European Commission

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

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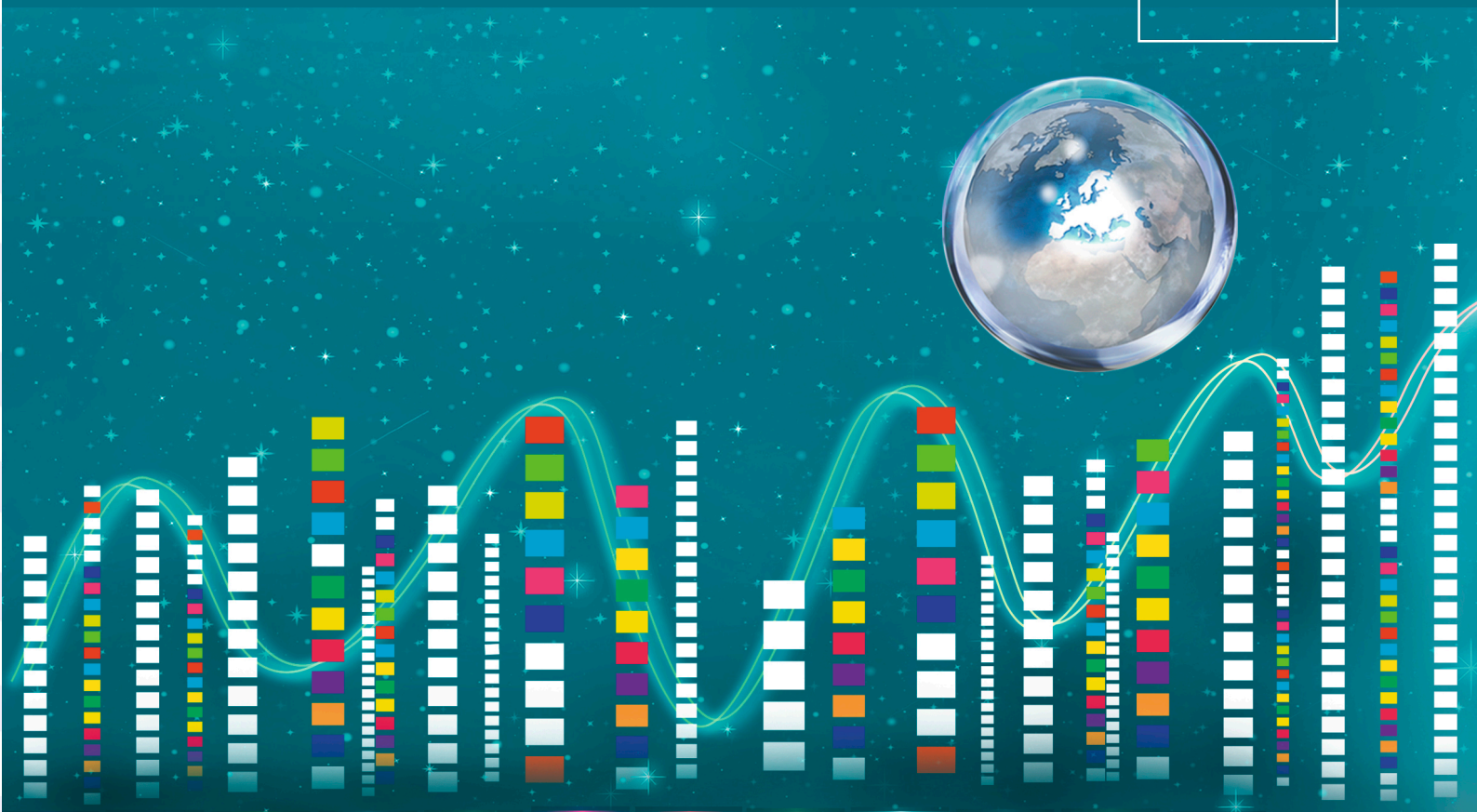
Report



Research and Innovation

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

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EUROPEAN COMMISSION

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

In collaboration with

2020 Directorate-General for Research and Innovation EN

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Introduction

This Impact Assessment Study had the primary objective to support and provide input to the impact assessments of the first set of 13 European Institutionalised Partnerships based on Articles 185 and 187 of the Treaty on the Functioning of the EU (TFEU) that are envisaged to be funded under the new Framework Programme for Research and Innovation, Horizon Europe.

In addition, the Impact Assessment Study team contributed to future European policymaking on the overall European Partnership landscape by means of a horizontal analysis of the coherence and efficiency in the implementation of European partnerships. The purpose of this analysis was to draw the lessons learned from the implementation of the impact assessment methodology developed for this study and to formulate recommendations for the refinement and operational design of the criteria for the selection, implementation, monitoring, evaluation and phasing-out for the three types of European Partnerships. Finally, an impact modelling exercise was conducted in order to estimate the potential for longer-term future impacts of the candidate Institutionalised European partnerships in the economic and environmental sustainability spheres.

Technopolis Group was responsible for the overall coordination of the 13 specific impact assessment studies, the development of the common methodological framework, and the delivery of the horizontal analysis. It also conducted specific analyses that were common to all studies, acting as a 'horizontal' team, in collaboration with CEPS, IPM, Nomisma, and Optimat Ltd. For the implementation of the individual impact assessment studies, Technopolis Group collaborated with organisations that are key experts in specific fields covered by the candidate Institutionalised European Partnerships. These partner organisations were Aecom, Idate, Steer, Think, and Trinomics. Cambridge Econometrics took charge of the impact modelling exercise.

The Impact Assessment Study was conducted between July 2019 and January 2020. The 13 Impact Assessment Studies were conducted simultaneously, based upon a common methodological framework in order to maximise consistency and efficiency. The meta-framework reflected the Better Regulation Guidelines and operationalised the selection criteria for European Partnerships set out in the Horizon Europe Regulation. The 'Horizontal analysis of efficiency and coherence of implementation' was conducted in the same time period, building upon the information available on the 44 envisaged European Partnerships landscape as in May 2019, complemented with information on five envisaged European Partnerships as decided by the European Commission in October and November 2019.

This final report contains the reports of all individual impact assessment studies and the 'horizontal' analyses. It is structured in two parts, reflecting the two strands of analysis:

PART I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

1. Overarching context to the impact assessment studies

This report sets out the overall policy context and methodological framework underlying the impact assessment studies for the candidate Institutionalised European Partnerships. It describes the changes in approach to the public-private and public-public partnerships under Horizon Europe compared to the previous EU Framework Programmes. An example is the requirement that all envisaged European Partnerships be implemented as either co-programmed, co-funded or institutionalised. The impact assessment studies will consider these three scenarios as the different options to be assessed, in compliance with the Better Regulation guidelines and against the functionalities that the candidate partnerships are expected to fulfil. The report describes the common methodological framework to assess the envisaged initiatives accordingly. The report also presents the landscape of European Partnerships at the level of Horizon Europe Pillar 2 clusters, which lay the grounds for all

of the impact assessment studies except the candidate Institutionalised European Partnership for Innovative SMEs.

2. EU-Africa Global Health Candidate Institutionalised European Partnership

This initiative focuses on research and innovation in the area of infectious diseases, with a particular focus on sub-Saharan Africa. It will address the challenges of a sustained high burden of infectious diseases in Africa, as well as the (re)emergence of infectious diseases worldwide. Its objectives will thus be to contribute to a reduction of the burden of infectious diseases in sub-Saharan Africa and to the control of (re)emerging infectious diseases globally. It will do so through investments in relevant research and innovation actions, as well as by supporting the further development of essential research capacity in Africa. The study concluded that an Institutionalised Partnership under Art. 187 of the TFEU is the preferred option for the implementation of this initiative.

3. Candidate Institutionalised European Partnership on Innovative Health

This initiative focuses on supporting innovation for health and care within the EU. It will address the EU-wide challenges raised by inefficient translation of scientific knowledge for use in health and care, insufficient innovative products reaching health and care services and threats to the competitiveness of the health industry. Its main objectives are to create an EU-wide health R&I ecosystem that facilitates translation of scientific knowledge into innovations; foster the development of safe, effective, patient-centred and cost-effective innovations that respond to strategic unmet public health needs currently not served by industry; and drive cross-sectoral health innovation for a globally competitive European health industry. The study concluded that an Institutionalised Partnership based on Article 187 of the Treaty on the Functioning of the EU (TFEU) is the preferred option for the implementation of this initiative.

4. Candidate Institutionalised European Partnership in High Performance Computing

The initiative focuses on coordinating efforts and resources in order to deploy a European HPC infrastructure together with a competitive innovation ecosystem in terms of technologies, applications, and skills. It will address the challenges raised by underinvestment, the lack of coordination between the EU and MS, fragmentation of instruments, technological dependency on non-EU suppliers, unmet scientific demand, and weaknesses in the endogenous HPC supply chain. The initiative has as its main objectives to enhance EU research in terms of HPC and related applications, continued support for the competitiveness EU HPC industry, and fostering digital autonomy in order to ensure long-term support for the European HPC ecosystem as a whole. The study concluded that an Institutionalised Partnership is the preferred option for the implementation of this initiative as it maximises benefits in comparison to the other available policy options.

5. Candidate Institutionalised European Partnership in Key Digital Technologies

This initiative focusses on enhancing the research, innovation and business value creation of European electronics value chains in key strategic market segments in a sustainable manner to achieve technological sovereignty and ultimately make European businesses and citizens best equipped for the digital age. It will address the risks of Europe losing the lead in critical industries and services and emerging KDTs. It will also tackle Europe's limited control over digital technologies that are critical for EU industry and citizens. It has as main objectives to strengthen KDTs which are critical for the competitive position of key European industries in the global markets, to establish European leadership in emerging technologies with high socioeconomic potential and to secure Europe's technological sovereignty to maintain a strong and globally competitive presence in KDTs. The study concluded that the Institutionalised Partnership is the preferred option for the implementation of this initiative.

6. Candidate Institutionalised European Partnership in Smart Networks and Services

This initiative focuses on the development of future networks infrastructure and the associated services. This includes bringing communication networks beyond 5G and toward 6G capabilities, but also the development of the Internet of Things and Edge Computing technologies. It will address the challenges raised by Europe delay in the deployment of network infrastructure and failure to fully benefit from the full potential of digitalisation. It has as main objective to ensure European technological sovereignty in future smart networks and digital services, to strengthen the uptake of digital solutions, and to foster the development of digital innovation that answers to European needs and that are well aligned with societal needs. The study concluded that an institutionalised partnership under article 187 is the preferred option for the implementation of this initiative.

7. Candidate Institutionalised European Partnership in Metrology

This initiative focuses on metrology - that is the science of measurement and the provision of the technical infrastructure that underpins accurate and robust measurements throughout society; measurements that underpin all domains of science and technology and enable fair and open trade and support innovations and the design and implementation of policy and regulations. It will address challenges in the fragmentation of national metrology systems across Europe and the need to meet ever-increasing demands on metrology infrastructure to support the measurement needs of emerging technologies and important policy domains in climate, environment, energy and health. The main objective of the initiative is to establish a sustainable coordinated world-class metrology system in Europe that will increase and accelerate the development and deployment of innovations and contribute to the design and implementation of policy, regulation and standards. The study concluded that an A185 Institutionalised Partnership is the preferred option for the implementation of this initiative.

8. Candidate Institutionalised European Partnership on Transforming Europe's Rail System

This initiative focuses on the development of a pan-European approach to research and innovation in the rail sector. It will address the challenges raised by the lack of alignment of research and innovation with the needs of a competitive rail transport industry and the consequent failure of the European rail network to make its full contribution to European societal objectives. It will also strengthen the competitiveness of the European rail supply industry in global markets. Accordingly, the objectives of the initiative are to ensure a more market-focused approach to research and innovation, improving the competitiveness and modal share of the rail industry and enhancing its contribution to environmental sustainability as well as economic and social development across the European Union. The study concluded that an institutionalised partnership under article 187 is the preferred option for the implementation of this initiative.

9. Candidate Institutionalised European Partnership for Integrated Air Traffic Management

This initiative focuses on the modernisation of the Air Traffic Management in Europe - an essential enabler of safe and efficient air transport and a cornerstone of the European Union's society and economy. The proposed initiative will address the challenges raised by an outdated Air Traffic Management system with a non-optimised performance. The current system needs to be transformed to enable exploitation of emerging digital technologies and to accommodate new forms of air vehicle including drones. The objective is therefore to harmonise European Air Traffic Management system based on high levels of digitalisation, automation and connectivity whilst strengthening air transport, drone and ATM markets competitiveness and achieving environmental, performance and mobility goals. This would create €1,800b benefits to the EU economy if the current initiative can

be built on and accelerated. The study concluded that an Institutionalised Partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

10. Candidate Institutionalised European Partnership on Clean Aviation

This imitative focuses on further aeronautical research and innovation to improve technology leading to more environmentally efficient aviation equipment. It will address the challenges raised by the growing ecological footprint of aviation and the challenges and barriers faced by the aviation industry towards climate neutrality. It will also strengthen the competitiveness of the European aeronautical industry in global markets. Accordingly, the objectives of the initiative are to ensure that aviation reaches climate neutrality and that other environmental impacts are reduced significantly by 2050, maintain the leadership and competitiveness of the European aeronautics industry and ensure safe, secure and efficient air transport of passengers and goods. The Impact Assessment study assessed the options for implementation that would allow for an optimal attainment of these objectives. The study concluded that an institutionalised partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

11. Candidate Institutionalised European Partnership on Clean Hydrogen

The report assesses the impact of potential initiatives to support, through research and innovation, the growth and development of clean hydrogen, among which an Institutionalised European Partnership is one of the options assessed. The existing challenges for clean hydrogen include the limited high-level scientific capacity and fragmented research activities, the insufficient deployment of hydrogen applications, and consequently weaker EU scientific and industrial value chains. Environmental, health and mobility pressures are also driving the need for cleaner hydrogen generation, deployment and use. An initiative for clean hydrogen must have as a main objective the strengthening and integration of EU scientific capacities, to support the creation, capitalisation and sharing of knowledge. This is necessary to accelerate the development and improvement of advanced clean hydrogen applications, the market entry of innovative competitive clean solutions, to strengthen the competitiveness of the EU clean hydrogen value chains (and notably the SMEs within them), and to develop the hydrogen-based solutions necessary to reach climate neutrality in the EU by 2050. The study concluded that an Institutionalised Partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

12. Candidate Institutionalised European Partnership on Safe and Automated Road Transport

This initiative focuses on Connected, Cooperative and Automated Mobility: the use of connected and automated vehicles to create more user-centred, all-inclusive mobility, while also increasing safety, reducing congestion and contributing to decarbonisation. With current road traffic collisions and negative local and global environmental impacts not reducing quickly enough, it will address the challenges raised by the current fragmentation of research across the field, and the threat to European competitiveness if the research agenda does not advance quickly enough. The initiative will focus on strengthening EU scientific capacity and economic competitiveness in the field of CCAM, whilst contributing to wider societal benefits including improved road safety, less environmental impact, and improved accessibility to mobility. The study concluded that a co-programmed partnership is the preferred option for the implementation of this initiative.

13. Candidate Institutionalised European Partnership for a Circular Bio-based Europe

This initiative focuses on intensifying research and innovation allowing to replace, where possible, non-renewable fossil and mineral resources with biomass and waste for the production of renewable products and nutrients, in order to drive forward sustainable and climate-neutral solutions that accelerate the transition to a healthy planet and respect

planetary boundaries. It will address the challenges raised by the fact that the EU economy does not operate within planetary boundaries, is not sufficiently circular and is predominantly fossil based. It will also address the insufficient research and innovation (R&I) capacity and cross-sectoral transfer of knowledge and bio-based solutions, as well as risks posed to the European bio-based industry's global competitiveness. The study concluded that Institutionalised European Partnership based upon Article 187 TFEU is the preferred option for the implementation of this initiative.

14. Candidate Institutionalised European Partnership for Innovative SMEs

The initiative is envisaged as a continuation of the Eurostars 2 programme which is managed by the Eureka network. The initiative focuses on international collaborative R&D of innovative companies, facilitated through a network of national funding organisations as included in the Eureka network. The funded projects are bottom-up and involve small numbers of project partners. The candidate partnership addresses a niche issue namely limited opportunities for international bottom-up collaboration. The partnership provides thus an opportunity for SMEs for international R&D collaboration but does not address specific technological, social, or environmental challenges. Its main objective is to improve the competitiveness of European SMEs through collaborative funding. The study concluded that a co-funded partnership is the preferred option for the implementation of this initiative.

PART II. Horizontal studies

1. Horizontal Analysis of Efficiency and Coherence in Implementation

The focus of this report is on the coherence and efficiency in the current European Partnership landscape under Horizon Europe and the potential to enhance efficiency in the European Partnerships' implementation.

European Partnerships are geared towards playing a pivotal role in tackling the complex economic and societal challenges that constitute the R&I priorities of the Horizon Europe Pillar II and are in a unique position to address transformational failures. Multiple potential interconnections and synergies exist between the candidate European Partnerships within the clusters, but few are visible across the clusters.

As for the improvement of the efficiency in implementation of institutionalised partnerships under Art. 187, potential efficiency and effectiveness gains could be achieved with enhanced collaboration. An option for a common back-office sharing operational implementation activities is worth exploring further through a detailed feasibility study in order to assess whether efficiency gains can be made. Ideally this would be co-designed as a common Partnership approach, leading to a win-win situation for all partners.

2. Impact Modelling of the Candidate Institutionalised European Partnerships

This report presents the results of the use of a macroeconomic model to assess the economic and environmental impacts of the preferred options identified in the individual 13 impact assessment studies. The model used is E3ME. It includes explicit representation for each EU Member State with a detailed sectoral disaggregation.

The impact modelling estimated the impacts of the envisaged initiatives at an aggregated as well as individual level. In total, 14 macroeconomic models have been run, one per reviewed initiative with a time horizon of 2035 and one that combines all initiatives with a time horizon of 2050. The results of each of these models were compared with those of a baseline scenario, which corresponds to a situation where the initiatives would be funded through regular Horizon Europe calls rather than European Partnerships.

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Part I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

1. Overarching Context to the Impact Assessment Studies

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Introduction

This report sets out the overall policy context of the impact assessment studies for the candidate Institutionalised European Partnerships and the methodological framework that was developed for the impact assessment studies.

It describes the changes in approach to the public-private and public-public partnerships under Horizon Europe compared to the previous EU Framework Programmes. An example is the requirement that all envisaged European Partnerships be implemented as either co-programmed, co-funded or institutionalised. The impact assessment studies will consider these three scenarios as the different options to be assessed, in compliance with the Better Regulation guidelines and against the functionalities that the candidate partnerships are expected to fulfil. The report describes the common methodological framework to assess the envisaged initiatives accordingly.

The report also presents the landscape of European Partnerships at the level of Horizon Europe Pillar 2 clusters, which lay the grounds for all of the impact assessment studies except the candidate Institutionalised European Partnership for Innovative SMEs. This analysis is presented in more depth in the report on the 'Horizontal analysis of efficiency and coherence of implementation' in Part II of the Impact Assessment Study report.

The report is structured around two main headings:

- Chapter 1: Background and context to European Partnerships in Horizon Europe and focus of the impact assessment– What is decided
- Chapter 2: The Candidate European Partnerships under Horizon Europe – What needs to be decided

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1 Background and context to European Partnerships in Horizon Europe and focus of the impact assessment– What is decided

1.1 The political and legal context

1.1.1 Shift in EU priorities and Horizon Europe objectives

Horizon Europe is to be set in the broader context of the pronounced **systemic and holistic approach** taken to the design of the new Framework Programme and the overarching Multi-annual Financial Framework (MFF) 2021-27.

The future long-term budget will be a budget for the Union's priorities. In her Political Guidelines for the next European Commission 2019 – 2024, the new President of the European Commission put forward six overarching priorities for the next five years, which reach well beyond 2024 in scope: A European Green Deal; An economy that works for people; A Europe fit for the Digital Age; Protecting our European way of life; A stronger Europe in the world; and A new push for European democracy. These priorities build upon A New Strategic Agenda for 2019–2024, adopted by the European Council on 20 June 2019, which targets similar overarching objectives. Together with the United Nations Sustainable Development Goals (SDGs), they will shape future EU policy responses to the challenges Europe faces and will steer the ongoing transitions in the European economy and society,

The MFF 2021-27 strives to provide a framework that will ensure a more coherent, focused and transparent response to Europe's challenges. A stronger focus on European added value, a more streamlined and transparent budget, more flexibility in order to respond quickly and effectively to unforeseen demands, and above all, an effective and efficient implementation are among the key principles of the MFF. The objective is to strengthen the alignment with Union policies and priorities and to simplify and reform the system in order to "unlock the full potential of the EU budget" and "turn ambitions into reality". Investment from multiple programmes is intended to combine in order to address key crosscutting priorities such as the digital economy, sustainability, security, migration, human capital and skills, as well as support for small businesses and innovation.[1]

These principles underlying the MFF 2021-27 are translated in the intent for Horizon Europe "to play a vital role, in combination with other interventions, for creating new solutions and fostering innovation, both incremental and disruptive." [2] The new Framework Programme finds its rationale in the daunting challenges that Europe 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."

In the Orientations towards the first Strategic Plan for Horizon Europe, the need strategically to 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, "Actions under Pillar II of Horizon Europe will target only selected themes of especially high impact that significantly contribute to delivering on the political priorities of the Union."

Figure 1, below, which gives an indicative overview of how the EU political priorities are supported under Horizon Europe, shows the major emphasis placed on contributing to the priority 'A European Green Deal', aimed at making Europe the first climate-neutral

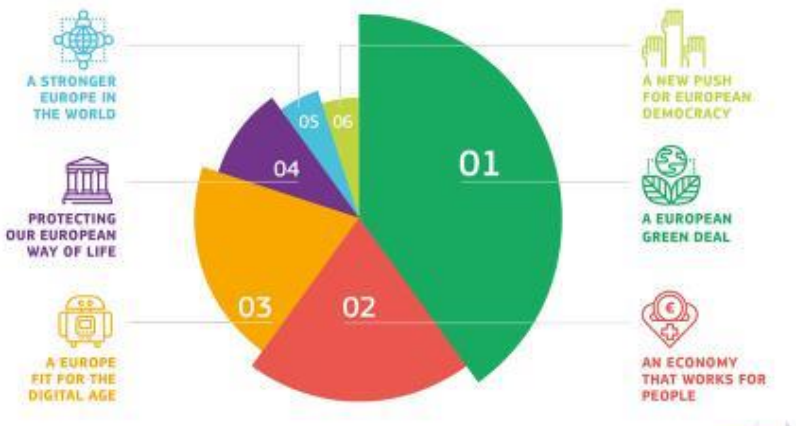
[1] EC (2018) *A Modern Budget for a Union that Protects, Empowers and Defends. The Multiannual Financial Framework for 2021-2027*. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions,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

[2] EC (2019), *Orientations towards the first Strategic Plan for Horizon Europe*.

continent in the world. At least 35 % of the expenditure from actions under the Horizon Europe Programme will address the Sustainable Development Goal 13: Climate Action.

Especially the R&I activities funded under Pillar II, including seven Partnership Areas (see below), are expected to contribute to the attainment of these objectives in an interconnected manner.

Figure 1: Targeted impacts under Horizon Europe by priority



Note: Preliminary, as described in the General orientations towards the first Strategic Plan implementing Horizon Europe.
Source: European Commission (2019) Orientations towards the first Strategic Plan for Horizon Europe, December 2019.

1.1.2 Renewed ambition for European Partnerships

Reflecting its pronounced systemic nature aimed at 'transformation' of the European R&I system, Horizon Europe intends to make a more effective use of these partnerships with an **ambitious approach** that is impact oriented and ensures complementarity with the Framework Programme. The **rationalisation** of the partnership landscape, both in terms of number of partnership forms and individual initiatives, constituted a first step in the direction of the strategic role that these policy initiatives are expected to play in the context of Horizon Europe. Future partnerships are expected to "provide mechanisms to consistently aggregate research and innovation efforts into more effective responses to the policy needs of the Union".[3] The expectation is that they will act as **dynamic change agents**, strengthening linkages within their respective ecosystems and with other related ecosystems as well as pooling resources and efforts towards the common objectives in the European, national and regional landscape. They are expected to develop *close synergies* with national and regional programmes, bring together a *broad range of actors* to work towards a common goal, translate *common priorities* into concrete roadmaps and coordinated activities, and turn research and innovation into *socio-economic results and impacts*.

The exact budget dedicated to European Partnerships under Horizon Europe will be agreed only upon decisions on the multiannual financial framework (MFF) 2021-2017 and the overall budget for Horizon Europe. In December 2017, the Council nevertheless introduced the principle of a "possible capping of partnership instruments in the FP budget".[4] Accordingly, it reached the common understanding, with the European Parliament, that "the majority of the budget in Pillar II [€52.7bn] shall be allocated to actions outside of

[3] European Commission (2019) *Orientations towards the first Strategic Plan implementing the research and innovation framework programme Horizon Europe*. Co-design via web open consultation. Summer 2019.

[4] Council of the European Union (2017) *From the Interim Evaluation of Horizon 2020 towards the ninth Framework Programme*. Council conclusions 15320/17.

European Partnerships" (Article 8.2(a) of the Common Understanding on the proposal for a regulation establishing Horizon Europe).[5]

1.1.3 Key evolutions as regards the partnership approach

The European R&I partnerships were initially conceived as a means to increase synergies between the European Union and the Member States (Article 181 of the Treaty on the Functioning of the European Union TFEU). Their objectives were to pool the forces of all the relevant actors of R&I systems to achieve breakthrough innovations; strengthen EU competitiveness; and, tackle major societal challenges. The core activities of the European partenrships consist therefore of building critical mass mainly through collaborative projects, jointly developing visions, and setting strategic agendas. They help accelerate the emergence of a programming approach in European R&I with the involvement of all relevant actors and provide flexible structures for partnerships that can be tailored to their goals.[6]

In the consecutive Framework Programmes up to the current Horizon 2020, the partnerships and their forms have mushroomed, leading to an increasing complexity of the partnership landscape. The Horizon 2020 interim evaluation highlighted that the overall landscape of EU R&I funding had become overly complex and fragmented, and a need to improve the partnerships' openness and transparency. The Lamy report suggested that the European Partnerships should focus on those areas with the greatest European Added Value, contribute to EU R&I missions and would need a simplified and flexible co-funding mechanism.

The Competitiveness Council conclusions of December 2017 called on the Commission and the Member States to jointly consider ways to rationalise the EU R&I partnership landscape. In 2018, the ERAC Ad-hoc Working Group on Partnerships concluded, "the rationalisation of the R&I partnership landscape is needed in order to ensure that the portfolio of R&I partnerships makes a significant contribution to improving the coherence, functioning and quality of Europe's R&I system and that the individual initiatives are able to fully achieve their potential in creating positive scientific and socio-economic impacts and/or in addressing societal challenges".

Horizon Europe has taken on board these concerns. The Impact Assessment of Horizon Europe gave a clear analysis of the achievements of Partnerships so far as well as the expectations for the new generation of Partnerships. Greater transparency and openness of the partnerships were considered as essential, as well a clear European added value and long-term commitments of the stakeholders involved.

A list of criteria to decide how European Partnerships will be selected, implemented, monitored, evaluated and phased-out was attached as an Annex III to the proposal to establish Horizon Europe (as revised by the partial political agreement). The rationalisation of the Partnership portfolio in Horizon Europe is expected to allow for a reduction from the current 120 to between 45 and 50 partnerships.

[5] Council of the European Union (2019) *Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rule for participation and dissemination*. Common understanding 7942/19.

[6] European Commission (2011) Partnering in Research and Innovation. Communication from the Commission COM(2011) 572 final.

1.1.4 Overview of legal provisions

The Horizon Europe Regulation (common understanding) defines 'European Partnership' 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." It stipulates that "parts of Horizon Europe may be implemented through European Partnerships".

The Horizon Europe Regulation (common understanding) also stipulates that the European Partnerships are expected to 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." The provisions and criteria set out for the selection and implementation of the European Partnerships reflect these principles.

1.1.5 Overview of the eight Partnership areas

The Horizon Europe Regulation also identifies the following "Areas for possible institutionalised European Partnerships on the basis of Article 185 TFEU or Article 187 TFEU":

- Partnership Area 1: Faster development and safer use of health innovations for European patients, and global health.
- Partnership Area 2: Advancing key digital and enabling technologies and their use, including but not limited to novel technologies such as Artificial Intelligence, photonics and quantum technologies.
- Partnership Area 3: European leadership in Metrology including an integrated Metrology system.
- Partnership Area 4: Accelerate competitiveness, safety and environmental performance of EU air traffic, aviation and rail.
- Partnership Area 5: Sustainable, inclusive and circular bio-based solutions.
- Partnership Area 6: Hydrogen and sustainable energy storage technologies with lower environmental footprint and less energy-intensive production.
- Partnership Area 7: Clean, connected, cooperative, autonomous and automated solutions for future mobility demands of people and goods.
- Partnership Area 8: Innovative and R&D intensive small and medium-sized enterprises.

