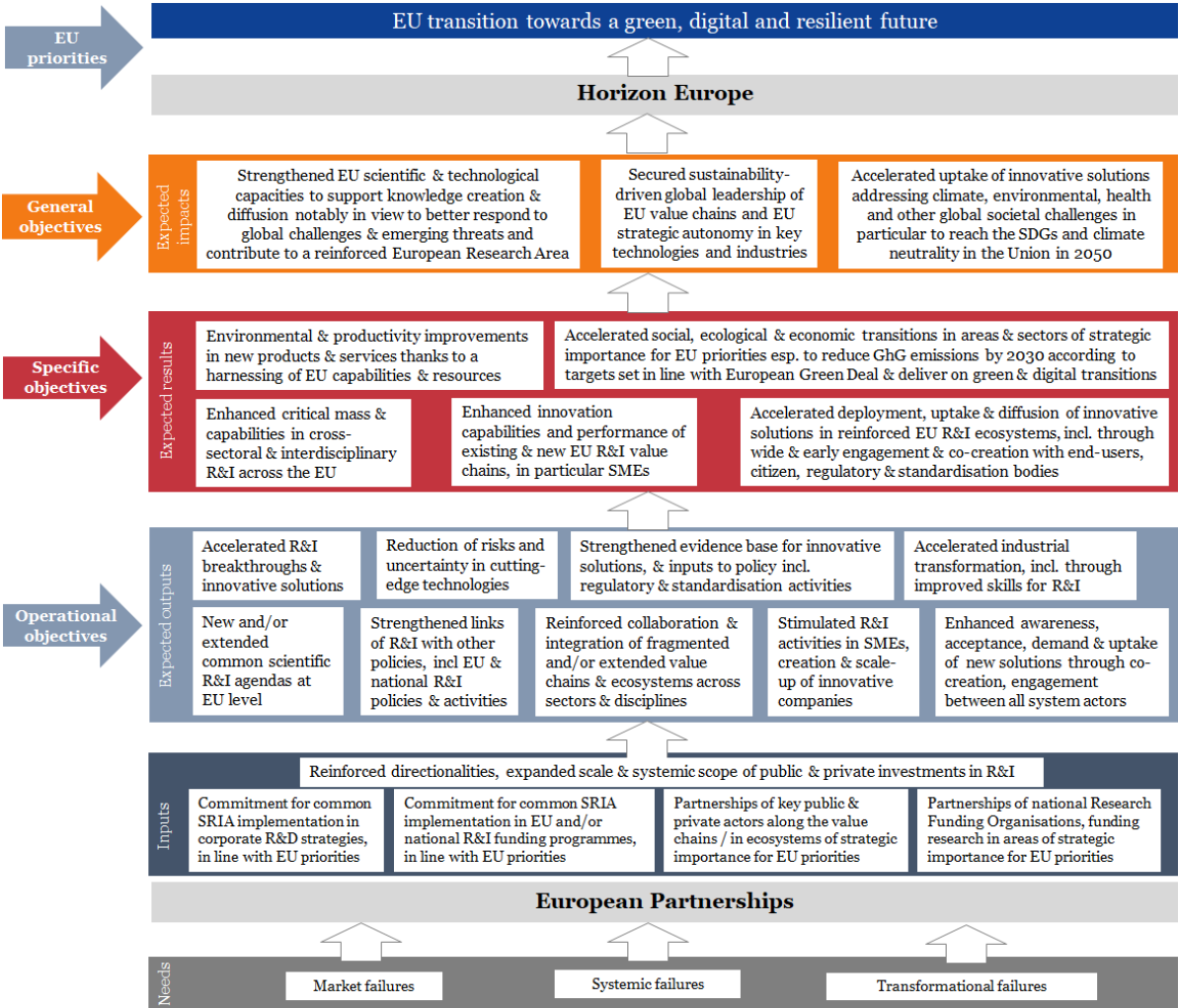
monitoring and evaluation arrangements are concluding the assessment, with an identification of the key indicators to track progress towards the objectives over time.

2.4. Horizontal perspective on candidate Institutionalised European Partnerships

2.4.1. Overall impact orientation, coherence and efficiency needs

The consolidated **intervention logic** for the set of candidate Institutionalised European Partnerships in the Figure below builds upon the objectives as reported in the individual impact assessments.

Figure 5 – Overall intervention logic of the European Partnerships under Horizon Europe



Source: European Commission, DG Research & Innovation, Unit A2 Programme Analysis and Regulatory Reform, adapted from Technopolis Group (2020)

When analysed as a package the 12 candidate Institutionalised European Partnerships are expected to support the achievement of the European policy priorities targeted by Horizon Europe by pursuing the following joint general objectives:

- a) Strengthening and integrating EU scientific and technological capacities to support knowledge creation and diffusion notably in view to better respond to global challenges and emerging threats and contribute to a reinforced European Research Area;
- b) Securing sustainability-driven global leadership of EU value chains and EU strategic autonomy in key technologies and industries; and

- c) Accelerate the uptake of innovative solutions addressing climate, environmental, health and other global societal challenges contributing to Union strategic priorities, in particular to reach the Sustainable Development Goals and climate neutrality in the Union in 2050.

In terms of specific objectives, they jointly aim to:

- a) Enhance the critical mass and scientific capabilities in cross-sectoral and interdisciplinary research and innovation across the Union;
- b) Accelerate the social, ecological and economic transitions in areas and sectors of strategic importance for Union priorities, in particular to reduce greenhouse gas emissions by 2030 according to the targets set in line with the European Green Deal, and deliver on the green and digital transition;
- c) Enhance the innovation capabilities and performance of existing and new European research and innovation value chains, in particular SMEs;
- d) Accelerate the deployment, uptake and diffusion of innovative solutions in reinforced European R&I ecosystems, including through wide and early engagement and co-creation with end-users, citizen and regulatory and standardisation bodies;
- e) Deliver environmental and productivity improvements in new products and services thanks to a harnessing of EU capabilities and resources.

In terms of their operations, taking a horizontal perspective on all initiatives allows for the identification of further possible collective efficiency and coherence gains for more impact:

- **Coherence for impact:** The extent and speed by which the expected results and impacts will be reached, will depend on the scale of the R&I efforts triggered, the profile of the partners involved, the strength of their commitments, and the scope of the R&I activities funded. To be fully effective it comes out clearly that future partnerships need to operate over their whole life cycle in full coherence with their environment, including potential end users, regulators and standardisation bodies. This relates also to the alignment with relevant EU, national or regional policies and synergies with R&I programmes. This needs to be factored in as of the design stage to ensure a wide take-up and/or deployment of the solutions developed, including their interoperability.
- **Collaboration for impact:** Effectiveness could also be improved collectively through enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems. An adequate governance structure appears in particular necessary to ensure cross-fertilisation between all European Partnerships. This applies not only to initiatives where similar R&I topics are covered and/or the same stakeholders involved or targeted, but also to the interconnections needed between the ‘thematic’ and the ‘vertical’ Partnerships, as these are expected to develop methodologies and technologies for application in EU priority areas. Already at very early stages of preparing new initiatives, Strategic Research and Innovation Agendas and roadmaps need to be aligned, particularly for partnerships that develop enabling technologies that are needed in other Partnerships. The goal should be to achieve greater impacts jointly in light of common challenges.
- **Efficiency for impact:** Potential efficiency gains could also be achieved by joining up the operational functions of Joint Undertakings that do not have a strong context dependency and providing them through a common back-office³⁴. A number of

³⁴ See Annex 6 for an overview of the key functions/roles that could be provided by a common back office.

operational activities of the Joint Undertakings are of a technical or administrative nature (e.g. financial management of contracts), or procured from external service providers (e.g. IT, communication activities, recruitment services, auditing) by each Joint Undertaking separately. If better streamlined this could create a win-win situation for all partners leading to better harmonization, economies of scales, and less complexity in supervision and support by the Commission services.

2.4.2. Analysis of coherence of the overall portfolio of candidate initiatives at the thematic level

Looking at the coherence of the set of initiatives at the thematic level, the “**digital centric**” initiatives have a strong focus on supporting the digital competitiveness of the EU ecosystem. Their activities are expected to improve alignment and coordination with Member States and industry for the development of world-competitive EU strategic digital technology value chains and associated expertise. Addressing the Key Digital Technologies, the 5G and 6G connectivity needs as part of a Smart Networks and Services initiative and the underlying supercomputing capacities through a European High Performance Computing initiative present potential for synergies that can be addressed through cooperative actions (e.g. joint calls, coordinated support activities, etc.). They may as well profit from and contribute to Partnerships envisaged for Photonics, AI, data, robotics, Global competitive space system and Made in Europe, together with the EIT Digital. Synergies between these initiatives and several programmes (Digital Europe and Connecting Europe as well as cohesion programmes) are needed in areas where EU industry has to develop leadership and competitiveness in the global digital economy. They are expected to impact critical value chains including on sectors where digital is a strong enabler of transformation (health, industrial manufacturing, mobility/transport, etc.).

The **transport** sector face systemic changes linked to decarbonisation and digitalisation. Large scale R&I actions are needed to provide cleaner, safer, and economically viable services for citizens and businesses, with digitalisation and automation as enablers. Past decades have shown that developing and implementing change is difficult in transport due to its systemic nature, many stakeholders involved, long planning cycles and large investments needed. A systemic change of the air traffic network through an Integrated Air Traffic Management initiative should ensure safety and sustainability of aviation, while a Clean Aviation initiative should focus on the competitiveness of tomorrow’s clean aircrafts made in Europe. The initiative for Transforming Europe’s rail system would comprehensively address the rail sector to confirm it as a cornerstone in tomorrow’s clean and efficient door-to-door transport services, affordable for every citizen as well as the most climate-friendly mode of transport, and becoming more attractive for passengers and freight. Connected and Automated Mobility is the future of road transport, but Europe is threatened to fall behind other global regions with strong players and large harmonised markets. The initiative Safe and Automated Road Transport would bring stakeholders together, creating joint momentum in digitalising road transport and developing new user-based services. Stronger links and joint actions will be established between initiatives to enable common progress wherever possible. The Clean Hydrogen initiative would be fundamental to that regard. Synergies would also be sought with partnerships driving the digital technological developments.

To deliver a deep decarbonisation of highly emitting industrial sectors such as the steel, transport and chemical industries would require the production, distribution and storage of **hydrogen** at scale. The candidate hydrogen initiative would have a central positioning in terms of providing solutions to the challenges for sustainable mobility and energy, but also is expected to operate in synergies with other industry related initiatives. The initiative

would interact in particular with initiatives on the zero emission road and water transport, transforming Europe's railway system, clean aviation, batteries, circular industry, clean steel and built environment partnerships. There are many opportunities for collaboration for the delivery and end-use of hydrogen. However, the Clean Hydrogen initiative would be the only partnership focused on addressing hydrogen production technologies.

Metrology, the science of measurement, is an enabler across all domains of R&I. It supports the monitoring of the Emissions Trading System, smart grids and pollution, but also contributes to meeting demands for measurement techniques from emerging digital technologies and applications. More generally, emerging technologies across a wide range of fields from biotechnologies, new materials, health diagnostics or low carbon technologies are giving rise to demands requiring a world-leading EU metrology system.

The initiative for a **Circular Bio-based Europe** is intended to solve a shortage of industry investments in the development of bio-based products whose markets do not have yet certain long-term prospects. The **Innovative Health Initiative** and **EU-Africa Global Health** address the lack of investments in the development of solutions to specific health challenges. The initiative on **Innovative SMEs** supports innovation-driven SMEs in participating in international, collaborative R&I projects with other innovative firms and research-intensive partners. As a horizontal initiative it is expected to help innovative SMEs to grow and to be successfully embedded in global value chains by developing methodologies and technologies for potential application in the other partnership areas or further development by the instruments of the European Innovation Council.

The description of the interconnections between all initiatives for each Horizon Europe cluster is provided in the policy context of each impact assessment and further assessed in the coherence assessment for each option.

PART 2 - THE CANDIDATE EUROPEAN PARTNERSHIP ON TRANSFORMING EUROPE'S RAIL SYSTEM

3. INTRODUCTION: THE POLITICAL AND LEGAL CONTEXT

Transport is fundamental to Europe's economy and society. It plays a key role in fulfilling citizens' travel needs and distributing the goods which they buy and use. As a result, transport enables economic growth and job creation: in 2019, the transport industry directly employed around 11.7 million people in the EU and accounted for about 5% of Gross Domestic Product (GDP)³⁵ and 7% of European export.

Railways contribute to the Single European Transport Area (SETA) and represent a fundamental element of the EU long term sustainable development strategy policy³⁶. Rail is already a very sustainable mode of transport, with policies such as the European Green Deal addressing the need of shifting to rail from less sustainable modes such as road in order to promote more environmentally friendly modes of transport integrating the logistic value chain as well as journeys for passengers. In terms of economic size, the direct gross value added of the Europe rail sector is € 69 billion and the indirect value amounted at € 80 billion³⁷, 1.3 million persons were directly employed in the rail sector and more than one million indirectly.

Rail transport has a series of significant advantages: a very high safety level (only 15 fatalities in 2017³⁸), low land use, high energy efficiency³⁹ and much lower environmental impact than other modes⁴⁰ (being already largely electrified), and the capacity to serve and connect both dense population areas as well as dispersed European areas (e.g. rural). Rail also contributes to decongesting dense urban areas. However, its ability to leverage these advantages and meet the evolving expectations of the European citizens and businesses is hampered by high costs, national operational barriers and limited flexibility, and in some cases poor reliability. These weaknesses have been compounded by divergent national technical standards and operating procedures, and inheritance of legacy systems, limiting the opportunities for extensive capacity use, mass manufacture, standard solutions, and, in addition, hindering cross border passenger and freight flows with the overall consequence of jeopardising the long term capacity of the system to answer the European socio-economic needs.

Over the recent years, the Europe rail sector has experienced increased competition from other non-European countries, especially in Asia, who built upon European know-how to develop rail technologies through subsidised internal markets. Maintaining a high and advanced technological position is key for global competitiveness and European jobs, with innovation being driven by demand and supply.

The introduction of new operational and technological innovative solutions to rail – enabled by digital advancements, robotics and automation to vehicles, European traffic management

³⁵ European Commission (2019): EU Transport in Figures. Statistical Pocketbook 2019.

³⁶ <https://ec.europa.eu/transport/sites/transport/files/2019-transport-in-the-eu-current-trends-and-issues.pdf>

³⁷ <http://cer.be/topics/economic-footprint>

³⁸ https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

³⁹ 6 times more energy efficient than road (source CER).

⁴⁰ Rail is 9x less CO2 intensive than road for freight and air travel for passengers (source CER).

system, infrastructure, asset management, and interfaces with passengers and logistic value chain – will allow rail to transform its performance over the years, breaking down barriers.

This document focuses on assessing the most effective, efficient and coherent way of implementing an initiative which would focus on joint European research and innovation activities, covering the full innovation lifecycle for impact, to transform Europe's rail system under Horizon Europe.

3.1. Emerging challenges in the field

Environmental challenges and climate change are issues that are going to shape more and more citizen's everyday life and will affect the transport system too. Transport accounts for some 25% of all GHG emissions. Extreme weather conditions (e.g. flooding, hurricanes and storms) are experienced more and more often and this is increasing the risk of disruptions, damage and failure of critical infrastructure.

Another challenge is the **congestion of infrastructure -and ageing population**. 75% of the world's population (6.1 billion people) currently lives in urban areas, doubling the numbers registered in 1975, while in the EU is estimated to increase from 72% in 2015 to 84% by 2030⁴¹. The ageing of the population affects not only the end-users but also the work force in the rail sector: a large portion of operators and infrastructure managers, in particular, have a staff population with an average age above 50, which means that they will lose large part of their staff within the next decade requiring a substantial shift of skills and competencies.

Rapid technological development, notably digitalisation, automation and robotics, reshape mobility concepts and open new opportunities. The emergence of new technologies (such as 5G, big data, the Internet of Things, automation, artificial intelligence, and blockchain) is considered a powerful driver, increasing efficiency and effectiveness of the solutions and addressing environmental/sustainability challenges delivering resilient, versatile and flexible services for both passengers and freight. However, technological changes carry a significant risk of cyber-attacks that require to consider security mechanisms in the early stages of development of new technological solutions.

Box 1 Possible impact of Covid-19 crisis

The short-term impact of the pandemic on the transport sector, in particular passenger transport, is dramatic and unprecedented on this scale. The long-term effects on transport activity will be related to the length of the pandemic and the depth of the post COVID economic shock.

Mobility patterns and hence the demand are impacted. Sector associations reported an 80-90% reduction in international passenger traffic and increase in ticket reimbursement requests. New entrant operators indicated deep financial distress and may struggle to survive. Rail freight transport was largely exempted from these measures and continues to run smoothly, albeit with much reduced demand overall (some -30%). Still, it saw demand increased on some market segments (combined transport, food products, consumer goods), linked to a shift from road transport to rail.

⁴¹ See United Nations Population Division, World Urbanisation Prospects 2018, available at: <https://population.un.org/wup/Download/>

According to first estimations⁴², the global rail freight market is expected to decline from \$97.3 billion in 2019 to \$94.9 billion in 2020 at a compound annual growth rate (CAGR) of -2.5%. The decline is mainly due to economic slowdown across countries owing to the COVID-19 outbreak and the measures to contain it. The market is then expected to recover and grow at a CAGR of 7% from 2021 and reach \$114.3 billion in 2023.

Moreover, behavioural changes taking place around the world might carry over beyond the pandemic. It is unclear yet to what extent the restrictions would impact the demand for rail services.

Taken together, these challenges have important implications for both the direction and organisation of rail-related research and innovation in the next programming period.