Considering the realm of these partnership areas, potential synergies exist with the future **missions**. Horizon European introduced these cross-discipline and cross-sector policy instruments as part of its core objective of stimulating further excellence-based and impact-driven R&I. In contrast with the challenges targeted in Horizon 2020, the missions aim at the achievement of well-defined goals to provide solutions, within a specified timeframe, to scientific, technological, economical and/or societal problems. As part of the preparation of Horizon Europe, the European Commission set up five boards to formulate the future missions in the following areas:

- Adaptation to climate change including societal transformation

- Cancer
- Healthy oceans, seas, coastal and inland waters
- Climate-neutral and smart cities
- Soil health and food

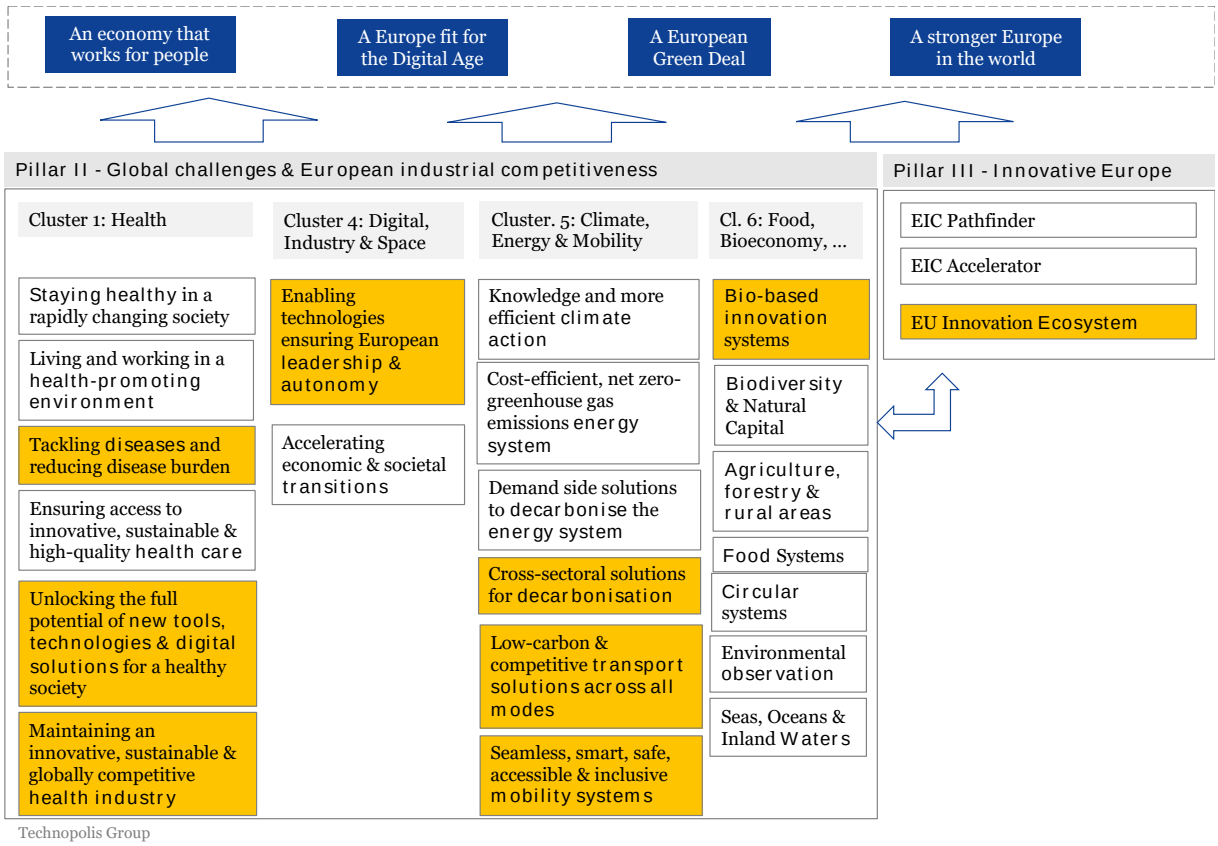
1.2 Typical problems and problem drivers

The European Partnerships are integral part of the framework programme and its three-pillar structure. They are predominantly funded under Pillar 2 "Global Challenges and European industrial competitiveness" and four of its thematic clusters. These clusters cover sectors and technologies, in which research and innovation activities are deemed of crucial importance in solving pressing scientific, societal or economic challenges and ensuring the scientific, technological and industrial leadership of Europe. Only one European Partnership, targeting innovative and R&D intensive SMEs, will instead act under Pillar 3 "Innovative Europe".

The European Partnerships are intended to contribute to the attainment of the pillars' and clusters' **challenges and R&I priorities**. Overarching EU policy priorities addressed are predominantly the European Green Deal, a people-centred economy, the fit for the Digital Age, and a stronger Europe in the world.

In Figure 2, below, the R&I priorities in the Pillars II and III to which the candidate *Institutionalised* Partnerships intend to contribute are highlighted in yellow.

Figure 2: Contribution of Candidate European Institutionalised Partnerships to the Horizon Europe priorities in Pillars II and III



The European Partnerships under Horizon Europe most often find their rationale in addressing **systemic failures**. 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 agenda and/or R&I funding programmes.

The concentration of efforts and resources and pooling of knowledge, expertise and skills on common priorities in a view of solving complex and multi-faceted societal and economic challenges is at the core of these initiatives. Enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems are among the key objectives of these policy instruments. In the light of Horizon Europe, the aim often is to drive system transitions and transformations.

Especially in fast-growing technologies and sectors such as ICT, the envisaged European Partnerships also react on 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.

Transformational failures addressed aim at reaching a better alignment of the strategic R&I agenda and policies of public and private R&I funders in order to pool available resources, create critical mass, avoid unnecessary duplication of research and innovation efforts, and leverage sufficiently large investments where needed but hardly achievable by single countries.

Market failures are less commonly addressed and relate predominantly to enhancing industry investments thanks to the sharing of risks.

1.3 Description of the options

The proposal for a regulation establishing Horizon Europe[7] stipulates that parts of the Horizon Europe Framework Programme may be implemented through European Partnerships and establishes three implementation modes: Co-programmed European Partnerships, Co-funded European Partnerships, and Institutionalised Partnerships in accordance with Article 185 TFEU or Article 187 TFEU.

1.3.1 Baseline option – Traditional calls under the Framework Programme

Under this option, strategic programming for research and innovation in the field will be done through the mainstream channels of Horizon Europe. The related priorities will be implemented through traditional calls under the Framework Programme covering a range of activities, but mainly calls for R&I and/or innovation actions. Most actions involve consortia of public and/or private actors in ad hoc combinations, some actions are single actor (mono-beneficiary). There will be no dedicated implementation structures and no further support other than the Horizon Europe actions foreseen in the related Horizon Europe programme or cluster.

Strategic planning mechanisms in the Framework Programmes allow for a high level of flexibility in their ability to respond to particular needs over time, building upon additional input in co-creation from stakeholders and programme committees involving MS. The broad scope of the stakeholders providing their input to the research agenda, however, implies a lower level of directionality than what can be achieved through the partnerships. Often, the long-term perspective of the stakeholder input is limited, which risks reducing strategic capacity in addressing priorities.

The Horizon Europe option also implies a lower level of EU budgetary long-term commitment for the priority. Without a formal EU partnership mechanism, it is also less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual financial commitments beyond the single project participation.

[7] Proposal for a Regulation of the European Parliament and of the Council stablishing Horizon Europe - the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination - Common understanding', March 2019

1.3.2 European Partnership

All European Partnerships will be designed in line with the new policy approach for more objective-driven and impactful partnerships. They are based on the common criteria in Annex III of the Horizon Europe Regulation, with few distinguishing elements for the different forms of implementation. All European Partnerships will be based on an agreed Strategic Research and Innovation Agenda / roadmap agreed among partners and with the Commission. For each of them the objectives, key performance and impact indicators, and outputs to be delivered, as well as the related commitments for financial and/or in-kind contributions of the partners will be defined ex-ante.

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 European Commission and the private and/or public partners. Private partners are typically represented by one or more industry association, which also functions as a back-office to the partnership. It allows for a *high flexibility* in the profile of organisation involved, objectives pursued, and/or activities implemented.

Co-programmed European Partnerships address *broader communities* across a diverse set of sectors and/or value chains and where the actors have *widely differing capacities and capabilities*. They may encompass one or more associations of organisations from industry, research, NGOs etc as well as foundations and national R&I funding bodies, with no restriction on the involvement of international partners from Associated and non-associated third countries. Different configurations are possible: private actors only, public entities only, or a combination of the two.

The basis, as for all European Partnerships, is the rationale is to create a *platform for 'concertation'*, i.e. in-depth and ongoing consultation of the relevant actors in the European R&I system for the co-development of a strategic research and Innovation agenda, typically covering the period of the next 10 years. The primary ambition is to generate *commitment to a common strategic research and innovation agenda* (SRIA). For the private actors involved, this would allow for a de-risking of their R&I investments and provide predictability of investment paths, for the public actors, it serves as a means to: inform national policy-makers on EU investments and allows for coordination and alignment of their efforts to support R&I in the field at the national level.

The *level of 'additionality is possibly lower than for other partnerships*. There is no expectation of a legally binding commitment from the partners to taking an integrated approach in their individual R&I implementation and it is based on 'best efforts'. However, the Union contribution to the partnership is defined for the full duration and has a comparable level of certainty for the partnerships than in the other forms of implementation. The priorities for the calls, proposed by the partnership members for integration in the Framework Programme Work Programmes, are subject to further input from Member States (comitology) and Commission Services. The full implementation of the Union contribution in the Framework Programme implies that the full array of Horizon Europe funding instruments in the related Pillar can be used, ranging from RIAs to CSAs and including grants, prizes, and procurement.

Option 2 – Co-funded European Partnership

The Co-funded Partnership is based on a Grant Agreement between the Commission and the consortium of partners, resulting from a call for a proposal for a programme co-fund action implementing the European Partnerships in the Horizon Europe Work Programme. Programme co-fund actions provide co-funding to a programme of activities established and/or implemented by entities managing and/or funding research and innovation programmes. Therefore, this form of implementation only allows to address public partners

at its core (comparable to the Article 185 initiatives below), while industry can nevertheless be addressed by the activities of the partnerships, but not make formal commitments and contributions to it. The expectation is that these entities would cover most if not all EU Member States (MS). Also 'international' funding bodies can participate as partners, which creates the potential for an efficient interaction with strategic international partners. Legal entities in countries that are not part of the programme co-fund consortium, are usually excluded from funding under the calls launched by the consortium.

The basic rationale for this partnership option is to bring MS together to invest at scale in key R&I issues of general and common interest. The joint programme of activities is agreed by the partners and with the EU and typically focuses on societal grand challenges and specifically, areas of high public good where EU action will add value while reflecting national priorities and/or policies. The ultimate intent is to create the greatest possible impact by pooling and/or coordinating national programmes and policies with EU policies and investments, helping to overcome fragmentation of the public research effort. Member States that are partners in this partnership become the 'owners' of the priority and take sole responsibility for its funding. Commitments of the partners and the European Union are ensured through the Grant Agreement.

Based on national programmes, this partnership option shows a particularly high level of flexibility in terms of activities to be implemented - directly by the national funding bodies (or governmental organisation "owning" institutional programmes), or by third parties receiving financial support (following calls for proposals launched by the consortium). The broad range of possible activities include support for networking and coordination, research, innovation, pilot actions, and innovation and market deployment actions, training and mobility actions, awareness raising and communication, dissemination and exploitation, any relevant financial support, such as grants, prizes, procurement, as well as Horizon Europe blended finance or a combination thereof.

Option 3 – Institutionalised European Partnership

This type of Partnership is the most complex and high-effort arrangement and will be based on a Council Regulation (Article 187) or a Decision by the European Parliament and Council (Art 185) and implemented by dedicated structures created for that purpose. The legal base for this type of partnership limits the flexibility for a change in 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 agenda's in the private and/or public sectors in Europe in order to address a strategic challenge or realise an opportunity. The focus is on major long-term strategic challenges and priorities beyond the framework of a single Framework Programme where collective action – by private and/or public sectors – is necessary to *achieve critical mass* and *address the full extent of the complexities* of the ecosystem concerned.

The long-term commitment expected from the European Union and its partners is therefore much larger than for any of the other options, given the considerably higher investment in the preparation and implementation of the Partnership. As a result, this type of partnership can be selected only if 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. The commitment for contributions by the partnership members is expected to be at least equal to 50% and may reach up to 75% of the aggregated European Partnership budgetary commitments.

The partnership members have a high degree of autonomy in developing the strategic research agenda and annual work programmes and call topics, based on a transparent and accessible process, and subject to the approval of the Commission Services. The choice of topics addressed in the (open) calls are therefore strongly aligned with the needs defined. Normally, the strategic priorities are fully covered by the annual work programmes in the

partnership, even though it is in principle possible to keep certain topics for calls in the FP thus complementing the activities in the partnership. The full integration in the Framework Programme implies that the full array of Horizon Europe funding instruments in the related Pillar can be used, ranging from RIAs to CSAs and including grants, prizes, and procurement.

Two forms of Institutionalised Partnerships are of direct relevance to this study, influencing the constellation of partners involved.

Institutionalised Partnerships based upon Art 185 TFEU

Article 185 of the TFEU allows the Union to participate in programmes jointly undertaken by Member States and limits therefore the scope of partners to 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 dedicated legal entity (Dedicated Implementation Structure) for the implementation. By default, membership of non-associated Third Countries is not foreseen. Such membership is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement. Eligibility for participation and funding follows by default the rules of the Framework programme, unless a derogation is introduced in the basic act.

Institutionalised Partnerships under Art. 187 TFEU

This type of Institutionalised Partnership aims at reaching the greatest possible impact by integrating the strategic R&I agendas of private and/or public actors and by leveraging the partners' investments in order to tackle R&I and societal challenges and/or contribute to Europe's wider competitiveness goals.

It brings together a stable set of 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) 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). By default, membership of non-associated Third Countries is not foreseen. Such membership is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement. Eligibility for participation and funding follows by default the rules of the Framework programme, unless a derogation is introduced in the basic act.

2 The Candidate European Partnerships under Horizon Europe – What needs to be decided

2.1 Portfolio of candidates for Institutionalised Partnerships under Horizon Europe

2.1.1 The process for identifying the priorities for Institutionalised Partnerships under Horizon Europe

In May 2019, the European Commission consulted the Member States on a list of 44 possible candidates for European Partnership which it had identified as part of the preparation of the first Strategic Planning of Horizon Europe. This list was also part of the

Orientations towards the first Strategic Plan implementing Horizon 2020[8] which served as a basis for an Open Public Consultation from July to October 2019. In October and November 2019, the European Commission and the Member States agreed on increasing the number of candidate European partnerships to 49. Subsequent discussions until the adoption of Horizon Europe will focus on ensuring the overall consistency of the EU partnership landscape and its alignment with the EU overarching priorities and on defining the precise implementation modalities.

In parallel, the European Commission completed inception impact assessments on the candidate institutionalised European partnerships. Stakeholders had the opportunity to provide their feedback on these inception impact assessments in August 2019. A web-based open public consultation to collect opinions on all candidate institutionalised partnerships (but the candidate EuroHPC partnership) was organised between September and October 2019.

2.1.2 Overview of the overall landscape of candidate European Partnerships subject to the impact assessment

Figure 3, below, gives an overview of all European Partnerships that are currently envisaged for funding under Horizon Europe. The candidate Institutionalised Partnerships that are the subject for this impact assessment study are coloured in dark orange.

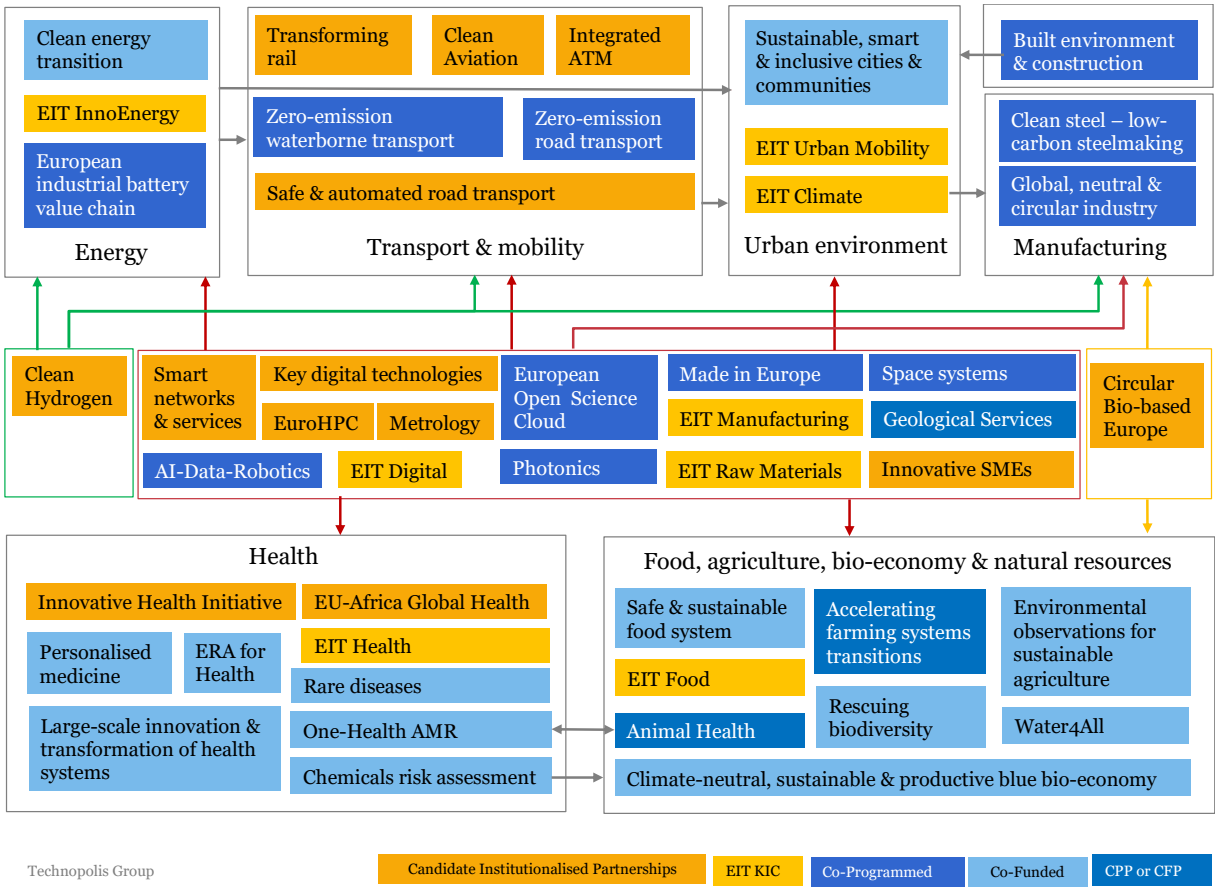
The European Partnerships can be categorised into two major groupings: *'horizontal' partnerships* focused on the development of technologies, methods, infrastructures and resources/materials, and *'vertical' partnerships* focused on the needs and development of a specific application area, be it industrial or societal.

The diagram below shows the central position of the **'horizontal' partnerships** in the overall landscape, developing methodologies, technologies or data management infrastructures for application in the other priority areas. These 'horizontal' partnerships are predominantly proposed as Institutionalised or Co-programmed Partnerships, in addition to a number of EIT KICs. The European Open Science Cloud (EOSC) partnership, for example, will support research partnerships by providing an infrastructure for the storage, management, analysis and re-use of research data.

The upper banner of the diagram groups the **industry-oriented 'vertical' partnerships**. Under Horizon Europe, they have in common a pronounced focus on enhancing sustainability. In this context, the banner includes also one of the most recent agreed-upon partnerships focused on the urban environment. This partnership illustrates the introduction under Horizon Europe of *challenge-oriented* cross-cluster partnerships. Multiple interconnections are envisaged among the 'vertical' partnerships in the different industry sectors covered. In the transport sector, the partnerships are predominantly proposed as Institutionalised Partnerships. In the other sectors, we see a mix of Co-Programmed Partnerships and EIT KICs. There are only two Co-Funded Partnerships.

[8] Orientations towards the first Strategic Plan implementing the research and innovation framework programme Horizon Europe, Co-design via Web Open Consultation (2019), see more here https://ec.europa.eu/research/pdf/horizon-europe/ec_rtd_orientations-towards-the-strategic-planning.pdf

Figure 3: Landscape of European Partnerships under Horizon Europe (2019)



The lower banner includes the '**vertical' partnerships in the societal application areas**. Striking is the dominance of the Co-Funded Partnerships (to be noted that in the Food/agriculture cluster, the partnership type still needs to be decided for several envisaged partnerships). We also note the limited interconnections that are envisaged between the two areas. An exception is the newly envisaged cross-cluster European Partnerships 'One Health AMR'.

2.2 Assessing the necessity of a European Partnership, possible options for implementation and their cost-effectiveness

In this section we set out the methodological framework that underpins the impact assessment studies. In line with the Better Regulation Guidelines, the impact assessment is intervention logic-based and impact-oriented.

The impact assessment allowed also for the conduct of the 'necessity test' for a European Partnership as set out in the Horizon Europe regulation. Pivotal in this context was the identification of the Horizon Europe calls as Option 0 as well as Baseline Option, allowing for a comparative analysis of the three partnership forms (Options 1-3) along all of the assessment dimensions – in relation to each other as well as to the Horizon Europe calls. The options assessment therefore incorporated the required 'necessity test'.

2.2.1 Assessment of the selection criteria

The common methodological framework that we defined for the 13 individual Impact Assessment studies reflects the approach defined in the Better Regulation guidelines. It also integrates the specific criteria for the use of the different types of European Partnerships as they are defined in the Horizon Europe Common Understanding (Article 8 and Annex III). Specifically this regards the **selection criteria** which have to be demonstrated as a minimum in order to justify the necessity of a European Partnership instead of regular Horizon Europe calls only and the implementation criteria in Article 8

1(a), (b) and (c) with certain elements distinguishing the use of the different partnership implementation modes (Table 1).

Table 1: Horizon Europe selection criteria for the European Partnerships

Common selection criteria and principles	Specifications
More effective (Union added value) clear impacts for the EU and its citizens	• delivering on global challenges and research and innovation objectives
	• securing EU competitiveness
	• securing sustainability
	• contributing to the strengthening of the European Research and Innovation Area
	• where relevant, contributing to international commitments
Coherence and synergies	• within the EU research and innovation landscape
	• coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions
Transparency and openness	• identification of priorities and objectives in terms of expected results and impacts
	• involvement of partners and stakeholders from across the entire value chain, from different sectors, backgrounds and disciplines, including international ones when relevant and not interfering with European competitiveness
	• clear modalities for promoting participation of SMEs and for disseminating and exploiting results, notably by SMEs, including through intermediary organisations
Additionality and directionality	• common strategic vision of the purpose of the European Partnership
	• 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
	• demonstration of expected qualitative and significant quantitative leverage effects, including a method for the measurement of key performance indicators
	• exit-strategy and measures for phasing-out from the Programme
Long-term commitment of all the involved parties	• a minimum share of public and/or private investments
	• In the case of institutionalised European Partnerships, established in accordance with article 185 or 187 TFEU, the financial and/or in-kind, contributions from partners other than the Union, will at least be equal to 50% and may reach up to 75% of the aggregated European Partnership budgetary commitments

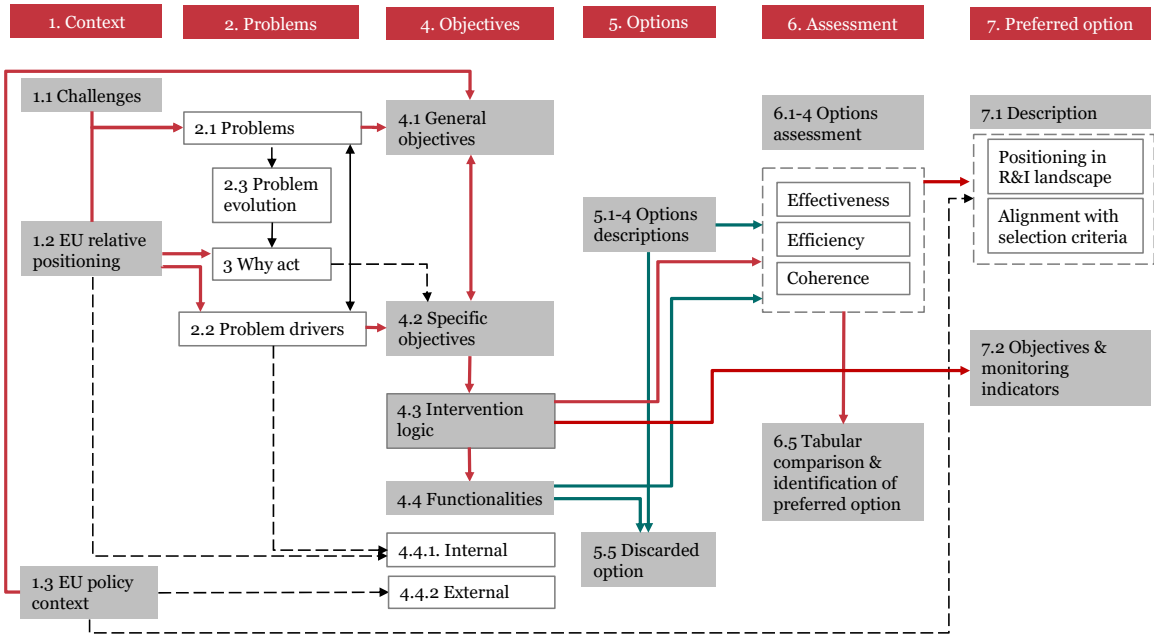
The **Better Regulation guidelines** remained the primary point of reference for the 13 individual Impact Assessment studies. The different steps of the IA process were carried out in a consistent manner in the 13 individual IA studies, supported by horizontal analyses (i.e. common to all studies) such as bibliometrics/patent analysis, social network analysis, the partnership portfolio mapping and analysis, as well as the analysis of the Open Public Consultation data.

The **selection criteria** for the European Partnerships related to effectiveness and coherence fit reasonably well in the Better Regulation impact assessment structure. More problematic was the coverage of the other three criteria groupings, i.e. the criteria of Openness and Transparency, Additionality and Directionality, and the Ex-ante demonstration of commitment.

The solution was the introduction of a section on the **'Functionalities of the initiative'**, in which set out our view on *how* the initiative should *concretely* respond to the selection criteria of 'coherence and synergies', 'openness and transparency' and 'additionality and directionality' in order to reach its objectives. We focused on those aspects that are not covered in other sections of this report, such as coherence and synergies, and covered those elements that from our analysis of the partnership options resulted being **key distinguishing features** of the partnership options, i.e. the composition of the partnership ('openness', including from a geographical perspective), the type of activities implemented ('flexibility'), and the level of directionality and integration of the stakeholders' R&I strategies needed ('directionality and additionality').

The logical process is summarised in Figure 4, below. The diagram shows how the 'functionality' sections constituted an important passage from the objectives and intervention logic sections to the options assessment. Building upon information collected in the previous sections (context, problem and objectives analysis) and in combination with the description of the available options, the description of the desirable 'functionalities' allowed for, on the one hand, the identification of the discarded option(s) and, on the other hand, the options assessment against coherence and against the selection criteria of 'Openness and Transparency' and 'Additionality and Directionality'. In the final chapter of the Impact Assessment report, the alignment of the preferred option with the criteria for the selection of European Partnerships was described, emphasising the outcomes of the 'necessity test'.

Figure 4: Flow of the analysis



Notes: the numbers indicate the related chapters or sections in the Impact Assessment reports

2.2.2 Methodological approach

Overview of the methodologies employed

The understanding of the overall context of the candidate institutionalised European Partnerships relies on a desk research partly covering the main impacts and lessons learned

from their predecessor partnerships (if any). This was complemented with a set of quantitative analyses of the Horizon 2020-funded partnerships, or in case these did not exist, the H2020-funded projects in the field. 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 (see below).

Public consultations (open and targeted) supported the comparative assessment of the policy options. Each study interviewed up to 50 relevant stakeholders (policymakers, business including SMEs and business associations, research institutes and universities, and civil organisations, among others). They also used the results from the Open Public Consultation organised by the European Commission (Sep – Nov 2019) and the feedback on the Inception Impact Assessments of the 13 candidate institutionalised European Partnerships that the European Commission received in September 2019.

The timing of the Impact Assessment studies, in parallel to the negotiations between the European Commission and the existing Joint Undertakings on the specific implementation of the rules for the future European Partnership, as well as the ongoing discussions within the existing partnership on their future research directions, has set potential limits to the validity of the input and feedback collected from the stakeholders during the consultations.

A more detailed description of the methodology is provided in the Annexes C of each impact assessment report.

Method for identifying the preferred choice

The four policy options were compared along a range of key parameters. The comparison along these parameters was carried out in an evidence-based manner. A range of quantitative and qualitative evidence was used, including ex-post evaluations; foresight studies; statistical analyses of Framework Programmes application and participation data and Community Innovation Survey data; analyses of science, technology and innovation indicators; econometric modelling exercises producing quantitative evidence in the form of monetised impacts; reviews of academic literature on market and systemic failures and the impact of research and innovation, and of public funding for research and innovation; sectoral competitiveness studies; expert hearings; etc.

Options assessment related to effectiveness and coherence

On the basis of the evidence collected and gathered, the Impact Assessment study teams assessed the effectiveness of the retained policy options along three dimensions corresponding to the different categories of likely impacts: scientific, economic and technologies, and societal (including environmental) impacts. The Impact Assessment study teams considered to which extent the retained policy options fulfilled the desirable 'functionalities' and were therefore likely to produce the targeted impacts. This analysis resulted in a scoring of the policy options along a three-point scale.[9] Instead of a compound score, the assessment of the effectiveness of the policy options concluded on as many scores as there are expected impacts.

Likewise, the impact assessment study teams attributed scores (using the same approach as above) reflecting the potential of each retained policy option for ensuring coherence with programmes and initiatives within (internal coherence) and beyond (external coherence) Horizon Europe.

[9] Scores vary from + to +++, where + refers to low potential for presenting a low potential for reaching the likely impacts, ++ to a good potential, and +++ to a high potential.

Scores were justified in a consistent and detailed manner in order to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation was provided of why certain scores were given to specific impacts.

When assessing the respective efficiency of the retained policy options, the Impact Assessment study teams considered the scores related to effectiveness and the identified costs to conduct a "value for money" (or cost-effectiveness) analysis. They accordingly attributed a comparative score to each of the options ranging from 1 (option with the highest costs) to 3 (options with the lowest costs).

Options assessment related to efficiency

A standard cost model

The 'horizontal' team has reviewed the cost categories and costs for each of the four policy options, at some length. Our first model used published data from past partnerships and Horizon 2020 calls working with the Commission's standard accounting codes (Title 1, Title 2, Title 3). The analysis revealed wide-ranging differences in costs across partnerships and functions, which was thought to be too complex to be helpful to the current exercise. As a result, we created a static, common model using average costs as a means by which to indicate the order of magnitude of effort and thereby reveal the principal differences between each of the policy options.

The model was developed jointly with the European Commission services and is presented in the study Data report (D1.2), along with an explanation of the data sources used and the assumptions made.

It is important to note that the costs identified are theoretical and do not reflect the actual costs of any existing individual partnership. In light of this fact, and to avoid any risk of misunderstanding, we have transposed the financial estimates into a qualitative presentation using + / - system in order to compare the various cost elements for each policy option with the equivalent costs for the baseline policy options (see Table 2).

The principal differences in costs as compared with regular Horizon Europe calls relate to the European Partnerships' one-off costs (e.g. developing the proposal and Strategic Research and Innovation Agenda), additional supervision by the European Commission and any additional programme management effort. The main difference between the three types of European Partnership are twofold: (i) the extent to which a partnership will need to run a limited or comprehensive programme management unit and (ii) the extent to which a new partnership may benefit from a pre-existing programme management unit that will greatly reduce or eliminate the set-up costs that would apply to a wholly new partnership.

Table 2: Intensity of additional costs compared with HEU Calls (for Partners, stakeholders, public and EC)

Cost items	Option 0	Option 1	Option 2	Option 3 -Art. 185	Option 3 -Art. 187
Preparation and set-up costs					
Preparation of a partnership proposal (partners and EC)	0	++	++	++	++
Set-up of a dedicated implementation structure	0	0	0	Existing: + New: ++	Existing: ++ New: +++
Preparation of the SRIA / roadmap	0	++	++	++	++

Cost items	Option 0	Option 1	Option 2	Option 3 -Art. 185	Option 3 -Art. 187
Ex-ante Impact Assessment for partnership	0	0	0	+++	+++
Preparation of EC proposal and negotiation	0	0	0	+++	+++
Running costs (Annual cycle of implementation)					
Annual Work Programme preparation	0	+	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	0	0	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

Rationale for the comparative scoring on 'overall costs' and 'cost-efficiency' in the scorecard

In the scorecard analysis, the scores related to the set-up and implementation costs will allow the study teams to consider the scale of the expected benefits and thereby allow a simple "value for money" analysis (cost-effectiveness).

Table 3 shows how we translated the cost analysis into a series of numerical scores.

Table 3: Cost-efficiency matrix

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 2: Co-funded	Option 3: Institutionalised
Overall cost	3	2	1	1
Cost-efficiency	3	3	2	2

For the 'overall cost' dimension, we assigned a score 1 to the option with the highest additional costs and a score 3 to the option with the lowest additional costs compared to the baseline. This was based on the following considerations:

- **Horizon Europe regular calls** will have the lowest overall cost among the policy options and have therefore been **scored 3** on this criterion, using a scale of 1-3 where 3 is best (lowest additional costs). This adjudged score is based on two facts: firstly, that Horizon Europe will not entail any additional one-off costs to set up or discontinue

the programme, where each of the other policy options will require at least some additional set-up costs; and secondly, that Horizon Europe will not require any additional running costs, where each of the other policy options will involve additional efforts by the Commission and partners in the carrying out of necessary additional tasks (e.g. preparing annual work programmes).

- A **co-programmed partnership** (Option 1 - CPP) will entail slightly higher overall costs as compared with the baseline policy option and has therefore been given a **score of 2**, using a scale of 1-3 where 3 is best (lowest additional costs). There will be some additional set-up costs linked for example with the creation of a strategic research and innovation agenda (SRIA) and additional running costs linked with the partners role in the creation of the annual work programmes and the Commission's additional supervisory responsibilities. A CPP will have lower overall costs than each of the other types of European Partnership, as it will function with a smaller governance and implementation structure than will be required for a Co-Funded Partnership or an Institutionalised Partnership and – related to this – its calls will be operated through the existing HEU agencies and RDI infrastructure and systems.
- The **Co-Funded Partnership (**Option 2 – CFP) has been **scored 1** on overall cost, using a scale of 1-3 where 3 is best (lowest additional costs). This reflects the additional set-up costs of this policy option and the substantial additional running costs for partners, and the Commission, of the distributed, multi-agency implementation model.
- The **Institutionalised Partnership** (Option 3 - IP) has been **scored 1** on overall cost, using a scale of 1-3 where 3 is best (lowest additional costs). This reflects the substantial additional set-up costs of this policy option – and in particular the high costs associated with preparing the Commission proposal and negotiating that through to a legal document – and the substantial additional running costs for the Commission associated with the supervision of this dedicated implementation model.

In relation to **cost-efficiency**, we considered that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when we take into account financial leverage (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 and CPP policy options – and the least cost-efficient – the CFP and IP. We have therefore assigned a score of 3 to the baseline Option 0 and CPP options for cost-efficiency (no or minor additional costs, as compared with the baseline) and a score of 2 for the CFP and IP policy options (medium additional costs, as compared with the baseline).

Scorecard analysis for the final options assessment

The scorecard analysis built a hierarchy of the options by individual criterion and overall. The scorecard exercise supported the systematic appraisal of alternative policy options across multiple types of monetary, non-monetary and qualitative dimensions. It also allowed for easy visualisation of the pros and cons of alternative options.

Each option was attributed a value of 1 to 3, scoring the adjudged performance against each criterion with the three broad appraisal dimensions of effectiveness, efficiency and coherence.

Scores were justified in a consistent and detailed manner in order to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation was provided of why certain scores were given to specific impacts, and why one option scores better or worse than others.

The scorecard analysis allowed for the identification of a single preferred policy option or in case of an inconclusive comparison of options, a number of 'retained' options or hybrid. The final selection is a policy decision.

2.3 Cross-partnership challenges in Horizon Europe clusters

In this section we set the envisaged and candidate partnerships in the context of the Horizon Europe clusters and the related higher-level EU policy objectives and priorities. We focus on the evolution of the policy context including the new European Green Deal/climate neutrality objectives, the Horizon Europe Framework relevant to this cluster, and the link to the relevant Sustainable Development Goals. Seeing the focus on the Pillar II clusters, this section excludes the candidate *Institutionalised Partnership for Innovative SMEs*.

2.3.1 Cluster 1 – Health

Research and innovation (R&I) actions under this cluster will aim at addressing the major socio-economic and societal burden that diseases and disabilities pose on citizens and health systems of the EU and worldwide.

The R&I activities funded under the Pillar II Cluster Health aim at contributing to the achievement of the Sustainable Development Goal 'Ensuring healthy lives and promoting well-being for all at all ages' resulting from investments in research and innovation focused on three overarching EU policy objectives: 'An economy that works for people', 'A Europe fit for the Digital Age', and 'A European Green Deal' (see Figure 5, below). The Horizon Europe proposal for a regulation defined the areas for possible institutionalised European partnerships on the basis of Article 185 TFEU or Article 187 TFEU as "*Partnership Area 1: Faster development and safer use of health innovations for European patients, and global health".*

At the core in this cluster are the R&I orientations that aim at ensuring that citizens *stay healthier throughout their lives* due to improved health promotion and disease prevention and the adoption of healthier behaviours and lifestyles, the development of *effective health services* to tackle diseases and reduce their burden, and an improved access to *innovative, sustainable and high-quality health care*. These objectives require an unlocking of the full potential of *new tools, technologies and digital solutions* and ensuring a *sustainable and globally competitive health-related industry* in the EU, allowing for the delivery of, e.g. personalised healthcare services. Last but not least, the citizens' health and well-being need to be *protected from environmental degradation and pollution*, addressing a.o. climate-related challenges to human health and health systems.

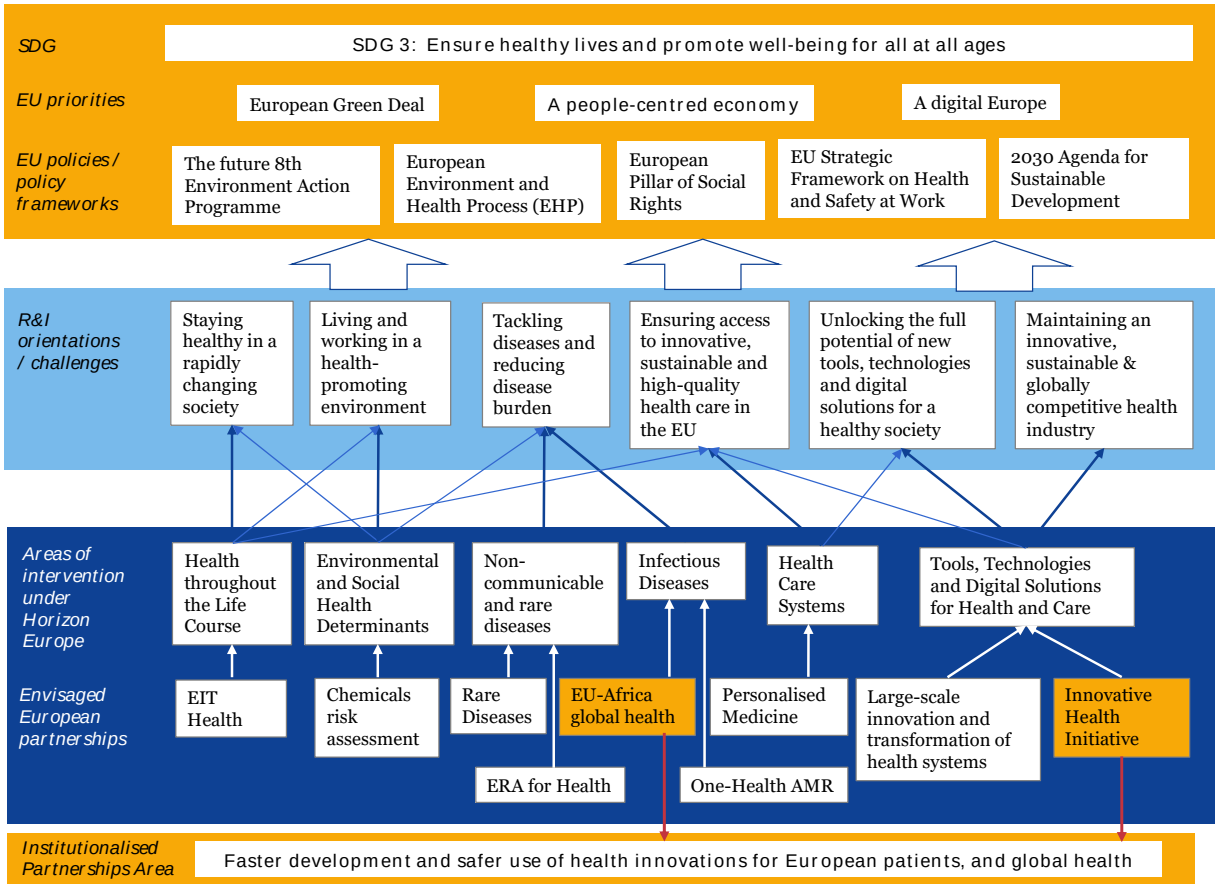
Figure 5, below, shows that the portfolio of envisaged European Partnerships in this cluster[10] aims to contribute to all of the R&I orientations in this cluster. However, there is a pronounced focus on the 'tackling diseases and reducing the disease burden' objective, addressed by five out of the ten partnerships (amongst which there is one candidate Institutionalised Partnership). The objectives focused on an improved exploitation of digital solutions and competitiveness of the EU health-related industry are addressed by two partnerships amongst which one is a candidate Institutionalised Partnership.

In this context, it should be noted that the portfolio of European Partnerships in this cluster predominantly encompasses Co-funded Partnerships, focused on joining the R&I programmes and investments at the national level. There is therefore overall a limited level of involvement of the private sector in the development of the SRIAs (i.e. as partners of the envisaged partnerships), be it from the supply or user side in the value chains. The only exceptions are the Innovative Health Initiative and the EIT KIC Health. European Partnerships also provide limited support for the assessment of environmental and social health determinants, uniquely addressed from a chemical risks perspective.

[10] As proposed in the Horizon Europe 'Orientations towards the first Strategic Plans', dd. December 2019

The description of the interconnections between the partnerships in this cluster and the ones funded in the context of other clusters, provided in the reports of the individual impact assessment studies, sheds more light on this topic.

Figure 5: R&I priorities and higher-level objectives of the Horizon Europe Cluster 1 – Health



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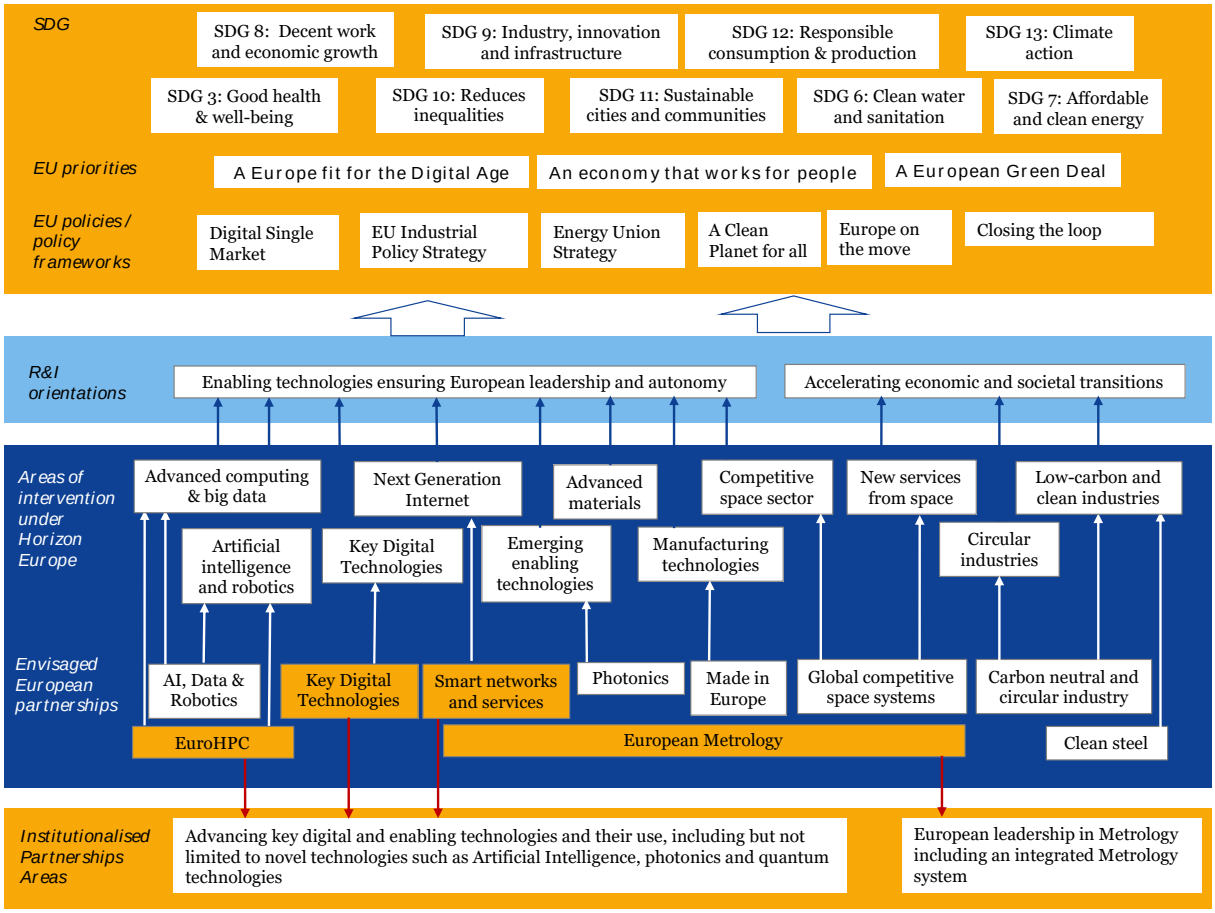
2.3.1 Cluster 4 – Digital, Industry and Space

In this cluster the focus is on the digitisation of European industry and on advancing key enabling, digital and space technologies which will underpin the transformation of our economy and society at large. The overarching vision for R&I investments in this cluster is "a European industry with global leadership in key areas, fully respecting planetary boundaries, and resonant with societal needs – in line with the renewed EU Industrial Policy Strategy." The expected effects on the European economy and society imply that the R&I activities under this cluster will contribute to various Sustainable Development Goals and respond to three key EU policy priorities: 'A European Green deal', 'A Europe fit for the digital age', and 'An economy that works for people' (Figure 6).

The cluster pursues three objectives: 1) ensuring the competitive edge and sovereignty of EU industry; 2) fostering climate-neutral, circular and clean industry respecting planetary boundaries; and 3) fostering social inclusiveness in the form of high-quality jobs and societal engagement in the use of technologies. A human-centred approach will be taken, i.e. technology development going hand in hand with European social and ethical values.

The key R&I priorities are grouped in two general categories: (I) Enabling technologies ensuring European leadership and autonomy; and (II) Accelerating economic and societal transitions (these will be complemented by priorities of other clusters). European Partnerships envisaged to support the R&I in the specific intervention areas are mainly co-programmed partnerships. Exceptions are the three candidate Institutionalised Partnerships in the digital field and the candidate Institutionalised Partnership in metrology, reflecting their related Partnership Areas.

Figure 6: R&I priorities and higher-level objectives of the Horizon Europe Cluster 4 – Digital, Industry and Space



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Multiple convergences exist between the technologies that are covered in the first strand of the priorities in this cluster, i.e. "enabling technologies ensuring European leadership and autonomy". In their function of 'enabling' technologies, they will also make critical contributions to the attainment of the desired 'transitions' in the 'vertical' industry sectors targeted in the second strand of priorities in this cluster as well as in the other clusters. A major contribution from this perspective can be expected from the four candidate Institutionalised Partnerships as well as from the 'Made in Europe' partnership, focused on manufacturing technologies.

2.3.2 Cluster 5 – Climate, Energy and Mobility

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 including affordable and clean energy (SDG7); industry, innovation & infrastructure (SDG9); sustainable cities & communities (SDG11); sustainable consumption & production (SDG12); and climate action (SDG13). The cluster is most closely aligned to the EU priority for 'A European Green Deal' but also has synergy with two of the other five priorities; 'An economy that works for people' and 'A Europe fit for the Digital Age'. This extends across various policies including a Clean Planet for all, the Energy Union strategy, Single European Railway Area, European ATM Master Plan, Single European Sky, and Europe on the Move (Figure 7).

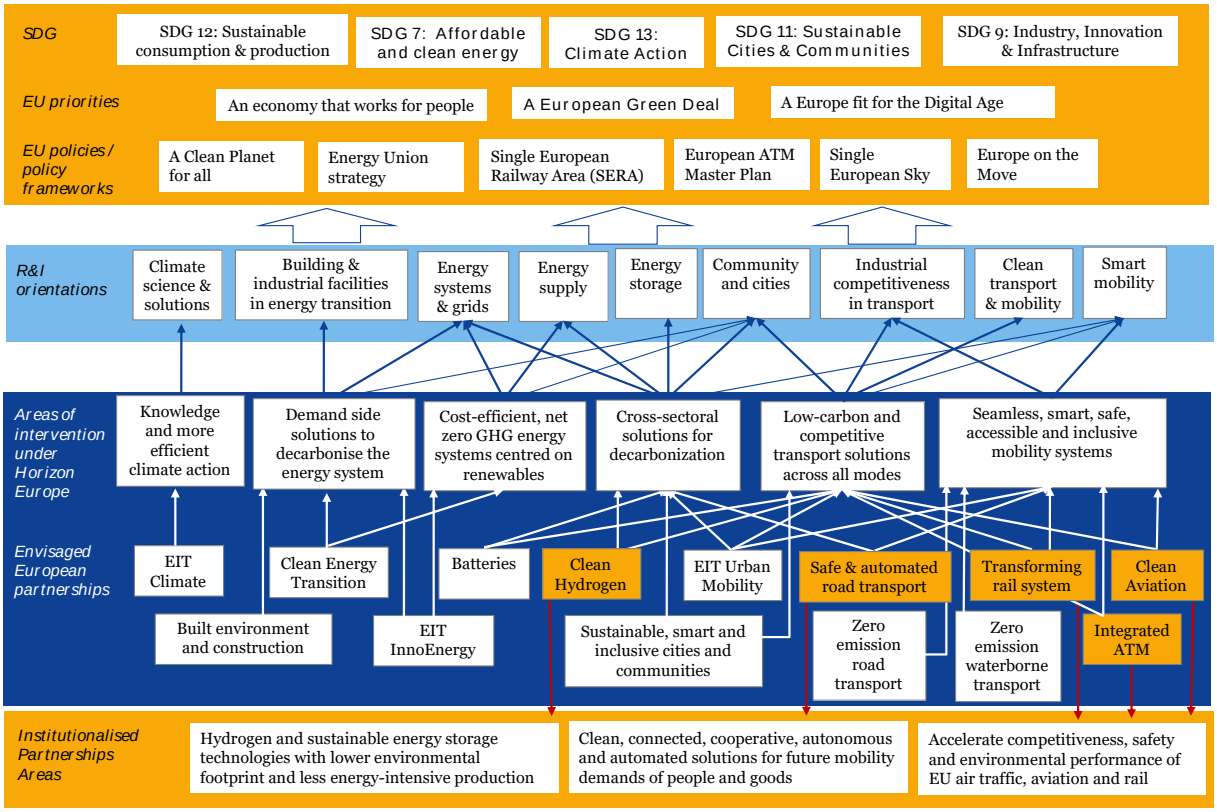
The cluster is directly relevant to several of the areas for possible institutionalised European partnerships on the basis of Article 185 TFEU or Article 187 TFEU, namely:

- Partnership Area 4: Accelerate competitiveness, safety and environmental performance of EU air traffic, aviation and rail

- Partnership Area 6: Hydrogen and sustainable energy storage technologies with lower environmental footprint and less energy-intensive production
- Partnership Area 7: Clean, connected, cooperative, autonomous and automated solutions for future mobility demands of people and goods

Cluster 5 is structured under six areas of intervention under Horizon Europe and nine R&I orientations. Figure 7, below, shows the portfolio of envisaged European Partnerships that are relevant to this cluster and their link to the areas of intervention.

Figure 7: R&I priorities and higher-level objectives of the Horizon Europe cluster Climate, Energy and Mobility



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There are 14 candidate Partnerships that align with this cluster of which eight are possible Institutionalised Partnerships, including five Article 187 initiatives and three EIT-KICs. There are no candidate Article 185 Partnerships in this cluster. The other partnerships are envisaged as either Co-programmed and/or Co-funded Partnerships.

The diagram above shows the strong orientation of the possible Institutional Partnerships towards the mobility area and more limited direct synergies between the envisaged Partnerships and the 'climate science & solutions' priority. Of course, the climate change challenge underpins the whole of this cluster, except where the focus is on industrial competitiveness, but this will also be at least partially dependent on innovation related to clean energy and mobility products and services.

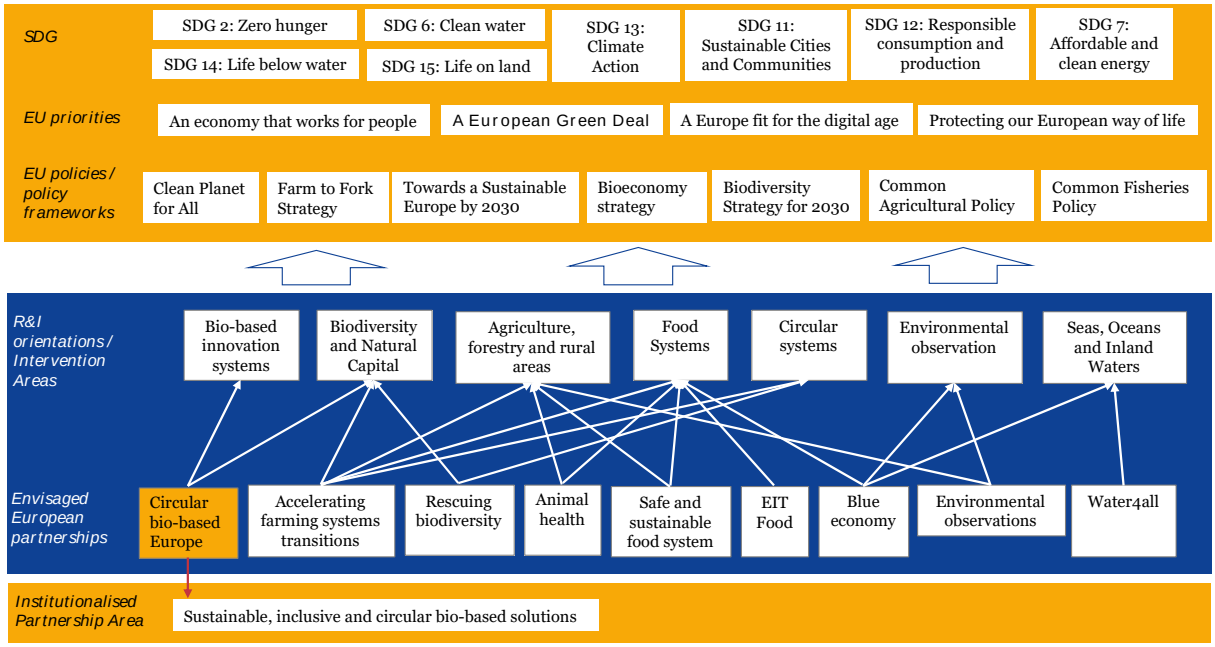
2.3.3 Cluster 6 – Food, Bioeconomy, Natural Resources, Agriculture and Environment

The key objective of Cluster 6, 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' is to advance knowledge, expand capacities and deliver innovative solutions to accelerate the transition towards the sustainable management of natural resources (such as biodiversity, water and soils). The cluster has a large realm and aims to address a wide range of challenges relating to climate change, biodiversity and ecosystems, natural resources, and the production and consumption patterns that may affect them. It encompasses a single area for possible institutionalised European Partnerships aimed at the development of "sustainable, inclusive and circular, bio-based solutions".

The R&I activities funded under the Pillar II Cluster 6 contribute first and foremost to the 'European Green Deal'. More precisely, they will be instrumental to the announced climate change actions, the Biodiversity Strategy for 2030, the "Farm to Fork Strategy", the zero-pollution ambition, the New Circular Economy Action Plan, and the comprehensive strategy on Africa and trade agreements. However, through cooperation with the other clusters, Cluster 6 may make some contribution to the other EU overarching policy priorities. The R&I activities funded under this cluster therefore aim to contribute to the achievement of several United Nations SDGs including: SDG 2: Zero hunger; SDG 6: Clean water and sanitation; SDG 7: Affordable and clean energy; SDG 11: Sustainable cities and communities; SDG 12: Responsible consumption and production; SDG 13: Climate action; SDF 14: Life below water; and, SDG 15: Life on land.

Cluster 6 is structured around six targeted impacts and seven research and innovation orientations, as shown in Figure 8, below. The R&I activities funded under this cluster aim to (1) develop solutions for mitigation of, and adaptation to, *climate change*; (2) halt the *biodiversity* loss and foster the restoration of *ecosystems*; (3) encourage the sustainable (and circular) management and use of *natural resources*; (4) stimulate inclusive, safe and health *food and bio-based systems*; (5) a better understanding of the determinants of *behavioural, socio-economic and demographic changes* to accelerate system transformation; and, (6) improve solutions for *environmental observations and monitoring systems*.

Figure 8: R&I priorities and higher-level objectives of the Horizon Europe Cluster 6 – Food, Bioeconomy, Natural Resources, Agriculture and Environment



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The European Commission envisages nine partnerships under Cluster 6, two of which would be institutionalised (Circular bio-based Europe and EIT Food), four would be either co-programmed or co-funded (Animal Health; A climate-neutral, sustainable and productive Blue Economy; Safe and Sustainable Food Systems for People, Planet and Climate; Water4All), and three would be co-funded (Accelerating Farming System Transition; Agriculture for Data; Rescuing Biodiversity to safeguard life on Earth).

There is seemingly a good balance between the three types of partnerships. However, industry may have some interest in being involved in the design of the Strategic Research and Innovation Agendas regarding living labs and other research infrastructure ('Towards more sustainable Farming' envisaged partnership) to develop solutions for accelerating the transition of farming systems, and technologies to collect agriculture data.

The proposed portfolio of European Partnerships covers the full range of R&I orientations under Cluster 6.

All but one of the proposed partnerships contribute to orienting R&I activities towards the development of food systems that will ensure both sustainable and healthy diets and food and nutrition security for all. The food system has an impact on several challenges. It directly relates to nutrition and diets, access to food, food security, and has an influence on the use of natural resources, water and soil pollution, climate change. Food waste is a key component of circular systems and biomass has strong potential to offer bio-based energy solutions. Finally, the transformation of food systems should take into consideration demographic changes and the accelerating urbanisation (which reduces lands available for food production but offers opportunities for new types of agriculture such as urban farming).

Two R&I orientations are covered by less than half of the proposed partnerships: Environmental Observations (even though achievement in this area could make significant contribution to the other areas) and Bio-based innovation systems (which is nevertheless at the core of the candidate institutionalised partnership for a circular bio-based Europe).

EUROPEAN COMMISSION

Part I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

10. Candidate Institutionalised European Partnership on Clean Aviation

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Abstract

This document is the final report of the Impact Assessment Study for the candidate Institutionalised European Partnership on Clean Aviation under Horizon Europe. The study was conducted by Steer from July to December 2019, under coordination of Technopolis Group. The methodological framework reflects the Better Regulation Guidelines and operationalises the selection criteria for European Partnerships set out in the Horizon Europe Regulation.

This imitative focuses on further aeronautical research and innovation to improve technology leading to more environmentally efficient aviation equipment. It will address the challenges raised by the growing ecological footprint of aviation and the challenges and barriers faced by the aviation industry towards climate neutrality. It will also strengthen the competitiveness of the European aeronautical industry in global markets. Accordingly, the objectives of the initiative are to ensure that aviation reaches climate neutrality and that other environmental impacts are reduced significantly by 2050, maintain the leadership and competitiveness of the European aeronautics industry and ensure safe, secure and efficient air transport of passengers and goods.

The Impact Assessment study assessed the options for implementation that would allow for an optimal attainment of these objectives. The study concluded that an institutionalised partnership is the preferred option for the implementation of this initiative.