Stakeholder opinion

There was strong support among stakeholders responding to the Open Public Consultation for aligning the direction of R&I under Horizon Europe with key European policy objectives, in particular decarbonisation of the European economy. A substantial majority of business organisations (both large organisations and SMEs), business associations, academic and research institutions, public authorities and EU citizens considered that any future European Partnership should respond effectively to European policy goals. A majority of these groups also confirmed the importance of meeting societal needs and contributing to Sustainable Development Goals while supporting EU global competitiveness. There was particularly strong

3.2. EU relative positioning in the field

The majority of rail transport is already electric (circa 80% of passenger-km and freight tonne-km⁴³), and more generally rail is very energy efficient. A significant increase of the modal share of rail transport⁴⁴ for passengers and especially for freight would allow rail to make a very substantial contribution to the decarbonisation of the transport system (increasing electrification and fuel efficiency will further reduce emissions per passenger-km and per tonne-km). The Green Deal calls for a significant part of the freight transport currently carried by road to be shifted to rail and inland waterways. Rail freight's modal share has been stagnating over the past years. It is particularly energy efficient, but in order to attract new traffic, rail freight operators have to offer more flexible and reliable services.

The EU has already started to tackle sustainability and cost-efficiency issues but it is only through intensive exploitation of the existing infrastructure, via a substantial transformation of rail systems' concept of operations, in all its segments, that a significant increase of the modal share for passengers and especially for freight could be achieved. Thus addressing the problems preventing rail taking a higher market share is a key deliverable for transport decarbonisation.

⁴² Rail Freight Global Market Report 2020-30: Covid 19 Impact and Recovery

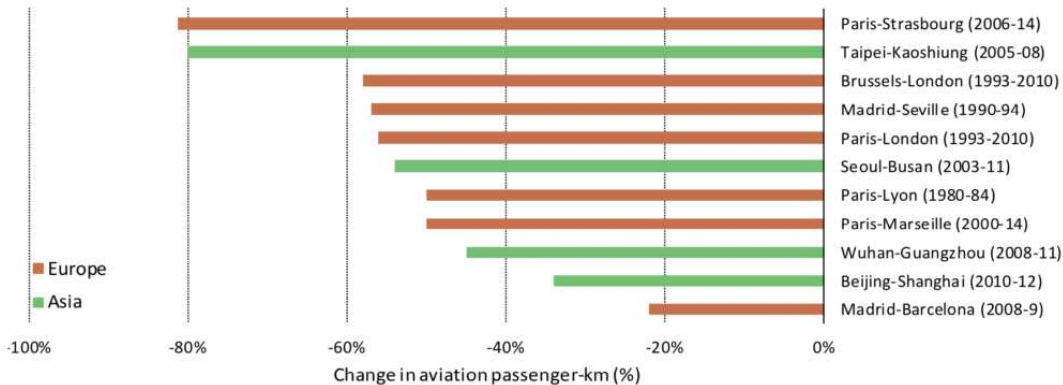
⁴³ https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

⁴⁴ The modal share of rail transport (including heavy rail, tram and metro services) remained stagnant over a period of more than 10 years. However, it has to be noted that heavy freight (coal, steel etc.) in which rail was historically very strong, has greatly declined due to changes in broader industrial structure, and so the fact that overall rail freight market share has remained more or less constant demonstrates that rail *has* managed to increase its share in other sectors.

Similarly, the contribution of rail in addressing the challenges arising from increased urbanisation, including congestion and poor air quality should be higher. This would require further improving the quality of the rail services: 66% of Europeans are satisfied with the frequency of trains, and punctuality and reliability are also well received, with 59% of users satisfied⁴⁵, but further improvements in the quality of rail services would encourage people to travel more by rail. A change in the mobility behaviour is also a result of the increased awareness for sustainability among the population.

High-speed rail provides an important alternative to aviation. According to a report produced by IEA in 2019⁴⁶, high-speed rail lines can reduce aviation transport on the same routes by as much as 80%, see Figure 1.

Figure 1 - Average change in passenger activity on selected air routes after high-speed rail implementation



The integration of rail within the multimodal transport system has proceeded in the past on a piecemeal slow-pace basis, constraining improvements in connectivity.

The European Rail Supply Industry (RSI) has been highly competitive in global markets over many years⁴⁷, and its technological leadership has been strengthened considerably by various EU policy initiatives, notably the European Railway Traffic Management System (ERTMS). The European RSI is a major exporter of rail equipment, for example exporting €4.8 billion of locomotive and rolling stock products in 2017 compared with €2.3 billion exported by China and a similar value by the US.

However, the European rail supply industry’s competitive position has been increasingly challenged by suppliers based in Asia, and particularly China, over several years, not least because of their substantial investment in R&I and support provided by their respective national governments⁴⁸. More generally, a perceived imbalance in the openness of Europe’s rail market compared to that in other countries has prompted the Commission to explore

⁴⁵ European Commission (2018), Flash Eurobarometer 463: Europeans’ satisfaction with passenger rail services, available at: https://data.europa.eu/euodp/en/data/dataset/S2172__ENG

⁴⁶ <https://www.iea.org/reports/the-future-of-rail>

⁴⁷ European Commission (2019), Final report of the expert group on competitiveness of the European rail supply industry, October 2019, available at: <https://ec.europa.eu/docsroom/documents/37829>

⁴⁸ See European Commission (2019b), op. cit.

ways of stemming unfair competitive practices and of providing support to European firms struggling to access global markets⁴⁹.

Through joint Rail Research and Innovation, the RSI working with the key stakeholders of the sector – railway undertakings, infrastructure managers, scientific community, etc. - through co-creation – from exploring, conception, research, design, testing and demonstrating at large operational scale – could build upon its strengths and a portfolio of solutions – e.g. ERTMS – to maintain its leadership at global level.

A review⁵⁰ conducted in 2015⁵¹ highlighted the significantly higher intensity of R&D effort in competing sectors, notably aviation and automotive, notwithstanding their apparent similarity to rail in terms of both industry structure and the costs and risks of R&D investment. The rail industry still gets relatively small amounts of R&I investments, especially when compared to the automotive industry (40 times smaller)⁵². UNIFE has estimated the level of investment in R&I undertaken by the RSI in 2014 at around 2.7% of the industry's turnover. Moreover, the total amount of European R&I investments in the rail sector is still significantly lower when compared to the US and China⁵³.

Furthermore, the competitiveness of the RSI relies heavily on the ability to maintain know-how as well as generate and protect intellectual property rights.

The recent study on the competitiveness of the RSI, undertaken for the Commission, found that of the 187,642 patents granted worldwide between 2011 and 2017 under the International Patent Classification 'B61 – Railways', 66% were granted by the relevant Chinese authority.

Hence, Europe's role and contribution to the current research and innovation efforts has implications for the strategic development and competitiveness of the European RSI⁵⁴.

In addition, there is a key role of the railway operating community at large and for the different segments. The market opening requires a shift in the business model relation between infrastructure managers and railway operators, as well as with the supply industry. This new business model, largely unique in the world, requires to innovate railway as an integrated system of systems, ensuring that the interfaces are duly managed and benefits maximized for the European passengers and freight business.

Support for the field in the previous Framework Programmes

⁴⁹ European Political Strategy Centre (2019), EU Industrial Policy after Siemens-Alstom: Finding a new balance between openness and protection, available at: https://ec.europa.eu/epsc/sites/epsc/files/epsc_industrial-policy.pdf

⁵⁰ Nash and Smith February (2019), op. cit., based on Wiesenthal et al (2015), Innovation in the European transport sector: A review

⁵¹ Hence before Shift2Rail JU had started operations.

⁵² Wiesenthal T., Condeco-Melhorado A., Leduc G. (2015), Innovation in the European transport sector: A review, *Transport Policy*, V. 42, pp. 86-93. The study analyses the EC data on railway transport provided in 2011.

⁵³ European Commission (2013), Impact Assessment accompanying the document: Proposal for a Council Regulation establishing the Shift2Rail Joint Undertaking, p.13.

⁵⁴ While published research results are, by definition, available to industries around the world, suppliers of rail products and services based close to, and potentially working collaboratively with, leading research organisations in the field are likely to benefit most from the research outputs that they produce.

Box 2 Support for the field in the previous Framework Programmes – key strengths & weaknesses identified

What was/is being done with EU research and innovation funding until now

Dedicated R&I activities related to transport and rail in particular have been supported for many years through the Framework Programmes. This covers traditional (collaborative) projects but also support provided through the Shift2Rail Joint Undertaking (S2R JU) under Horizon 2020.

The S2R JU was established in 2014 to strengthen the role of rail in the European transport system through more effective sponsorship and management of the sector's R&I effort. It manages an extensive programme of R&I activity, aligned with the delivery of a series of major operational and technological innovations set out in its Master Plan and further elaborated in a detailed Multi-Annual Action Plan (MAAP). The Union financial contribution is EUR 450 million that is matched by a similar contribution from the members. Details on how the S2R JU functions are available in Annex 6.

The activity overseen by the JU represents a substantial contribution to the R&I effort of the European RSI. The relatively low intensity of R&I activity in the rail sector observed before Horizon 2020 was an important factor in building the case for establishing the JU.

The founding members of the JU, including the manufacturers Alstom, Ansaldo STS (now Hitachi), Bombardier, CAF, Siemens and Thales and the infrastructure managers Network Rail and Trafikverket, are major contributors to the work programme, as are the associate members Deutsche Bahn and SNCF.

Educational and scientific and research institutions are well represented, although participation is concentrated on a relatively limited number of organisations such as the KTH Royal Institute of Technology, Fraunhofer Gesellschaft and Deutsches Zentrum für Luft und Raumfahrt (DLR).

While the interests of rail operators are clearly represented, including by associate members, representation is distributed in favour of major national passenger operators, freight operators and operators of urban networks are less involved (although organisations such as DB Cargo, Wiener Linien, Metro de Madrid and London Underground have participated in a limited number of projects).

SMEs participate in the Open Calls; for example, 90 SMEs participated in the 2019 Call (i.e. 23% of the applicants) and 40 SMEs were beneficiaries in proposals retained for funding (i.e. 40%). Overall, the SMEs represent 30% of the entities receiving funding from S2R JU.

What has or is being achieved so far

The JU is the first of its kind. It has been successful in building participation from organisations throughout the rail industry value chain, including infrastructure managers, train operators and a wide range of organisations from the RSI as well as research and educational institutions. The profile of participation tends to reflect the allocation of available Union funding, with 40% allocated to founding members, 30% to associated members and their affiliates and 30% to open calls (in accordance with Article 17 of Annex 1 of the Regulation).

According to the Interim Evaluation⁵⁵ the JU had already achieved positive effects by bringing many organisations together to work towards common goals, thereby overcoming industry fragmentation and ensuring greater continuity of research objectives. The report noted widespread support for the JU across the industry, particularly in view of its role in enabling large-scale demonstration projects. Overall, it was judged to be well-placed to achieve the level of trust and partnership characteristic of other transport JUs, providing a catalyst for new ideas and new relationships. Much of the research being undertaken would not have happened if the JU had not existed, and there was wide agreement of the value of the JU when it comes to large-scale demonstration projects.

To date, the JU appears to be making a strong contribution to the development of a more competitive rail transport industry, with its Annual Activity Report for 2019 highlighting significant progress across a range of activities. The Catalogue of Solutions⁵⁶ published by the JU in 2019 illustrates what R&I investments generate as innovative solutions for market uptake. It includes 54 solutions in relation to the whole rail system and hence, covering all IPs. Each solution includes a description and specifies a targeted market, market outlook and estimated date for market uptake.

To give another example, S2R JU developed, in collaboration with industry organisations such as CAF and Wabtec Corporation, competitive automatic coupling solutions to be demonstrated on Trafikverket freight trains in September 2020. It is also seeking the support of its members in preparing a business case for the deployment of the technology, which will require funding of Euro 6 billion over six years with an indicative payback of seven years. This is expected to have a significant impact on the market for freight wagons and on the efficiency of European rail freight services.

Furthermore, the JU helped identify the areas where there is a need to better align the R&I activities with the needs of a competitive sector and confirmed the need of developing a common vision for the future technical evolution. In particular, experience has shown a need to focus in the future on system issues rather than incremental improvements to parts of the complex railway system (hence the focus should be in the future on automation and traffic management) where pan-European standardisation is vital.

What lessons have been learned?

A number of areas for improvement were identified in the interim evaluation of the Joint Undertakings under Horizon 2020⁵⁷ and will have to be better addressed in a new initiative on European rails system. These challenges include:

- With regard to directionality, a more balanced research agenda, taking account of societal and operational issues facing the rail industry and better addressing the needs of freight operators needs to be adopted.
- There is a need for greater emphasis on demonstration projects to improve market take-up of R&I outputs. This requires a move towards more R&I programmes at TRL 7-9, a significant change from the focus on TRL 1-6 under Horizon 2020.
- It is important that both the research outputs and the demonstrators are relevant to a wide range of players and the links with the operational side of both passenger and freight as

⁵⁵ Commission Staff Working Document - Interim Evaluation of the Joint Undertakings operating under Horizon 2020, {SWD (2017) 339 final}

⁵⁶ <https://shift2rail.org/wp-content/uploads/2019/10/Catalogue-of-Solutions-Web.pdf>

⁵⁷ Commission Staff Working Document - Interim Evaluation of the Joint Undertakings operating under Horizon 2020, {SWD (2017) 339 final}

well as with urban rail players should be strengthened. There is a need to increase the participation of a greater number of railway undertakings, and the presence of the urban sector and encouraging more Member States and especially SMEs.

- The Programme of S2R JU is structured around five Innovation Programmes (IPs)⁵⁸. This structure is not flexible enough for a strong system approach to deal with all interfaces between the subsystems and between the railway system and the “outside world and bears the risk of working in silos.
- Maximising the impacts of transport research and innovation requires supporting solutions that are closer to the market and bridging the gap to large-scale deployment of innovation. A possible successor of S2R JU should have a stronger deployment agenda.
- There has been insufficient exploitation of synergies between the S2R JU and other JUs, particularly in view of application of key technologies such as digital across the transport sector and more broadly.

It has to be noted that the S2R JU achieved autonomy in May 2016, therefore it was too early for any research results to be included in the evaluation, as no projects had then reached the stage of having concrete outputs.

3.3. EU policy context beyond 2021

At the end of 2019 the Commission presented its new priorities for the upcoming years, including the **European Green Deal**, a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. Priority areas include accelerating the shift to sustainable and smart mobility. Road, rail, aviation, and waterborne transport will all have to contribute to the 90% reduction in transport emissions, which is needed by 2050. As a matter of priority, a substantial part of the 75% of inland freight carried today by road should shift onto rail and inland waterways.

The **New Industrial Strategy for Europe**⁵⁹ (March 2020) underlined that sustainable and smart mobility industries, such as the rail industry, have both the responsibility and the potential to drive the digital and green transition, support Europe’s industrial competitiveness and improve connectivity. In this context, the Strategy mentions the need for promoting the technological leadership of EU mobility industries.

In Horizon Europe, the candidate partnership for Transforming Europe’s Rail System is part of the R&I activities funded under the **Pillar II Cluster Climate, Energy and Mobility** are intended to contribute to the attainment of at least three of the six main ambitions for Europe: ‘A European Green Deal’, ‘A People-centred Economy’ and ‘A Digital Europe’.

The main objectives of this cluster are to fight climate change, improve the competitiveness of the energy and transport industry as well as the quality of the services that these sectors bring to society. This is supportive of several Sustainable Development Goals (SDG) including affordable and clean energy (SDG7); industry, innovation & infrastructure

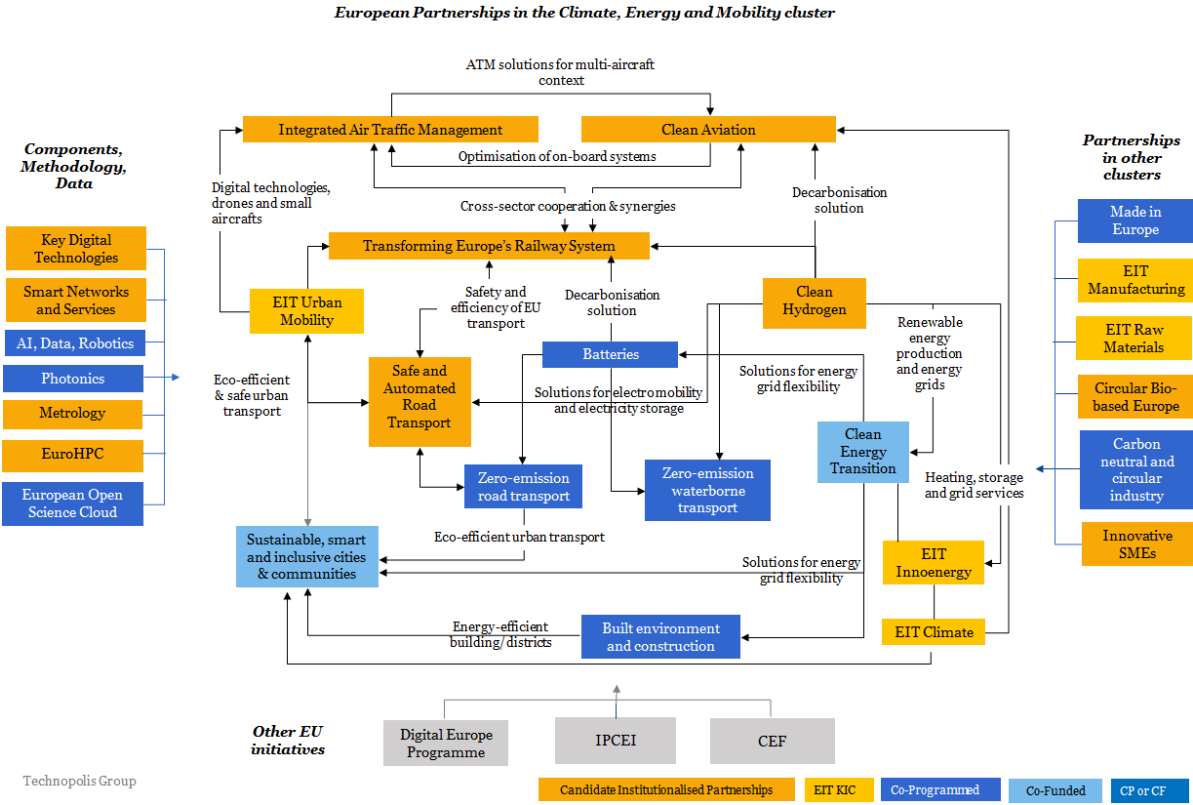
⁵⁸ The five Innovation Programmes (IP) are: Cost-efficient reliable trains, Advanced traffic management, Sustainable and Reliable Infrastructure, IT Solutions and Technologies for Rail Freight. Across all five IPs are overlaid five cross cutting themes and activities (CCAs).