Executive Summary

This document is the final report of the Impact Assessment Study for the candidate Institutionalised European Partnership on Clean Aviation under Horizon Europe. The study was conducted by Steer from July to December 2019, under coordination of Technopolis Group. The methodological framework for this study, described in the report on the overarching context to the impact assessment studies, reflects the Better Regulation Guidelines and operationalises the selection criteria for European Partnerships set out in the Horizon Europe Regulation. This report contains the findings of this specific study.

Clean Aviation is intended to deliver focused, transformative, and impact-oriented research and innovation (R&I) for the development and demonstration of integrated aircraft technologies able to contribute to climate neutrality by 2050. It will build on the activities supporting aeronautics-related R&I under Horizon 2020, in particular the work undertaken by the Clean Sky 2 Joint Undertaking to reduce aviation environmental impacts by accelerating development and deployment of cleaner air transport technologies.

Aviation has significant impacts on climate change: it emits carbon dioxide (CO_2), nitrogen oxides, contrails, sulphur dioxide, carbon monoxide, hydrocarbons, ultra-fine particulate matter and soot. In addition, more than 50% of the climate impact from aviation is estimated to be due to non-CO_2 effects. Efficiency improvements are constantly being incorporated into newer generation aircraft, however, provided that growth in passenger numbers and reductions in fuel consumption continue at current rates, the overall effect is that the ecological footprint of aviation will continue to rise.

The path towards zero emissions is not obvious in the aviation sector, and established solutions in other sectors cannot simply be transferred. Furthermore, the EU industrial leadership is exposed to increasing non-EU competition and the lack of an EU industrial policy, combined with a fragmented approach between EU institutions and national governments.

In order to address the problems identified, aeronautics-related R&I activity under Horizon Europe should contribute to the being climate neutrality of aviation and significantly reduced environmental impacts by 2050. This will mean supporting a broad research agenda including the full range of technologies and applications. Furthermore, the intervention should ensure that it contributes to competitiveness of the European aeronautics industry. Finally, the third objective should be to ensure the safe, secure and efficient air transportation.

Given the very ambitious public objectives set and the pre-established roadmap developed by the industry, it is absolutely essential that there is a strategic vision for the initiative, so that efforts can be prioritised, focused and directed toward achieving the environmental objectives. Inclusion of the full range of stakeholders from across the value chain, different sectors, backgrounds and disciplines and EU country origin is essential. However, it is essential that the industry does not work in isolation and that public bodies play a strong role in the governance of the partnership. Flexibility in the selection of projects, implementation and possibly membership will be crucial as well. It will also be particularly important that there are synergies and established lines of communications between this and other initiatives, most importantly the proposed Clean Hydrogen initiative.

The relevant policy options for this assessment were Horizon Europe calls (Option 0), Co-Programmed Partnerships (Option 1) and Institutionalised Partnerships based on Article 187 TFEU (Option 3). Our conclusion is that an Institutionalised Partnership is the preferred option, as it is the most adequate at securing long-term industry commitments and leverage, at providing a stable framework for encouraging the participation of organisations from different stakeholder groups and building relationships with other partnerships and initiatives.

Résumé exécutif

Ce document est le rapport final de l'étude de support à l'analyse d'impact de la proposition de partenariat européen institutionnalisé pour une aviation propre dans le cadre d'Horizon Europe. L'étude a été menée par Steer et coordonnée par Technopolis de juillet à décembre 2019. Le cadre méthodologique de cette étude, décrit dans le rapport sur le contexte général des études de support aux analyses d'impact, tient compte des lignes directrices pour une meilleure réglementation et opérationnalise les critères de sélection des partenariats européens définis dans le règlement d'Horizon Europe. Le présent rapport contient les résultats spécifique à cette étude.

L'initiative pour une aviation propre vise à fournir une recherche et une innovation (R&I) ciblées, transformatrices et axées sur les impacts pour le développement et la démonstration de technologies aéronautiques intégrées capables de contribuer à la neutralité climatique d'ici 2050. Elle s'appuiera sur les activités soutenant la R&I liées à l'aéronautique dans le cadre d'Horizon 2020, en particulier les travaux de l'entreprise commune Clean Sky 2 pour réduire l'impact environnemental de l'aviation en accélérant le développement et le déploiement de technologies de transport aérien plus propres.

L'aviation a des impacts importants sur le changement climatique : elle émet du dioxyde de carbone (CO2), des oxydes d'azote, des traînées de condensation, du dioxyde de soufre, du monoxyde de carbone, des hydrocarbures, des particules ultrafines et de la suie. De plus, on estime que plus de 50% de l'impact climatique de l'aviation est dû à des effets non liés au CO2. Des améliorations de l'efficacité sont constamment intégrées aux avions de nouvelle génération, pourtant, si la croissance du nombre de passagers et la réduction de la consommation de carburant se poursuivent aux taux actuels, l'effet global sera une augmentation continue de l'empreinte écologique de l'aviation.

La voie vers zéro émission n'est pas évidente dans le secteur de l'aviation car les solutions établies dans d'autres secteurs ne peuvent pas être simplement transférées. En outre, le leadership industriel de l'UE est exposé à une concurrence non européenne croissante et à l'absence d'une politique industrielle de l'UE, combinée à une approche fragmentée entre les institutions européennes et les gouvernements nationaux.

Afin de réduire les problèmes identifiés, les activités de R&I liées à l'aéronautique dans le cadre d'Horizon Europe devraient contribuer à faire en sorte que l'aviation soit neutre sur le plan climatique et que ses impacts environnementaux soient considérablement réduits d'ici 2050. Cela signifiera soutenir un vaste programme de recherche comprenant une gamme complète des technologies et applications. En outre, l'intervention devrait garantir qu'elle contribue à la compétitivité de l'industrie aéronautique européenne. Enfin, le troisième objectif devrait être d'assurer un transport aérien sûr, sécurisé et efficace.

Compte tenu des objectifs publics très ambitieux fixés et de la feuille de route préétablie élaborée par l'industrie, il est absolument essentiel qu'il y ait une vision stratégique pour l'initiative, afin que les efforts puissent être hiérarchisés, concentrés et orientés vers la réalisation des objectifs environnementaux. L'inclusion de l'ensemble des parties prenantes de la chaîne de valeur, de différents secteurs, antécédents et disciplines et pays d'origine de l'UE est essentielle. Cependant, il est aussi nécessaire que l'industrie ne travaille pas de manière isolée et que les organismes publics jouent un rôle important dans la gouvernance du partenariat. La flexibilité dans la sélection des projets, la mise en œuvre et éventuellement l'adhésion sera également cruciale. Il sera également particulièrement important qu'il y ait des synergies et des voies de communication établies entre l'initiative et les autres, surtout celle proposée pour l'Hydrogène propre.

Les options politiques pertinentes pour cette analysse étaient les appels à projets ouverts d'Horizon Europe (option 0), les partenariats co-programmés (option 1) et les partenariats institutionnalisés au titre de l'article 187 du TFUE (option 3). Notre conclusion est qu'un

partenariat institutionnalisé est l'option privilégiée, car il est le plus adéquat pour garantir les engagements et un effet de levier à long terme de l'industrie, pour fournir un cadre stable permettant d’encourager la participation d'organisations de différents groupes de parties prenantes et pour établir des relations avec d'autres partenariats et initiatives.

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Glossary

ACARE	Advisory Council for Aviation Research and Innovation in Europe
Article 185	Article 185 of the Treaty on the Functioning of the European Union (TFEU). It covers public-public partnerships, with participation of the EU in research and development programmes undertaken by several EU countries
Article 187	Article 187 of the Treaty on the Functioning of the European Union (TFEU). It covers public-private partnerships, typically involving the EU, industrial association(s) and other partners. These partnerships are managed by legal entities called joint undertakings which are responsible for implementing the research agenda in the area they cover
ATM	Air Traffic Management
CEF	Connecting Europe Facility
CO2	Carbon dioxide
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation (ICAO)
CS 1	Clean Sky (2008-2016)
CS 2	Clean Sky 2
CS 1 JU	Clean Sky Joint Undertaking
CS 2 JU	Clean Sky 2 Joint Undertaking (2014-2024)
DG MOVE	Directorate General - Transport and Mobility
EASA	European Union Aviation Safety Agency
EC	European Commission
ETD	Energy Taxation Directive
ETS	Emissions Trading System
FP	Framework Programme
FP7	Seventh Framework Programme
Horizon 2020	European Union Research and Innovation programme covering the period 2014-2020
Horizon Europe	European Commission's proposed programme for Research and Innovation to succeed Horizon 2020, for the period 2021 to 2027
IA	Impact Assessment
IADP	Innovative Aircraft Demonstration Platform
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IP	Intellectual Property

IPs	Institutionalised Partnerships
ITD	Integrated Technology Demonstrators
JTI	Joint technology initiatives
JU	Joint Undertaking: legal entity defined in the Article 187 of the Treaty on the Functioning of the European Union (TFEU) which is responsible for implementing the research agenda in the area it covers. It typically involves a public-private partnership between the European Union, industrial association(s) and other partners.
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MFF	Multiannual financial framework
NACE	Statistical classification of economic activities in the European Community
NER 300	NER 300 is a funding programme pooling together about € 2billion for innovative low-carbon energy demonstration projects, so-called due to the sale of 300 million emission allowances from the New Entrants' Reserve (NER).
NOX	Nitrous Oxide
OEM	Original Equipment Manufacturer
OPC	Open Public Consultation
PM	Particulate Matter
PPP	Public Private Partnership
PRM	Persons with reduced mobility
R&I	Research and Innovation
RTO	Research and Technology Organisations
SAF	Sustainable Aviation Fuels
SES	Single European Sky
SESAR	Single European Sky ATM Research
SME	Small to Medium-sized Enterprise
SOX	Sulphur Oxide
SRG	States' Representative Group
SRIA	Strategic Research and Innovation Agenda
SRA	Strategic Research Agenda
TA	Transverse Activity
TE	Technology Evaluator
TFEU	Treaty on the Functioning of the European Union
TMA	Terminal Manoeuvring Area

TRL	Technology Readiness Level, a categorisation of the maturity of a technology during its development
ufPM	Ultrafine Particulate Matter
VOC	Volatile Organic Compounds
WBS	Work Breakdown Structure
WP	Work Package

1 Introduction: Political and legal context

This document presents the impact assessment of the candidate institutionalised partnership Clean Aviation, which is one of the initiatives that will enable implementation of the Commission's vision for the period beyond 2020 under the Horizon Europe Pillar II, specifically the Climate, Energy and Mobility Cluster. It is one of the envisaged European Partnerships in the Transport Partnership Area.

1.1 Emerging challenges in the field

The civil aviation market is continuing to grow as the option of flying becomes more accessible to greater proportions of the world's population. The emergence of cheaper air fares, largely resulting from the growth of low-cost carriers and strong competition in the market, combined with rising levels of disposable income has increased people's propensity to fly. In Europe, passengers grew at an average rate of +4.4% per year between 2011 and 2018.[1] This trend is expected to continue as rising levels of wealth open-up air travel to more persons. Many publicly available forecasts support this expectation: IATA suggests that passenger numbers will double over the next twenty years, reaching 8.2 billion passengers in 2037 (CAGR +3.5%),[2] whilst Airbus and Boeing's market forecasts predict slightly stronger growth at +4.4% and +4.7% respectively.

Aviation has significant impacts on the environment: it contributes to climate change through the emission of carbon dioxide (CO_2) and nitrogen oxides (NO_X), but also through the emission of contrails, sulphur dioxide (SO_2), carbon monoxide (CO), hydrocarbons, ultra-fine particulate matter (ufPM) and soot. All are a product of kerosene (fossil fuel) combustion. An additional key environmental issue is the generation of noise, specifically in the vicinity of airports where it has impacts on the population living close to the airport area as well as under the main flight paths for take offs and landings. CO_2 emissions from the aviation sector currently represent around 3% of total anthropogenic emissions worldwide, and its share is growing continuously. In addition, more than 50% of the climate impact from aviation is estimated to be due to non-CO_2 effects.[3]

Efficiency improvements are constantly being incorporated into newer generation aircraft, reducing fuel consumption and in turn reducing CO_2 and ufPM emissions, while improvements are also incorporated to reduce NO_x and noise. Over time these improvements have been estimated to reduce fuel consumption and emissions by approximately 1.5% per year.[4] Provided that growth in passenger numbers and reductions in fuel consumptions continue at current rates, the overall effect is that emissions from the air transport industry will continue to rise.

An overview of the resulting challenges facing the European aviation sector has been broadly defined below in Table 1. A fuller discussion is included in Appendix D.

[1] Eurostat (2019)

[2] IATA (2018), IATA Forecast Predicts 8.2 billion Air Travelers in 2037 - available at https://www.iata.org/pressroom/pr/Pages/2018-10-24-02.aspx

[3] Climate Impact of Aviation, CO_2 and non-CO_2 effects and examples for mitigation options, DLR, Volker Grewe, 2018

[4] European Commission, PRIMES Scenario and Inception Impact Assessment

Table 1: Overview of the challenges emerging

Social	Whilst there is strong demand for air mobility for personal and professional reasons, "flight shame" is developing across Europe and may render air travel a less attractive travel option than it once was. The EU aviation industry, which manufactures half of the world's fleet, has a strong responsibility to address becoming climate neutral and promoting all efforts already made in recent decades. The free movement of people and goods among countries is a basis of the European Union. Constraining air transport can constrain the European project for many citizens and companies, especially where no other practical means of transport at European level are available. Increased public health issues linked to the release of pollutants, particulates and noise emissions by the aviation industry, primarily in the vicinity of airports as well as globally: air pollution emissions from civil aviation across the world could be responsible for premature deaths. [5] Public acceptance of the technological solutions to be developed will be key, so that they are perceived as safe and environmentally efficient.
Technical and technological	Although there are some emerging technological R&I solutions to reduce the environmental impact of the aviation industry (such as electrification of aircraft, sustainable aviation fuels, hydrogen, improvement of propulsive efficiency), achieving them is less straightforward than for other modes of transports and they are not at a high state of TRL. Some of the most interesting solutions identified so far heavily rely on clean hydrogen, for which there are not yet any established large supplies.
Economic	Air travel demand remains highly correlated to air fares (driven to a large extent by the price of kerosene) and the state of the economy (especially for air freight). Overall, strong demand for air travel in Europe is anticipated, driven by the development of low-cost flights, increased urbanisation, growing middle-classes, mobile student populations and workforces, ageing population with disposable income and few equivalent alternatives from other transport modes such as trains. However, the demand for air travel could be curbed by the development of environmental concerns by the travelling public and legislators. For the manufacturing industry, apart from regular demand/production cycles, a doubling of the fleet is forecasted. The European industry is also expected to maintain its leadership. The aeronautical value chain is heavily driven by the certification phase (which could reach a quarter of the total R&D investments costs).[6]
Environmental	Although the aviation industry has achieved a steady and substantial reduction in emissions (CO_2, NOx, noise, ufPM), the commercial air transport industry is increasingly being perceived through its negative environmental impacts.
Political, policy and regulatory framework	There is much stronger political will to achieve climate-neutrality now, which is likely to translate into more demanding targets for manufacturing, commercial aviation and ATM (such as kerosene taxes or other economic incentives). The implementation of even stricter European legislation on aviation emissions, energy or noise appears likely.

[5] MIT study, published in Environmental Research Letters journal (volume 10), based on 2006 levels of ozone and particulate matter PM2.5 emissions from aircraft. This study estimates premature deaths caused by aircraft emissions in the world to be in the order of 16,000 per year.

[6] PIPAME (2009), Etude de la chaine de valeur dans l'industrie aéronautique

	There remain strong threats of tariffs/trade wars between Europe and the USA, affecting the entire European aeronautical industry. In the case of a Brexit no-deal or under "hard Brexit" scenarios, there could be important consequences for the European aeronautics industry, ranging from relocation of parts the supply chain and manufacturing, tariffs and additional customs costs, EASA certification issues, and/or changes in the value chain.

Source: Steer analysis, based on taxonomy of failures by Technopolis Group (2018), modified from Weber & Rohracher (2012)

There was strong support from stakeholders responding to the open public consultation (**OPC**) to making significant contributions towards achieving the EU's climate-related goals. The vast 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 achieving European policy goals and recognised that this is hindered by development cycles in the industry that were both lengthy and costly. Most of these groups also confirmed the importance of meeting societal needs and contributing to both EU climate related goals and UN Sustainable Development Goals through the effective deployment of new technology whilst also maintaining European competitiveness in the market.

Stakeholders interviewed, whether industry, research institutes, academics or other types of organisations were generally very supportive of the proposed objective of achieving climate neutrality by 2050. It was felt that that objective, whilst ambitious, was more encompassing of the effects of aviation and also allowed a more long-term solution to be realised.

Virtually all stakeholders providing feedback on the **inception impact assessment** also noted their support for the previous objective[7] of achieving deep-decarbonisation in the industry.

1.2 EU relative positioning

1.2.1 Competitive positioning of Europe in the field

Europe has a leading position in today's aeronautical sector (four EU companies rank among the top ten aeronautical manufacturing companies in terms of revenue, while the other six are US companies),[8] but continued investment is needed to maintain the current position in the face of stronger competition. The industry provides a positive contribution to the EU trade balance (EUR 96 billion in EU exports).[9] Technological capability and innovation potential within the industry have become key differentiating factors for competitiveness, increasingly driven by the integration of big data and digitalisation.

Airbus and Boeing operate largely as a duopoly in the global commercial aircraft market, resulting in 50% of the commercial aircraft fleet designed and manufactured in Europe. However other aircraft manufacturers, such as UAC in Russia and Comac in China are also emerging. These developments may potentially weaken the positions of Airbus and Boeing positions as the new manufacturers can tap into their large and expanding home markets, whilst also offering very price competitive products for export. For example, the Chinese C919, which will compete with the Airbus A320neo, has accrued over 1000 orders and is

[7] The objective was changed from deep-decarbonisation to climate neutrality after the inception impact assessment was issued.

[8] European Commission (2015), An Aviation Strategy for Europe. File COM(2015) 598 final – accessible at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52015DC0598

[9] ASD Facts and Figures

scheduled to enter service in 2021.[10] The list price for this aircraft is reported to be US$50 million, which is approximately 50% cheaper than competing equivalent aircraft manufactured by Airbus and Boeing.[11] Russia and China have also announced plans to collaborate on a new wide-body aircraft, which would enter service in 2027.[12] In 2015, the Aviation Strategy estimated that emerging economies will represent over 50% of the demand for new aircraft over the next twenty years.

Nonetheless, the European industry is reacting: Airbus recently acquired the C-series programme from Bombardier. This operation adds a new and complementary aircraft to the Airbus product line. The C-series sales may significantly benefit from direct access to Airbus' procurement programme, sales, marketing expertise, and customer support network. Boeing is following a similar strategy with the proposed joint venture with Brazil's Embraer.

Additionally, more aeronautics companies are setting up engineering offices in India as a way to access cheaper labour and be active in promising markets. However, potential risks also arise when moving parts of the manufacturing or even the design process to third countries, such as China, with possible forced technology transfers or risks to intellectual property. The United States has for instance claimed that foreign companies that want to operate in China are required to share part of their intellectual property.[13]

Other market segments where the European industry plays a key role include civil helicopters (Airbus, AgustaWestland, Leonardo), engine manufacturing (Rolls-Royce, Safran, GE Avio and MTU) and manufacturing, repairs and overhaul (MRO). Europe had a relatively weak positioning on the regional aircraft market although it is a leader in turboprops with the Airbus-Leonardo Joint Venture ATR and now with the A220 regional jet. In addition, the corporate governance of Airbus can be affected by national interests (e.g. on employment location or technology leads).[14]

Compared to its key competitor (the USA), the European aeronautics industry has fewer companies of sufficient size and capability for large risk-sharing projects, and crucially does not benefit to the same extent as US companies (such as Boeing, Lockheed Martin, General Electric) from government-funded military and space research spill-over effects. R&D investments in the US (from industry and government) are generally higher than in Europe[15] (four times higher in 2017). Lastly, the European industry is exposed to currency exchange risks with revenues traditionally accrued in USD and costs in euros.

[10] Flight Global (2018), Comac marches forward with ARJ21 and C919 – accessible at https://www.flightglobal.com/news/articles/analysis-comac-marches-forward-with-arj21-and-c919-452053/

[11] BBC (2019), Can China's plane-maker take on Boeing and Airbus? – accessible at https://www.bbc.co.uk/news/business-47689386

[12] Flight Global (2019), CR929 boss details progress, timeline – accessible at https://www.flightglobal.com/news/articles/interview-cr929-boss-details-progress-timeline-456061/

[13] Bloomberg (2019), Forced or Not? Why U.S. Says China Steals Technology – accessible at https://www.bloomberg.com/news/articles/2019-06-15/forced-or-not-why-u-s-says-china-steals-technology-quicktake

[14] Competitiveness of the EU Aerospace Industry, Ecorys, 2009

[15] ASD, facts and figures, 2018

Table 2: International competitiveness of the global aeronautics industry

	Large Civil aircraft	Regional aircraft	Business/general aviation	Helicopter	Engines	MRO
Market Situation	Airbus/Boeing Duopoly	All dominant players linked with Airbus/Boeing	Dominance of North American players	Dominant European and US players	Rolls Royce and Safran (CFM) are significant players	Many independent and dependent players
Development	China and Russia entering the market	China, Russia and Japan entering the market				
European Aeronautics Industry	Airbus has grown to compete for the market 50:50 with Boeing	Airbus purchased the C-Series from Bombardier. Airbus own a stake in ATR	Dassault and some smaller players	Civil market leader and technology leader	Rolls-Royce and Safran (through CFM) are major world players	Strong European position

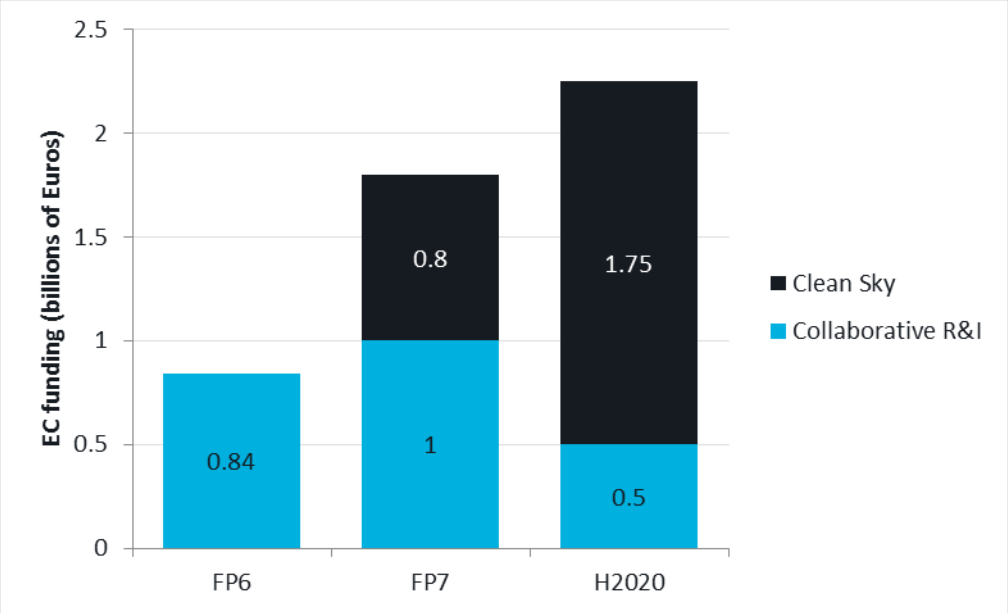
Source: Competitiveness of the EU Aerospace Industry, Ecorys, 2009, updated by Steer to reflect market developments since.

Standardisation efforts and regulatory convergence in the field of certification and common rule making by the European Commission and EASA also contribute to the competitiveness of the European aviation sector, as a significant part of the revenues of the industry are generated through exports.

1.2.2 Support for the field in the previous Framework Programme

More than three-quarters of the EU funding in Horizon 2020 was provided through the Clean Sky 2 Programme, whereas under FP7 the Clean Sky 1 Programme only accounted for just under 50% of the total EU research funding. In terms of value, the budget available for collaborative R&I has been drastically halved in Horizon 2020 compared to FP7 (also reduced by 40% from FP6), which is likely to have reduced the incoming technology at low TRL available for the Clean Aviation initiative.

Figure 1: Framework Programmes funding of the aeronautics industry



Source: Steer

The Clean Sky 1 Joint Undertaking (CS 1 JU) was established in 2008 by Council Regulation (EC) 71/2008 to manage the Clean Sky 1 programme for the period up to 31 December 2017.

The Clean Sky 2 Joint Undertaking was established in 2014 by Regulation (EC) 558/2014 and runs until 2024. Upon the establishment of CS 2, the CS 1 JU was terminated and the Clean Sky 2 Joint Undertaking (CS 2 JU) acquired responsibility for the CS 2 programme and the remaining parts of the CS 1 programme. Both Clean Sky initiatives were Public Private Partnerships (PPPs) between the European Commission and the aeronautical community to further aeronautical research and innovation through improved technology leading to more environmentally efficient aviation equipment. The governance of the CS 2 JU is described in Appendix F.

Under the provisions of the Regulation, the total funding available to the JU under Horizon 2020 is €3.94 billion, including:

- A contribution from the European Commission of €1.75 billion, representing a substantial increase compared to the funding of CS 1 (€0.8 billion) made available under Framework Programme 7 (FP 7);
- In-kind contributions from Leaders and Core Partners totaling at least €2.19 billion, including:
    - Contributions from Leaders and Core Partners of €965 million in support of additional activities outside of the work plan of the Clean Sky 2 Joint Undertaking but contributing to the objectives of the Clean Sky Joint Technology Initiative. The scope of the additional activities is at the discretion of the members and these activities are not eligible for financial support by the CS 2 JU
    - The remaining sum is in the form of in-kind contributions to operational activities and financial contributions to administrative costs

The activity overseen by the JU represents a substantial contribution to the R&I effort of the European R&I. In 2018 ASD estimated that the aeronautics industry invested €9 billion

in R&I annually,[16] although it should be observed that this figure includes product development which is usually significant more expensive than technology development (which is the prime focus of EU funding). Stakeholders have also reported as part of this study that they estimate industry research efforts for Clean Aviation to be in the order of €12 billion with an additional €50 billion to be spent on product development.

Both the CS 1 and CS 2 Programmes were established with the objective of reducing the environmental impacts of aviation by accelerating the development and deployment of cleaner air transport technologies and, in particular, the integration, demonstration and validation of these technologies. However, whilst there is a degree of continuation in Clean Sky, CS 1 and CS 2 are different programmes with different structures and different baselines. In particular, CS 2 aims at expediting the rate of efficiency of improvements normally observed with each new generation of aircraft: typically, new-generations of aircraft deliver efficiency savings of 15-20% versus their predecessors.[17]

The scope of the JU's activity is structured around three Innovative Aircraft Demonstration Platforms (IADPs), three Integrated Technology Demonstrators (ITDs), two Transverse Activities (TAs) and a Technology Evaluator programme assessing the performance of the technologies developed, as summarised in Appendix F.

Article 2 of Regulation 558/2014[18] specifies a number of general objectives for CS 2:

- to contribute to the finalisation of research activities initiated under Regulation (EC) No 71/2008 and to the implementation of Regulation (EU) No 1291/2013, and in particular the Smart, Green and Integrated Transport Challenge under Part III — Societal Challenges of Decision 2013/743/EU;
- to contribute to improving the environmental impact of aeronautical technologies, including those relating to small aviation, as well as to developing a strong and globally competitive aeronautical industry and supply chain in Europe. This can be realised through speeding up the development of cleaner air transport technologies for earliest possible deployment, and in particular the integration, demonstration and validation of technologies capable of:

  increasing aircraft fuel efficiency, thus reducing CO_2 emissions by 20% to 30% compared to 'state-of-the-art' aircraft entering into service as from 2014;

  reducing aircraft NO_x and noise emissions by 20% to 30% compared to 'state-of-the-art' aircraft entering into service as from 2014.

Article 2 of the Regulation identifies three key performance indicators (KPIs)[19] that align with the objectives of the overall policy framework for aviation (as presented above). Notwithstanding the progress made since the establishment of the JU, findings from conversations with stakeholders and desk research have highlighted a number of issues relevant to the impact assessment of a potential partnership under Horizon Europe. These include the following observations:

[16] https://www.asd-europe.org/sites/default/files/atoms/files/ASD%202018%20Facts%20and%20Figures.pdf

[17] Example cited is the fuel burn of A320neo versus A320 and should not be understood to be attributed to CS 1 or CS 2. Source: Flight Global (2019), Analysis: What operators have to say about the A320neo. https://www.flightglobal.com/news/articles/analysis-what-operators-have-to-say-about-the-a320n-454247/

[18] Council Regulation (EU) No 558/2014 of 6 May 2014 establishing the Clean Sky 2 Joint Undertaking

[19] See b)i) and ii) of Article 2 of Regulation 558/2014

Table 3: Current issues highlighted by the experience of the CS 2 JU

Market failures	
Market power	Project participation rates are distributed in favour of a relatively limited number of organisations. A large share of the funding is reserved to Leaders and Core Partners.
Information asymmetry	Uncertainty, significant capital requirements and short-time horizon of private investors lead to undersupply of funding for aviation R&I. This has been recognised by Member States which have offered various mechanisms (loan, guarantees, etc) to support the R&I activities of the aviation industry. It is not always easy to establish what the precise outcomes of CS 1 and CS 2 have been.
Systemic failures	
Institutional	There are aspects of the design and implementation of the CS 2 JU that appear to have limited effectiveness: In particular, certain aspects of its governance arrangements such as the role of the States Representative Groups. The lack of involvement of EASA in Clean Sky may have an impact on the "time to market" which benefits from an early assessment of potential safety risks and other issues related to certification of new products and technologies. Safety topics may also have been excluded from the scope of JU R&I.
Network	The industry network, encompassing manufacturers and their supply chain, ground equipment manufacturers, operators, airports, service providers, research and educational institutions, is particularly well established compared to some other industrial sectors. However, there is a risk that SMEs or EU-13 Member States participants may find it difficult to join it, as project participation in the CS 2 JU is concentrated among a relatively limited number of players reflecting the composition of leaders and core partners.
Infrastructural	Similarly, elements of CS 2 JU procedural infrastructure are constraining the R&I effort. There is arguably a need for greater flexibility and for reduction in the administrative burden. There are also some communication improvements that could be made.
Transformational failures	
Policy coordination	There has not been much involvement of CS 2 JU in working towards aligning national and EU aviation research programmes. There is a lack of multi-level policy coordination (e.g., regional/national/European), whilst the horizontal coordination between research, technology and innovation policies is good in the European aviation sector.