⁵⁹ https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en

(SDG9); sustainable cities & communities (SDG11); sustainable consumption & production (SDG12); and climate action (SDG13). The candidate partnership for Transforming Europe’s Rail System also has the potential to support SDG 3 (Good Health and Well-being) -by encouraging greater use of rail services, which in turn will have a positive effect on reduction of greenhouse gas emissions, particulate pollution and noise-, SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation and Infrastructure), by enhancing the competitiveness of rail and especially freight (thereby reducing the volume of freight traffic moving by road) and by addressing many of the challenges such as the increased urbanisation of Europe’s population.

A detailed analysis of synergies for the envisaged and candidate Partnerships that are related to this cluster is shown in Figure 2.

Figure 2 - Interconnections between the envisaged partnerships in the Climate, Energy and Mobility cluster



In terms of the **policy goals for the sector**, rail is at a point where substantial transformation is needed. Over the past 25 years, the Commission - and more recently with the European Union Agency for Railways (ERA)-, has developed a single technical framework for rail, with the objective of gradually replacing divergent legacy national approaches developed over the previous 150 years.

The technical pillar of the **4th Railway Package** adopted in 2016 but only in force in all Member States from November 2020 is expected to boost the competitiveness of the railway sector by significantly reducing costs and administrative burden for railway undertakings wishing to operate across Europe, starting with ERA issuing vehicle authorizations for

placing on the market and safety certificates for railway undertakings, valid throughout the EU.

This has been accompanied by progressive market liberalisation. The market pillar of the 4th Railway Package adopted in 2016 completes the process of gradual market opening. Competition in rail passenger service markets will encourage railway operators to become more responsive to customer needs, improve the quality of their services and their cost-effectiveness.

Despite the support provided by the current EU legislation to the harmonisation and interoperability of the EU rail market, the large majority of national legacy systems is still far away from integration into the European system⁶⁰. Full realisation of the Single European Rail Area⁶¹ will however require further time due to the very long asset life of rail equipment. For instance, in 2018 there were still some 30 different signalling systems in place which were not interoperable.⁶²

There is now a great opportunity to build the future railway on a common system – which is vital for harnessing the huge potential for digitalisation and automation to reduce rail’s costs, increase capacity, and enhance its flexibility and reliability. In the absence of a major system transformation during the next decade to set the basis for a system wide deployment of new technologies and operational solutions, much of the rail potential would not be realised, and undertakings would be lumbered with stranded costs, without a shared European concept of operations and joint effort to deploy it in the market.

Stakeholder opinion

There was strong support among stakeholders responding to the Open Public Consultation for aligning the direction of R&I under Horizon Europe with key European policy objectives, in particular decarbonisation of the European economy. A substantial majority of business organisations (both large organisations and SMEs), business associations, academic and research institutions, public authorities and EU citizens considered that any future European Partnership should respond effectively to European policy goals. A majority of these groups also confirmed the importance of meeting societal needs and contributing to Sustainable Development Goals while supporting EU global competitiveness. There was particularly strong

⁶⁰ [Study on the competitiveness of the Rail Supply Industry – Final Report \(2019\)](#)

⁶¹ Established by Directive 2012/34/EU.

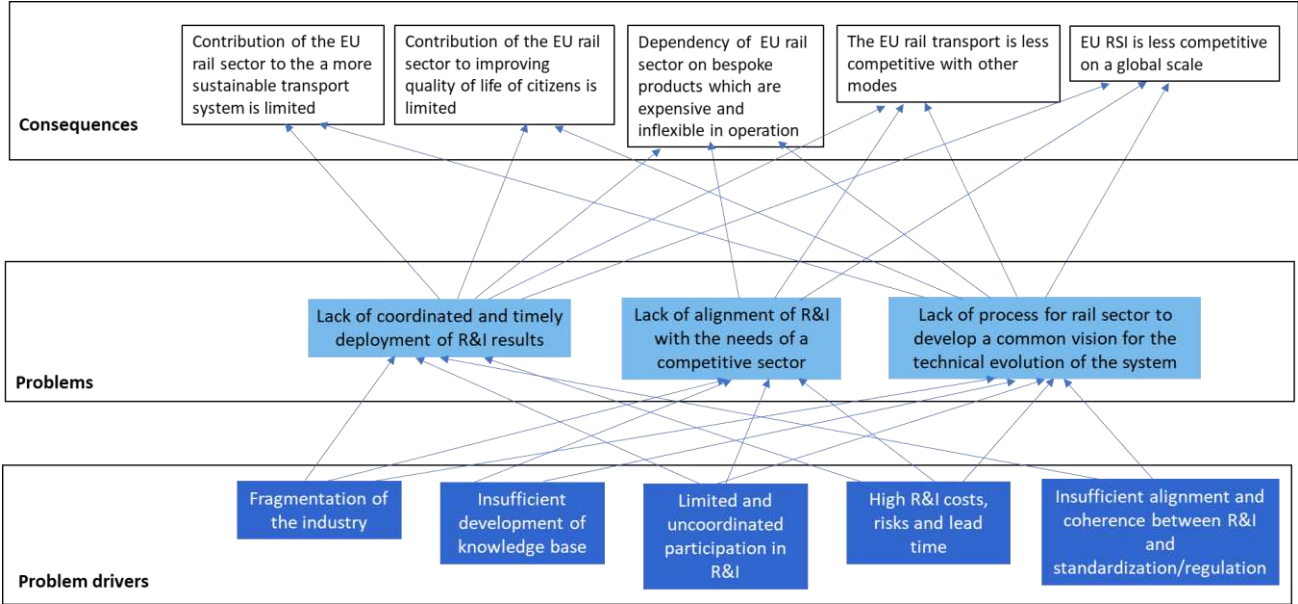
⁶² [ERTMS – A guide for stakeholders \(2020\)](#)

4. PROBLEM DEFINITION

4.1. What is/are the problems?

Given the scale of the challenges ahead for a transition to sustainable mobility, the current scientific, technological and economic positioning of Europe in the field, and the overarching EU policy context, a set of problems have been identified where EU research and innovation in the field of rails systems would have a specific role to play (see Figure 3).

Figure 3 - Problem tree behind an initiative for European research and innovation on Transforming Europe’s Rail System



2.1.1 Lack of coordinated and timely deployment of R&I results both between the RUs and IMs and across the network

The current low status of deployment of innovative solutions is explained mainly by the reluctance of many IMs and RUs to invest in the necessary equipment without the assurance that there will be sufficient infrastructure to exploit the investment (where done by an RU) or trains adapted to fully exploit the infrastructure (where the IM invests) – a classic chicken and egg problem. In the absence of an adequate framework, the stakeholders considering the business case do not have confidence in the return for investment.

Previous framework programmes showed that in the absence of a strong coordinated approach at EU level, the market uptake and impact of rail R&I projects is low and slow, and neither technological nor policy-relevant outputs would be as prevalent. For projects selected individually through traditional calls for proposals the consortia are set up ad-hoc according to the specific needs of the project and dismantle afterwards without creating long term value. This hinders the continuous collaborations of partners beyond single projects, resulting in lack of trust, lack of willingness to share information – two essential factors in projects developing outputs with direct commercial value – and strategic decisions on solutions based on the monies invested in the projects instead a shared vision.

2.1.2 Rail research and innovation activities not aligned with the needs of a competitive rail sector

The lack of competitiveness of rail against other modes of transport reflects both the persistence of inefficiency, contributing to relatively high costs and/or excessive calls on public funding, and a lack of innovation.

The impact assessment accompanying the proposal to establish the S2R JU noted that R&I efforts under previous Framework Programmes had not been sufficiently targeted towards the completion of the Single European Rail Area (SERA), notwithstanding that the creation of a large internal market for rail products might have been expected to increase the competitiveness of European rail services. The recent report of the expert group on the competitiveness of Europe's RSI⁶³ noted that the industry faces several major challenges such as embracing new technologies on which both its position in global markets and the R&I activities conducted in a fragmented manner would have a little impact on meeting the needs of the sector as they would unlikely result in the level and scope of R&I activity required to materially improve the competitive position of the rail transport industry.

2.1.3 Lack of process for rail sector to develop a common vision for the technical evolution of the system

The EU rail system was historically characterised by segmentation into national networks with specific technical standards requiring bespoke rolling stock and infrastructure equipment, often supplied by preferred national manufacturers. This resulted in high costs, difficulties in providing international services and a general lack of flexibility. Even where new technologies were developed, these were often applied differently in different Member States, preventing interoperability⁶⁴. Even when a European approach (ERTMS) was developed, customisation to fit existing railway operations was allowed, again limiting the intended interoperability – a problem we are still dealing with.

Successful innovation in the rail sector must deal with these issues and also address the fact that for many developments there will only be a strong business case where wide scale network deployment in a truly interoperable manner can be ensured within a reasonable time scale.

Misalignment of incentives between infrastructure managers and railway undertakings must also be addressed. Finally, in the absence of rapid cross industry agreement on the preferred approach to new technology (including standardisation and/or inclusion of innovations in the EU Technical Standard for Interoperability Regulations) is vital to avoid that divergent solutions are adopted at national level, breaking interoperability and preventing the cost advantages delivered by common EU product specifications. These issues must be addressed with an inclusive governance system at the R&I stage to ensure broad industry acceptance of the finished technology.

⁶³ See European Commission (2019a) Report of the expert group on the RSI's competitiveness

⁶⁴ The classic example is modern train protection systems, where different automated systems were developed in the 1980s and 90s, meaning that trains needing to run in several Member States must have up to 11 different systems – adding hugely to cost and certification difficulty.

Stakeholder opinion

A substantial majority of business organisations, business associations, academic and research institutions, public authorities and EU citizens responding to the Open Public Consultation considered that the need to strengthen the role of rail in the transport system through R&I was very relevant, and support for improving the competitiveness and attractiveness of rail services was also strong among all these groups. Stakeholders also identified the importance of aligning R&I under Horizon Europe with EU societal objectives, in particular climate-related objectives. At the same time, there was strong support for common action to advance key technologies and radically transform rail, particularly from larger business organisations and public authorities.

4.2. What are the problem drivers?

4.2.1. Fragmentation

Today's fragmentation is the legacy of a patchwork of national rail systems slowly growing together:

- Infrastructure – which is and is likely to remain a national, state-owned, monopoly (with limited exceptions such as a few Public-Private-Partnerships). The need for compatibility between infrastructure and rolling stock imposes design constraints on the latter, though these are being progressively eliminated through full application of the Commission's "Technical Standards for Interoperability" (TSI) Regulations.
- Historically close links between national railways and local manufacturers, limiting incentives to develop truly pan-European products.
- Liberalisation is recent and open access for "commercial" services is small compared to services under Public Service Obligations (PSO) which represent about two thirds of the total market for passenger transport. In addition, barriers to entry are high as there is the need for example for bespoke rolling stock and to create economies of scale.
- Limited role of the cross-border traffic as 95% of it is national. Freight is very different – after 20 years of EU liberalisation the sector has evolved, with operators operating across the EU; services between Member States represent 60% of freight tonne km.
- Long life of railway assets: 40-50 years for rolling stock, while for infrastructure (including for some signalling components) is much longer.

The high level of product customisation and lack of European standardisation not only prevented the creation of single European railway market, it also resulted in increased production costs and low operational margins. The creation of the Single European Rail Area has addressed these issues by creating a single technical basis – the Technical Specifications for Interoperability (TSI) – for the system. However, it will take many years for the system to fully comply with the TSIs and in the meantime new equipment has to address interface with the legacy systems. For example, the need to manufacture rolling stock to meet specific national track and loading gauge, signalling and other standards inevitably reduces the number of trains that can be produced to a given specification and

increases the unit cost of production⁶⁵. This means that underlying R&I activities need to be properly coordinated and synchronised to ensure the interoperability of solutions.

Furthermore, the problem of fragmentation is compounded by the technical complexity of rail systems, with the risk, that, in the absence of a coordinated approach for R&I at EU level, research projects would mostly be focused on just one component of the rail system, rather than on improving the system as a whole. Given the strength of large Original Equipment Manufacturers (OEMs), there is also a limited focus on the development of a system vision or standardised interfaces between components which would allow greater scope for competition between component manufacturers and updating of such components to reflect innovation. This is being addressed in particular in the S2R JU's IPX work stream.

In addition, prior to S2R JU, there was also fragmentation along the innovation life cycle, with research projects focusing on pre-competitive innovation at low TRLs, which frequently came to an end without any plan for follow-up activity leading to market uptake. It was thus difficult to develop ambitious, large-scale and long-term innovation programmes capable of proposing breakthrough solutions that have a real impact on the whole system and that can be deployed EU wide.

Stakeholder opinion

A majority of business organisations (including SMEs), business associations, academic and research institutions, public authorities and EU citizens responding to the Open Public Consultation considered the various aspects of fragmentation discussed above to be relevant or very relevant. They also confirmed the lack of a coordinated approach to programming and funding and the need to bring together the research community, the RSI, train operators and infrastructure managers. A majority of all these groups similarly considered the market take-up of innovations to be slow, either because of deployment issues or as a result of the regulatory framework.

Several of the stakeholders participating in the interviews similarly stressed the difficulties in overcoming the fragmentation of the European rail system, particularly in view of the perceived slow progress in deploying ERTMS and delivering full interoperability. They also highlighted the long-life cycle of railway assets and the costs and risks of R&I investment as major constraints on the speed of innovation. There was a strong consensus that, in the absence of policy intervention, it would not be possible to achieve the long-term strategy and level of stakeholder participation and coordination needed to translate R&I results into higher quality, more efficient rail services. In addition, some stakeholders expressed the view that Horizon Europe represented an important opportunity to substantially improve the competitiveness of rail freight.

The business organisations providing feedback on the inception impact report also confirmed the importance of some of the problem drivers identified above, in particular the sector fragmentation. These and other stakeholders, including EU citizens, also emphasised the importance of ensuring that investment in R&I activity made a difference to the rail industry and its customers through more extensive and rapid take-up of innovation.

⁶⁵ Firm evidence of the extent of economies of scale in rolling stock manufacture is limited. However, analysis of rolling stock production in Australia by Deloitte Access Economics indicates that a quadrupling of the size of an order from, say, 40 to 160 vehicles can result in a reduction in vehicle unit cost of around 50%. See Deloitte Access Economics (2013), Opportunities for greater passenger rolling stock procurement efficiency, September 2013, available at: <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-passenger-rolling-stock-procurement-efficiency-opportunities-270913.pdf>

4.2.2. *Uncoordinated and limited participation in R&I*

Complex technical interactions between subsystems (infrastructure, rolling stock and signalling) and non-coordinated contribution of the railway actors (equipment manufacturers, railway undertakings and infrastructure managers, research community) limit the potential of improving one specific part of the system or the potential of proposing breakthrough solutions that have an impact on the whole system.

Before Horizon 2020, traditional calls for proposals led to formation of ad-hoc consortia and one shot demonstration projects, without all relevant market players with a commitment of implementation. Moreover, consortia frequently failed to include passenger and freight operators, notwithstanding the need to ensure that R&I activity took account of market needs.

The past set-up of EU rail R&I had limited direct leverage of EU funding. The average share of private sector funding for the FP7-Transport was only 34%, and only three projects obtained more than a 40% contribution from private sector participants. In addition, only 28% of rail projects funded under FP7-Transport were coordinated by private companies, while 43% were coordinated by university and other research organisations. This resulted in greater emphasis on projects targeting relatively low TRLs (pre-competitive research at TRL 1-3) rather than development and demonstration projects (TRL 4-7).

S2R JU shows the added value of a better representation of the whole value chain, creating continuous collaboration of partners beyond single projects, resulting in growing confidence among partners and, in many cases, greater market uptake. It runs a R&I Programme of a value of EUR 920 million, which is delivered by the European rail industry at large that contributes with own financial resources, resulting in a net contribution of EUR 470 million. The Union contribution is EUR 450 million. The leverage based on direct costs is 1 Euro funding creating 3 EUR of R&I activities.⁶⁶

The results of the consultation activities undertaken as part of this impact assessment confirm the importance of more active participation from a range of stakeholders, bringing different capabilities and a balance of perspectives. While each group has a key contribution to make, they face different incentives and constraints; therefore, operating in isolation, in the absence of a European coordination mechanism, they may be unwilling or unable to contribute in ways that maximise the efficiency and effectiveness of available R&I resources.

4.2.3. *High R&I costs, risks and lead times*

Generic innovation risks are in the rail sector intensified by the need for synchronicity between innovations. Long and diverging product lifecycles and lack of modularity, inhibiting the rapid deployment of new rail technologies; unequal distribution of innovation benefits between stakeholders, reducing incentives to invest in new technologies; lack of synergies and common standards with other industrial sectors, especially in emerging technologies.

In addition, unequal distribution of the benefits of innovation can undermine incentives to invest. Moreover, both infrastructure managers and rail operators become familiar with

⁶⁶ The current S2R JU Members funding rate is 44.44% of their overall total project costs for the indirect action they perform, corresponding to around 33% of the direct costs plus the 25% flat rate for the indirect costs.

application of technologies they have been using for many years such as electric interlocking technology, which is considered reliable and safe, and are therefore reluctant to explore the full potential of digital technology, with its own safety risks. While the prevalence of such an industry mind-set cannot be demonstrated unequivocally, to the extent that it exists it may act to further lower the industry's willingness to invest in R&I.

Furthermore, the interdependency of the different rail sub-systems means that a specific innovation (e.g. Automated Train Operation, signalling) needs to be accompanied by timely innovation in infrastructure or business models, for it to have an impact on the whole system. A Synchronicity between innovations is crucial; an innovation in one sub-system could have negative impacts on other sub-systems if not coordinated properly.

The S2R JU started delivering results breaking down the resistance to change of the rail sector and the rigidity and detachment of the rail-prone standardised/regulatory framework; but major work shall integrate the value chain of innovation to achieve the rapid deployment of innovations.

4.2.4. *Insufficient development of the knowledge base*

Historically, Europe has made a strong contribution to rail-related research, with universities and research-based institutions generating substantial numbers of publications each year. Between 2010 and 2018 China published substantially more research results than any other country, including all the main countries in which Europe's RSI is based. Moreover, while collectively the European Member States account for more publications than China and the US together, the magnitude of research effort in both these countries is sufficient to suggest that the sustainability of Europe's lead in rail research is at risk.

Before Horizon 2020, traditional calls for proposals led to formation of ad-hoc consortia with dissemination and exploitation of results on a project basis, with no links between projects and continuity. Therefore, a significant part of knowledge generated by stand-alone European R&I projects under and before FP7 never found its way to the market. Since rail-related research undertaken today provides the basis for development and innovation in the rail industry in the future, Europe's contribution to the current research effort has implications for the further development and competitiveness of the European RSI⁶⁷. In particular, the number of registered industrial designs and patents generated by the RSI is partly a function of the level of more fundamental research undertaken in the past to which suppliers have had access, either through formal collaboration with research-based organisations or because of a significant in-house research capability. The extent to which the industry can maintain intellectual property of this kind is an important determinant of its technological lead, and hence its competitiveness, in global markets.

4.2.5. *Insufficient alignment and coherence between R&I and standardisation/regulation*

With the TSIs, a strong common technical basis for key rail components has been created at EU level. However there are still significant national divergences as regards operating procedures, safety rules, and components not directly impacting interoperability. If these are not addressed and standardised in parallel with R&I development via a coordinated

⁶⁷ While published research results are, by definition, available to industries around the world, suppliers of rail products and services based close to, and potentially working collaboratively with, leading research organisations in the field are likely to benefit most from the research outputs that they produce.

approach at EU level, they will result in the continued customisation of products to national requirements, again creating complexity, cost and generally discouraging rapid innovation (see above the ERTMS example). Standardisation of rail system applications would not be approached in a coherent manner, and would not lead to new solutions that are interoperable by design and – at the same time – accelerating the market-uptake of such solutions.

Overcoming these issues is particularly important given the potential – and need – to develop and deploy new and European standardised solutions for automatic train operation, signalling, traffic management and freight operations.

A common Reference Functional System Architecture that capitalizes on the work of S2R JU can exploit standardisation opportunities. This European integration through a common understanding of the global performance of the mainline rail system and common application of operations across EU is the necessary step to ensure the achievement of SERA. To continue to build on this approach it is not sufficient to standardise once research results and products emerge. The basic system framework must be defined, through a process involving both manufacturers and operators in parallel with the commissioning of R&I work so that the results can be melded into a coherent whole.

Stakeholder opinion

Widespread recognition of the importance of these problem drivers was reflected in the responses to the Open Public Consultation. A majority of business organisations (including SMEs), business associations, academic and research institutions, public authorities and EU citizens considered the various aspects of fragmentation discussed above to be relevant or very relevant. They also confirmed the lack of a coordinated approach to programming and funding and the need to bring together the research community, the RSI, train operators and infrastructure managers. A majority of all these groups similarly considered the market uptake of innovations to be slow, either because of deployment issues or as a result of the regulatory framework.

4.3. How will the problems evolve?

There are indications⁶⁸ that the market uptake of innovative solutions has been substantially higher since the S2R JU was established and it would fall in case of no action. But in the absence of coordinated action at European level, the needs of the sector will not be met in full and the transformation of the system will not be achieved, as isolated investments in R&I done by RUs, IMs or manufacturers alone cannot ensure that. The problems that impacted the sector before the establishment of S2R JU would return.

In the absence of coordinated and higher level investment in R&I, potentially comparable with the levels achieved in the other sectors, the outputs of R&I projects would be limited as well as their market potential. Necessary improvements in the reliability, cost efficiency and capacity of the European rail network would not materialise, hindering the ability of the sector to deliver better and more cost-effective services, hence becoming more competitive and achieving the increase in modal share vital for delivering the Green Deal objectives. Especially for freight, a sector that, as mentioned above, has over the past 10 years seen a

⁶⁸ Foster Rail (on behalf of ERRAC) (2016), Evaluation of finalised projects with clear understanding of the market uptake mechanism, May 2016

stable modal share, in the absence of action at EU level, research on the communication systems, enhancing the interoperability of IT systems, and ensuring that there is enough capacity in all the routes would most probably not be done. This research would be needed to help rail freight to cope with the challenges faced, such as lower priority than for passenger services, underinvestment in infrastructure and agility and technological innovation in road transport.

If outputs already achieved under Horizon 2020 are taken up across the system, then improvements in life cycle costs could be expected by 2030. Synergies between Horizon Europe and Connecting Europe Facility (CEF) will ensure that the latter supports large scale roll-out and deployment of innovative technologies and solutions also in rail⁶⁹. They will therefore need to be combined with the market uptake assumptions to generate an estimate of actual efficiency gains. Some additional efficiency improvements are likely to be generated through additional R&I activity and investment at the national level, but these are difficult to quantify.

Stakeholder opinion

Stakeholders participating in the interviews tended to support the view that the lack of progress in addressing issues such as fragmentation and inadequate coordination of R&I activity observed before Horizon 2020 would be likely to remerge in the absence of significant further policy intervention during Horizon Europe. Similarly, stakeholders providing feedback on the inception impact assessment tended to suggest that the problems identified in the document would be likely to persist in the absence of policy intervention.

⁶⁹ In June 2018, the European Commission, as part of proposals for the next long-term budget (2021-2027), proposed adapting the CEF programme to support investment in Europe's transport, energy and digital infrastructure networks. A provisional agreement was reached by co-legislators in March 2019.

5. WHY SHOULD THE EU ACT?

5.1. Subsidiarity: Necessity of EU action

In the absence of a rapid cross industry agreement on the preferred approach to new technology (including standardisation and/or inclusion of innovations in the TSIs it is essential to avoid that divergent solutions are adopted at national level, breaking interoperability and preventing the cost advantages delivered by common EU product specifications. An inclusive governance system at the R&I stage is required to ensure the broad industry acceptance of the developed technologies.

R&I funded at the national or organisational level, while potentially contributing to the broader development of the European rail system, is unlikely to enable the rail industry to meet European transport and broader policy objectives, advance the completion of SERA by delivering on an integrated and sustainable rail system, and lead to better and more cost effective services for passengers and businesses, as well as to an increased modal share of rail. The overall result would be a rail system whose performance will be stretched, jeopardising years of investments and action and unable to meet expectations stated in the Green Deal. There can be no Green Deal in terms of Decarbonising transport goes hand in hand with railway taking on more traffic, and for this performance and capacity have to increase more than incrementally.

Similarly, without EU action, the European Rail Supply Industry is unlikely to be able to compete in international rail product markets against suppliers based in China and other third countries actively building their indigenous rail sector capability, including through major R&I programmes.

Stakeholder opinion

Among stakeholders responding to the Open Public Consultation there was widespread recognition of the problem of fragmentation and lack of effective coordination of R&I activity underpinning the case for intervention at the European level. Stakeholders participating in the interviews and providing feedback on the inception impact assessment were also generally fully supportive of EU action to address these and other aspects of the problem.

5.2. Subsidiarity: Added value of EU action

A European integrated and complex network like rail needs a European answer: only through jointly performed rail research and innovation at Union level it will be possible to break national silos, converge on operational concepts, introduce digital technologies that will integrate local systems, create a common baseline on which to build new solutions and integrate with other modes of transport, commingle the resources to move away from 150 years old concepts and deliver an ambitious rejuvenation of rail. This should benefit from a joint effort led by Union policy to enable collaboration among actors from across Europe and along the value chain to define an integrated programme mirroring the needs of a complex system designed to address market needs, and enable a fast and targeted delivery on the objectives.

R&I at Union level would bring together the know-how of the sector reducing the overall costs in two important ways. First, it would allow pooling of resources available for R&I, thereby reducing the potential for competing and conflicting projects focusing on the needs of national networks (and tending to reinforce the geographical fragmentation of the sector). Second, it would encourage the RSI to develop products and systems that further enable the development of a fully integrated European rail system, thereby advancing the creation of a single European market for equipment and allowing them to exploit economies of scale in production more effectively.

Another aspect to be considered is that the rail sector in the different Member States, and especially SMS in South-Eastern Europe, have very different needs and are mostly concerned about meeting their basic connectivity needs (upgrading infrastructure) and focus less on R&I than the other Member States. It is important to understand these differences and apply different measures to bring EU rail systems to the same level, some of which would not be within the scope of the proposed initiative (e.g. funding and financing from EIB, CEF, ESIF); all Member States should participate in demonstrations of innovative solutions developed under this initiative.

6. OBJECTIVES: WHAT IS TO BE ACHIEVED?

6.1. General objectives of the initiative

Based on the identified problems, the following general objectives have been defined:

- The first general objective is that rail-related R&I activity under Horizon Europe should enhance rail's contribution to societal development in Europe through:
 - Support the delivery of the European Green Deal, partly by further reducing the emissions generated by the rail transport industry itself but more importantly by improving the attractiveness of rail services relative to less environmentally friendly modes (such as road and aviation) and thus enhancing air quality;
 - Supporting rail's contribution to improving the quality of life, in particular with a view to increasing connectivity, within and between Member States, by offering efficient, attractive and affordable transport services.
- The second general objective is to advance the completion of the Single European Railway Area by delivering on an integrated rail system. This would be based on a vision shared by the sector towards improved operational reliability, robustness and

efficiency, and secure the sustainability of business models for the European passengers and the freight logistic value chain. It would create a larger market for rail products and reduce costs.

- The third general objective is modernising rail freight so that it increases capability and capacity. Rail freight needs to become digital, for increased efficiency and reliability, and to be fully integrated in the logistic value chain.
- The fourth general objective is to ensure that rail-related R&I activity is better aligned with rail market needs through a user-centric approach. This will mean designing a R&I programme that delivers outputs addressing specific issues identified by rail operators, infrastructure managers and other stakeholders through a whole integrated system of systems approach, thereby delivering better performance in terms of efficiency of rail services and increasing their attractiveness to passengers and freight customers.

These objectives are fully in line with several of the SDGs⁷⁰ supported by the Climate, Energy and Mobility Cluster, including SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

6.2. Specific objectives

In order to achieve the general objectives, five specific objectives are defined. These specific objectives respond to each of the problem drivers discussed in Section 2.2. The list of specific objectives is the following:

- Eliminate barriers to interoperability and provide solutions for full integration, covering traffic management, vehicles, infrastructure and services, in order to deliver a high capacity integrated European railway network. By exploiting the huge potential for digitalisation and automation, innovative solutions will be developed to reduce rail's costs, increase capacity, and enhance its flexibility and reliability.

The above should be based upon a solid Reference Functional System Architecture⁷¹ shared by the sector, which main part is currently under development within the S2R JU together with the sector, and in coordination with the European Union Agency for Railways (ERA).

- Increase R&I activities related to rail freight and intermodal transport services, to deliver a competitive green rail freight fully integrated into the logistic value chain. Automation and digitalisation of freight train is the core, but also its operations, yards and intermodal terminals based on real time data are areas which require further R&I.
- Deliver a sustainable and resilient transport system: by developing zero-emission, silent railway system and resilient infrastructure, applying circular economy to the rail sector, and complementarity with the overall transport system.

Establish an ecosystem that facilitates interaction between stakeholders and makes cooperation within and across value chains more efficient. This will ensure that that

⁷⁰ European Commission International Cooperation and Development (2019), The Sustainable Development Goals – available at https://ec.europa.eu/europeaid/policies/sustainable-development-goals_en

⁷¹ A shared and guiding Reference Functional System Architecture includes all structural rail subsystems and their functionalities (i.e. control command and signalling, rolling stock, energy, infrastructure, etc.) and identifies the necessary interfaces and interdependencies to ensure the System maximize its performance.

research is translated into market focused innovation through demonstration and deployment.

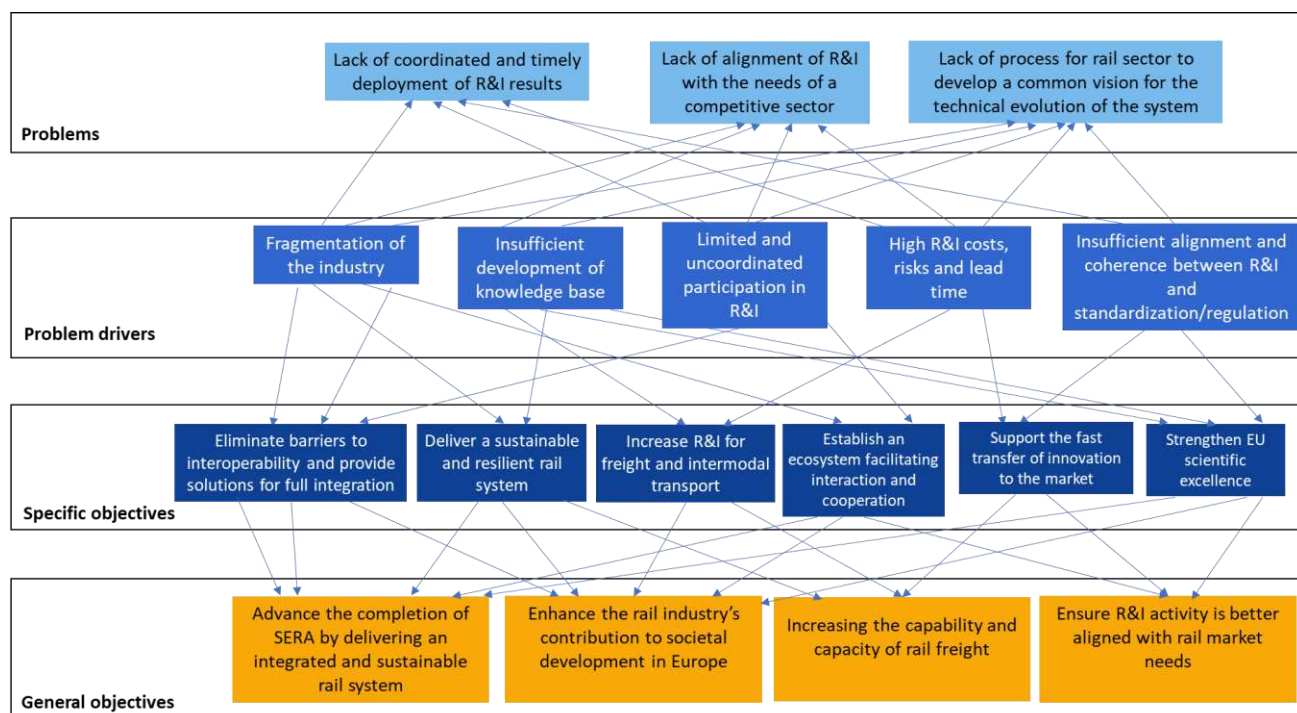
The administration and procedures for participation in the initiative would be simplified to make it accessible and attractive to new organisations. The target is to streamline administrative practices to sensibly reduce the complexity, eliminating any double EU and national intervention at all level of the operations (proposals, projects, audits).

- Launch large-scale projects supporting the fast transfer of innovation to the market. This specific objective would support large scale projects, such as demonstrations that bring together technology suppliers and users. These actions mobilise a high volume of resources and require the combination of public (European and national) and private resources under a common scheme. Large-scale projects bring specific value to the implementation of a long-term strategic planning and, by combining resources, help reducing the risks of R&I investment for organisations within the RSI and the broader rail transport sector seeking to develop and deploy new products and services. Exploiting standardisation and modularity opportunities, and facilitating the interfaces with other modes and systems would open the door to new business opportunities and contributing maintaining the leadership of the European supply industry.
- Strengthen EU scientific excellence and exploit the innovative potential of SMEs and start-ups. This would ensure achieving an advanced scientific knowledge base that could guide the development of required policy measures and technologies essential to catalyse the transition to a climate-neutral emissions economy and society. To stimulate the participation of SMEs and start-ups, efforts to simplify the administrative requirements linked to participation – with respect to those of the current partnership - will be important.

6.3. Intervention logic of the initiative

The relationship between the general and specific objectives of the potential initiative on Transforming Europe's rail system is shown in Figure 4.

Figure 4 - Intervention logic for the initiative for Transforming Europe's Rail System



How would success look like?

Should the initiative deliver on its specific objectives, it is expected that it would translate in practice into the following impacts:

Scientific impacts

- A strengthened pipeline of potential innovation available to the rail sector
- Deliver scientific results breaking down the current operating limitations
- Development of the knowledge base
- A new generation of “rail” engineers and scientists coming from different fields
- Ideas that would challenge current systems and a new thinking

Future rail research and innovation activities delivered through the partnership would contribute to scientific knowledge connecting the European research and scientific rail community with others and through the publication of results. Given the participation of a wide range of stakeholders with complementary skills and capabilities, coupled with appropriate peer review mechanisms, this would enable the development of a strong science base in the field.

Moreover, these activities would provide opportunities for research staff located in both the rail sector and academic and research institutions, and could also contribute to building relationships between universities and research-based institutions and the industry, including formal organisations and informal networks. This would result in an increase in the overall number of high-quality jobs across the European economy.