Source: Steer, based on taxonomy of failures by Technopolis Group (2018), modified from Weber & Rohracher (2012)

1.3 EU policy context beyond 2021

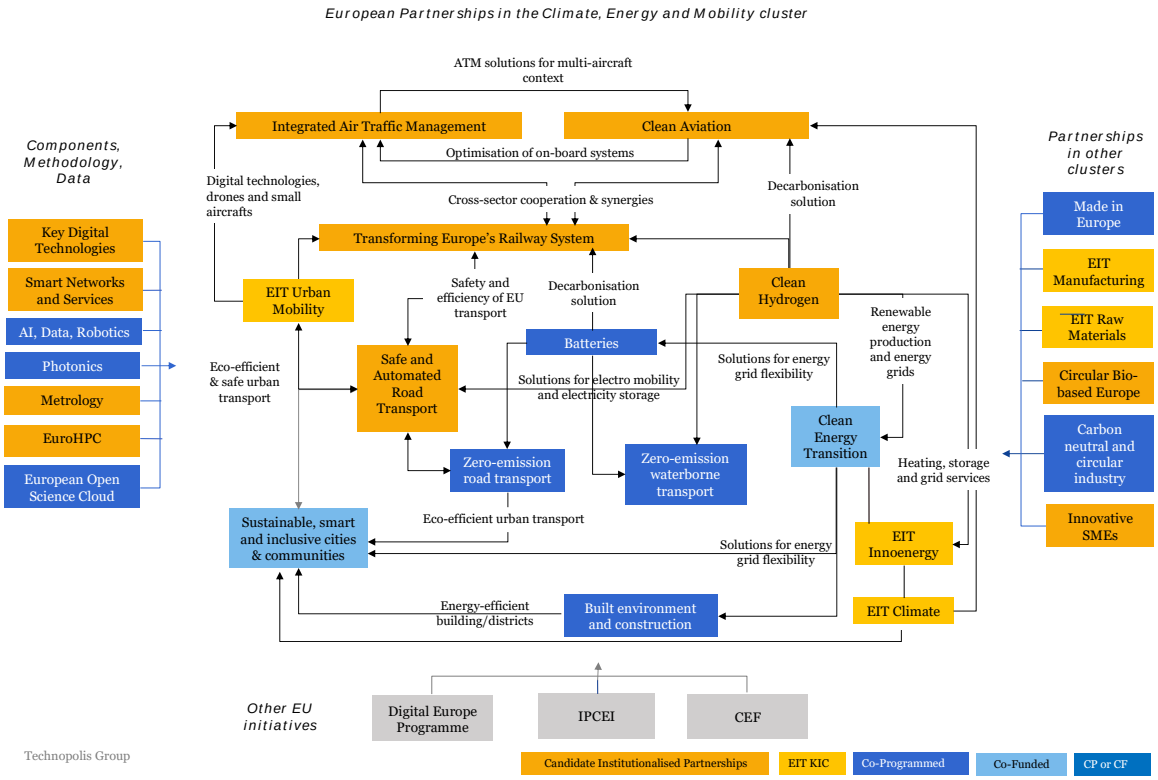
As set out in the report on the overarching context to the impact assessment studies, the R&I activities funded under the Pillar II Cluster Climate, Energy and Mobility are intended to contribute to the attainment of at least three of the six main ambitions for Europe: 'A European Green Deal', 'A People-centred 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. It is supportive of several of the Sustainable Development Goals, particularly Affordable and Clean Energy (SDG 7), Industry Innovation and Infrastructure (SDG 9), Sustainable Cities and Communities (SDG 11) and Climate Actions (SDG 13).

With regard to the candidate initiative on Clean Aviation, it addresses several Sustainable Development Goals including industry, innovation & infrastructure (SDG9); sustainable cities & communities (SDG11); sustainable consumption & production (SDG12); and climate action (SDG13). It is most closely aligned to the EU priority for 'A European Green Deal' but also has synergy with another priority 'An economy that works for people and relevance to a European ATM Master Plan, Single European Sky, and Europe on the Move.

There are eight candidate institutionalised partnerships within the Climate, Energy and Mobility cluster. All except the one concerned with 'Mobility and Safety through Automated Road Transport (MOSART)' would build on previous Article 187 initiatives or EIT-KICs funded under Horizon 2020.

A detailed analysis of synergies for the envisaged and candidate Partnerships that are related to this cluster is shown in Figure 2. This highlights the five possible candidate initiatives and the synergies between them and with other initiatives. Four of these can be considered as 'application' sector partnerships with the other (clean hydrogen) being more 'technology' orientated. The central position of batteries and hydrogen, as enablers of zero emission transport and the clean energy transition, is also clear from the analysis. Likewise, there are synergies with the other technology-related partnerships, particularly in the digital area, and those that are manufacturing or materials-orientated. This also highlights the twin challenges of digitisation and decarbonisation for the future energy/mobility sectors. Finally, the European Open Science Cloud partnership will provide 'horizontal' (infrastructural) support to collaborative research and innovation within each envisaged partnership in Cluster 5, while also facilitating exchange and re-use of research data for the integration of new technologies into energy and mobility solutions.

Figure 2: Interconnections between the envisaged partnerships in the Climate, Energy and Mobility Sector



There would appear to be many areas for collaboration between the candidate partnerships and across clusters. A good example of coordination and consolidation of partnerships from Horizon 2020 is 'Clean Energy Transition', which would build on 10 separate ERA-NET Co-fund actions that have synergy with the SET-Plan. These are primarily related to renewable energy technologies (e.g. solar, wind, geothermal, marine and biotechnology) and also smart grids, which are needed to deal with the increasing proportion of distributed renewables in the energy mix. This is one of only two proposed Co-funded Partnerships (CF) in this cluster (the other is 'sustainable, smart and inclusive cities and communities') that would involve the national R&I funding organisations. The others (A187/CP/EIT-KIC) are primarily driven by industrial and research stakeholders.

There is less evidence of coordination and consolidation amongst the mobility-related partnerships. For example, there is a lack of a cross-modal perspective across the four prospective initiatives as their titles imply different objectives and stakeholders. There are, however, several areas where there is surely scope for collaboration, if not rationalisation. These would include:

- Integrated Air Traffic Management' will have an influence on 'Clean Aviation' but also has wider objectives related to the EU priority of 'an economy that works for people'.
- 'Safe and Automated Road Transport' and 'Zero-emission Road Transport' have some common industry stakeholders (i.e. vehicles industry) but one is orientated towards the digital industries and the other with the energy industry.
- 'Zero-emission Road Transport' and 'Zero-emission Waterborne Transport' have supply chain synergies and challenges, particularly in relation to heavier duty applications.

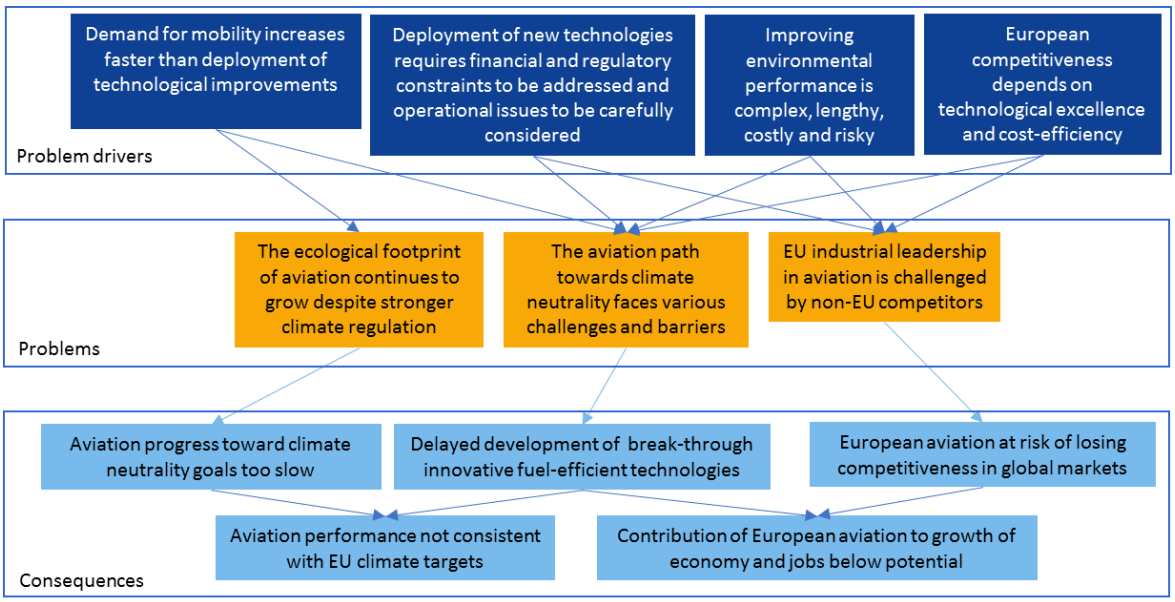
This would suggest the more recent candidate Co-funded Partnership on 'sustainable, smart and inclusive cities & communities' could play a strategic role in fostering cross-modal activities and encouraging collaboration. Likewise, the three candidate EIT-KICs map precisely with the cluster topics and could also play a coordinating role. In the case

of Clean Aviation, we would also anticipate scope for joint programming of R&I activity with the Clean Hydrogen partnership, recognising the potential of the use of such energy on the aviation sector.

2 Problem definition

This section provides a discussion of the problems to be addressed in relation to the emerging challenges presented in Section 1.1, drawing on evidence from desk research and the findings of the stakeholder consultation undertaken as part of this study. A problem tree portraying related problems, their drivers and consequences is presented in Figure 3 and described in detail in the following sections. Note that as the baseline for the impact assessment is defined as the Horizon Europe open calls (i.e. the absence of a JU or any other type of formal partnership), an examination of the situation prevailing before CS 1 JU and CS 2 JU, as well as of the current situation, appears relevant. While the problems identified by the CS 2 JU impact assessment have been addressed to some extent through CS 2 JU management of R&I during Horizon 2020, it is clear that several of the underlying issues remain and that the main problems described below would be likely to re-emerge in the absence of ongoing policy intervention.

Figure 3: Problem tree for the initiative on Clean Aviation



Source: Steer analysis

2.1 What are the problems?

2.1.1 Growing ecological footprint

The ecological footprint of aviation is growing, despite all the technological improvements, regulatory schemes and policies in place to reduce the externalities of aviation. The overall performance of aviation is diverging further from carbon neutral growth and the EU objectives to reduce noise and NO_X below the WHO-recommended levels. This is not consistent with the EU objective of climate neutrality by 2050. If this objective is not achieved, European citizens will soon demand further measures to reduce air mobility and impose limitations on the aviation industry which will have a detrimental effect on mobility and connectivity.

2.1.2 Unclear path to climate neutrality

The path towards zero emissions is not obvious in the aviation sector, and established solutions in other sectors, such as batteries, electrification and fuel cell technologies, cannot simply be transferred from one sector to another. In many cases the application of

new technologies is currently not suitable, owing to weight or scalability issues. For example, the gravimetric energy density of batteries is significantly lower than that of kerosene, thus battery integration would have a significant impact on airframe mass. Technologies supporting climate neutrality, and which can be used on large-scale in commercial aviation, do not yet exist and are not likely to be developed in the shorter term. Possible technologies that may encompass some or all the areas are listed below:

- Co-electrolysis combining hydrogen with carbon from CO2 to create synthetic fuels (also called electrofuels). Such fuels can perform at close to near zero emissions and are carbon circular, provided that they are produced only from zero emission electricity. Current issues exist with the scaling-up of this technology because of costs
- Fuel-cells where hydrogen is combined with oxygen to create electric energy
- Hydrogen combustion
- Electric or hybrid-electric aircraft (only for short-range)

Additionally, new technologies cannot be implemented without proper investigations into their safety and efficiency. Safety certification will require EASA to be involved with the development of these technologies. In addition to demand driven by regulatory measures, green aircraft will only be attractive to airlines if they offer operating cost-competitiveness compared to their current fleets. This will further reinforce the need for manufacturers to deliver aircraft with a fuel-burn as low as possible, since the price for SAFs – when available - is estimated to be two or three times the current price of kerosene.

2.1.3 Challenges to EU industrial leadership

The EU aeronautical industry faces strong international competition from traditional manufacturers (from the USA in particular) and increasingly from emerging competitors in a complex evolving global environment.

- The US aeronautical industry continues to benefit from strong public support from the US government. The set of regulations, policies and tools put in place over the years by US administrations to support its civil aeronautical industry is extensive and leverages the defence sector very effectively, especially for research, technology and development (including federal budget allocations for research programmes).[20]
- In China, the government has identified the development of a national civil aeronautical industry as a key priority, whilst it has the ability to approve all purchases of aircraft by Chinese airlines to encourage the purchase of domestically produced aircraft.

National industrial policies exist in some EU countries, but there is a lack of an EU industrial policy to support the aeronautical industry and allow it to compete on a level playing field in the context of strong competition, combined with a fragmented approach between EU institutions and national governments. There is no coherent industrial strategy in place involving all relevant actors at EU, national and inter-governmental levels.

Many of the stakeholders responding to the **OPC** confirmed the importance of these issues. A substantial majority of business organisations, business associations, academic and research institutions, public authorities and EU citizens strongly recognise the impact that long development and innovation cycles and high associated costs of demonstration are having on the growing ecological

[20] European Economic and Social Committee, Challenges and Industrial Change in the EU Aerospace Sector, 2018

footprint, whilst all parties also recognise that a future partnership must also make significant contributions to EU global competitiveness.

These themes were echoed during the **interviews**, with several stakeholders (from across industry, Member States, academics and research institutes) also highlighting the long development and innovation cycles and high associated costs as contributing to the growing ecological footprint, and that a transformative change was required to achieve sustainability in the industry, despite the practicalities of this being unclear at this stage. Most stakeholders noted the importance of EU industrial leadership in the field, especially in the face of increasing competition from China and Russia. Many business stakeholders also expressed the need for the industry to deliver cost-efficient products that would be affordable for their airline customers.

Similar points are noted by several of the stakeholders providing feedback on the **inception impact assessment,**[21] especially regarding the need for greater collaboration between stakeholder groups in order to bring about the innovation and impact required to achieve the objective.

2.2 What are the problem drivers?

The key problem drivers affecting R&I performance in the aeronautical sector are discussed in more detail in the following paragraphs and summarised according to a standard taxonomy in Appendix G. We have identified four problem drivers that will need to be addressed by any future initiative on aeronautical-related R&I under Horizon Europe, and which reflect key characteristics of the aviation industry, notably that:

- Demand for mobility increases faster than the deployment of technological improvements
- Improving the environmental performance of the aviation industry is complex, lengthy, costly and risky
- Economic incentives for greener aviation are not strong enough
- Ensuring strong competitiveness of the EU aeronautics industry is complex

2.2.1 Demand for mobility increases faster than the deployment of technological improvements

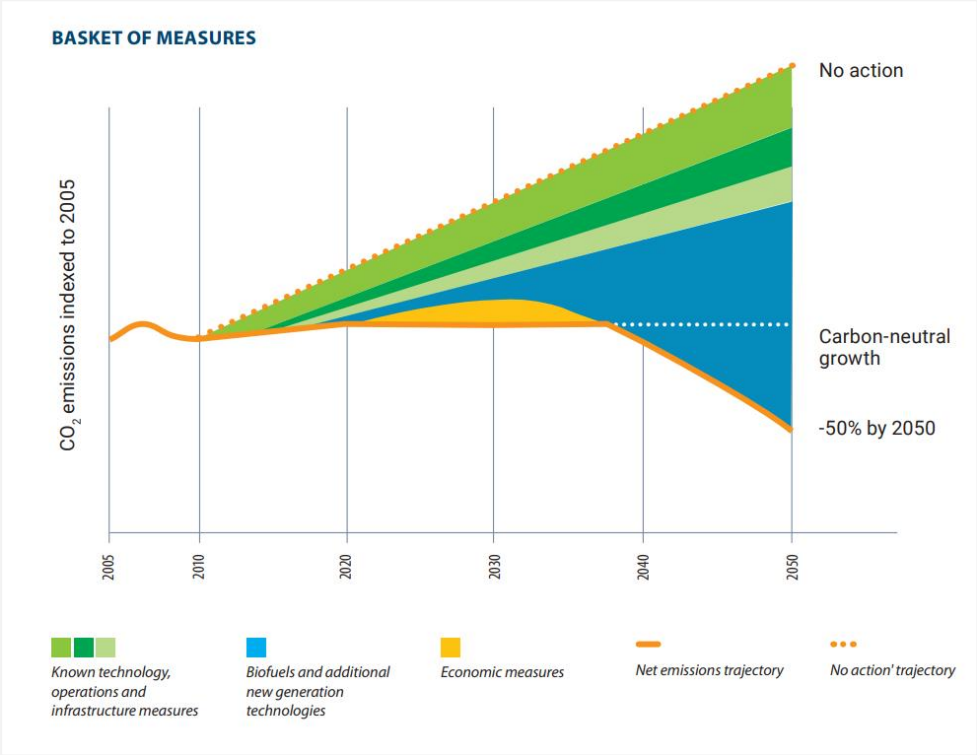
Whilst advancements in technology reduce the average fuel consumption and emissions per passenger by -1.5% per annum, average annual passenger growth of +4.4% more than counteracts this, resulting in fuel consumption and emissions rising by approximately +2.9% per annum or doubling every 25 years.[22] Without transformative interventions in next generation aircraft, the aviation industry's CO_2 emissions will be approximately 136% higher by 2050 compared to 2020.[23]

[21]https://ec.europa.eu/info/law/better-regulation/initiative/11904/publication/5722372/attachment/090166e5c639d431_en

[22] Source: European Commission

[23] European Commission (2018), Global Energy and Climate Outlook 2018: Sectoral mitigation options towards a low-emissions economy – accessible at http://publications.jrc.ec.europa.eu/repository/bitstream/JRC113446/kj1a29462enn_geco2018.pdf

Figure 4: ICAO's schematic CO_2 emissions reduction roadmap for the aviation industry



Source: Eurocontrol (2019), Think Paper #4, Decarbonisation Issues

ICAO's schematic CO_2 emission reduction roadmap highlights the effects of different measures on the aviation industry and shows the means by which carbon-neutral growth can be achieved from 2020. Whilst improvements to current aircraft technologies, infrastructure and operating procedures will achieve some savings, they are not sufficient to achieve carbon-neutral growth in the context of growing levels of air traffic. Instead radically new technologies and SAFs are required to address the substantially increased level of EU aviation CO_2 emissions (+95% from 1990 to 2016)[24]. Economic measures (such as, but not limited to, taxes on kerosene) can also be used as a mean to decrease the demand and thus control the growth of emissions. Whilst they could be used to reduce the demand until climate-neutral solutions have been developed, however they would also reduce airline profitability leading to reduced investments in new aircraft and technologies. The introduction of economic measures would need to be carefully designed so that they adequately incentivise airlines to invest faster in greener technologies or accelerate the demand for SAF (the industry believes that achieving 2% of global jet fuel from non-fossil sources by 2025 could create a tipping point for production and cost of SAF)[25], whilst recognising that there are no proper alternatives to aviation to reach long-haul destinations in a reasonable amount of time.

2.2.2 Improving the environmental performance of the aviation industry is complex, lengthy, costly and risky

The development of new aeronautical products represents a complex, lengthy, costly and risky process which requires expert knowledge and highly refined development and manufacturing activities. Commercial aircraft combine a wide range of different

[24] EASA (2019), European Aviation Environmental Report 2019 – accessible at https://www.easa.europa.eu/eaer/system/files/usr_uploaded/219473_EASA_EAER_2019_WEB_HI-RES_190311.pdf

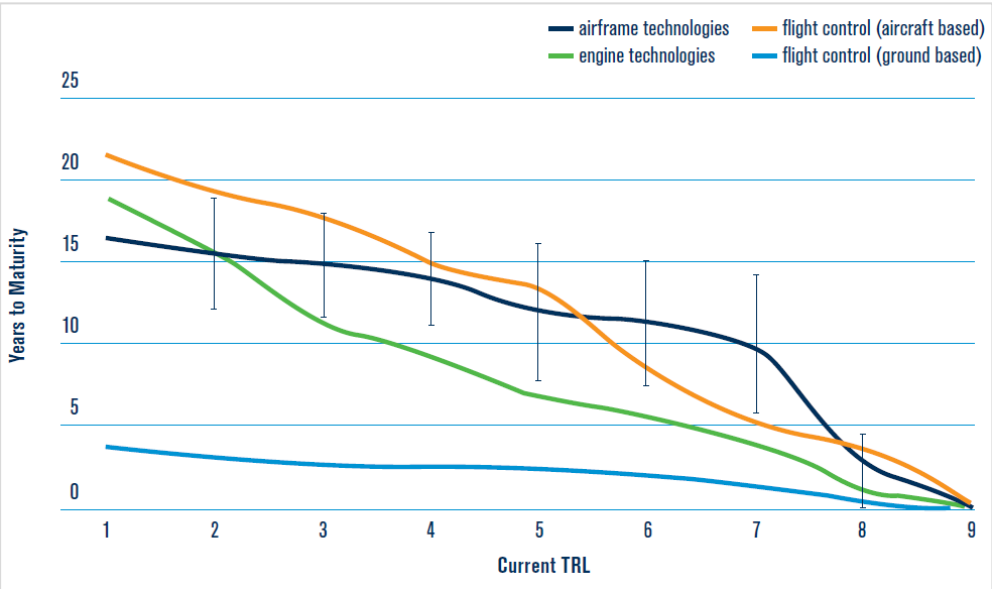
[25] https://aviationbenefits.org/newswire/2019/12/opportunity-for-aviation-in-europe-s-green-deal/

components for propulsion, navigation, aviation, and communication that are each very complex. The integration of the different components is substantially more difficult but equally crucial for safe and effective aircraft performance. To ensure the existence of a wide knowledge base, a multidisciplinary approach is used which in Europe relies heavily on European cooperation.

A built aircraft may behave differently in operation than what design and engineering data predict, due to the complex and non-linear interaction between the components. Testing of aircraft functionality and safety is therefore a crucial but timely and costly process. As a result, long aircraft lifecycles are not uncommon, characterised by extended production phases and long usage and maintenance periods. The research, technology and product development of a new aircraft type from conception phase (Technology Readiness Level 1) through all the steps of maturing the technologies to "fit-to-fly" (Technology Readiness Level 9) take between 10 and 20 years (see Figure 5 below). Existing demonstrators are usually only developed for high Technological Readiness Levels (5 or 6).

The long developmental phase requires a substantial financial investment and can result in cash-flow issues for companies which either need to be in a strong cash position or have access to alternative sources of funding, for instance from the Member States, to be able to manufacture major systems or aircraft.

Figure 5: Time to mature aircraft technologies



Source: IATA technology roadmap (2016)

Due to high costs associated with the production process of aircraft, manufacturers seek to receive certification for their aircraft quickly and the early involvement of regulators in research and the deployment of emerging technologies can reduce time to market significantly. EASA also notes that more integration between regulators and industry is needed as aspects of design, production and servicing of aircraft become more dispersed.[26] At the same time absolute independence between regulators and industry must be ensured to guarantee that neither the required levels of safety, nor the environmental performance of new technologies are compromised in order to bring products to market more quickly.

[26] EASA (2019), Emerging Technologies and Aircraft Certification – accessible at http://congress.cimne.com/emus2019/frontal/doc/PL_Abstract/PL_Abstract_Waite_Expert.pdf

Normal market mechanisms are not always well adapted to the aviation industry which requires a high amount of capital while also bearing very high risks of failures, as outlined above. At the national level, Member States support aviation industry players through grants, loans, and tax rebates. The German federal government supported the development of the Airbus A380 with a state loan for €0.942 billion,[27] followed by a further €759 million loan for the A350.[28]

2.2.3 Deployment of new technologies requires financial and regulatory constraints to be addressed and operational issues to be carefully considered

Currently, airlines' operating models are driven by cost per seat rather than environmental requirements: for instance, the reduction in CO_2 emissions over the years has been driven by the incentive to reduce fuel costs (which constitute around 25-35% of total operating costs) rather than to reduce the environmental footprint. Because the full environmental costs that arise from negative externalities, such as emissions and noise, are borne by the general society, air transport operators and manufacturers are not paying for the full environmental costs of the industry. This, in turn, leads to sub-optimal investment in and deployment of new technologies that are more environmentally friendly. There is a European Regulation[29] laying down the rules for the environmental certification of aircraft and related products, including noise certificates, as well as permitted levels of exhaust emissions.

Existing regulatory measures which set performance standards for aircraft emissions, such as environmental certification standards for aircraft, noise-dependent landing fees at airports and ICAO's global technical standards to limit engine emissions and aircraft noise have proven to be a step in the right direction, but they have been of limited effectiveness; these measures regulate emission sources separately and at different levels (aircraft, local/regional, global) with limited policy coordination (and sometimes effectiveness) towards climate neutrality.

Operational measures could also be considered to mitigate the impact of aviation. These would for instance require aircraft trajectories to be optimised (in terms of speed, cruising altitudes, climate restricted airspace, etc.), taking into account the environmental and climate impacts of flights and the resulting cost trade-offs.

2.2.4 European competitiveness depends on technological excellence and cost-efficiency

The European aeronautical industry is a leading sector in terms of production, employment and exports, providing over 500,000 direct high-quality jobs (rising to one million if indirect jobs are added) and generating a turnover of nearly €140 billion.[30] Europe has become the global leader in the supply of large civil aircraft, as one half of the Airbus-Boeing duopoly. Two main European OEMs, Rolls Royce (UK) and Safran (F), hold almost 40% of the world market for engines, and Safran and GE (US) run a very successful joint venture (CFM) that dominates the global market for large civil aircraft engines. Europe is by far the

[27] Deutsche Welle (2019), Airbus A380: Ein Fall für den Steuerzahler – accessible at https://www.dw.com/de/airbus-a380-ein-fall-f%C3%BCr-den-steuerzahler/a-47769801

[28] Welt.de (2018), Airbus schuldet Deutschland 759 Millionen Euro, accessible at https://www.welt.de/wirtschaft/article173413684/Luftfahrt-Airbus-schuldet-Deutschland-759-Millionen-Euro.html

[29] European Commission (2012), Regulation (EC) No 748/2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations

[30] European Commission (2013) - https://ec.europa.eu/growth/sectors/aeronautics_en

international leader in the supply of civilian helicopters. Europe also plays a significant role in the market for maintenance, repair and overhaul of aircraft.

Internationally, the aeronautical sector represents a complex environment characterised by strong competition. The maintenance of Europe's leadership position in the global aeronautical market in an increasingly competitive environment depends on technological excellence and cost efficiency.

Responses to the **OPC** widely agreed on the nature of the problem drivers. Most of stakeholders agreed strongly that innovation and development cycles in the industry are both too long and too costly and these views were held in similar proportions across all stakeholder groups. Stakeholders also noted the presence of regulatory barriers in the context of standards and disruptive technology development, although these considerations were felt less strongly than those regarding the innovation cycles. A majority of stakeholders also noted that the lack of global integrated standards undermines the benefits of R&I activities developed at an EU level, thus affecting European competitiveness.

Similar views were also emphasised by most **stakeholders participating in the interviews**, particularly supporting the views that the development cycles in the industry are both long and costly, and that regulatory barriers need to be suitably addressed to not cause further delay to development cycles. There was a strong consensus, in the absence of policy intervention, that it would not be possible to achieve the long-term strategy and level of stakeholder participation required to achieve the goal of climate neutrality by 2050.

2.3 How will the problem(s) evolve?

Without any policy action, it is anticipated that:

- An increased gap will form between the demand for mobility and the achievement of the climate neutrality target
- Improving the environmental performance of aircraft will be more complex, lengthy, expensive and riskier
- The European aviation sector will be at greater risk of losing competitiveness in the global market which would be detrimental to the Green Deal as other manufacturers would have fewer incentives to develop greener aircraft technologies

The combined effects will mean that aviation performance will not be consistent with EU climate targets and that the contribution of European aviation to the growth of the economy and employment will be below potential. Table 4 below outlines the potential evolution of the problem if there is no intervention. It displays two sets of numbers: the first set is based on the EC SECTION Reference Scenario whilst the second set comes from the EC Inception Impact Assessment.[31] Note that while the Inception Impact Assessment numbers are more accurate, given that SECTION is one of the European Commission's key analysis tools in the areas of energy, transport and climate action, it was important to include them too (SECTION allows policy makers to analyse the long-term economic, energy, climate and transport outlook based on the current policy framework).

[31] https://ec.europa.eu/info/law/better-regulation/initiative/11904/publication/5722372/attachment/090166e5c639d431_en

Table 4: Evolution of the problem

Parameter	Position from 2022	Source	Commentary on starting point and evolution during period of Horizon Europe
Air passenger traffic growth	Ranges between +2.2% per annum to +4.4% per annum	EC (SECTION) EC (Inception Impact Assessment)	Different sources of traffic forecasts anticipate different rates of air passenger growth: the EC SECTION Reference scenario estimates that air passenger will grow at an average of +2.2% per annum, whilst the EC IIA estimates that it will grow at +4.4% per annum. External actions, such as increased taxes on kerosene, have the ability to alter demand for air travel.
Average evolution of fuel consumption per passenger	-1.5% per annum	EC (SECTION)	Fuel consumption have been observed to decrease at an average rate of 1.5% per annum. It is assumed that this trend will continue without intervention.
CO_2 emissions (by 2050 compared to 2020)	Ranges between +0.6% per annum to +2.8% per annum (depending on the air traffic forecast source)	Calculated from EC (SECTION) and EC (Inception Impact Assessment)	The joint impacts of air passenger traffic growth and fuel consumption per passenger results in fuel consumption and emissions rising between +0.6% and +2.8% per annum. Taking the worst-case scenario, CO_2 emissions will rise by a further 22% during Horizon Europe. If there is no intervention by 2050 this will rise to 137%
Funding of civil aeronautics research activities (outside of Clean Sky) by public and private stakeholders	€9 billion per annum	ASD	Currently approximately 7% of the civil aeronautical industry turnover is spent on research and development activities. No change is predicted without intervention
Years necessary to achieve TRL 1 to 9	Between 10 and 20 years	IATA	No change is predicted

Source: Steer analysis

Without transformative technology interventions in the next generation of aircraft, the aviation industry's CO_2 emissions will continue to rise as the current achievements in fuel consumption reduction do not offset the effect of passenger growth. The overall result will be an increased consumption of kerosene (and thus an increased release of emissions) of 22% during the Horizon Europe programme. If the worst case scenario growth is extrapolated out to 2050, this results in kerosene consumption (and emissions) increasing by 137% compared to the 2020 level.

Whilst industry and public funding will still be made available for research and development activities, the lack of a framework to secure the necessary long-term commitments needed to reach the critical mass required will result in significant investments not materialising. This may result in the delay or cancellation of demonstrators or system integration projects. It is widely acknowledged in the aeronautical industry that demonstrators cannot occur if preparatory research, development and integration have not been funded and taken place, meaning that flight demonstrators are the ultimate outputs of two or sometimes three decades of roadmaps of industrial research at low and later high TRLs. Technology maturation requires an exponential increase in resources, rather than a linear one, as the technological maturity increases. This is due to the fact that the more integration towards the final product/system is reached, the more complexity needs to be addressed.

The European aviation sector will also become increasingly at risk of losing competitiveness against both established and emerging aviation markets. Slower gains in new technology integration will lead to products that are more susceptible to competition as the other markets will continue to develop.

The evolution of the problem will also be driven by the overall aviation strategies that will be put in place at the EU level and MS level, and to a lesser extent at the international level, on the regulatory framework, and the provision of economic incentives or loans. The publication of the Commission's Green Deal will provide more clarity for the European and the national aviation strategies that will be implemented. We nonetheless anticipate that the transitional use of synthetic aviation fuels would occur without a specific partnership as they use the same infrastructure as aviation kerosene and do not require (compared to other technological solutions) significant certification processes or new airport infrastructure. However, we note that these new types of fuels are still in a development phase, particularly linked to the challenges of industrialisation. In addition, a key consideration here is the price of these types of fuels as they are currently considerably more expensive than kerosene.

Stakeholders responding to the **OPC** were not explicitly asked about how the problem might evolve in the absence of policy intervention.

Those participating in the **interviews** tended to support the view that intervention was required in order to bridge the gap between academic-based innovations and their commercial application in the marketplace which was more prevalent before Horizon 2020.

Stakeholders providing feedback to the inception impact assessment tended to support the view that problems would persist in the absence of policy intervention.

3 Why should the EU act?

3.1 Subsidiarity: Necessity of EU action

The rationale for EU intervention follows directly from the previous discussion of the problems. In particular, it arises from the fact that European aviation industry stakeholders, whether acting alone or in commercially driven consortia, do not have sufficient size to fund the types of projects required to significantly reduce the environmental impact of aviation without resorting to risk sharing: the high costs of demonstration of innovative solutions act as a barrier to commercialisation.

In addition, the nature and magnitude of the issues are such that action at the EU level is needed, rather than the Member States acting alone. Support of innovation and incentives currently already exist in Europe at the national level. Programmes that increase or aim to foster R&D and innovation operate in several Member States alongside aeronautical research funding mechanisms in the form of grants or loans. Alternative support

mechanisms may consist of fiscal incentives, venture capital funds, or repayable launch investment.

While funding at the national level provides an important contribution, the scale of the research, innovation and funding that is required for improving the sustainability of aviation is larger than what can be achieved by a single Member State or by private companies acting alone. National programmes are also often restricted to allocating funding at the national level only. Given the pan-European nature of the industry, having only national programmes inevitably results in major gaps in some areas as well as overlaps in other research areas. Overlaps result in reduced efficiency and prevent advances in other areas, especially as the anticipated EU/FP budget capping may also require the leveraging of more resources.

Collaborative research is an essential part of developing innovation at the European level and is essential if the industry is to make the expected contribution to a reduction in greenhouse gas emissions, noise and air emissions generated by European aviation and retain its competitive position as a leading worldwide aeronautical supplier. Collaborative research allows participants to break away from their natural choice of suppliers and develop new partnerships with different types of organisations (academia, research centres, industry). This is not something which has been traditionally undertaken at the MS level or that can be promoted through ways other than policy intervention, so this is an area where EU intervention is needed.

In the context of the specific characteristics of the aeronautical sector where costs and risks for new developments depend on effective cooperation, inter-firm collaboration on a European scale is essential to sustain the competitiveness of the aeronautical sector. Cooperation between different stakeholders is important, both in the development stages as well as during the maturing of innovative technologies.

3.2 Subsidiarity: Added value of EU action

There are a number of national R&I schemes, some with significant budgets: Germany, France and UK through their national research programmes (LUFO, CORAC and ATI, respectively), each committed approximately EUR 2-3 billion of funding over a five-year period. However, these programmes are insufficiently coordinated within the Member States, between Member States and with the EU. In some cases, national interest in local employment and technology leads to non-complementary policies, with a possible duplication of activities.[32] Platforms also exist for the coordination of initiatives (EACP for clusters and ERA-NET) in addition to sectorial groups (the academic network of EASN) or regionally focused actions (European Regions Research and Innovation Network).

There is much fragmentation in the R&I actions undertaken in the field. Now that there is a clearly focussed Climate Policy objective for Europe (the Green Deal), there is a strong need for directionality of European investments as well as additionality in order to address climate objectives as well as maintain competitiveness. EU action would not replace national schemes, but it would at least provide a clearer policy approach, especially as innovations are urgently needed to achieve the objectives.

[32] Competitiveness of the EU Aerospace Industry with focus on Aeronautics Industry, Ecorys, 2009

Among stakeholders responding to the **OPC** 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. Member States and businesses agreed that the pan-European nature of the industry coupled with uncoordinated support for R&I at national level justified EU action.

4 Objectives: What is to be achieved?

4.1 General objectives

In order to tackle the problems identified in Section 2, it is important to clarify the objectives of EU action in the field of research and innovation. We have identified three general objectives corresponding to the main problems discussed in Section 2.1. These can be summarised as follows.

First, aeronautics-related R&I activity under Horizon Europe should **ensure that aviation reaches climate neutrality and other environmental impacts are significantly reduced by 2050.** This will mean:

- Increasing its ability to support the delivery of the European Green Deal announced by the President of the European Commission by further reducing the greenhouse gas and other emissions generated by the aviation transport industry;
- Enabling the industry to deliver new aircraft configurations towards increased aircraft environmental performance, emphasis on electrification (e.g. hybrid-electric/ full-electric for regional use), use of sustainable alternative fuels (including synthetic fuels and/or hydrogen), more environmentally-friendly aircraft operations, significant further efficiency improvements, ecological and cost-efficient manufacturing, maintenance, reuse and recycling, including end-of-life procedures;
- Supporting a broad research agenda including the full range of technologies and applications, including especially those addressed by the Clean Hydrogen initiative.

This objective is fully in line with several of the sustainable development goals (SDGs) supported by the Climate, Energy and Mobility Cluster, including SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). It is also consistent with the broader objectives of the cluster itself, as described in the report on the overarching context to the impact assessment studies, in particular developing seamless, smart, safe, accessible and inclusive mobility systems.

The second general objective is to ensure that aeronautics-related R&I activity contributes to the leadership and competitiveness of the EU aeronautics industry. This will mean enhancing the ability of the European aeronautics industry to compete in global markets by ensuring it delivers products that are climate-friendly as well as being cost-effective to airline customers. This objective is similarly aligned with a number of SDGs, particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production), and with broader cluster objectives.

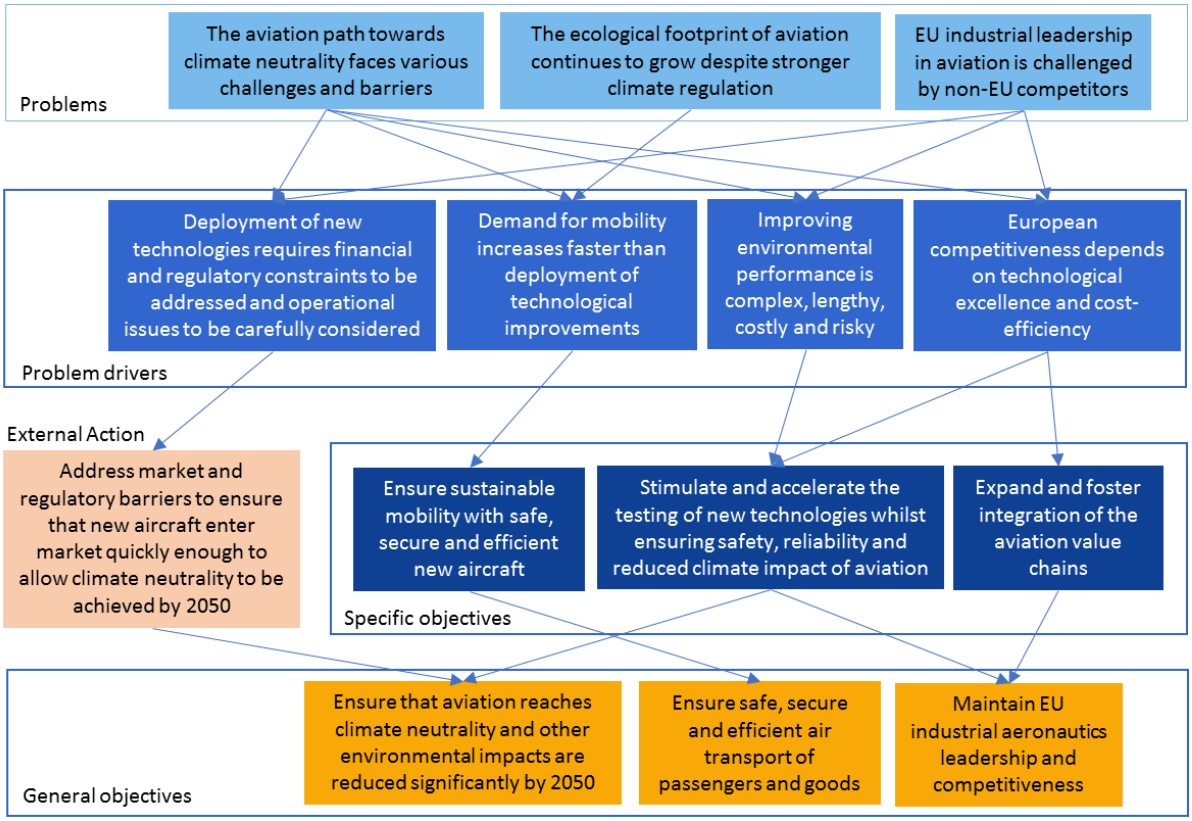
The third objective is to ensure the safe, secure and efficient transportation of passengers and goods by air. This will mean designing R&I programmes that deliver products with enhanced levels of air mobility safety, security and efficiency, increasing their attractiveness to passengers and freight customers. Note that meeting the second general

objective will also facilitate meeting the third, since a more competitive aeronautics industry will be more likely to deliver more efficient aircraft products. This objective is similarly aligned with a number of SDGs, especially SDG 9 (Industry, Innovation and Infrastructure).

4.2 Specific objectives

In order to achieve the general objectives, we have identified four specific objectives. These specific objectives respond to each of the problem drivers discussed in Section 2.2. The relationship between the general and specific objectives is shown in Figure 6. Note that one of these specific objectives is an external action[33] to the initiative; market and regulatory barriers have to be addressed so that the initiative is enabled to achieve its objectives as on their own, R&I outputs will not be sufficient to reach solutions to reach climate neutrality if they are not part of a comprehensive and wider strategy including market incentives, regulatory or other measures. This external action is part of the Green Deal strategy. This will need to be coordinated and achieved by others beyond the initiative, including European, national and international authorities. The achievement of this external action will ensure that the deployment of the Clean Aviation research and technological outputs will be incentivised, so that new products can enter the market (and be purchased) within a suitable timeframe to achieve desired climate impacts.

Figure 6: Objectives tree for the initiative for Clean Aviation



Source: Steer analysis

[33] External action should be understood as an action outside the scope of the initiative, and not as a reference to the European External Action Service which is the diplomatic service and combined foreign and defence ministry of the European Union.

Expand and foster integration of the aviation value chains

Given the challenges faced by the aeronautical industry in improving the environmental performance of new generations of aircraft, a specific objective of a Clean Aviation initiative should be to draw from all relevant stakeholders and initiatives in order **to expand and foster the integration of the aviation value-chains**, so that the best solutions can be found as quickly as possible.

In addition, since climate neutrality in 2050 will not be reached through refinements or increments to today's technologies, a specific objective of the initiative should be **to stimulate and accelerate the testing of innovative and disruptive research and technological outputs that can provide a pipeline of solutions**. Specifically, another objective of these solutions will be to ensure safe, reliable and environmentally-friendly aircraft.

Stimulate and accelerate the testing of new technologies whilst ensuring safety, reliability and reduced climate impact of aviation

Bearing in mind that the competitiveness of the European aeronautics industry depends on technological excellence combined with cost-efficient aircraft, a key specific objective of the initiative will be, as already noted, **to stimulate and accelerate the development of new technologies, whilst ensuring safety, reliability, and reduced climate impact of aviation**. This will require the following:

- New aircraft products, parts and appliances, which will rely on new technologies, to be certified comprehensively by the regulatory authorities to be safe;
- New technologies to be as reliable and affordable as existing technologies to ensure they are taken up by the market, at the right pace;

Given the complexity and scale of the challenge, the common roadmap will allow stakeholders to focus on the tasks at hand. This will mean that a specific objective of the initiative will be to expand and foster integration from the aviation value chains, ultimately accelerating the testing and demonstration of promising technologies. The efficient and economical development of new solutions will allow European competitiveness to remain strong in global markets.

Ensure sustainable mobility with safe, secure and efficient new aircraft

Considering that the demand for mobility by air increases faster than the deployment of technological solutions, it is suggested that one of the specific objectives of the intervention should be **to ensure sustainable mobility with safe, secure and efficient new aircraft**, as airlines renew their fleets. Note also that meeting the specific economic and technological objective described above will also enable the delivery of a more competitive aeronautical industry, which will itself contribute to the achievement of environmental and societal objectives. The initiative will respond to the growing public awareness and demand for flights with an improved environmental footprint.

The **OPC** responses of stakeholders from several different groups, including business organisations of different sizes, business associations, academic and research institutions, public authorities and EU citizens, largely endorsed the view that a European Partnership should be responsive to societal needs and should make a significant contribution to achieving the UN SDGs and EU climate-related goals. The vast majority also agreed that more focus should be placed on bringing about a transformative change towards sustainability through the development and effective deployment of technology, whilst also making significant contributions towards EU global competitiveness.

Stakeholders participating in the **interviews** supported a range of general and specific objectives. There was support to focus higher proportions of the budget on larger aircraft as resulting developments would have larger impacts versus other airborne modes. Nearly all stakeholders interviewed supported the inclusion of the regulator (EASA) throughout the development process, albeit in an observational capacity, to assist in addressing market barriers to entry.

Industry, academics and environmental organisations providing feedback to the **inception impact assessment** were generally very supporting of the objectives identified in the document, in particular the need to explore, mature and demonstrate new technologies, whilst also ensuring competitiveness of the European aeronautical industry.

4.3 Intervention logic and targeted impacts of the initiative

4.3.1 Likely scientific impacts

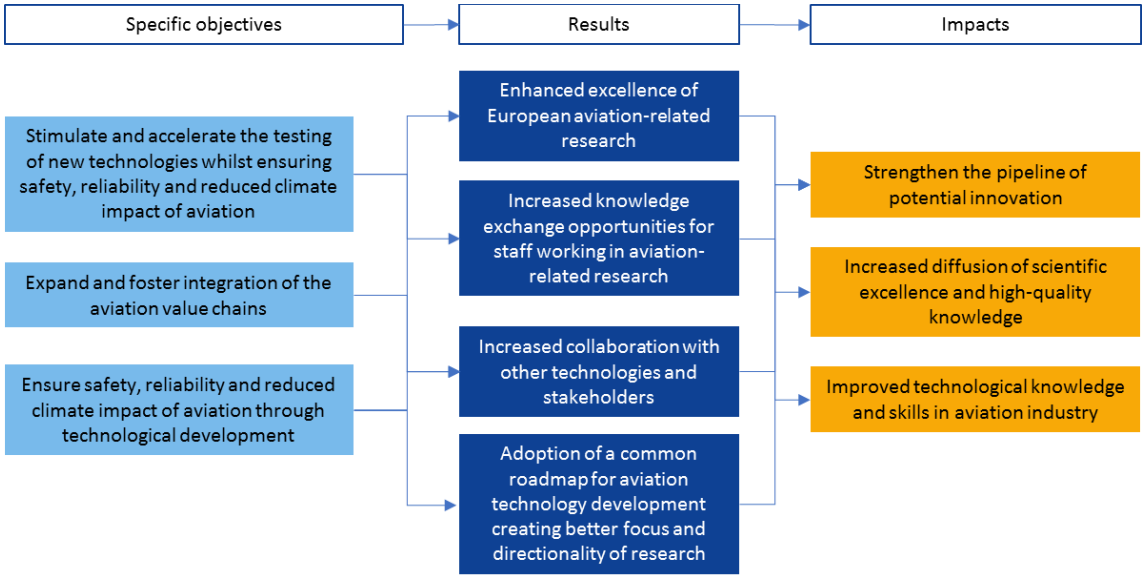
Meeting the specific objectives of the intervention is likely to lead to three main impacts, as illustrated in Figure 7 and further described below. We would expect to see these impacts materialise during the duration of the Clean Aviation initiative as they are relatively medium-term.

The future aeronautics-related R&I will continue to contribute to the excellence of the European scientific knowledge through the publication of results and sharing of knowledge through Open Science, whether supported through open calls or some form of formal partnership arrangement. This will mean an increase in opportunities for staff working in research in this field, whether in universities, research institutes or private companies to gain and exchange knowledge, contributing to enhanced relationships and larger networks. This will also translate into improved skills for staff employed in the industry and for companies.

Furthermore, R&I activity at TRL 1-3 is particularly important in generating a pipeline of new ideas that could have practical applications in the future (whether in Clean Aviation or beyond). As new areas of fundamental research that are not traditionally within the aeronautical scientific ecosystem will need to be considered and integrated, the initiative will result into increased collaboration with other sectors and the emergence of entirely new branches of the aeronautical industry, such as new sources of propulsion, systems or airframes which will enhance European competitiveness.

The innovation pipeline is likely to result in an aviation industry relying on different technological solutions, rather than the current "one size fits all" situation where the entire industry uses kerosene for all aircraft types. In the future, as technologies develop and mature, it is likely that different kinds of fuels/energy sources (such as SAFs, hydrogen, batteries) will be used in parallel, depending on the most appropriate application with regard to journey length and payload requirements. Specific areas of applied research could include the use of batteries for aviation (although this may be covered to an extent by the Battery Initiative). However, this will not be a suitable solution for aircraft beyond the regional size or on medium and long-range routes. Sustainable aviation fuels are far more likely to represent a necessary step towards decarbonisation, given that they do not require too much R&I for their development, but rather on their industrialisation and production processes as they remain energy intensive. The definition of the future aeronautics-related R&I will result in creating better directionality of research, so that the pipeline of innovation is strengthened and focused.

Figure 7: Impact pathway leading to scientific impacts



Source: Steer analysis

Among **OPC** respondents, all academic and research institutions were highly in favour of the potential partnership being used for the advancement of science. This was supported by the vast majority of businesses and other stakeholder groups too. The views on its role in development of new scientific knowledge and capabilities were similarly highly positive among all stakeholder groups.

Similar opinions were expressed by stakeholders engaging in the **interviews**, particularly academic and research institutions. During these interviews many academic and research institutions mentioned that more research resulting from the partnership should be published.

Stakeholders responding to the **inception impact assessment** were generally supportive as well of the view that an initiative under Horizon Europe would have important scientific impacts.

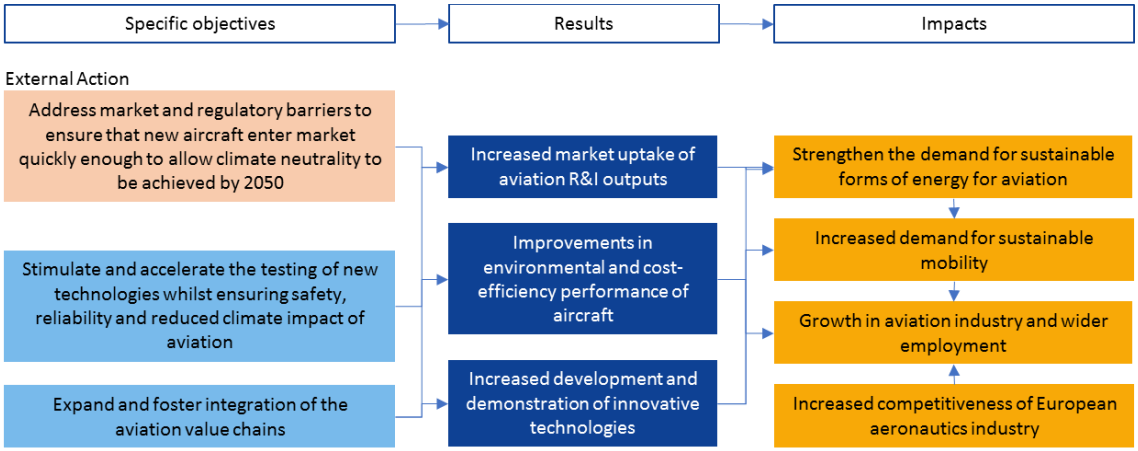
4.3.2 Likely economic/technological impacts

The impact pathways resulting from the specific economic and technological objectives described are varied and relatively complex. These are mapped out in Figure 8. A key enabling external action is necessary as the standalone impacts from research would not be sufficient. As technologies are developed, demonstrated and deployed (noting that this may require support from other sources), the market take-up of new aircraft (airline fleet renewal rate) will increase as newer and more environmentally-friendly products become available and they are seen as cost effective versus current technologies.

As the new products will likely be more expensive than current products, manufacturers and the entire supply-chain will need to ensure cost-efficiency improvements so that they are economically attractive to airlines. New products providing efficient operating costs will further reinforce the competitiveness of the European aeronautical industry.

The increased development of new technologies will further strengthen the demand for sustainable forms of energy for the aviation industry (provided that the supply of sustainable forms of energy is available for all needs) which will result into an increased demand for air mobility – compared to the scenario with no new environmentally-friendly technologies. Employment and jobs will be generated as a result.

Figure 8: Impact pathway leading to economic/technological impacts



Source: Steer analysis

Virtually all stakeholders consulted as part of the **OPC** scored the resulting economic and technological impacts from the partnership as being very relevant. In the sub-sections of the OPC, the following impacts received high relevance scores: increased industrial leadership and uptake of new technologies; the acceleration of key technologies through selected demonstrators; as well as the creation of high-skilled jobs in the low-carbon economy.

In addition to supporting above views, several stakeholders who participated in the **interviews** highlighted the importance of encouraging participation from a wide group of stakeholders, including those outside the traditional aviation-market, to assist with the development of innovative technologies. As mentioned previously, there was a general consensus that regulatory bodies should also have early knowledge of all developments to ensure that the regulation process did not ultimately delay the introduction of new technologies.

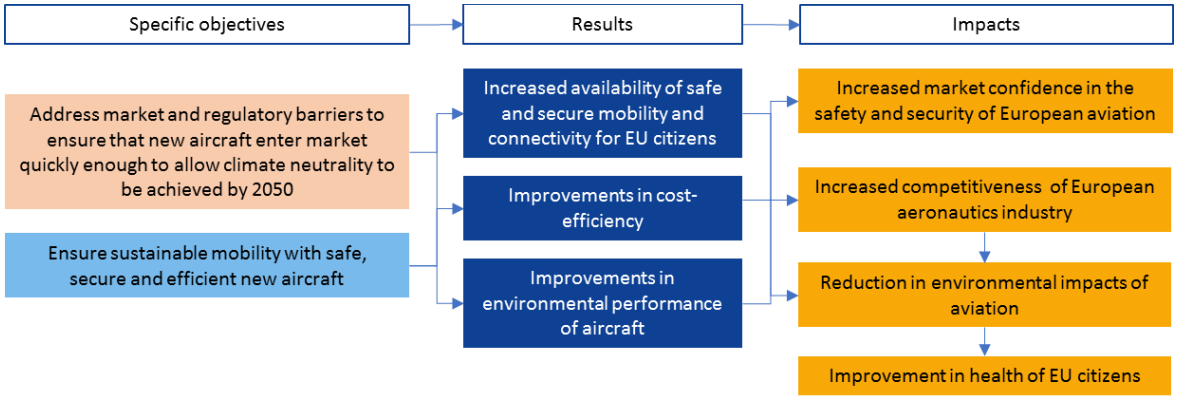
Stakeholders responding to the **inception impact assessment** generally confirmed that an initiative under Horizon Europe could be expected to deliver substantial economic and technological benefits, whilst ensuring competitiveness of the European aeronautics industry.

4.3.3 Likely societal impacts

As already noted, the economic and technological impacts discussed above will also support the achievement of various sustainable development goals, not the least SDG 13 (Climate Action), since new environmentally friendly technologies will reduce the demand for less environmentally friendly forms of transport. The associated impact pathways are shown in Figure 9.

The timescales over which these impacts are likely to be observed are similar to those for others already discussed, since they also partly depend on the deployment of innovation within established networks and hence the replacement of aircraft with long lives (30 years, although with radical new technologies this might change).

Figure 9: Impact pathway leading to societal impacts



Source: Steer analysis

The development of sustainable air mobility will improve people's quality of life. It will have a direct and positive impact on the health and well-being of EU citizens, starting with those living in the vicinity of airports as well as all Europeans and citizens from other parts of the world. This will be a long-term objective, although some impacts may be recorded at different locations at different times, depending on specific local circumstances (such as type of aircraft fleet used by main airline, etc). The increased competitiveness of the European aeronautical industry (which is derived from the technological and economic impacts) will also be a catalyst for a further reduction in environmental impacts. Together, these impacts will contribute to the achievement of SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

4.3.4 Likely impacts on simplification and/or administrative burden

We do not anticipate any material impact in terms of simplification or the administrative burden of aeronautics-related R&I activity supported under Horizon Europe.

4.3.5 Likely impacts on fundamental rights

Since the exercise of fundamental rights (freedom of movement of goods and persons) is frequently dependent on individual mobility, the rights of EU citizens will be strengthened through improved air mobility and connectivity. For example, they will have greater possibilities to pursue career, educational and leisure opportunities of their choice through improved domestic and international air mobility and to travel in a safe, secure and healthy environment.

The majority of the stakeholders consulted as part of the **OPC** have mentioned the importance of societal benefits and view the reduction in CO_2 emissions and the improvement in public health as being particularly relevant impacts associated with the future partnership.

The vast majority of **interviewees** maintained the view that safety in European aviation was of paramount importance, but also mentioned that developments from new technologies would ensure the longevity and relevance of the European aeronautics industry, whilst also resulting in reductions of gas and noise emissions, which in turn would contribute to improved societal impacts.

Societal benefits resulting from technology improvements have also been noted by a number of stakeholders, who responded to the **inception impact assessment**.

4.4 Functionalities of the initiative

This section outlines the functionalities that need to be considered when assessing the policy options in Section 6, reflecting the selection criteria for European Partnerships

defined in the Commission proposal for the Horizon Europe Regulation.[34] In the following paragraphs, we discuss the implications of the criteria relating to the type and composition of the actors involved, the range of activities to be undertaken and the directionality required if the initiative is to deliver the objectives discussed above. We also consider the complementarities and synergies with other, related initiatives under Horizon Europe and beyond.

4.4.1 Internal factors

Type and composition of the actors involved

This functionality relates to the criterion "Involvement of partners and stakeholders from across the entire value chain, from different sectors, backgrounds and disciplines, including international ones when relevant and not interfering with European competitiveness". It concerns the need to involve the full range of stakeholders that can usefully contribute to delivering the future R&I agenda.

Inclusion of the full range of stakeholders from across the value chain, from different sectors, backgrounds and disciplines and EU country origin is essential if the initiative is to leverage all relevant expertise and capability, from both inside and outside the industry, and result in R&I outputs that address a broader set of industry needs than in the past. The participation of all partners, including SMEs, should be a key functionality of an initiative for Clean Aviation. As SMEs are less able to participate in European initiatives, an initiative for Clean Aviation should ensure that participation of SMEs is encouraged, and results are widely disseminated.

International participation should be carefully examined and allowed where it makes sense from an industrial point of view (such as when R&I activities of non-European stakeholders take place in Europe as well as generate skilled manufacturing jobs within Europe), but transparency and openness to third countries[35] should not be a seen as key functionality of the Clean Aviation partnerships as risks related to intellectual property and commercial secrets are real.

Certification ensures that aircraft are manufactured according to an approved design, and that the design ensures compliance with airworthiness requirements. Before a newly developed aircraft model may enter operation, it must obtain a type certificate which will have required a long and complex process. Certification of aircraft is not easy and requires that EASA, the authority responsible for the certification of aircraft in the EU and some non-EU countries, establishes a set of rules that will apply for the certification of this specific aircraft type (certification basis), establishes the Certification Programme, performs a detailed examination of the demonstration of compliance and issues the certificate. The longest part of the process is the examination of the certificate of compliance which is set at five years but may be extended, if necessary. Therefore, a key factor to consider is the possibility of the effective involvement of EASA from an early stage of the development of new technologies, whilst ensuring strict and effective independence of the authority from the industry.