Further, R&I activity at TRL 1-3 is particularly important in generating new ideas that could have practical applications in the future. The activities covered by the S2R JU's IPX on system architecture indicate some areas that might be investigated further under Horizon Europe. These include for example the use of block chain technology in the management of

remote condition monitoring data. There is a need to move away from the high cost evolutive maintenance of the sector to a virtuous cycle of R&I, where rail becomes permeable to the introduction of new solutions and ideas.

Stakeholder opinion

Among the respondents to the Open Public Consultation a majority of business organisations (both large organisations and SMEs), business associations, academic and research institutions, EU citizens and public authorities considered the creation of new scientific knowledge and capabilities by the candidate institutionalised partnership for the rail sector to be relevant or highly relevant. Most of these groups also expected the partnership to create high quality jobs in the sector, although public authorities were less persuaded of the importance of this impact.

Economic/technological impacts

- An increase in rail's modal share of passenger and freight markets
- An improvement in the competitiveness of the RSI
- An increase in rail industry direct and indirect employment
- Creation of new business models and opportunities for the rail stakeholders

Overall, this initiative would lead to a more customer-oriented and market-focused delivery of R&I and to an improvement in the competitive position and market share of rail services in European transport markets, including both passenger and freight markets, and an improvement in the global competitiveness of the RSI.

Should the initiative be successful, the future generation of rail operations and services will create value for the stakeholders as well as for the users of the rail systems. A performance based approach in the revenue apportion should be re-considered and should also result in reducing the public budget envelope invested by Member States annually in each rail system, estimated at EUR 40 billion per year.

It would also encourage greater involvement of SMEs, who have the flexibility to develop innovations and bring them to market relatively rapidly, and of technology-based organisations outside the rail industry, including start-up, who can increase industry awareness of emerging technologies with potential applications in rail.

The initiative would also provide a platform for planning the progression of R&I activity through the TRLs, with the development of internal strategic plans defining the transition from fundamental research, through the development stage, to demonstration and offering to the sector migration plans for future deployment, outside its remit. Finally, it will enable a more effective leveraging of the Union funding, since stakeholders would be more confident of the potential returns from supporting the initiative if their contribution is part of a collaborative effort reflecting differences in capability and expertise.

Societal impacts

- Reductions in the environmental impacts of transport
- Improvements in the safety, security and health of EU citizens
- Affordable and accessible mobility and connectivity

The initiative would be particularly important in achieving sustainable development goals, since a significant increase in the modal share of rail (especially for freight) would reduce

the demand for less environmentally friendly forms of transport (such as road). In addition, an increase in R&I activity focused on rail freight and intermodal transport is expected to have broader societal impacts, leading to innovations that enhance the attractiveness and accessibility of these services for existing and potential users.

Environmental impacts

Given that rail transport already has a good environmental impact, much of the additional positive environmental impact of R&I would be achieved through making rail more attractive (for both passengers and freight) and thus attracting traffic volume from less sustainable modes of transport.

It is not about rail, whose energy and climate neutrality performance are out of reach for many other modes of transport, it is about making rail more attractive (for both passengers and freight) thus interacting and integrating with other modes of transport to transfer volumes and maximize the overall environmental performance of mobility and transport.

R&I activity focused on various elements (including interfaces of rail with other modes) has the potential to improve the quality of the urban environment in several ways. In particular, the provision of a more integrated transport network including cities across Europe would reduce the need for car travel, reducing congestion and improving air quality while contributing to target reductions in greenhouse gas and other emissions, and noise.

Similarly, greater innovation in the rail freight industry, suitably focused on the needs of the industry's customers, could substantially increase service quality, in such a way that logistics companies and shippers would consider rail as an alternative to road across a much wider range of markets and distances than at present. This effect would be reinforced if innovation also improved the efficiency of freight services and require to include non-rail actors to achieve it. Taken together, these effects could significantly reduce the level of road freight traffic, particularly on inter-urban and inter-regional routes, thereby contributing to a reduction in greenhouse gas and other emissions, and noise.

Social impacts

By putting a greater emphasis on the integration of national, regional and local rail systems with other modes, including through the development of collective transport systems that combine conventional rail with new services such as flexible mobility, the initiative would greatly improve connectivity within and between Member States. This would benefit EU citizens, including persons with reduced mobility (PRMs), by enabling greater freedom of movement, notably for those living in peripheral regions and remote locations whose journey opportunities would otherwise be limited.

Enhancing connectivity would provide access to a wider range of opportunities for employment, education and leisure. It would similarly promote the broader well-being of the citizens, for example by improving air quality. In addition, given the extent that R&I activity is directed towards improving the safety and security of collective transport services, users of such services would benefit from a safer travelling environment and reductions in the level of service disruption. Further, the increase of the efficiency and reduction of costs would make travelling by rail more affordable and accessible to everyone and hence increase its social inclusiveness and attractiveness compared to other modes.

6.4. What is needed to achieve these impacts – Key functionalities needed

Given the focus of the impact assessment on comparing different forms of implementation, the identification of “**key functionalities needed**” allows making the transition between the definition of the objectives and what would be crucial to achieve them in terms of implementation. These functionalities relate to the type and composition of actors that have to be involved, the type of range of activities that should be performed, the degree of directionality needed and the linkages needed with the external environment.

6.4.1. *Type and composition of the actors to be involved*

Inclusion of the full range of rail stakeholders, and some key actors dealing interfacing with rail, is essential to leverage all relevant expertise and capability, and result in R&I outputs that address a broader set of needs than in the past, for transforming rail’s system architecture, increasing emphasis on freight and digitalisation and enhancing focus on deployment of innovative solutions. A comprehensive and balanced representation of the sector (also geographically) would also facilitate the broad acceptance of the solutions developed. The main categories of stakeholders that should be involved are:

- The operating community: European rail infrastructure managers, Rail Undertakings;
- Manufacturers of rail systems or components, contractors and service providers (e.g. maintenance activities) covering the full spectrum of the value chain, from SMEs to large integrators;
- More SMEs and start-ups which can introduce agile innovation within the rail system, including those coming from different domains of activity;
- The Scientific Community;
- Freight forwarders and logistic service providers;
- EU standardisation bodies (e.g. CEN, CENELEC and ETSI) to act on the outcomes of research and innovation activities generated by the partnerships to facilitate the evolution of EU regulation, and to anticipate standardisation activities that can accelerate the market uptake and remove barriers.

There may also be a need to change the profile of stakeholder participation, as well as the geographical diversity, for example by more flexibility in the rules governing participation to ensure that specific gaps in expertise can be filled effectively and efficiently.

The initiative would require the long-term commitment of participating stakeholders to deliver solutions ready to enter industrialisation, operations and deployment. As explained above, a wide range of actors in the rail system, from across the rail supply industry and operational sectors should participate, in order to develop a “system of systems” approach, and that stakeholders familiar with the outputs of, for example, a given development project have a role in the subsequent demonstration programme to achieve a substantial impact during the next decade.

A series of stakeholders, members as well as non-members of the current S2R JU, already expressed their commitment to contribute (also financially) to a future initiative on rail R&I. Further, sectoral association expressed in position papers their support for the initiative.

While the initiative is industry driven, particular attention will be paid to the cooperation with Member States, which is important not only for the fast implementation of the developed solutions but also for avoiding duplication and create more synergies between activities at national and European level. The participation of state-owned companies will ensure the leverage of some national programmes. Special focus will be put on promoting further participation of stakeholders from EU-13 for example through Large Scale Operational Demonstrations.

6.4.2. *Type and range of activities needed*

The initiative should be a catalyst to address present and future challenges in the transport sector and improve mobility across Europe.

The initiative aims at transforming rail's system architecture, increasing emphasis on freight and digitalisation and enhancing focus on deployment of innovative solutions. Focus on these areas at the level of the partnership is vital since deployment of innovation affecting the *systemic* elements of rail (as opposed to improvements in individual components/vehicles) requires many or all actors in the rail system to make coordinated changes – otherwise trains and track no longer work together, or interoperability between different lines is lost. Such coordinated change is only possible where the industry has collectively agreed on the way forward. As explained above, development of rail freight is a key element of the Green Deal – but the economic performance of the sector is currently poor, so investment in innovation unattractive on a purely commercial basis: hence again the need for EU Partnership intervention.

The following will be particularly important in meeting the identified general and specific objectives:

- Automatic Train Operation (ATO), boosting safety and capacity and resulting in significant (up to 30%) energy savings, deployed in different forms from unmanned vehicles to unmanned self-driving systems;
- New traffic management systems, which maximise performance by allowing trains to run together as effectively as possible through optimising the speed and movements of trains on the network. In particular it should boost the reliability of very long distance trains – in particular those running internationally – and enhance the ability of networks to recover from disruption;
- Control Command Signalling harmonisation at European level – bringing the sector together to develop the operational concepts for passenger and freight services, functions driven by one shared system architecture, and associated specifications and standards, subsuming and replacing previous initiatives;
- Further exploration of the benefits of relevant technologies, for example 5G, digital maintenance, automation, cybersecurity, the realisation of which can be expected to both increase the efficiency and competitiveness of European rail sector and strengthen the technological lead of the European RSI;

The development of technologies supporting a step change in the competitiveness of the rail freight sector, such as management of integrated information to enhance the

customer experience, remote monitoring of the cargo environment, automated loading and unloading and remote monitoring of wagon condition⁷².

The delivery of these activities would require coordination across the TRLs, with work focused on industry and market needs, and focused demonstration activities designed to provide robust evidence of the potential benefits of innovations for users and providers of rail services. It has to be noted that, in the context of the European RSI, SMEs manufacture mostly rail components. A higher TRL would foster the SMEs participation in the initiative, since the results of their research activities would be more likely to be taken up by large manufacturers and system integrators.

It would also be important to establish links with other, related fields of research and associated policy interventions, for example through the specification of joint R&I programmes funded under two or more initiatives with a common focus on a particular field of research or technological application.

6.4.3. *Priority setting system and level of directionality required*

The initiative should enable or support the following:

- Alignment of the R&I strategy with EU policy objectives: the initiative should support the completion of SERA, in particular through the development of a long-term shared vision of an integrated European railway system: the further development of Europe's railways would need to be based on a whole-system approach to investment, cutting across the various interfaces, which recognises the long-lived nature of railway assets.
- Maximum leverage of available resources: the initiative will also need to ensure that limited resources available for R&I are used as efficiently as possible, and that EU funds are supplemented by financial and/or in-kind resources provided by the RSI, the rail transport industry and technology-based organisations from outside the rail sector.
- An implementation approach with a strong and committed governance led by the Union, and with an inclusive participation. This would also require to define the procedures that would allow an efficient and effective implementation. Transparent decision-making and visibility of outputs: the initiative must be supported by decision-making processes that involve all relevant stakeholders and ensure clear accountability for results. It will also need to be subject to clear rules governing intellectual property, striking a balance between protecting organisations making substantial investment in R&I and ensuring that the outputs of individual projects are sufficiently visible to enable further development and high rates of market take-up.
- Dialogue at the national and international level: the initiative must enable effective dialogue between those engaged in R&I activity and those responsible for rail policy and regulation at the international and national level (including international standards bodies). Efforts should be made to ensure a robust and effective participation of Member States and organisations from EU-13.

⁷² See, for example, Rail Freight Forward, 30 by 2030: Rail Freight Strategy to Boost Modal Shift, available at: <https://www.railfreightforward.eu/about-rail-freight-forward>, for a discussion of how digital technology, together with other factors, could increase the modal share of rail freight to 30% by 2030.

6.4.4. *Coherence needed with the external environment*

In order to maximise complementarities and synergies with all concerned sectors, clear and strong collaboration with other initiatives and EU programmes is key in order to reach the expected impacts.

The following provide an illustration of the possible synergies between R&I in rail and other areas:

- Application of digital technology, starting from improving the functionality of ERTMS.
- Exploring complementarity with road, maritime and air transport –exploit the benefits of different modes at different stages of the journey and minimise environmental impacts.
- Exploiting developments in battery and fuel cell technology and other forms of power that has applications in different parts of the transport sector. It is important that the potential benefits for rail of further developments in different sources of power are fully explored. There could be scope for joint programming of R&I activity with the Batteries partnership, recognising the potential for greater use of battery and hydrogen fuel cell technology to reduce the need for investment in electrification of rail infrastructure.
- Synergies with other programmes and initiatives would be needed, in particular: the Digital Europe Programme (DEP) that will focus on reinforcing Europe's capacities in high performance computing, artificial intelligence, cybersecurity and advanced digital skills and ensuring their wide application across the economy and society.
- Synergies with other funding sources and financing mechanisms that would support innovation in particular the Connecting European Facility (CEF) for deployment of the innovative solutions.
- Synergies with the European Regional Development Fund (ERDF) and Cohesion Fund (CF) in order to increase economic and social cohesion and reduce imbalances.
- Global synergies related to new emerging and non-traditional land transport technologies such as hyperloop, hyper-speed maglev, pods' concepts, etc. where experience is shared at global level to accelerate possible future new business models and services that can revolutionize transport and mobility, while maintaining a European know-how competitive edge.

7. WHAT ARE THE AVAILABLE POLICY OPTIONS?

This section describes the specific functionalities that could be provided under the baseline scenario of traditional calls and the different options of different types of European partnerships.

7.1. What is the baseline from which options are assessed?

The baseline scenario used in this impact assessment is a situation without a Partnership and only traditional calls of Horizon Europe. Given that there is a predecessor Partnership as well as other funding sources in the area, these will continue generating effects even if there is no new Partnership. In particular it is expected that these already existing initiatives will still create effects on the ongoing evolution of the rail system, the digitalisation of the sector and the ongoing efforts to meet the EU Green Deal objectives. However, in the absence of a new Partnership, these benefits would be limited in time and their scope is going to be significantly reduced. This is taken into account in the effectiveness assessment.

In parallel, the baseline situation means that the current implementation structure of the Article 187 would be closed, which bears winding down and social discontinuation costs. There would also be financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. This is taken into account in the efficiency assessment.

Table 2 - Key characteristics of the baseline – Option 0

	What is feasible under this option - Functionalities of option
Enabling appropriate profile of participation (actors involved)	<ul style="list-style-type: none"> • The Commission would need to prepare or delegate the preparation of the Strategic Research and Innovation Agenda (SRIA) consulting extensively with a wide range of stakeholders to translate the strategic R&I agenda for rail into annual work programmes. • There would be no formal and financial commitment from partners to jointly develop and implement the Programme defined in the SRIA. • A well-defined process would be needed to ensure that the Programme Committee responsible for mobility was properly informed about R&I priorities, including key demonstration programmes. • An evolving profile of participation would be needed, with different consortia forming at different stages to take different types of activity forward, in order to maximise the expected outputs.
Supporting implementation of R&I agenda (activities)	<ul style="list-style-type: none"> • Implementation would rely on standard infrastructure underpinning the procedure of calls under the work programme, drawing on resources of relevant executive agencies and Commission IT systems. • Calls for proposals would be part of the work programmes of Horizon Europe. • Transparency and open publication of results would ensure their availability to interested parties. • Dissemination of knowledge and share of practice would happen predominantly among partners within the project consortia. • Uptake of outcomes into technical specifications for interoperability (TSI) and rail standards would happen sporadically and be heavily dependent on the objectives and quality of results of individual projects. • Contribution to the systemic and integrated transformation of the European rail sector would depend on the level of participation in and quality of individual projects.
Ensuring alignment with R&I agenda (directionality)	<ul style="list-style-type: none"> • The governance structure and the lack of formal commitment from private partners would not fully enable the implementation of the long-term vision defined in the SRIA. Specification of calls for activity at higher TRLs, particularly demonstration programmes, would need substantial input from industry. • Calls would need to take into account the results of the S2R JU to ensure continuity where appropriate. • R&I activity would focus on the short to medium term needs of the sector in alignment with the EU policy objectives, although it would also include fundamental research. • Commission input into specification and oversight of calls would help to ensure alignment with overarching policy objectives but full integration with other programmes would require additional coordination.
Securing effective leveraging of resources (additionality)	<ul style="list-style-type: none"> • Progress of R&I effort would depend largely on EU funding, with no expectation of significant leveraging of industry support. • Given more limited funding than in the past, critical R&I priorities would need to be identified at the outset.
Key differences compared to the current situation	<ul style="list-style-type: none"> • No formal and financial commitment from private partners to implement the long-term vision defined in the SRIA. • Limited participation based on the composition of ad hoc consortia for specific projects. • Sporadic translation of projects results into standards and TSIs. • Piecemeal approach to R&I (as opposed to the current systemic approach). • Lack of long term vision for the transformation of the European rail system. • Increased reliance on EU funding as a result of limited leveraging of industry support.

- Limited synergies with other Partnership and EC Programmes (e.g. CEF).
- Sector fragmentation due to the creation of barriers between different rail segments, undermining the overall performance of the network
- Long term phasing out of national barriers undermining the contribution of rail to the Union policies, in particular the Green Deal.
- Increasing operational cost of the rail systems to the detriment of public budget and finances

7.2. Description of the policy options

Option 1 - Co-programmed European Partnership

Table 3 - Key characteristics of Option 1

	What is feasible under this option - Functionalities of option
Enabling appropriate profile of participation (actors involved)	<ul style="list-style-type: none"> • The option would encourage participation of some key stakeholders committing to jointly support the development and implementation of a R&I programme based on common strategic R&I agenda. • It would need to consult with a wide range of stakeholders to ensure that the R&I agenda, and ultimately the work programme, was aligned with industry and market needs. • It would offer some degree of flexibility to change the profile of participation) over time, thanks to the possible leading role of sector Associations, with new partners joining in response to emerging results and changing priorities.
Supporting implementation of R&I agenda (activities)	<ul style="list-style-type: none"> • Implementation of EU funded R&I agenda would rely on standard administrative infrastructure underpinning the calls under the work programme procedure, drawing on resources of relevant executive agencies and Commission IT systems. • Calls for proposals would be part of the work programmes of Horizon Europe. • Partners would implement their additional activities separately. Sector Associations could provide back-office with relevant functionalities to run the Partnership under Horizon Europe standard implementation would ensure transparency and open publication of results for the interested parties.
Ensuring alignment with R&I agenda (directionality)	<ul style="list-style-type: none"> • The governance structure and the formal commitment from private partners could enable the implementation of the long-term vision defined in the SRIA, provided that a wide range of partners join the Partnership. • Work programmes would need to reflect the requirement for R&I activity across TRLs, with input from the various partners to achieve an appropriate balance of activity directed towards different markets (e.g. freight transport). • The partnership would be responsible for ensuring that priorities for calls were specified in line with R&I priorities, including demonstration programmes. • R&I activity would be likely to focus on the medium-term needs of the sector combined with EU policy priorities. • Programme Committee responsible for mobility or similar configuration would have important role in ensuring alignment with overarching policy objectives and coordination with related programmes. • Limited participation from sector's partners could result in limited efficiency to develop outputs that would be rapidly applied across the network.
Securing effective leveraging of resources (additionality)	<ul style="list-style-type: none"> • Aspirations for partner contributions would be clearly defined at the outset in the contractual arrangement. • In-kind commitments from private partners are expected to match Union contribution. • Expected in-kind contributions from the private sector would be identified in the work programme.

Key differences compared to the current situation

The Co-Programmed partnership (Option 1) would entail the dismantling of the current S2R JU with the following consequences:

- The implementation of a common vision and ambitious objectives in the area would be less efficient and take longer (if a common vision could be developed at all);
- The basis for R&I cooperation under a stable structure would disappear;
- Large scale R&I actions (pilots, platforms) could not be implemented, affecting the coverage of TRL 5-8 and diminishing the impact of the initiative;
- EU support to the area would move from a shared long-term commitment with the industry to a full financing by the EU, with a much lower volume of resources available;
- Combined European/national public funding of actions would not be possible;
- Winding down and discontinuation costs of the current S2R JU (see rationale at Section 8.2 - Efficiency)

Option 2 – Institutionalised European Partnership under Article 187 TFEU

Table 4 - Key characteristics of Option 2

	What is feasible under this option - Functionalities of option
<p>Enabling appropriate profile of participation (actors involved)</p>	<ul style="list-style-type: none"> • The option would enable participation by all key stakeholders to jointly support the development and implementation of a programme of research and innovation activities contributing to the specification and delivery of the SRIA. • In order to increase the use of results in national contexts, the rail operating community should contribute to the definition of needs, specifications, requirements, and interfaces together with the rail supply industry and research community. • This option would enable the development of high-TRL solutions closer to the market, thus fostering SME’s participation in the Programme, since the results of their research activities are more likely to be taken up by large manufacturers and system integrators. • The governance structure would allow the delivery of sector’s needs and EU policy objectives. It creates an interface for consulting stakeholders on R&I priorities and the work programme in a transparent, structured and targeted manner, ensuring that they are aligned with industry, research and market needs and with the agenda of other partnerships and sectoral programmes. • Becoming a partner/member would be less flexible than under other options, but it might nevertheless be possible to change the profile of participation over time, with new partners joining to support new areas of activity in response to emerging challenges and evolving priorities. • The definition of an integrated R&I Programme looking at internal and external interfaces would attract rail actors of all segments who will find their needs answered. An agile approach should be put in place to address the needs of the beneficiaries to achieve an ambitious programme. • The definition of the shared vision driven by the Union mobility and transport policy based on a functional system architecture will attract the participation of sector representatives setting the basis for a more delivery oriented R&I Programme.
<p>Supporting implementation of R&I agenda (activities)</p>	<ul style="list-style-type: none"> • A dedicated administrative structure would be established to coordinate the specification of R&I activity, manage implementation and report on the results (with administrative expenditure subject to rules relating to its level and distribution). This could be mitigated through the use of existing structure under S2R JU and the setting up of a joint back office for a number of JUs. • Calls for proposals would be published broadly by the administrative structure allowing efficient coordination among stakeholders. • Transparency and open publication of results would ensure their availability to interested parties. • The creation of a community of stakeholders, with potential diffusion activities managed by the partnership structure would enable the share of knowledge and practices. • The interface with national authorities, ERA, European and international standardisation bodies would ensure that results would enter properly the pipeline of regulatory or

	<p>standard framework for market uptake and impact.</p> <ul style="list-style-type: none"> • An Institutionalised Partnership would make full use of available financial instruments within the limits of the Horizon Europe and of the Partnership Basic Act, building on the experience of the S2R JU (e.g. the use of the lump sum model, prizes, etc.). • Dissemination and communication activities will be not limited to typical inwards project events, such as in H2020 or future HE programme, but resources would be commingled to leverage a common investment and connect with other sectors and modes. • The administrative structure would become the single coordinating body to converge the sector together towards a shared vision on concept of operations, ensuring a sector-driven action led by the Union policies towards a major transformation of railway.
<p>Ensuring alignment with R&I agenda (directionality)</p>	<ul style="list-style-type: none"> • Based on the long-term joint agenda, the partnership would be responsible for defining a work programme fully in line with the R&I priorities identified by the industry, combining activities across the TRLs (including key demonstration programmes) and in different areas (e.g. freight transport). • In order to achieve a balanced approach between blue-sky and applied research, the Institutionalised Partnership would have the mandate and resources to allow for the completion of the R&I cycle, including industrialisation of innovative solutions. • The work programme would reflect the medium to long term needs of the sector aligned with EU policy priorities, drawing on the perspectives of different stakeholders. • The work programme would build on, but not be constrained by, the current programme to ensure continuity where appropriate. • Commission participation in the partnership governance arrangements and approval of the work programme would help to ensure alignment with overarching policy objectives and enable integration with other programmes.
<p>Securing effective leveraging of resources (additionality)</p>	<ul style="list-style-type: none"> • Legally binding funding requirements would be clearly defined at the outset, with private sector partners expected to provide a substantial part of the resources through in-kind and/or financial commitments. • An institutionalised partnership would allow investments for long-term research with the medium or high risk of failure. Also, it would help to recruit and maintain research teams for research activities with a medium or high risk of failure. • An institutionalised partnership would allow a structure aimed at the deployment of innovation. In particular, strong coordination with the CEF Programme would help filling the qualitative gap to move from TRL 7 to full deployment. • An institutionalised partnership would allow reducing the overall cost of bringing research and innovation to the market, as it would involve in its processes ERA and standardization bodies.
<p>Key differences compared to the current situation</p>	<ul style="list-style-type: none"> • The administrative structure of S2R JU would be taken over by the new institutionalised partnership. • Governance, administrative procedures and practices will be adapted as to ensure that operations are as transparent and efficient as possible. • The governance structure would reflect the enhanced need for a systemic approach e.g. by including a system pillar steering group.

7.3. Options discarded at an early stage

The co-funded partnership and an institutional partnership created under Article 185 of the TFEU are not considered relevant for the impact assessment of the Transforming Europe's Rail System partnership. This is because of the need to secure the engagement of private sector and other commercial organisations in the co-funding, programming and delivery of R&I, not least because of the key role of such organisations in both the delivery of rail services in Europe and the supply of rail-related products and services in global markets. As the only forms of partnership in which the private sector can participate are the co-programmed partnership and the institutionalised partnerships established under Article 187,

the analysis in the following section is restricted to a comparison of these options with the baseline option of calls under the Work Programmes of Horizon Europe.

8. HOW DO THE DIFFERENT POLICY OPTIONS COMPARE TO ACHIEVE THE EXPECTED IMPACTS?

Based on the objectives pursued by the initiative and the key functionalities identified to be able to achieve them, each option for implementation is assessed in terms of effectiveness, efficiency and coherence compared to the baseline scenario of traditional calls. The analysis is primarily based on the degree to which the different options would cater for the key needed functionalities. All options are compared to the baseline situation of traditional calls, which is thus consistently scored at 0 to serve as reference point.

8.1. Effectiveness

To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into ‘expected impacts’ - how success would look like -, differentiating between scientific, economic/ technological, and societal (including environmental) impacts. This section considers to which extent the different policy options would allow delivering these expected impacts – confronting what is needed (functionalities) with what each form of implementation can provide in practice. The assessments in this section set the basis for the comprehensive comparative assessment of all retained options against all dimensions in Section 6.4, based on a scoring system⁷³.

Scientific impact - Creation and diffusion of high-quality new knowledge, skills, technologies and solutions to global challenges

Under the **baseline option** of traditional calls under Horizon Europe the volume of publications from European universities and research-based organisations is expected to increase at a rate similar to that observed during previous Framework Programmes. Given that this option does not provide a consistent and coordinated ecosystem of stakeholders, it could deliver significant outputs for low and medium TRL, if a clear agenda is set up.

However, the scientific impact under this option would be limited by a number of factors:

- It would be difficult to coordinate the wider participation among stakeholders, since the composition of consortia responding to the calls under Work Programme could not be easily directed and managed according to a common strategy.
- It would not be possible to provide technical solutions and sufficient knowledge to address, since there would be some dislocation between calls launched at different times and no guarantee that the appropriate stakeholders would be involved throughout a given research programme.
- The effective diffusion of any results obtained would be challenging given the fragmentation at project level and the lack of coordination at programme level.

Against this background, Europe’s contribution to the knowledge base is expected to develop in a fragmented manner under the baseline option, with China continuing to

⁷³ A more in depth and detailed analysis of each policy option is provided in Technopolis Group (2020)

strengthen its position in the publication of fundamental research and to dominate the creation of new intellectual property.

Given the higher degree of stability and based on the feedback received in various consultation processes, a greater degree of participation is expected under a European Co-Programmed Partnership than under the baseline option. The scientific impacts under this option would probably be greater than those estimated under the baseline option, with European universities and research-based organisations having easier access to the Programme, thus making a stronger contribution to the volume of publications and the RSI registering marginally more patents and industrial designs as well as possible creation of jobs. Its score would therefore be good compared to the baseline with +.

However, the volume of creation and diffusion of high-level knowledge making a scientific impact would again be constrained by the partial participation of key stakeholders from the rail sector. This option would therefore be subject to many of the same limitations as the baseline. Its score would therefore be similar to the baseline with 0.

An Institutionalised European Partnership established under Article 187 TFEU would be subject to a well-defined legal and financial framework, with a wide range of partners contributing resources in accordance with legally binding requirements relating to the proportion of EU and partner funds, set out in a Council Regulation.

The coordinated involvement of research and industry actors with a long-term commitment, could contribute to the emergence of new applications and to continuous efficiency, quality and reliability improvements in applications and equipment. This impact will be even higher compared to the S2R JU, in light of the stronger system focus of the new Partnership. This would in turn also have an impact in terms of creation of high-quality jobs. The score of Option 2 would therefore be high compared to the baseline with ++.

In addition, creation of networks linking universities and research-based organisations under the coordination of the future Partnership, is expected to strengthen the scientific impact of this option. This, in turn, can encourage interest from organisations that have not participated in the current S2R JU, including SMEs, start-ups and entities from outside the rail sector, resulting in a more dynamic process of exchange and collaboration. The score of Option 2 would therefore be high compared to the baseline with ++. The score for the scientific impact for each option is presented in Table 6.

Table 6 - Overview of the options’ effectiveness compared to the baseline -Scientific impacts

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 2: Institutionalised Article 187
Increase in number of high-quality jobs	0	+	++
Strengthened pipeline of potential innovation	0	0	++

Notes: Score ++ : Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline.

Economic/Technological impacts - Foster all forms of innovation and strengthen market deployment of innovative solutions

The technological and economic impacts under the **baseline option** of traditional calls would be limited by the difficulties of coordinating wider stakeholder participation and

market uptake of innovations and strengthening collaboration in accordance with a long-term strategy.

In addition, lack of participation on the part of some stakeholders would reduce the level of investment in R&I during Horizon Europe as compared with that under Horizon 2020. Progress towards disruptive innovation, for example through delivery of the kind of efficiency, punctuality and capacity targets previously defined for the S2R JU, would therefore be considerably slower.

The market take-up of innovation is not expected to increase substantially under a co-programmed European Partnership (**Option 1**), although some increase might be expected given a more structured approach to industry participation compared with one based entirely on traditional calls under the Work Programme. The estimated take-up rate between 45% and 60%⁷⁴, represents a significant but not necessarily transformative improvement on the rate achieved before Horizon 2020 and reflecting the degree of uncertainty surrounding the impact of this option⁷⁵.

The European RSI's technological lead is expected to be eroded under this option, since it would not enable sufficient incremental investment in R&I, over and above that which the industry would anyway undertake, to deliver a step change in the level of both fundamental research and market-focused development. Hence, while the marginal increase in intellectual property could strengthen the industry's position in some countries, for example those where there is potential to deploy ERTMS, this would probably be insufficient to address the challenge from countries such as China and Japan. The score would therefore be good compared to the baseline with +.

Since the stable governance framework of an Institutionalised European Partnership under Article 187 TFEU (**Option 2**) would ensure a more structured approach in terms of number and composition of actors, coordination of activities and coherence with external environment and other ongoing activities, it could be expected to deliver substantially higher technological and economic impacts, including better leverage of EU funding. In particular, wider, more focused and more structured participation of stakeholders, including key actors within the rail transport industry as well as SMEs and technology-based organisations, combined with better coordination of R&I effort along the value chain, would enable a substantially higher level of demonstration activity. This includes a strong focus on the speed-up of deployment of innovation and market uptake to implement a systemic transformation of rail transport. Moreover, wide and coordinated participation will allow the development of a system of systems and a coordinated approach to transform the rail sector's system architecture, resulting in more tangible economic and technological impacts compared to the S2R JU. The involvement of Member States will be essential in this respect, as they will be in a position to foster the deployment at national level of innovative solutions developed at European level in the Partnership.

The long-term vision and related financial stability provided by an institutionalised partnership would be key to foster stakeholders' involvement, in the aftermath of the Covid-19 breakout and its expected negative economic impacts which could include cuts in the

⁷⁴ Source: Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Candidate Institutionalised European Partnership on Transforming Europe's Rail System - Study for the European Commission, DG Research & Innovation

⁷⁵ There is no direct experience of a co-programmed partnership in the rail sector and hence no firm evidence on which to base the market take-up assumption.

resources invested in R&I by the sector. Whilst it is too early to say if the Covid-19 crisis will finally lead to major supply chain changes, there are good reasons to assume that ultimately economies of scale will still largely prevail in most sectors. Structural issues such as repatriation of production, questioning of global supply chains and globalisation in general will however all be under review. As a result, digitalisation might be accelerated as opportunity also for the rail sector for new efficiency gains. The score of the option would therefore be high compared to the baseline with ++.

In view of the long term commitment of partners of a JU and the additional resources available to it, such a partnership should target a market take-up rate of between 50% and 100%. The estimate impacts of this option assume a take-up rate of between 50% and 75%⁷⁶ and that the efficiency targets set for the current JU are achieved by 2031. The score would therefore be high compared to the baseline with ++.

These improvements lead to a significant contribution to the increase in the competitiveness of the rail transport industry, with rail’s share of passenger traffic rising to 10% or more and its share of rail freight traffic reaching around 20% by 2031, and contributing to the Green Deal objective to shift a substantial part of the 75% of inland freight carried today by road onto rail and inland waterways. The increase in rail industry and other employment under this option is also substantially higher than under those previously discussed. The score would therefore be high compared to the baseline with ++.

Table 7 shows the estimated range of technological and economic impacts of each option. Economic and technological impacts have been estimated using a model developed for a European Commission ‘Study on the Cost and Contribution of the Rail Sector’⁷⁷. The model has been adapted to investigate the effect of different combinations of transport cost savings and investment (see Annex 4 for a detailed description of the model). These values do not consider the potential impact and consequences of the Covid-19 pandemic, which are still under assessment.

Table 7 – Technological and economic results and impacts

Range of values in 2031		Option 0	Option 1		Option 2	
		Value	Lower	Upper	Lower	Upper
Results	Reduction in railway costs compared to baseline scenario (€ bn)	0	11.3	15.2	33.2	51.0
	Increase in railway investment compared to baseline scenario (€ bn)	0	5.7	7.6	16.6	25.5
Impacts	Increase in passenger traffic compared to baseline scenario (bn passenger-km)	0	23	32	74	123

⁷⁶ Source: Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Candidate Institutionalised European Partnership on Transforming Europe’s Rail System - Study for the European Commission, DG Research & Innovation

⁷⁷ <https://ec.europa.eu/transport/sites/transport/files/modes/rail/studies/doc/2015-09-study-on-the-cost-and-contribution-of-the-rail-sector.pdf>

Increase in freight traffic compared to baseline scenario (bn tonne-km)	0	23	32	73	122
Increase in total employment compared to baseline scenario by 2031 (thousands of people).	0	201	269	591	904

For each option, the score for the potential to achieve economic/technological impacts is presented in Table 8.

Table 8 - Overview of the options' effectiveness compared to the baseline - Economic/technological impacts

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 2: Institutionalised Article 187
Increase in rail's modal share of passenger/ freight markets	0	+	++
Improvements in the competitiveness of RSI	0	+	++
Increase in rail industry and wider employment	0	+	++

Notes: Score ++ : Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline.

Stakeholder opinion

The Open Public Consultation responses provide further support for the view that a well-defined legal structure of the kind underpinning an institutional partnership would increase the economic and technological impacts of the initiative. A substantial majority of business organisations of different sizes, business associations, academic institutions, public authorities and EU citizens considered that such a structure was either relevant or very relevant for achieving more effective and faster implementation of the initiative, increased financial leverage, better links to both regulators and practitioners on the ground, more long-term commitment from partners and harmonised standards.