Involvement of Member States is also important for the initiative: co-ordination between European and national R&I programmes would be particularly useful to develop better synergies at national and regional levels. The precise role and composition of the Member

[34] European Commission (2018), Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018PC0435&from=EN

[35] After its departure from the European Union, it will be key for the Commission to define how the UK will be treated for Clean Aviation, owing to the current large reliance on UK-based aeronautical products and services.

States which will engage with the initiative needs to be carefully considered so that the Member States presence in the initiative can maximise the leverage effect of research programme synchronisation.

Table 5 below summarises the stakeholders that need to be involved and indicates the capabilities that they can bring.

Table 5: Type and composition of actors

	Aeronautical Industry	Universities and research institutions	Member States	End-users (Airline and airports)	EASA	Technology-based organisations
Long term perspective	✓	✓	✓	✓	✓	✓
Flexibility and disruptive thinking	✓	✓				✓
Expertise in aircraft operations		(✓)		✓	✓	
Understanding of passenger needs				✓		
Understanding of current R&I	✓	✓	✓			✓
In-kind support	✓	✓			✓	✓
Financial contribution	✓		✓			✓

Source: Steer analysis

There may be a need for punctual amendments to the profile of stakeholder participation, for example with members selected according to their potential contribution to an evolving R&I agenda, particularly as new technologies develop/are shelved, and/or more flexibility in the rules governing participation to ensure that specific gaps in expertise can be filled effectively and efficiently. However, the broad composition of actors will need to be set-up from the inception phase through open competitive calls to expedite work and impacts.

Type and range of activities

This functionality relates to the criterion "Approaches to ensure flexibility of implementation and to adjust to changing policy, societal and/or market needs, or scientific advances". It concerns the types of activity that the policy is intended to encourage, such that it is able to respond effectively to the challenges and problems described in Section 2 and the trends discussed in Appendix D.

Whilst the general objectives can be expected to remain the same throughout the programming period, flexibility in the selection of projects, implementation and possibly membership will be crucial to ensure that a Clean Aviation initiative is empowered enough to deliver. In practice, there will be a balance to be struck between, on the one hand, stability of the programmes and support of stakeholder participation (which will facilitate planning and assist key stakeholders in securing internal approval for financial and in-kind support) and, on the other, flexibility in the direction of R&I activity to ensure that it

remains relevant and responsive to new market, industry and technological developments. There should be clear milestones for the projects selected, with regular reviews against the objectives and planned benefits allowing for projects not delivering the planned outputs or at the planned pace to be stopped or redirected. The policy intervention will need to accommodate the appropriate balance. At the same time, there should also be some flexibility in the allocation of budget so that as technologies develop – including those supported by other initiatives - there is some funding left for these new projects.

In the context of a Clean Aviation initiative, it will be particularly important that there are synergies and established lines of communications between the initiative and others, most importantly the proposed Clean Hydrogen initiative. As highlighted above in this report, hydrogen R&I solutions are among the most promising forms of technologies to make aviation "greener". However, manufacturing low- and zero-emission hydrogen on a considerable scale will be challenging, particularly in the short-term and it is important that the Clean Aviation initiative does not assume that there will be an unlimited availability of renewable hydrogen in this timeline.

With the objective of the initiative to support the deployment of clean aircraft in a timeframe such that these new aircraft can enter the market as soon as possible (2035-2040-2045), activities will necessarily need to focus heavily on high TRLs (4 to 6), so that demonstration activities can provide firm evidence of the potential benefits of innovations. However, these technologies will be so emerging for most of them, that it would be helpful to also have a small share of activities focused on low TRLs (1 to 3), so that emerging technological issues can be tackled as quickly and effectively as possible through fundamental research.

Directionality and additionality required

This functionality relates to the criteria "Common strategic vision of the purpose of the European Partnership" and "Creation of qualitative and significant quantitative leverage effects". The former highlights the importance of ensuring that all participating stakeholders have a common understanding of the purpose of the policy intervention and the direction of the R&I activity it is intended to encourage. The leverage effects relate to the creation of spill over effects of the knowledge gained in the broader community as well as the crowding-in effects on private investments in R&I – both among participating stakeholders and in the broader community, and/or the pooling of resources from EU Member States.

Given the very ambitious public objectives set, and the pre-established roadmap that was developed by the industry in response to it, it is absolutely essential that there is a strategic vision for the initiative, so that efforts can be prioritised, focused and directed on achieving the environmental objectives of the Commission (and of European citizens). It is important that the initiative is able to take ownership of the 2050 objective and set out a comprehensive strategic plan including milestones and deliverables. However, it is essential that the industry does not work in isolation and that public bodies play a strong role in the governance of the partnership, including through the availability of skilled public staff and political willingness. This will ensure that public bodies act as "players" rather than merely as "payers".

Demonstration of expected qualitative and significant quantitative leverage effects should be expected to be a functionality of any partnership, including Clean Aviation. Similarly, systematic measurement and reporting of KPIs should be expected to be a functionality of any partnership. An exit-strategy and measures for phasing-out from the Programme should be expected to be a functionality of any partnership, including Clean Aviation. However, as the general objective on climate change neutrality by 2050 for the aviation industry significantly exceeds the scope of the programming period (seven years), this should be taken into consideration when the exit-strategy is set up.

4.4.2 External factors

The proposed Regulation for Horizon Europe also identifies the need to consider *"Coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions"* when assessing the case for a partnership. It concerns the potential for linkages with other relevant R&I initiatives proposed or planned for the forthcoming Framework Programme, at the EU level in the context of the MFF 2021-27, and beyond. Possible synergies between R&I for Clean Aviation and other areas include:

- Clean Hydrogen initiative: hydrogen and fuel cells as one of the "transformational carbon-neutral solutions" that the EC has identified. Fuel cell and hydrogen technologies have made notable progress in the last decade, but the sector is still in a pre-deployment stage. Massive cost reductions across the entire supply chain are still necessary to enable mass commercialisation as well as specific technological challenges such as safety of hydrogen storage. The success in the deployment of clean hydrogen will be one of the enabling factors for the Clean Aviation initiative.
- Integrated Air Traffic Management initiative: Due to the nature of air traffic flows, the air traffic management technologies installed on-board aircraft and, on the ground, (in airports and control towers) need to be compatible, interoperable and harmonised at EU level. There is a need to accelerate the pace of development, validation and industrialisation of these highly automated components.
- Battery Initiative: New battery technology has applications in different parts of the transport sector, and it is important that the potential benefits for aviation of further developments in battery capability are fully explored. The use of battery technology in new short-range or regional aircraft can help to bring forward the transition from kerosene to electric or hybrid power and accelerate the delivery of greater fuel efficiency and environmental benefits. Any policy intervention in support of aeronautical-related R&I could also enable the industry to help shape the direction of battery research and technology integration.

We also note the importance of links with the following broader policy initiatives, which can be expected to support the achievement of the general objectives described in Section 4.1:

- European Investment Bank loans: The EIB may provide loans to both public and private sector entities to finance projects or investment programmes aligned with one or more priorities of the EIB. One of the current priorities of the EIB is climate and environment, including sustainable transport. Guarantees are also available to cover risks of large and small projects, as well as loan portfolios.
- European Structural and Investment Funds: The European Regional Development Fund (ERDF) and Cohesion Fund (CF), which aim to increase economic and social cohesion and reduce imbalances and disparities between the regions of the European Union, may also provide funding to support the further development of the aeronautical industry in different Member States. The investment priorities for ERDF include low-carbon economy, support for R&I and support for SMEs. These funds are particularly relevant in view of the need to strengthen the participation of aviation sector stakeholders from Eastern Europe in the delivery of R&I programmes.
- Connecting Europe Facility (CEF): CEF is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at the European level. It is expected to target synergies in the areas of connected and autonomous mobility, clean mobility based on alternative fuels, energy storage and

smart grids,[36] and could encourage the deployment of these technologies, in particular in terms of fuel/electrification at airports and setting up of green door-to-door air transports corridors.

Airport and air transport management infrastructure and operations will also need to be considered, as new technologies of aircraft may translate into new operational requirements for airlines, airports and air navigational service providers. The needs of the airlines will need to be considered from the start of the development of new aircraft as they will be making the decisions on fleet renewal, as well as those of airports and service providers as they are key enablers of airline operations.

End-user acceptance will also be a key factor. Passengers and cargo customers will need to feel comfortable and safe flying in newer aircraft relying on technologies with which they are unfamiliar. Whilst this might not be a problem for SAFs, it will be critical that hydrogen technologies are considered to be safe as well as being perceived as reliable for air mobility. Single-pilot aircraft operations might also come into use, which would be a new development for commercial aviation and its passengers.

Whilst societal acceptance of greener aircraft should be strong, likely increases in ticket prices to enable it will be less popular. Air fares are one of the most important drivers of the demand for air transport, so the overall price paid by customers will be an important factor of success of the initiative.

It will therefore be critical that the European regulatory framework for internal and external aviation policy is designed to achieve the overarching objective of climate neutrality by 2050. A key factor will be the design of economic incentives or policies for airlines operating in Europe to ensure take-up of new aircraft in suitable volumes and times as well as ticket prices reflecting all air transport externalities so that there is strong societal acceptance.

5 What are the available policy options?

In this chapter, we provide an overview of the key characteristics of the policy options for this initiative. The Horizon Europe regulations put forward three forms of European Partnerships that constitute the policy options for this initiative; standard Horizon Europe calls are a fourth option while acting also as a baseline against which the three partnership options will be compared.

To ensure a correct assessment of the different options and their effectiveness, it is crucial to take into consideration both the objectives and the functional requirements outlined in Section 4.4. The descriptions of the options in the sections below therefore focus on the implications of the options' characteristics related to these functionalities. They are based on the options' characteristics specifically related to the functionalities listed in Appendix H. A full description of the options is provided in the report on the overarching context to the impact assessment studies.

5.1 Baseline option – Traditional calls under the Framework Programme

Under the baseline option, coordination of R&I would be reliant on the mechanisms for managing open calls under the Horizon Europe Framework Programme.

[36] European Parliamentary Research Service (2018), Connecting Europe Facility 2021-2027 - Financing key EU infrastructure networks, BRI(2018)628247

Table 6: Key characteristics of the baseline – Option 0

	Implications of option
Enabling appropriate profile of participation	• A well-defined process would be needed to ensure that the programme committees of Member States/Associated States were properly informed about R&I priorities, including key demonstration programmes. • The specification of calls over the period of the Framework Programme could reflect the need for an evolving profile of participation, with different consortia forming at different stages to take different types of activity forward.
Supporting implementation of R&I agenda	• Implementation would rely on standard infrastructure underpinning the open calls procedure, drawing on resources of relevant Commission executive agencies and systems, benefiting from economies of scale. • Administrative costs for the European Commission would be significantly reduced. • Calls for proposals would be published in the work programmes of Horizon Europe. • Transparency and open publication of results would ensure their availability to interested parties.
Ensuring alignment with R&I agenda	• Work programmes would need to reflect the requirement for R&I activity across TRLs, with input from representatives of all relevant stakeholders. • Specification of calls for activity at higher TRLs, particularly demonstration programmes, would need input from industry. • Calls would need to be informed by CS 2 JU ITDs/IATDs to ensure continuity where appropriate • R&I activity would focus on the short to medium term needs of the industry. • 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. • Selection of high TRL projects would require provision of external expert (and independent) advice to the Commission (as has been done in the past in FP5, FP6, etc)
Securing effective leveraging of resources	• Progress of R&I effort would depend largely on EU funding, with no expectation of binding leverage of industry support. However, depending on the R&I scope and co-financing rules, substantial leverage of industry support could be expected. • Demonstration programmes would require significant in-kind support and collaboration from industry, but there are some unknowns as to whether critical mass could be reached. • Given more limited funding than in the past, critical R&I priorities would need to be identified at the outset.

Source: Steer analysis

5.2 Option 1: Co-programmed European Partnership

A co-programmed partnership would provide for focused input from partners into the determination of the R&I agenda and clear aspirations for leveraged funding of activity while continuing to rely on the Commission and/or executive agencies for administration. At the same time, while it would allow for flexibility in the profile of stakeholder participation, progress in the delivery of the R&I programme would depend on the willingness of stakeholders to support individual projects rather than on legally binding commitments.

Table 7: Key characteristics of Option 1

	Implications of option
Enabling appropriate profile of participation	• The partnership would enable participation by all key stakeholders potentially contributing to the specification and delivery of the 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. • At the same time, it would offer the flexibility to change the profile of participation over time, with new partners joining to support new areas of activity in response to emerging results and changing priorities.
Supporting implementation of R&I agenda	• Implementation would rely on standard administrative infrastructure underpinning the open calls procedure, drawing on resources of relevant Commission executive agencies and IT systems. • Calls for proposals would be published in the work programmes of Horizon Europe. • Transparency and open publication of results would ensure their availability to interested parties.
Ensuring alignment with R&I agenda	• 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. • The partnership would be responsible for ensuring that priorities for calls were specified in line with R&I priorities, including demonstration programmes. • Specification of calls would need to be informed by CS 2 JU ITDs/IATDs to ensure continuity where appropriate • R&I activity would be likely to focus on the medium to long-term needs of the industry. • Commission co-steering role and Transport Programme Committee would ensure alignment with overarching policy objectives and coordination with related programmes.
Securing effective leveraging of resources	• Aspirations for partner contributions would be clearly defined at the outset. • Industry commitments would not be legally binding. • Expected in-kind contributions from the private sector would be identified in the work programme. • Given more limited funding than in the past, critical R&I priorities would need to be identified at the outset.

Source: Steer analysis

5.3 Option 2: Co-funded European Partnership

Since private sector stakeholders from the aeronautics industry could not participate directly in a co-funded partnership, the R&I programme would need to be developed by national funding bodies and/or research instiutions before being agreed with the Commission. In addition, it would not be possible to leverage Commission funding with private sector resources under this option.

Table 8: Key characteristics of Option 2

	Implications of option
Enabling appropriate profile of participation *(actors involved)*	• Since private sector entities cannot participate in this form of partnership, national funding bodies or governmental research institutions would need to support the development of an R&I programme to be agreed with the Commission. Such bodies and institutions might need to be created, since hitherto the R&I effort in many Member States has been led by private sector organisations. • National bodies would need to consult widely with their respective aeronautical sectors to develop a market-focused R&I strategy.
Supporting implementation of R&I agenda ***(activities)***	• Funds would be distributed either according to the rules applying to relevant national funding arrangements or under a centrally managed open calls procedure. • Private sector entities hitherto sponsoring a significant level of R&I activity in the aeronautics sector would not be eligible to receive funding.
Ensuring alignment with R&I agenda ***(directionality)***	• In principle, would enable a broad range of activities across the TRLs but the alignment of these with industry needs would need to be by proxy, with national research institutions consulting on the R&I agenda with industry stakeholders. • The Commission would ensure alignment with overarching policy objectives and coordination with related programmes. The R&I strategy would nevertheless focus on common national priorities.
Securing effective leveraging of resources ***(additionality)***	• It would not be possible for private sector organisations to contribute directly to the resourcing of the partnership and leverage of Commission funding would therefore be limited.

Source: Steer analysis

5.4 Option 3: Institutionalised European Partnership

5.4.1 Institutionalised Partnerships under Art 185 TFEU

As in the case of Option 2, an institutionalised partnership under Article 185 of the TFEU would not be open to private sector participation. Hence, while the R&I strategy and work programme could in principle address long-term issues affecting the aeronautics industry at the European level, it would need to be developed by Member States rather than being industry-led. In addition, the partnership would not be able to leverage significant private sector funding.

Table 9: Key characteristics of Option 3: Institutionalised Partnership Art 185

	Implications of option
Enabling appropriate profile of participation *(actors involved)*	• Since private sector entities cannot participate in this form of partnership, Member State representatives would need to support the development of an R&I programme to be agreed with the Commission. • Member States would need to consult widely with their respective aeronautical sectors to develop a market-focused R&I strategy.
Supporting implementation of R&I agenda ***(activities)***	• Funds would be distributed according to the rules of the partnership and managed by a dedicated implementation structure. • Private sector entities hitherto sponsoring a significant level of R&I activity in the aeronautical sector would not be eligible to receive funding.
Ensuring alignment with R&I agenda ***(directionality)***	• In principle, would enable a broad range of activities across the TRLs but the alignment of these with industry needs would need to be by proxy, with Member States consulting on the R&I agenda with industry stakeholders. • The Commission would ensure alignment with overarching policy objectives and coordination with related programmes. The R&I strategy would focus on major challenges requiring collective action at the European level.
Securing effective leveraging of resources ***(additionality)***	• Leveraging of Commission resources would be primarily through pooling of Member State funding. • While, in principle, the partnership could attract strategic private sector investment, it would not provide a vehicle for coordinating R&I funding from private sector stakeholders within the aeronautics industry.

Source: Steer analysis

5.4.2 Institutionalised Partnerships under Art. 187 TFEU

An institutional partnership established under Article 187 of TFEU would provide a structured framework for bringing together the capabilities of all stakeholders potentially contributing to aviation-related R&I under Horizon Europe. This would include dedicated administrative resources to support the development of the strategic R&I agenda for the whole of the Framework Programme and legally binding funding arrangements.

Table 10: Key characteristics of Option 3: Institutionalised Partnership Art 187

	Implications of option
Enabling appropriate profile of participation	• The partnership would enable participation by all key and willing stakeholders potentially contributing to the specification and delivery of the strategic R&I agenda through a clearly defined membership structure. Note that some stakeholders may not want to participate if their competitors are also involved, unless all activities are addressed by open competitive calls. • It would provide a forum for consulting stakeholders on R&I priorities and the work programme, ensuring that they were aligned with industry and market needs. • Participation 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 results and changing priorities.
Supporting implementation of R&I agenda	• 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 limited to 4% of the budget and subject to 50:50 allocation between the Commission and private partners). • Dissemination of knowledge among partnership participants would mainly take place within calls consortia and within JU participants.
Ensuring alignment with R&I agenda	• The partnership would be responsible for specifying a work programme fully in line with the R&I priorities identified by the industry to fulfil the European policy needs. • The work programme would reflect the medium-to-long term needs of the industry, drawing on the perspectives of different stakeholders. • The work programme would build on, but not be constrained by, the current CS 2 JU ITDs/IADPs 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, assuming sufficient Commission political willingness and staff resource available.
Securing effective leveraging of resources	• Legally binding funding requirements would be clearly defined at the outset, with private sector partners expected to provide between 50% and up to 75% of partnership resources through in-kind and/or financial commitments. • Given more limited funding than in the past, critical R&I priorities would need to be identified at the outset.

Source: Steer analysis

5.5 Options discarded at an early stage

A co-funded partnership and an institutional partnership created under Article 185 of the TFEU are not considered relevant for the impact assessment of the Clean Aviation initiative.

In a co-funded partnership option, the partners do not include private sector companies and instead include only public authorities with research funders (or governmental research organisations) and other public authorities at the core of the consortium.

These types of partnerships rely on pooling and/or coordinating national programmes and policies with Union policies and investments, to help overcome fragmentation. This form of implementation only allows to address public partners at its core (comparable to the Article 185 initiatives), with Member States that are partners in this partnership becoming the 'owners' of the priority and taking sole responsibility for its funding. The industry R&I can nevertheless be addressed by the activities of the partnerships, but it does not make formal commitments and financial contributions.

In the context of Clean Aviation, industry involvement is absolutely essential as there is a definite need for the industry to define, programme, deliver and fund research, not least because of the key role of such organisations in both the delivery of aviation services in Europe and the supply of aviation-related products and services in global markets. In addition, Airbus,[37] Rolls-Royce,[38] and Safran[39] each spend annually €3.2 billion, €1.5 billion and €1.1 billion respectively on research and product development.[40] It is crucial that these substantial research budgets may contribute to the achievement of the objectives of a Clean Aviation initiative.

The same rationale applies for institutional partnerships created under Article 185 of the TFEU, where the partners are simply Member States and do not include private partners. For these reasons, these two options have been discarded at an early stage and are not considered suitable for a Clean Aviation initiative where a public-private partnership is sought.

6 Comparative assessment of the policy options

6.1 Assessment of effectiveness

Based on the intervention logic, the initiative aims to deliver scientific, economic/technological and societal (including environmental) impacts through a set of pathways (Section 4.3), which require a set of critical factors in place to be achieved in the best possible way (Section 4.4). This section assesses the extent to which each retained policy option has the potential to allow for the attainment of the likely impacts in the scientific, economic/technological and societal sphere, based upon its characteristics (Section 5). At the end of each section we summarise the outcomes of the assessment by assigning a non-numerical score to each option for each impact desired.

The assessments in this section set the basis for the comprehensive *comparative* assessment of all retained options against all dimensions in Section 6.4. Table 11 lists the desired impacts in the three impact areas.

[37] https://annualreport.airbus.com/pdf/Complete_Annual_Report.pdf

[38] https://www.rolls-royce.com/investors/annual-report-2016.aspx#group-at-a-glance

[39] https://www.safran-group.com/media/safran-2016-annual-results-20170224

[40] Note that these figures include product development beyond TRL6

Table 11: Likely impacts of the initiative

Impact area	Likely impacts
Scientific impact	Strengthened pipeline of potential innovation
	Increased diffusion of scientific excellence and high-quality knowledge
	Improved technological knowledge and skills in aviation industry
Economic / technological impact	Strengthened demand for sustainable forms of energy for aviation
	Increased demand for sustainable mobility
	Growth in aviation industry and wider employment
	Increase in competitiveness of the European aeronautical industry
Societal impact	Increased market confidence in the safety and security of European aviation
	Increased competitiveness of European aeronautical industry
	Reduction in environmental impacts of aviation
	Improvement in health of EU citizens

Source: Steer analysis

6.1.1 Scientific impacts

Option 0: Horizon Europe calls (baseline)

We would expect R&I activity under the baseline option to make a significant contribution to the scientific knowledge base, with the volume of publications from European universities and research-based organisations increasing at a rate similar to that observed during FP5 and FP6. The open calls procedure would enable a pipeline of projects at TRL 1-6, contributing to the global knowledge base while providing a platform for innovation. The outputs obtained would continue to underpin the registration of patents by the European industry. The pipeline of activity generated by open calls would also provide opportunities for SMEs and, possibly, technology-based organisations outside the aviation sector, to participate in projects across the TRLs.

The following points should be considered for the scientific impacts of this option:

- The European Commission would provide the strategic vision for the pipeline of innovation, potentially drawing from the ACARE strategic agenda.
- The pipeline of innovation may potentially lead to the emergence of more disruptive technologies than under the other options since the it would be set by the public (i.e. Commission).
- Without specific constraints on participation, the industry would be entirely free to suggest the composition of consortia to respond to open calls, from within and outside the industry.
- It is expected that key leaders of the industry (such as manufacturers and integrators) would show a level of engagement similar to what they have previously displayed in FP5/6/7. However, it is likely that the overall level of funding provided by the industry may reflect the lack of a commitment in this option.

- The effective monitoring and assessment of any results obtained would be challenging in the absence of a dedicated administrative structure.
- It would not be possible to fully address the problem of lack of coordination of research activities, since there could be some dislocation between open calls issued at different times and no guarantee that the appropriate stakeholders would be involved throughout a given research programme.
- The dissemination of any results obtained would need to rely on well-defined rules providing for a balance between transparency and appropriate protection of intellectual property.

The number of jobs in Europe would be expected to increase in par with the resources available to support R&I under Horizon Europe.

Option 1: Co-Programmed

We would expect a greater degree of participation from stakeholders within the European aeronautics industry under a co-programmed partnership than under the baseline option. Stakeholders would be required to make some commitment to progressing a programme of R&I activity under a memorandum of understanding, which would provide a platform for dialogue and the development of a more strategic approach to the direction of effort, based on common objectives.

However, the impacts would be constrained by the potential lack of participation of key stakeholders from the industry and from outside it. This option would therefore be subject to many of the same limitations as the baseline, namely constraints on available resources as compared with Horizon 2020, insufficient industry participation to ensure a market-focused approach to innovation and lack of coordination across TRLs.

Option 3: Institutionalised Art 187

An institutionalised partnership established under Article 187 would be subject to a defined legal framework, with partners contributing resources in accordance with legally binding requirements set out in a Council Regulation. It would be governed and managed through dedicated structures supporting, inter alia, the development of a strategic vision for aeronautical-related R&I and the specification of annual work programmes. This would provide for:

- A profile of participation along the entire aeronautical value chain and from different sectors (including technology-based sectors outside the traditional aeronautics industry), with the potential to modify the profile over the period of Horizon Europe according to work programme progress effectively made and the needs of the strategic vision.
- However, the choices of actors made at the inset of the Partnership may also reduce the appetite for competing consortia to participate.
- A higher level of overall funding, not least because of a commitment of financial and in-kind resources from aeronautical industry organisations which are better able to engage under a legally binding framework governing the allocation of resources.
- More effective management of a pipeline of development and demonstration activities, with an appropriate allocation of resources to projects at different TRLs.
- Potentially emergence of less disruptive solutions at low TRLs than under the baseline, as there would be more emphasis on technologies that are more interesring to the industry than to the public.
- The dissemination of results would take place within the Partnership as a priority, potentially slowing down its dissemination outside of it.

The **OPC** responses pointed towards several factors that would contribute to a more effective delivery of scientific impacts under an institutionalised partnership. For example, a substantial majority of business organisations and associations, academic and research institutions, public authorities and EU citizens considered that the inclusion of a broad range of partners, with flexibility to change the profile of participation over time, was either relevant or very relevant. The responses also supported the view that the initiatives should enable the development of a long-term strategy, underpinned by a roadmap, that mainly draws on inputs from industry and academia, with additional inputs from Member States.

Nearly all **stakeholders interviewed** for this study supported the view that the scientific impacts under Horizon Europe would be best achieved through and institutionalised partnership. Most stakeholders emphasised the importance of a long-term strategy and greater participation of a wider selection of stakeholders. Some industry and Member States stakeholders were of the opinion that the budget should be solely focused on higher TRL projects, which would ultimately reduce the scientific impacts realised from more innovative technologies, whilst academics and research institutes were keen to ensure a better balance. Stakeholders interviewed also noted that the ability to have more flexibility with regards to programme composition and funding allocation during the partnership would enable resources to be better focused on more promising technologies, ultimately improving their scientific impact. During consultation, stakeholders have confirmed that a co-programmed partnership would not provide sufficient certainty of return from committed resources, notwithstanding the more formal framework of collaboration provided by a memorandum of understanding.

Almost all stakeholders responding to the **inception impact assessment** were similarly supportive of an institutionalised partnership due to its perceived compatibility with long-term strategies, which are particularly relevant in the aviation industry owing to long development cycles.

Summary

Table 12 shows the scores we have assigned for each of the policy options, based on the assessment above and taking account of the views expressed by the different stakeholders.

Table 12: Overview of the options' potential for achieving scientific impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Strengthened pipeline of potential innovation	+++	++	++
Increased diffusion of scientific excellence and high-quality knowledge	+++	++	++
Improved technological knowledge and skills in aviation industry	+++	+++	+++

Source: Steer analysis. Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.1.2 Economic/technological impacts

The technological, economic and societal impacts have been quantified using a model described in Appendix C. The key input to this model is the EC PRIMES Reference Scenario (as indicated in Section 2.3) which is the Commission's standard set of energy, transport and climate numbers. Ensuring that all impact assessments are based on PRIMES allows the Commission to analyse and benchmark[41] all its policy initiatives and their possible outlooks on the same basis and is a requirement to be used in impact assessments. However, the PRIMES Reference Scenario is only updated periodically, with the 2016 edition being the latest available, and it is likely to be less up-to-date with recent developments than other industry forecasts. For the industrial sectors under consideration by the initiative, this is an issue to keep in mind, as since 2016 there have been many changes in the energy and transport industries and in the knowledge and quantification of their climate impacts. In particular, the PRIMES Reference Scenario has not yet been updated to reflect the Green Deal policies and impacts.

Option 0: Horizon Europe calls (baseline)

Based on past experience in FP5/6/7, we have considered that we can anticipate a large industry participation in demonstrator programmes funded through open-calls. This would support the continued development of new aircraft, including certification processes, and, over the long-term, the market take-up of potentially valuable innovations. We have therefore assumed in this option that market uptake will remain broadly consistent that that witnessed today.

In this option, we have assumed that the regulatory conditions (external action) needed to ensure the delivery of the objectives also would be in place. We have modelled this as the introduction of a tax on kerosene that would bring the cost of this fuel on par with the cost of SAFs by 2050. This would create the necessary stimuli to grow the supply of aviation SAF, which we have estimated would replace 2% of the European volume of kerosene used for short and long-haul aircraft by 2025 reaching 50% by 2050 (+2% per annum).[42]

This would translate into positive environmental impacts, but also would lead to higher costs for airlines and ultimately their passengers, although we have assumed an airline-to-passenger cost pass-through of 50% reflecting the competitive airline market. Under these conditions, manufacturers would be expected to try to maximise the cost-efficiency of their new aircraft to make them as attractive as possible to airlines. Under this option it is expected that industry would only benefit from the introduction of SAF and the introduction of technologies from previous R&I projects; no acceleration in the deployment of new technologies compared to the current rate would be realised. Whilst aircraft purchase costs in this case are less than those in the other two options under consideration, the increased fuel prices will have a greater impact on airlines as these aircraft are not as fuel efficient as they could be. The overall cost-efficiency performance in this option was calculated to be +1.5% for short-haul and long-haul aircraft (per year).

Under this option, there would be no change related to the time necessary for development and deployment of technologies (assumed to be 20 years), which would mean that the global market share of the European aeronautical industry would remain stable compared to its current level, as airlines would have no additional incentive to buy new aircraft beyond regular fleet renewals and expansion plans. The competitiveness of the aeronautical industry would not change significantly compared to the no-tax situation. As a result of increased taxes on kerosene in Europe, European passenger demand would be

[41] https://ec.europa.eu/energy/en/data-analysis/energy-modelling/eu-reference-scenario-2016

[42] https://www.greenaironline.com/news.php?viewStory=2417

less strong, with an estimated 22% loss of passenger.km by 2038, compared to the scenario without external action. The level of passenger.km loss in 2038 represents the largest decrease in passengers, as the combined costs of kerosene and SAF in that year are the highest and the corresponding effect on airfares reduces demand. This decreases to an 11% difference in 2050, when the costs of kerosene and SAF are assumed to be equal. However, the overall growth in traffic is still significant compared to today's demand. Overall, the change in the level of employment generated by this option would lead to a loss of 2% of highly-skilled jobs.