A majority of the interviewees representing train operators, infrastructure managers and the RSI considered that an institutionalised partnership was essential if EU funding of rail-related R&I was to have a transformative economic and technological impact on the sector. In the view of a number of key stakeholders involved in the S2R JU, the legal framework established under this approach, together with the associated commitments in respect of the provision and allocation of funding, was essential if major public sector stakeholders were to obtain internal and external approval for their participation. It followed that, in the absence of such a framework, these stakeholders would substantially reduce their support for, or even disengage from, an initiative to promote rail-related R&I under Horizon Europe.

Most of the organisations providing feedback on the inception impact assessment also strongly supported the implementation of an institutionalised partnership. They considered such a partnership to be significantly more effective in delivering economic and technological impacts, noting that it would be better placed to develop a long-term strategy for R&I investment, coordinate the contributions of different stakeholders and ensure efficient use and better leverage of EU funding.

Societal impacts - supporting and implementing Union policies, and the uptake of innovative solutions in industry and society to global challenges;

Under the **baseline option**, the net reduction in CO₂ emissions in 2031 is estimated to be between 0.4 and 0.5 million tonnes⁷⁸ (after taking account of the impact of increased traffic levels and the transfer of traffic to rail), with a value of Euro 18 - 24 million⁷⁹, reflecting the limited modal shift for both passenger and freight noted above.

Moreover, the option is unlikely to contribute significantly to the better integration of transport systems needed to enhance connectivity for EU citizens and materially improve the quality of life for the growing proportion of the European population living in cities. This will depend on the involvement of national rail operators, infrastructure managers and other transport service providers who can help coordinate the R&I activity needed to identify improvements in the interface between national and local networks. Such participation would be limited in circumstances where support for R&I was restricted to standard calls under the Work Programme.

Under a Co-Programmed European Partnership (**Option 1**), the net reduction in CO₂ emissions is estimated between 1.0 and 1.4 million tonnes in 2031⁸⁰, valued at Euro 50 – 68 million. This is approaching three times the reduction achieved under the baseline but still limited when set against total emissions from transport in a single year. The score would therefore be good compared to the baseline with +. This form of partnership would not allow the development of a system of systems and a coordinated approach to transform the rail sector's system architecture, due to the limited participation of stakeholders. In particular, it would not encourage the level of participation from urban transport operators and other stakeholders needed to transform transport systems and increase quality of transport and life within and between cities. The score would therefore be good compared to the baseline with +.

Thanks to a coordinated and market-oriented sectorial approach and a coordinated effort to deploy innovative solutions, the reduction in CO₂ emissions is likely to be more substantial under an Institutionalised European Partnership under Article 187 TFEU (**Option 2**) as significantly more traffic would be diverted to rail from other, less environmentally friendly, modes. The expected reduction is between 2.5 and 4 million tonnes in 2031⁸¹. This impact could be expected to increase if the competitiveness of rail services continued to improve beyond the period of Horizon Europe, hence making a substantial contribution to the achievement of the Green Deal objectives.

Moreover, thanks to the coordinating role of the Commission and the involvement of Member States, an institutionalised partnership would be more likely to deliver the

⁷⁸ Source: Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Candidate Institutionalised European Partnership on Transforming Europe's Rail System - Study for the European Commission, DG Research & Innovation

⁷⁹ Carbon is valued at €48 per tonne, based on Handbook of External Costs of Transport 2014.

⁸⁰ Source: Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Candidate Institutionalised European Partnership on Transforming Europe's Rail System - Study for the European Commission, DG Research & Innovation

⁸¹ Source: Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Candidate Institutionalised European Partnership on Transforming Europe's Rail System - Study for the European Commission, DG Research & Innovation

transformational change to national transport systems making the European railways cheaper, more reliable and more flexible, hence more attractive. In addition, it would significantly contribute to improving quality of the environment in European cities. The score would therefore be high compared to the baseline with ++.

Since one of the objectives of the candidate rail partnership is to increase R&I activities related to rail freight, one core element of the transformation to logistic on-demand services is the link between customer demand and logistic service supply. This requires seamless, digitized customer communication linked to the management systems of RU, IM, ports, clients and multimodal service providers which can be achieved by means of a wide coordination under an institutionalised partnership. The score would therefore be high compared to the baseline with ++.

Stakeholder opinion

For the most part, various categories of stakeholders participating in the interview programme and responding to the inception impact assessment considered that an institutionalised partnership would be best-placed to deliver a range of beneficial societal impacts, including a reduction in environmental emissions and better integration of the European transport system in the interest of EU citizens.

In the Open Public Consultation, a majority of respondents indicated that the Partnership would be very relevant for contributing to a cleaner mobility at lower costs, reduced noise, energy consumption and emissions. Both companies and academic institutions highlighted the importance of ensuring the competitiveness of the European rail industry at the global level while focusing on societal objectives (e.g. increasing the use of renewable resources) and demonstrating the practical benefits of rail-related R&I to a wide audience.

For each option, the score for the potential to achieve societal impacts is presented in Table 9.

Table 9 - Overview of the potential for achieving societal impacts

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 2: Institutionalised Article 187
Reduction in environmental impacts of transport	0	+	++
Improvements in safety, security and health of EU citizens	0	+	++

Notes: Score ++ : Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline.

Expected impact on simplification and/or administrative burden

An Institutionalised Partnership would be capable to simplify the administration related to the membership participation in the research and innovation activities. A generic approach designed for a multibillion diversified Programme such as Horizon Europe with spread accountability and different funding tools would not match the expectations of a mission oriented programme such as rail Research and Innovation.

Expected impacts on fundamental rights

With a significantly strengthened integration of rail systems with other modes citizens would have greater freedom to pursue career, educational and leisure opportunities of their choice and to travel in a safe, secure and healthy environment. In addition, PRMs will be able to access such opportunities more easily. In addition, regional cohesion would be further enhanced, through collaboration in the Research and Innovation lifecycle as well as through the delivery of a new integrated rail system.

8.2. Administrative Costs/Efficiencies

In order to compare the policy options consistently in terms of their efficiency, a standard cost model was developed for the external study supporting the impact assessment for the set of candidate Institutionalised Partnerships. The model and the underlying assumptions and analyses are set out in the Common Part of this impact assessment, Section 2.3.2 and in the Methodology Annex 4. A dedicated Annex 3 also provides more information on who is affected and how by this specific initiative in line with the Better Regulation framework. The scores related to the costs set out in this context allow for a “value for money” analysis (cost-effectiveness) in the final scorecard analysis in Section 6.4. For the purpose of this analysis, the standard cost model is complemented with information based on the current experience of S2R JU, which contributes to providing a realistic estimate of costs of the future Partnership. Indeed, such analysis should take into due account the fact that initiatives deriving from an existing Partnership, such as Transforming Europe’s Rail System, would benefit from an administrative structure already in place and set up costs already borne, hence a significant overall cost reduction. In addition, for this specific initiative under the baseline scenario of traditional calls, there would be winding down and social discontinuation costs for the existing implementation structure of the current Article 187 initiative. These can be estimated at EUR 400.000. There would also be longer term financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. These can be estimated at EUR 3.5 million (EUR 1.6 million administrative costs, EUR 1.9 million personnel costs) per year of operation. The total running costs of the existing S2R JU cannot exceed EUR 27 million (50% from the EU and 50% from private Members through in cash, in kind and additional contributions). Private members will also contribute 50% to all administrative costs that would account for maximum 5% of operational expenditure. These costs are the baseline of the current S2R JU and should therefore be adapted on the basis of the ambition, programme and budget of the Transforming Europe’s Rail System candidate Partnership. In S2R JU, indicatively 30% of the funding is allocated to the operating community, whereas the supply industry and research community get approximately 70% of the available funds. Under the future Partnership, a more balanced approach in terms of funding distribution is envisaged.

Annex 3 provides additional information on costs and benefits of the preferred option. Overall it is estimated that the longer term cost savings from using traditional calls instead of an existing Article 187 initiative would considerably exceed the costs incurred for winding down operations. However, it should be also noted that higher costs of an Institutionalised Partnership result in a way more effective performance in terms of outputs for the benefit of European citizens and industry compared to other options. This overall situation is set as the starting point for the comparison of options. The score of this baseline scenario (traditional Horizon Europe calls) is set to 0 to be used as a reference point.

On this basis, the scores for the costs of the different options range from a value of 0, in case an option does not entail any additional costs compared to the baseline, to a score of (-)(-) when an option introduces limited additional costs when compared to the baseline and a

score of (-)(-) when substantial additional costs are expected in comparison with the baseline. In case the scores are lower than for the baseline scenario, (+) and (+)(+) are used.

It is considered that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when one takes into account the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution. From this perspective, there are only one or two percentage points that split the most cost-efficient policy options – the baseline (traditional calls) and the Co-Programmed policy options – and the least cost-efficient – the Institutionalised Partnership option. Indeed, in terms of cost-efficiency, the Co-Programmed Partnership (Option 1) is 2 percentage points more efficient than the baseline; and an Article 187 Partnership is 2 percentage points less cost-efficient than the baseline. A score of + is therefore assigned for **cost-efficiency** to the Co-Programmed options and a score of (-) for the Institutionalised Partnership policy option.

Table 6: Matrix on ‘overall costs’ and ‘adjusted cost scoring’

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 2: Institutionalised Article 187 TFEU
Administrative, operational and coordination costs	0	0	(-)(-)
Administrative, operational and coordination costs adjusted per expected co-funding (i.e. cost-efficiency)	0	+	(-)

Notes: Score 0 = same costs as for the baseline; score (-) = limited additional costs compared with the baseline; score (-)(-) = substantial additional costs compared with the baseline.

8.3. Coherence

8.3.1. Internal coherence

In this section we assess the extent to which the policy options show the potential of ensuring and maximising coherence with other actions, programmes and initiatives under Horizon Europe, in particular European Partnerships (internal coherence).

While some coordination of the activity could be achieved under the baseline option (**Option 0**), it would be difficult to ensure an effective progression of activity from fundamental research through development work to demonstration. This is a consequence of the difficulty of ensuring continuity between projects at different TRLs under a standard calls approach, not least because the parties responding to individual calls would typically be consortia formed on an ad hoc basis with limited knowledge of the broader strategic programme of R&I activity.

Similarly, coordination of R&I programmes with other initiatives, including any partnerships formed under the Climate, Energy and Mobility cluster or more generally under Horizon Europe, would be challenging, due to the fragmentation at consortia level. This option would allow a coherent approach through the Work Programme and strategic planning but would not enable a proactive approach in terms of activities which need more coordination (for example demonstration activities) and closer collaboration between research, industry and decision-makers.

While the memorandum of understanding underpinning a Co-Programmed European Partnership (**Option 1**) would reflect the technical content defined in the strategic research agenda, development and delivery of the work programme would rely on Commission

structures, with Member States approving the Work Programme under comitology procedure. Hence, the partnership would not have much control for the direction of rail-related R&I and it would be difficult for it to work with other partnerships within Horizon Europe to define an integrated work programme leveraging synergies in relevant areas. The score would therefore be good compared to the baseline with +.

An Institutionalised European Partnership under Article 187 TFEU (**Option 2**) would meet the functionality requirements described in *Section 4.4* more effectively and would therefore be better placed to deliver a more coherent long-term strategy for rail-related R&I, with the possibility to adjust its strategy considering the evolution of Union policies and stakeholders' needs. In particular, it would be able to call on dedicated management resources to develop the strategy and plan supporting work programmes in collaboration with other partnerships. This would ensure that the strategy could take account of links with key partnerships, such as ECSEL and 5G for digitalisation and automation, Clean Hydrogen and Batteries as alternatives for diesel trains and for autonomous new freight wagons and other transport partnerships concerning interfaces with other modes and multimodality. Synergies and cooperation with the Knowledge and Innovation Communities (KIC) would be established (e.g. with the urban mobility, energy and climate KICs) to increase demonstrations and facilitate deployment of technologies. Moreover, synergies and cooperation with the Missions could be established, in particular on Climate Change and Smart Cities. The score would therefore be high compared to the baseline with ++.

Stakeholder opinion

Stakeholders participating in the interview programme indicated that a future partnership would be able to cooperate more with other initiatives under Horizon Europe to leverage the benefits of technology that is not specific to the rail sector. One regulatory agency stressed the importance of developing a strategy and work programme that reflected the needs of a fully integrated transport system for Europe.

Responding to the Open Public Consultation, a majority of stakeholders stated that the legal structure underpinning an institutionalised partnership was either relevant or very relevant to the facilitation of collaboration with other partnerships under Horizon Europe. Support for this view was particularly strong among large business organisations and business associations, but it was also held by most SMEs, academic and research institutions, public authorities and EU citizens. A substantial majority in each of the same stakeholder groups confirmed that there would be scope for rationalising the activities of the candidate partnership for rail and to link it with other initiatives under Horizon Europe.

Respondents that are/were involved in a current/preceding partnership found a legal structure more relevant than other respondents when it concerned a faster to response to sudden market or policy needs as well as synergies with other programmes and collaboration with other partnerships.

Large companies showed a slightly higher relevance for implementing activities effectively, ensure better links to regulators, obtaining the buy-in and long-term commitment of other partners, synergies with other EU/MS programmes and collaboration with other EU partnerships than other open consultation respondents. Public authorities find it slightly less relevant to facilitate collaboration with other European Partnerships than other respondents.

8.3.2. External coherence

In this section we assess the extent to which the policy options show the potential of ensuring and maximising coherence with their external environment, including EU-level

programmes and initiatives beyond the Framework Programme and/or national and international programmes and initiatives, but as well as with overarching framework conditions, such as regulation, standardisation, etc. (external coherence).

Under the baseline scenario (**Option 0**), it would be difficult to coordinate the development of a work programme taking account of parallel, related activity under the Digital Europe Programme (DEP), Connecting Europe Facility (CEF), European Regional Development Fund (ERDF) and Cohesion Fund (CF). Despite that under this option, some coordination with other European Commission activities is possible at the level of priorities, coordination at the level of implementation is somewhat limited or even not feasible. Finally, collaboration with national or regional initiatives such as national programmes or the coordination with regional clusters is not feasible under this option.

In a Co-Programmed European Partnership (**Option 1**), the barriers to coordination within Horizon Europe would extend to coordination with other programmes under Digital Europe Programme (DEP), Connecting Europe facility (CEF), European Regional Development Fund (ERDF) and Cohesion Fund (CF). The European Commission can contribute to some extent to the coordination with European initiatives outside Horizon Europe at the level of the strategy. The non-systematic participation of Member States provides the opportunity for coordination with the national programmes and initiatives and the regional clusters. Even if joint programmes could be agreed in principle, there could be no guarantee that work undertaken in response to open calls would be fully aligned with the specification of activity anticipated under other funding initiatives. The score would therefore be the same compared to the baseline with 0.

An institutionalised European Partnership under Article 187 TFEU (**Option 2**) has necessary structures and resources to ensure a continuous dialogue among all players, including international, national, regional and local authorities and therefore does provide a clear global framework to mainstream rail efforts into the Green Deal objectives. It would be able to explore opportunities for funding of programmes and projects under DEP, CEF, ERDF and CF and set provisions for systemic synergies between the Partnership and existing funding mechanisms. These synergies have been developed only to a limited and occasional extent in the S2R JU and would therefore be more systematically exploited in the future Partnership. In particular, a novelty compared to the S2R JU would be the setting up of a dedicated deployment manager function to ensure strong coordination and synchronisation with the CEF Programme, filling the qualitative gap to move from TRL 7 to full deployment. Increasing the chances of deployment of innovative solutions would result in increased attractiveness of the future Partnership for potential Members, including SMEs.

Moreover, the partnership would also be able to represent the interests of the rail R&I community in discussions with other relevant European institutions, for example the European Investment Bank. Under this option, the possibilities of coordination and

Stakeholder opinion

A majority of the stakeholders responding to the Open Public Consultation considered that establishing a specific legal structure for the candidate European Partnership was either relevant or very relevant to the facilitation of synergies with other EU and national programmes. This view was particularly strongly held by the larger business organisations and business associations as well as by EU citizens.

Interviewees also expressed the view that a future partnership would be well-placed to develop a dialogue with other EU initiatives, notably CEF, and that it could facilitate opportunities for collaborative funding using sources outside the scope of Horizon Europe. A limited number of the stakeholders providing feedback on the inception impact assessment suggested that an institutionalised partnership would be better able to take account of the activities of other, relevant EU agencies and organisations and to explore the potential for support for R&I from CEF.

exploitation of synergies offered by the Co-Programmed option are expanded by the existence of the central coordination level which can improve and extend the collaboration at the level of projects. More generally, as the partnership would be in a better position to facilitate links with a wider range of EU institutions, agencies and initiatives, the score would be high compared to the baseline with ++.

The scores for internal and external coherence are summarized in Table 12.

Table 12 - Overview of the options' potential for achieving coherence

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Internal coherence	0	+	++
External coherence	0	0	++

Notes: Score ++ : Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline.

8.4. Tabular comparison of options and identification of preferred option

Building upon the outcomes of the analysis, this section presents a comparison of the options' 'performance' against the dimensions of effectiveness, efficiency and coherence.

Table 13 - Ranking of the policy options

	Items	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Effectiveness	Scientific impacts – increase in high quality jobs	0	+	++
	Scientific impacts – strengthened pipeline of potential innovation	0	+	++
	Technological/economic impacts – increase in rail's modal share	0	+	++
	Technological/economic impacts – increase in RSI competitiveness	0	+	++
	Technological/economic impacts – increase in total employment	0	+	++
	Societal impacts – reductions in environmental impacts	0	+	++
	Societal impacts – improvements in safety, security and health	0	+	++
	Coherence	Internal coherence	0	0
External - coherence		0	0	++
Efficiency	Overall cost	0	0	(-) (-)
	Cost-efficiency	0	+	(-)

Notes: Scores for effectiveness and coherence: Score ++: Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline. Scores for efficiency: Score 0 = same costs as for the baseline; score (-) = limited additional costs compared with the baseline; score (-)(-) = substantial additional costs compared with the baseline

Overall the **institutionalised partnership established under Article 187 of TFEU is the preferred option** as it dominates all dimensions apart from efficiency. Moreover, while it has higher overall direct transparent cost (without considering the cost of discontinuation of the current Joint Undertaking, which would impact the two other options), it ensures better capability to meet the objectives than the other options thanks to a sufficiently inclusive governance structure and the possibility to define an integrated cycle of research and innovation up to TRL 9 allowing the delivery of sector's needs and EU policy objectives.

This option best ensures that private and public sectors remain fully engaged in the development and implementation of a long-term strategy for rail R&I, while encouraging participation from key stakeholders with access to significant financial and in-kind resources that they would be willing to commit under a clearly defined and stable legal framework. This is all the more a decisive factor at a time when the sector is struggling to recover from the Covid-19 crisis. The upstream financial commitment and the preparation of the technical content through the Master Plan ensure that both private and public sector remain fully engaged in the development and implementation of a long-term strategy for rail R&I.

An Institutionalised Partnership would be based on a publicly accessible programme providing full transparency regarding planning and activities. Building on the experience and lessons learned in the S2R JU, the R&I Programme will be based on a shared concept of operations, establishing a functional system architecture and working on innovation enablers to meet the identified technical and policy objectives. The Partnership will include a strong nucleus of Members, with a balanced participation of key stakeholder groups, selected in a transparent manner. Based on the current experience of S2R JU, the overall number of partners involved could be estimated at more than 400, representing the rail sector value chain and beyond. Enhanced openness compared to the current Partnership will be achieved by attracting entities that will be ready to commit to a shared programme, contributing with their expertise and breakthrough technologies.

Particular attention will be paid to increasing participation of SMEs and possible involvement and creation of start-ups to ensure that rail related new ideas, projects, and solutions would find an opportunity to connect with the sector and explore the possibilities to scale-up. In particular, the development of high TRL solutions closer to the market is expected to foster SME's participation in the Programme, since the results of their research activities are more likely to be taken up by large manufacturers and system integrators.

This form of partnership would continue to provide a stable framework for encouraging the participation of organisations from all concerned sectors (including those outside the rail industry), securing and allocating resources, managing a wide range of RD&I projects across all TRLs and creating synergies with other partnerships and initiatives within and outside the Climate, Energy and Mobility cluster. It is also considered appropriate to develop a strategy for rail in order to implement European Green Deal transport priorities, and especially the European climate commitment, and with several sustainable development goals.

The transition from the current S2R JU to the future European Partnership will be seamless, given that the overall organisational structure will need only some adaptations, rather than radical changes. In terms of content, the S2R JU will ensure a complete and efficient transfer of activities and results into the new Partnership. This should avoid as much as possible dead ends of ongoing activities.

The impact of the Covid-19 breakout on future EU collaborative research needs to be carefully assessed. The financial stability provided by an institutionalised partnership would be reassuring for the European rail sector stakeholders' and would encourage their participation in the programme, also given that they may be under financial pressure and therefore reconsidering their planned investments in R&I.

A comparison of possible stakeholders' commitment and Member States collaboration is provided in the Table 14 (list not exhaustive), under the assumption of EUR 900 million Union contribution and EUR 1550 million contribution from members other than the Union.

Table 14 – Possible contribution of stakeholders and Member States

	Quantitative contribution (Million Euros)	Qualitative contribution
Rail Supply industries	650	Providing the technological know-how and the human resources needed to perform R&I activities leading to future market solutions, covering the whole spectrum of applied research and demonstration activities.
Infrastructure Managers	350	- Providing the network related know-how, the human resources and the installed facilities to perform the R&I activities. - Participating in related and additional deployment activities funded under CEF.
Operators (mainline and urban)	350	- Providing the operations related know-how, the human resources and the rolling stock or installed facilities to perform the R&I activities. - Participating in related and additional deployment activities funded under CEF.
Other stakeholders (such as research organisations)	200	Providing the basic research know-how needed for lower TRL research and scientific expertise in the applied research work.
Member States		- Providing the Transforming Europe's Rail System JU through the State Representatives Group with information on relevant activities in Members States and contribution to generating synergies with those activities. - Providing a coordinated position for the implementation of innovative solutions in the Technical Specification for Interoperability and safety for the realisation of a "future proof" a Single European Railway Area.

Box 3 Comparison between the preferred option & the current partnership existing in the area taking into account lessons from past evaluations

What continues	What is different
<ul style="list-style-type: none"> • Art 187 Union Body, with EC as Founding Member. 	<ul style="list-style-type: none"> • System of systems approach to the Programme, overcoming the silo-effect of the

<ul style="list-style-type: none"> • Strong link with the Single European Railway Area. • Vision to deliver, through railway research and innovation, the capabilities to bring about the most sustainable, cost-efficient, high-performing, time driven, digital and competitive customer-centred transport mode for Europe. • Systemic approach to collaborative research. • Overall partner composition involving all stakeholders active in the rail sector, including users. • Long term financial commitments from a number of core members. 	<p>current structure based on different Innovation Programmes (IPs).</p> <ul style="list-style-type: none"> • Increased focus on freight, automation and digitalisation, • Balanced representation of the rail sector across the EU, resulting in a more agile membership structure. • A more strategic and less administrative role for the Governing Board • Definition of new KPIs. • Structured synergies with other Horizon and national initiatives. • Setting up of a dedicated deployment manager function to ensure strong coordination and synchronisation with the CEF Programme, filling the qualitative gap to move from TRL 7 to full deployment. • Set up of dedicated activities to co-create with the sector at large independently from the membership of a shared vision and concept of operations led by Union policies. • A more agile Programme management implementation approach to ensure to meet the policy expectations while reducing the administrative burden. • Use of the different instruments made available in the General Financial Regulation to implement the Programme and adapt to the needs of the different activities to be implemented (e.g. grants, tenders etc.).
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9. THE PREFERRED OPTION - HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

9.1. The preferred option

In the table below, the alignment of the preferred option of Institutionalised European Partnership under Article 187 TFEU with the selection criteria for European Partnerships defined in Annex III of the Horizon Europe Regulation is depicted. Seeing that the design process of the candidate Institutionalised European Partnerships is not yet concluded and several of the related topics are still under discussion, the criteria of additionality/directionality and long-term commitment are covered in terms of expectations rather than ex-ante demonstration.

An institutionalised partnership established under Article 187 of TFEU for Transforming Europe's Rail System would meet the requirements set out in *Section 4.4* particularly effectively by:

- Facilitating the development of a strategy that is fully aligned with the completion of SERA, the Green Deal as well as a number of SDGs and the political priorities identified by the President of the Commission;
- Providing a stable framework for encouraging the participation of organisations from different stakeholder groups, also in the context of the post-Covid-19 recovery;

- Developing a system of systems and a coordinated approach to transform the rail sector’s system architecture and thereby rail’s performance for society;
- Integration of rail innovations in the overall mobility digital eco-system for all modes of transport.
- Leveraging industry financial and in-kind resources such that the impact of funding provided by the Commission is maximised;
- Providing for the effective management of R&I projects, encouraging a high level of market take-up of outputs;
- Facilitating relationships with other partnerships and initiatives within the Climate, Energy and Mobility cluster and other EU initiatives; and
- Enabling timely deployment of innovations with high EU added value through CEF and possibly other instruments, and
- Enabling effective dialogue with national and international standards bodies, Member States and third countries.

General success criteria would include:

- A high market uptake of innovative solutions,
- Increased competitiveness of the rail industry in particular outside Europe, keeping it at the forefront of innovation.
- Increased rail market share, in particular for freight.
- Increased integration of rail operations with other transport modes.
- Creation of jobs.

A number of issues remain open in the definition of the Transforming Europe’s Rail System Partnership, notably:

- The budget of the Partnership and, more specifically, the EU funding which will depend on the adoption of the next Multiannual Financial Framework.
- The detailed governance structure, including different categories of members and advisory groups, which is still under discussion with the sector.
- A programme which will be defined in the upcoming stages of the process.
- A specific set of Key Performance Indicators (KPIs) and their related methodology for assessing the achievement of the Partnership’s objectives.

Table 15 - Alignment with the selection criteria for European Partnerships

Criterion	Alignment of the preferred option
Higher level of effectiveness	<p>As demonstrated in Chapter 6, an institutionalised partnership would be considerably more effective in improving the competitiveness of both the rail transport industry and RSI and enabling a transformation of the European rail system, since it would ensure that a substantially higher proportion of R&I outputs would be taken up by the market than under other options.</p> <p>The institutionalised partnership would also be effective in meeting the Green Deal objectives and supporting the competitiveness of the European RSI.</p>

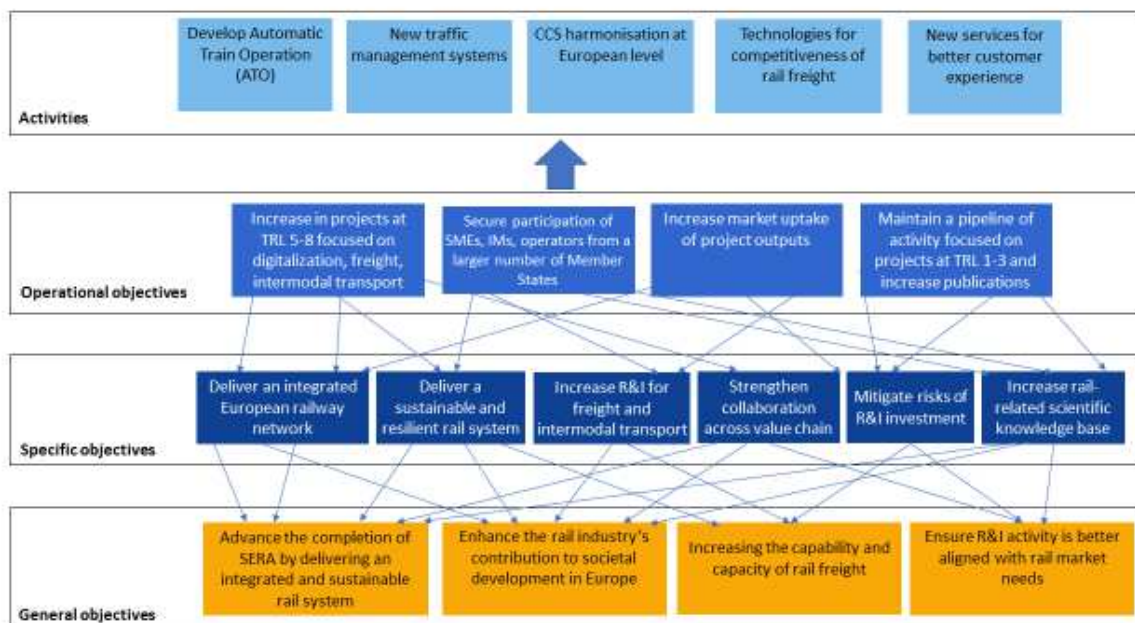
Criterion	Alignment of the preferred option
Coherence and synergies	<p>A dedicated administrative structure responsible for the development of a long-term strategy and supporting work programmes for rail-related R&I would ensure that these were fully integrated with relevant strategies and programmes developed by other partnerships and initiatives. This would enable the better exploitation of synergies from joint programmes and projects, such as ECSEL and 5G for digitalisation and automation, Clean Hydrogen and Batteries as alternative for diesel trains and for autonomous new freight wagon and other transport partnerships concerning interfaces with other modes and multimodality.</p> <p>Thanks to a dedicated deployment manager function, strong coordination with the CEF Programme would help filling the qualitative gap to move from TRL 7 to full deployment, thus addressing one of the main issues faced by the S2R JU.</p>
Transparency and openness	<p>An institutionalised partnership would have more impact in identifying priorities and objectives in terms of expected results and impacts, in involving partners and stakeholders from across the entire rail value chain, from different sectors, backgrounds and disciplines, including SMEs.</p> <p>An institutionalised partnership would be structured around a common, publicly accessible programme providing full transparency regarding the planned objectives and activities, while ensuring comprehensive and balanced representation of the sector (also geographically) and appropriate protection for intellectual property. The framework governing participation would provide for initial calls for members, attaching conditions relating to the provision of funding and a commitment to supporting EU rail policy objectives.</p>
Additionality and directionality	<p>An institutionalised partnership would develop a long-term strategy for rail-related R&I, in consultation with stakeholders inside and outside the rail industry and establish a set of common objectives governing the direction of R&I activity under Horizon Europe. This would be more focused on industry and market needs as well as on the implementation of EU policy objectives than would be the case under other options as well as under the S2R JU.</p> <p>In response to a challenge identified in the interim evaluation of the S2R JU, an institutionalised partnership would be able to set up the appropriate approaches to ensure flexibility of implementation and to adjust to changing policy, societal and/or market needs, or scientific advances, to increase policy coherence between regional, national and EU level.</p>
Long-term commitments	<p>An institutionalised partnership would also encourage long-term commitment of financial and in-kind resources from infrastructure managers, railway undertakings and other stakeholders (such as SMEs) with access to significant levels of internal funding for R&I activity. Hence, the partnership is expected to ensure a significant share of investment from private sector and other commercial stakeholders.</p>

9.2. Objectives and corresponding monitoring indicators

Several operational objectives have been identified which would enable the partnership to achieve its specific objectives, as shown in Figure 5 below.

The figure also lists a broad range of actions and activities, beyond the R&I activities that can be implemented under Horizon Europe. This reflects the definition of European Partnerships in the Horizon Europe Regulation as initiatives for which the Union and its partners “commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake.

Figure 5 - Operational objectives of the initiative



9.2.1. Monitoring indicators

In addition to Key Impact Pathways indicators set centrally in the Regulation of Horizon Europe, additional monitoring indicators have been identified to enable the tracking of progress of the partnership towards meeting its objectives. Data will be collected and processed through a dedicated work stream of the new Partnership, as is currently the case for S2R JU (work on Key Performance Indicators done under Cross Cutting Activities). These are shown in Table 15.

Table 16 - Monitoring indicators in addition to the Horizon Europe key impact pathway indicators

	Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
Scientific impact – Develop rail-related scientific knowledge base/Deliver scientific results breaking down the current operating limitations/ A strengthened pipeline of potential innovation available to the rail sector	Number of projects resulting in one or more publications	Number of times that publications generated by the partnership are cited in the global literature Number of project outputs taken up in EN standards and TSIs	Number of patents and industrial designs registered by suppliers of railway equipment and systems based in Europe. Project outputs taken up by the market
Scientific impact - A new generation of “rail” engineers and scientists	Number of individuals working on projects initiated by the partnership	Number of occupied and advertised jobs in rail-related R&I	Number of staff transferring between research-based institutions and the rail industry
Technological / economic impact – increase in rail industry direct and indirect	Number of individuals working on projects initiated by the partnership	Level and intensity of rail sector R&I, including new business models	Direct and indirect employment generated by the European rail sector

employment/Creation of new business models and opportunities for the rail stakeholders			
Technological / economic impact – An increase in rail’s modal share of passenger and freight markets	Number of programmed projects at TRLs 1 – 3 with a documented strategy for progressing to TRLs 4 - 7	Number of projects considered to have strong market take-up	Rail’s modal share of passenger and freight transport markets
Technological / economic impact – Creation of significant additional gross added value for the rail sector compared to 2017/Improvement of competitiveness of RSI	Number of programmed projects involving SMEs	Number of projects considered to have strong market take-up	European RSI’s share of global markets
Technological / economic impact – A new rail technological environment	Number of programmed projects developing digital applications	Number of digital projects considered to have strong market take-up	Rail’s modal share of passenger and freight transport markets
Environmental / sustainability impact - Reductions in the environmental impacts of transport	Number of programmed projects developing technological applications	Number of projects considered to have strong market take-up	Reduction of CO ₂ emissions generated by passenger and freight transport Reduction of other emissions (NO _x , noise, etc.)
Social impact - Improvements in the safety, security and health of EU citizens	Number of programmed projects developing safety/security technological applications	Number of relevant projects considered to have strong market take-up	Increased safety and security performance Positive impact on air quality and safety
Social impact - Affordable and accessible mobility and connectivity	Number of programmed projects developing technologies for increased accessibility	Number of relevant projects considered to have strong market take-up	Increased accessibility of rolling stock and stations

9.2.2. Evaluation framework

The evaluation of the Partnership will be done in full accordance with the provisions laid out in Horizon Europe Regulation Article 47 and Annex III, with external interim and ex-post evaluations feeding into the overall Horizon Europe evaluations. As set in the criteria for European Partnerships, the evaluations will include an assessment of the most effective policy intervention mode for any future action; and the positioning of any possible renewal of the Partnership in the overall European Partnerships landscape and its policy priorities. In the absence of renewal, appropriate measures will be developed to ensure phasing-out of Framework Programme funding according to conditions and timeline agreed with the legally committed partners ex-ante.

CONCLUSION

Based on the lessons learned from the S2R Joint Undertaking, it is clear that joint rail research activities coordinated by the EU contribute to a sustainable, punctual, interoperable, high-capacity rail system, providing a backbone for the whole mobility and transport sector in Europe and contributing to the Single European Railway Area. At the same time, the current S2R experience suggests a number of adaptations to make the future partnership even more successful. These include for example a system of systems approach aiming at

transforming rail's system architecture, a more agile governance structure, an increased emphasis on freight, automation and digitalisation and an enhanced focus on deployment of innovative solutions.

The analysis conducted in this Impact Assessment concludes that an Institutionalised Partnership under Article 187 TFEU is the most suitable policy option to develop rail research at the EU level. The stable financial and regulatory framework provided by an Institutionalised Partnership will ensure accessibility to the programme for a wide range of stakeholders, a clear set of objectives in line with the EU policy priorities and a higher level of effectiveness, resulting in increased market uptake. These elements are all the more important, at a time when the rail sector is expected to face a certain level of economic uncertainty, due to the effects of the Covid-19 breakout. Rail research will be key to address present and future challenges of the transport sector and improve mobility of passengers and goods across Europe. In order to achieve the most tangible impact for society, the focus should be on harnessing rail for digital and sustainable transformation of our economy and society.