Table 13 shows the technological and economic impacts of Option 0, derived from the model described in Appendix C and informed by the discussion above. Note that increases and decreases are calculated as the difference between modelled values for the option in 2050 and the corresponding values under the default scenario within the model that estimates traffic volumes and costs before taking account of the effects of the options.

Table 13: Technological and economic results and impacts of Option 0

		Values in 2050
Results	Market uptake of aviation R&I outputs (Increase in global market share of aircraft, measured in aircraft per year)	0*
	Environmental performance of aircraft (% in reduction of CO_2 per passenger.km versus 2021)	69%
	Development and demonstration of innovative technologies (years to go from TRL 1 to 9)	20
	Improvements in cost-efficiency performance of aircraft (% per annum)	+1.5%
Impacts	Air passenger traffic (trillions of passenger.km)	3,640
	Total employment, compared to default scenario (FTEs)	877
	European aeronautical industry competitiveness (€bn)	367

Source: Steer analysis. Note (*): under this option, "0" does not mean that there is no market uptake, but that the rate of market uptake does not change compared to today's situation.

Option 1: Co-Programmed

We would not expect the market uptake of aeronautics R&I to increase substantially under this option compared to open-calls. A small increase might be expected, given a more structured approach to industry participation compared with one based entirely on open calls, resulting in a small acceleration in new technologies becoming available. Under this option, aircraft manufacturers may be slightly more willing to take the risk of developing new aircraft, although we should note that their willingness to risk is also determined by other external factors, such as the state of the global aircraft market and competitor products (for instance, if Boeing were to launch a brand new short-haul model, this would need to be considered). This would mean a change in the time taken to develop new aircraft (18 years vs. 20 under Option 0), which would generate a higher take-up rate by the

airlines of 11%. In turn, the decrease in time taken to develop new aircraft will provide an increase in the competitiveness of the European aeronautical industry.

The same external action would take place as under Option 0, leading to the same increase in prices for passengers. Manufacturers would also be expected to try to maximise the cost-efficiency of their new aircraft to make them as attractive as possible to airlines. As more technological results would have been developed and demonstrated in this option, including efficiency improvements, the overall improvement of cost-efficiency (taking into account more expensive fuels) would be +1.4% for short-haul and long-haul aircraft. This represents a saving of 0.06% versus option 0; increases in airframe costs (due to faster renewal) are more than offset by the reductions in fuel consumption due to the higher take up of new technologies.

There is a small reduction in passenger demand (-1%) versus Option 0; however, as a result of the greater take-up of R&I outputs, 12% more jobs are anticipated to be created in the aeronautical industry versus the baseline.

The results and impacts estimated for this option are shown in Table 14.

Table 14: Technological and economic results and impacts of Option 1

		Values in 2050
Results	Market uptake of aviation R&I outputs (Increase in global market share of aircraft, measured in aircraft per year)	+11%
	Environmental performance of aircraft (% in reduction of CO_2 per passenger.km versus 2021)	71%
	Development and demonstration of innovative technologies (years to go from TRL 1 to 9)	18
	Improvements in cost-efficiency performance of aircraft (% per annum)	+1.4%
Impacts	Air passenger traffic (trillions of passenger.km)	3,596
	Total employment, compared to default scenario (FTEs)	983
	European aeronautical industry competitiveness (€bn)	436

Source: Steer analysis

Option 3: Institutionalised Art 187

Greater participation among a wider group of stakeholders and better coordination of R&I efforts would support a slightly higher level of demonstration activity than under the other options. The industry would benefit from increased interaction with a wider range of stakeholders and improved coordination of R&I efforts that are enabled through the establishment of a JU. We would expect these factors to lead to an increase in the volume of new patents generated through further development work.

While the competitiveness of the industry will continue to depend on various factors, including policy interventions (such as economic incentives), we would expect European

suppliers to be in a strong position to respond to competition from third countries under an institutionalised partnership. Under Option 2, we assume that there would be a slight acceleration in the time taken to develop new aircraft (17 years) compared to the other two options. In addition, the range of technologies developed, demonstrated and deployed would be significantly higher than under the other two options. The assumption is that external action would remain a necessary condition (with the same kerosene cost implications as in Option 0), and when combined with the technological developments, the impact has been estimated as the following:

- For regional aircraft: 2% of fuel consumption in 2040 replaced with hybrid "consumption" reaching 22% by 2050;
- For short-haul aircraft:
- 2% of kerosene consumption replaced by SAFs from 2025, reaching 50% in 2050; and
- For long-haul aircraft, same SAF use as for short-haul aircraft.

As new aircraft generations are brought to the market, this would generate significant additional cost, which manufacturers would need to address in order to be able to sell their products to European and global airlines. More radical efficiency improvements would be implemented so that airline operating costs per seat would be kept as competitive as possible. We have assumed the same airline-to-passenger cost pass-through of 50% as in Option 0. Overall this results in an improvement of cost-efficiency performance of 1.3% for short and long-haul aircraft.

As airlines would buy the new products, this would result into positive impacts for the competitiveness of the aeronautical industry. The European market share of commercial aircraft orders from China and Russia is assumed to decrease less, owing to the more advanced technologies available from the European market. Passenger demand, as a result of increased taxes, would remain similar to the level seen in Options 0 and 1, but the levels of employment generated by this option would lead to an increase of 24% of highly-skilled jobs.

Table 15: Technological and economic results and impacts of Option 3

		Values in 2050
Results	Market uptake of aviation R&I outputs (Increase in global market share of aircraft, measured in aircraft per year)	+17.6%
	Environmental performance of aircraft (% in reduction of CO_2 per passenger.km versus 2021)	75%
	Development and demonstration of innovative technologies (years to go from TRL 1 to 9)	17
	Improvements in cost-efficiency performance of aircraft (% per annum)	+1.3%
Impacts	Air passenger traffic (trillions of passenger.km)	3641
	Total employment, compared to default scenario (FTEs)	1,087

		Values in 2050
	European aeronautical industry competitiveness (€bn)	476

Source: Steer analysis

The **OPC** responses provided further support for the view that a well-defined legal structure of the kind underpinning an institutional partnership could be expected to 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, harmonised standards, facilitated synergies with EU/National programmes and facilitated collaboration with other partnerships.

Virtually all **interviewees** considered that an institutionalised partnership was essential if EU support of aviation related R&I was to have a transformative economic and technological impact on the sector. In the absence of such a framework, many of the larger organisations indicated that their support for the partnership would be substantially reduced. A large number of industrial stakeholders stated during consultation that they would not participate in R&I activity to the same extent if support from the Commission took the form of open calls alone.

Most of the organisations (business, research institutes) 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.

Summary

Table 16 shows the scores that we have assigned to each of the policy options in respect of economic/technological impacts.

Table 16: Overview of the options' potential for achieving economic/technological impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Strengthen the demand for sustainable forms of energy for aviation	++	++	+++
Increased in demand for sustainable mobility	+	+	+++
Growth in aviation industry and wider employment	+	++	+++
Increased competitiveness of European aeronautics industry	++	++	+++

Source: Steer analysis. Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.1.3 Societal impacts

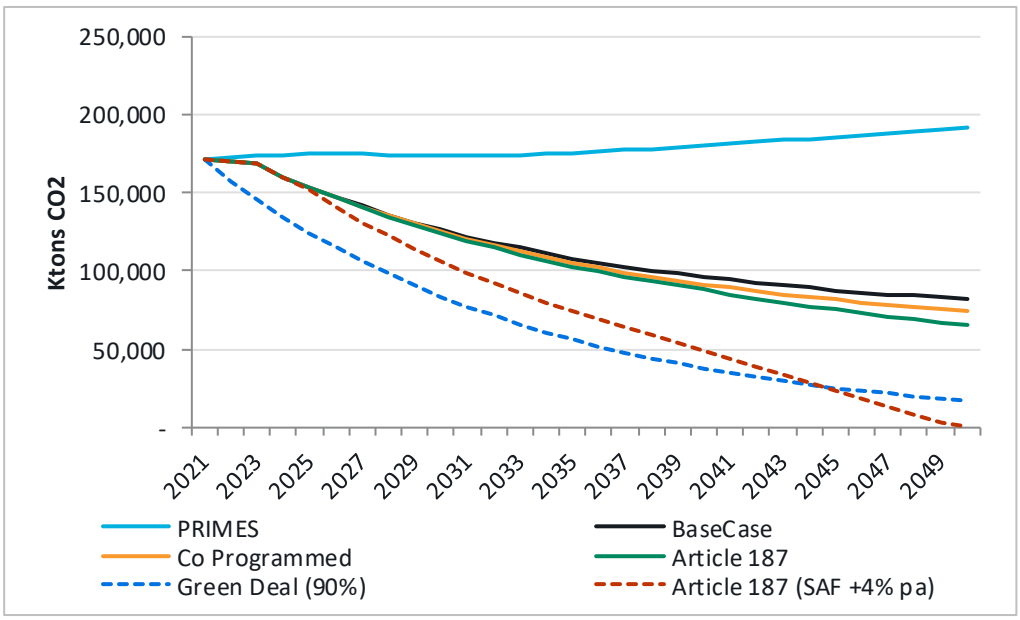
Option 0: Horizon Europe calls (baseline)

The societal impacts partly derive from the economic and technological impacts. Under this option, they are driven by the tax on fuel and by the emergence of innovative aircraft products over time. However, as it remains unclear if the market update of these new innovative aircraft products would effectively happen in time to meet European Climate targets, we have assessed the increased competitiveness of the European aeronautics industry to be lower in this option.

We do not foresee a difference in market confidence in the safety of the European aviation under all options, as all aviation products have to go through a rigorous programme of safety assessments. Regarding market confidence in the security of the European aviation, again, we do not see distinguishing features between all three options under consideration.

The loss in traffic, due to higher air fares, would contribute to a reduction in emissions (in black in the graphic below), overall achieving a 18.7% reduction in CO_2 emissions (a net reduction of 33 million tonnes), -37% of NOx emissions (a net reduction of 314,000 tonnes) and -38% of PM emissions (a net reduction of 9,000 tonnes) compared to the current situation forecasted without external action (in light blue below). What the base case (black line below), co-programmed (orange line) and Article 187 lines (green and red dotted lines) show is that the SAF assumption used in this model (based on ICAO's proposal of reaching 50% of SAF by 2050) is not enough to allow the Green Deal target to be achieved (blue dotted line). In order for the Green Deal target to be achieved, based on this model's assumptions, the prevalence of SAF in Europe must increase at a rate of approximately 4% per annum (as shown by the red dotted line). Note that it has not been possible to model noise emissions.

Figure 10: Tonnes of CO_2 emitted under the different options (based on EC PRIMES 2016)



Source: Steer analysis, based on EC PRIMES Reference Scenario 2016. Green Deal represents a 90% reduction in emissions by 2050.

Option 1: Co-Programmed

We estimate that total CO_2 emissions would decrease by 56.3 % (a net reduction of 96 million tonnes), NO_x emissions by 66.0% (a net reduction of 553 thousand tonnes) and PM by 66.7% (a net reduction of 15 thousand tonnes) compared to the current situation

forecasted without external action. As with Option 0, there would be some corresponding benefits for the health and well-being of EU citizens.

Option 3: Institutionalised Art 187

A more substantial reduction in CO_2 emissions is realised under this option: total CO_2 emissions are expected to decrease by 61.8% overall (a net reduction of 106 million tonnes), NO_x emissions by 70.2% (a net reduction of 588 thousand tonnes) and PM emissions by 70.9% (a net reduction of 16 thousand tonnes) compared to the current situation forecasted without external action. Whilst this option represents the most significant improvement in emissions compared with current values, the reductions in emissions realised do not deliver the full set of savings required under the Green Deal. Further savings could be realised through increased taxation of kerosene and improved incentives for the production and take-up of SAF.

This impact could be expected to increase if the competitiveness of the European aeronautical industry continues to improve. As a result of the decrease in emissions, there will be a positive impact on the quality of life and well-being of European and global citizens.

Whilst the number of passengers flying would still be affected compared to the no-tax scenario, enhanced connectivity should be enjoyed by EU citizens under this Option, as the overall number of passengers is still forecasted to grow.

Stakeholders responding to the **OPC** were not asked explicitly about which options would be likely to deliver the greatest societal impacts, however as mentioned in Section 4.3.3, the majority of stakeholder groups considered the societal impacts of a partnership to be relevant or very relevant.

The vast majority of stakeholders participating in the **interviews** considered an institutionalised partnership to be offer the best range of societal benefits, whilst striving for climate neutrality.

Summary

Table 17 shows the scores that we have assigned to each of the policy options with regard to societal impacts.

Table 17: Overview of the options' potential for achieving societal impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Increased market confidence in the safety and security of European aviation	++	++	++
Increased competitiveness of European aeronautics industry	++	++	+++
Reduction in environmental impacts of aviation	+	++	+++
Improvement in health of EU citizens	+	++	+++

Source: Steer analysis. Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.2 Assessment of coherence

6.2.1 Internal coherence

In this section, we assess the extent to which the policy options have the potential to ensure coherence with other programmes and initiatives under Horizon Europe, in particular European Partnerships.

Option 0: Horizon Europe calls (baseline)

In our view, it would be more difficult to ensure an effective progression of activity from fundamental research through development work to demonstration under the baseline option than under other options. This is a consequence of the lack of continuity between projects at different TRLs under an open calls approach, not least because the parties responding to individual calls would typically be consortia formed on an ad-hoc basis.

However, better coordination for the open calls, due to co-creation involving all relevant Commission services from inception, now allows ensuring that a proper strategic vision for the priorities of the calls can be set year-on-year. Open calls would provide a good opportunity for EASA to be involved when calls are strategically defined with the Commission and Member States. For instance, EASA would be able to ensure that safety-related topics are included.

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 possible but nonetheless challenging, as there would be no single organisation accountable for the development of a strategy for aeronautical-related R&I and capable of conducting a dialogue with other partnerships to identify potential synergies and joint activities. Rather, the Commission would need to consider the schedule of activity proposed by such partnerships alongside aeronautical industry priorities in formulating the annual work programme. This would result in a significant risk of misaligned activity and duplicated effort, especially if joint R&I activity were to be programmed over several years.

Option 1: Co-Programmed

The memorandum of understanding underpinning a co-programmed partnership would provide a vehicle for development, and delivery of the work programme would rely on Commission resources, with Member States approving Union contributions under comitology procedures. The partnership would not have full accountability for the direction of aeronautical-related R&I (although the Commission would) which would make it more difficult for the partnership to work with others within Horizon Europe to define an integrated work programme leveraging synergies in relevant areas. The risks of misalignment of projects and duplication of effort within the Climate, Energy and Mobility and other clusters would therefore arise in a similar way as in the baseline option, although they would be mitigated to some extent.

Option 3: Institutionalised Art 187

An institutionalised partnership would be able to call on dedicated management resources to plan work programmes over the period of Horizon Europe. It would also have a chief executive able to discuss with other partnerships about synergies and joint working. This would ensure that the strategy could take account of links with key partnerships both within and outside the Climate, Energy and Mobility cluster and provide for joint sponsorship of research in areas such as Clean Hydrogen, Battery technology and integrated Air Traffic Management.

In responding to the **OPC**, 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 business organisations with fewer than 250 people, 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 Clean Aviation and to link it with other initiatives under Horizon Europe.

Most stakeholders (industry mainly) participating in the **interviews** 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 aviation sector.

Some stakeholders responding to the **inception impact assessment** noted the importance of cooperating with other initiatives, such as the Clean Hydrogen initiative, to enable cutting-edge technologies to be incorporated into aviation.

6.2.2 External coherence

In this section we assess the extent to which the policy options have the potential to ensure coherence with EU-level programmes and initiatives beyond the Framework Programme and/or national and international programmes and initiatives.

Option 0: Horizon Europe calls (baseline)

For the same reasons as under internal coherence, under open-calls, the Commission would be able to explore opportunities for funding of programmes and projects under ERDF and CF, as it is directly involved in the other programmes with established inter-services committees. The Commission agency INEA will manages parts of Horizon Europe (aviation, transport, energy and digital) as well as CEF. However, effective coordination would require a strong, dedicated central planning capability, which, in our view, could not be provided by the Commission infrastructure planning open calls on an annual basis.

Option 1: Co-Programmed

The level of external coherence achieved by this option would be similar or slightly higher to that of open calls, since the Commission would be "at the helm": while the creation of a vehicle for developing a strategy and planning activity under a memorandum of understanding would provide a mechanism for the necessary collaborative dialogue, the inability of the partnership to ensure the direction of R&I activity would make it difficult to commit to joint programmes of work. Even if such 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.

Option 3: Institutionalised Art 187

In this option, as the partnership would be more visible than either of the other options, it would be likely to facilitate links with a wider range of EU institutions, agencies and initiatives. This would support more efficient use of overall EU funding of transport projects and potentially lead to even wider participation in the R&I programme for aeronautics. In addition, with the important involvement of the Commission on the Board of the institutionalised partnerships, it would be in a good position to be aware and inform the partnership of the opportunities for parallel, related activity funded through EIB loans or under ERDF or CEF and other international initiatives.

A significant proportion of the stakeholders' responses to the **OPC** show that the links with external organisations such as regulators and the synergies drawn from these relationships, are considered as relevant or very relevant topics which need to be addressed by the types of partnerships which are put forwards and reflected in their legal structure.

Summary

Table 18 below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 18: Overview of the options' potential for ensuring and maximising coherence

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

Source: Steer analysis. Notes: Score +++ : Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.3 Comparative assessment of efficiency

In order to compare the policy options under common standards, we developed a standard cost model for all 13 candidate Institutionalised Partnership studies. The model and the underlying assumptions and analyses are set out in the report on the overarching context to the impact assessment studies.

Table 19 below, shows the intensity of additional costs against specific cost items for the various options as compared to the baseline (Option 0 - Horizon Europe calls). In this table we have taken into account that for Option 3 (Institutionalised Partnership) there would be moderate additional costs for the set-up of a dedicated implementation structure seeing that such a structure is already exist. For Option 1 (Co-programmed), we did not consider an additional cost for the call and project implementation as MS would not be providing contributions.

Table 19: Intensity of additional costs compared with HEU Calls (for Partners, stakeholders, public and EC)

Cost items	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Preparation and set-up costs			
Preparation of a partnership proposal (partners and EC)	0	++	++
Set-up of a dedicated implementation structure	0	0	++
Preparation of the SRIA / roadmap	0	++	

Cost items	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Ex-ante Impact Assessment for partnership	0	0	+++
Preparation of EC proposal and negotiation	0	0	+++
Running costs (Annual cycle of implementation)			
Annual Work Programme (AWP) preparation	0	+	+
Call and project implementation	0	0	+
Cost to applicants	0	0	0
Partners costs not covered by the above	0	+	+
Additional EC costs (e.g. supervision)	0	+	++
Winding down costs			
EC	0	0	+++
Partners	0	+	+

Source: Technopolis analysis. Notes: 0: no additional costs, as compared with the baseline; +: minor additional costs, as compared with the baseline; ++: high additional costs, as compared with the baseline; +++: very high additional costs, as compared with the baseline

The scores related to the costs set out above will allow for a "value for money" analysis (cost-effectiveness) in the final scorecard analysis in Section 6.4. For this purpose, in Table 20 where we provide the scores for the scorecard analysis, based on our insights and findings and based on the scores above, we assign a score 1 to the option with the highest costs and a score 3 to the lowest.

Table 20: Matrix on 'overall costs' and 'cost-efficiency'

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised
Overall cost	3	2	1
Cost-efficiency	3	3	2

Source: Technopolis analysis. Notes: Score 1 = Substantial additional costs, as compared with the baseline; score 2 = Medium additional costs, as compared with the baseline; score 3 = No or minor additional costs, as compared with the baseline

We consider that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when we take into account financial leverage (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 separate the most cost-efficient policy options – the baseline Option 0 and the Co-Programmed policy options – and the least cost-efficient – the Institutionalised

Partnership. We have therefore assigned a score of 3 for cost-efficiency to the Option 0 and the Co-Programmed policy options and a score of 2 for the Institutionalised Partnership.

It should be noted that the potential for the creation of crowding-in effects for industry has been taken into account when assessing the effectiveness of the policy options.

6.4 Comprehensive comparison of the options and identification of the preferred option

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

In Section 6.4.1, we first compare the policy options against each other for each criterion in the effectiveness and coherence dimensions, resulting in a scorecard with scores from 1 to 3 where 3 stands for a substantially higher performance. Combined with the results from the comparative assessment for efficiency in Section 6.3, above, the final scorecard will allow for the identification of the preferred option in Section 6.4.2, taking all dimensions and criteria into account.

6.4.1 Comparative assessment

Effectiveness

The most effective option is the institutionalised partnership, although not necessarily for scientific impacts, where the open calls (baseline) and the co-programmed options score higher. This is because they would be more effective for the development of disruptive technologies as well as having less constraints on the participation of actors in the initiative. However, because of the binding commitments that would be made by the industry in the third option, this would enable higher level of market-focused development and demonstration projects and hence a substantially higher level of market take-up. This translates into higher technological and economic impacts.

Coherence

An institutionalised partnership would have the administrative structure needed to take account of the corresponding programmes of other partnerships, and to identify and commit to opportunities for collaboration. However the European Commission would be expected to liaise with European and global policy makers, regulatory organisations or standards bodies.

A ranking of the policy options is presented in the table below.

Table 21: Ranking of the policy options

	Items	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
Effectiveness	Scientific impacts – strengthened pipeline of potential innovation	3	2	2
	Scientific impacts – Increased diffusion of scientific excellence and high-quality knowledge	3	2	2
	Scientific impacts – Improved technological knowledge and skills in aviation industry	3	3	3

	Items	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Article 187
	Technological/economic impacts – Strengthen the demand for sustainable forms of energy for aviation	2	2	3
	Technological/economic impacts – Increased demand for sustainable mobility	1	1	3
	Technological/economic impacts – Growth in aviation industry and wider employment	1	2	3
	Technological/economic impacts – Increased competitiveness of European aeronautics industry	2	2	3
	Societal impacts – Increased market confidence in the safety and security of European aviation	2	2	2
	Societal impacts - reductions in environmental impacts of aviation	1	1	3
	Societal impacts - Improvement in health of EU citizens	1	1	3
Coherence	Internal coherence	1	2	3
	External - coherence	1	2	3
Efficiency	Overall cost	3	2	1
	Cost-efficiency	3	3	2

Source: Steer analysis. Notes: Increased competitiveness of European aeronautics industry which appears twice (under technological/economic impacts and societal) has been removed from societal impacts not to be double-counted.

Scores for effectiveness and coherence: 3 = *substantially higher performance*; 2 = *higher performance*; 1 = *lower performance*. Scores for efficiency: 1 = *substantial additional costs*, as compared with the baseline; 2 = *medium additional costs*, as compared with the baseline; 3 = *No or minor additional costs*, as compared with the baseline

6.4.2 Identification of the preferred option

The table shows that each option presents positives and negatives. The higher scores for efficiency of the open call and co-programmed option is due to the reliance on the Commission's common framework for administering open calls, which effectively spreads the cost of administration across a number of initiatives under Horizon Europe. However, both options do not score very well against the criteria for which the corresponding impact is critically dependent on participation and commitment of resources on the part of key

stakeholders. This is where the institutionalised partnership therefore dominates in the dimensions linked to effectiveness and coherence – both internal and external, and is therefore overall our preferred option. While it performs poorly in terms of overall cost, it is only marginally less cost-efficient than the other options.

7 The preferred option

7.1 Description of the preferred option

Based on the results of the assessment described in the previous chapter, we conclude that an institutionalised partnership established under Article 187 of TFEU is the preferred option. This is in line with the need to ensure than an all-encompassing strategy is put in place. In this option, the public sector (Commission, Member States and regions) will need to commit to this partnership by aligning their research efforts with the partnership R&I and with supporting economic measures in order to create a favourable environment for the research results. It is also consistent with the aim of leveraging industry financial and in-kind resources, such that the impact of funding provided by the Commission is maximised.

This form of partnership will provide a stable framework for encouraging the participation of organisations from different stakeholder groups, including organisations outside the traditional aeronautical industry, securing and allocating resources, managing a wide range of R&I projects across the TRLs and building relationships with other partnerships and initiatives within the Climate, Energy and Mobility cluster and more generally. It will also be well-placed to develop a strategy that is fully aligned with a number of sustainable development goals as well as the political priorities identified by the new President of the Commission.

In *Table 22* below, we indicate the alignment of the preferred option with the selection criteria for European Partnerships defined in Annex III of the Horizon Europe Regulation. Seeing that the design process of the candidate Institutionalised Partnerships is not yet concluded and several of the related topics are still under discussion at the time of writing, the criteria of additionality/directionality and long-term commitment are covered in terms of *expectations* rather than ex-ante demonstration.

Table 22: Alignment with the selection criteria for European Partnerships

Criterion	Alignment of the preferred option
Higher level of effectiveness	As demonstrated in Section 6, an institutionalised partnership would be more effective in achieving the objectives of the initiative within an adequate timeframe. It is also more effective at securing technical and project management skills for the staff involved.
Coherence and synergies	With adequate governance involvement of the European Commission, the dedicated management team of an institutionalised partnership could ensure that they coordinate as well as possible with relevant strategies and programmes developed by other partnerships and initiatives. This would enable exploitation of synergies from joint programmes and projects, in areas such as Clean Hydrogen, Integrated Air Traffic Management and Battery Technology.
Transparency and openness	An institutional partnership would ensure that the outputs of R&I programmes were transparent and available to stakeholders inside and outside the aeronautical industry. The framework governing participation would allow any organisation meeting defined criteria to participate, with a proportion of funded activity subject to open calls.

Criterion	Alignment of the preferred option
Additionality and directionality	Only a partnership would be able to secure the necessary industry commitments. The partnership would also be better able than other options to develop a long-term masterplan for aeronautical-related R&I and establish a set of common objectives governing the direction, outputs and timeframe of R&I activity under Horizon Europe.
Long-term commitment	The partnership would also encourage long-term commitment of in-kind resources from the industry with access to significant levels of internal funding for R&I activity. We would therefore expect the partnership to ensure a minimum share of investment from private sector and other commercial stakeholders, with at least 50% and possibly up to 75% of the budget coming from this source.

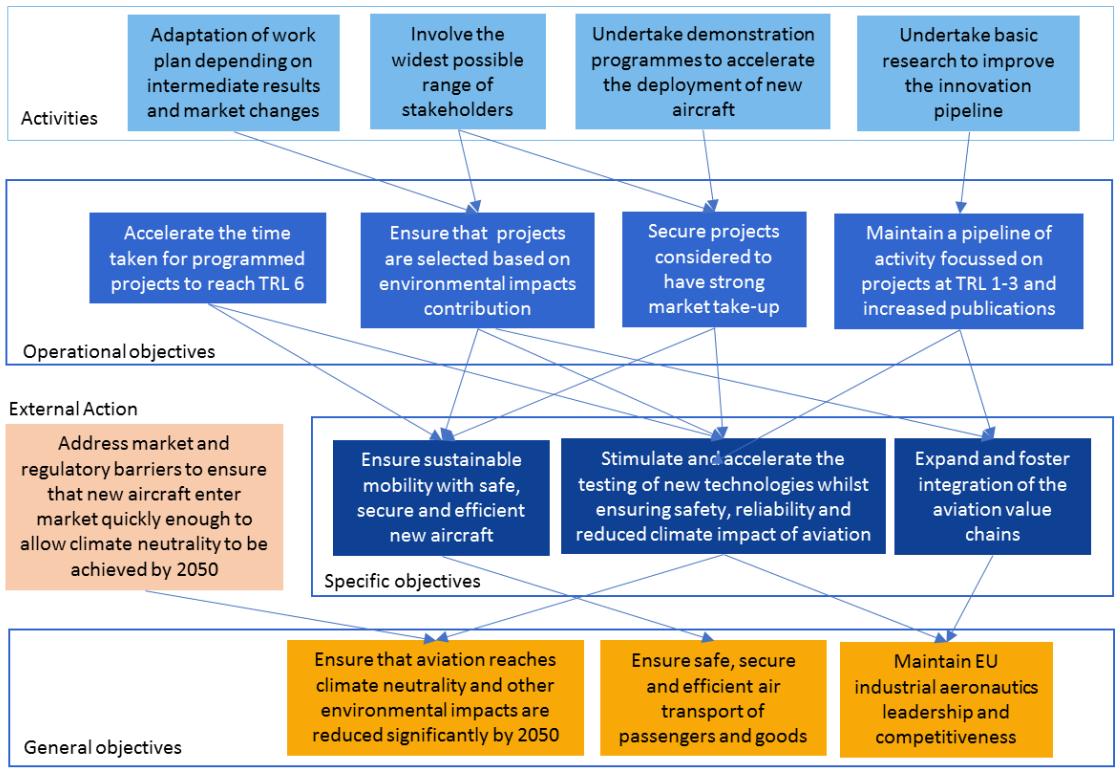
Source: Steer analysis

7.2 Objectives and corresponding monitoring indicators

7.2.1 Operational objectives

Figure 11 below identifies 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 where 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 11: Operational objectives of the initiative



Source: Steer analysis

7.2.2 Monitoring indicators

We have identified a number of short, medium and long-term monitoring indicators to enable the progress of the partnership towards meeting its objectives to be tracked. These are shown in Table 23.

Table 23: 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	Number of projects resulting in one or more journal citations Number of individuals working on projects initiated by the partnership	Number of times that journal citations generated by the partnership are cited in the global literature Number of occupied and advertised jobs in aeronautical-related R&I	Number of patents registered by the aeronautical industry and research organisations located in Europe Number of staff transferring between research-based institutions and the industry
Technological / economic impact	Number of programmed projects involving organisations outside the aeronautical industry Number of programmed projects with a documented strategy identifying the potential application of results to defined market needs	Number of programmed projects leading to validated demonstration of new applications of technology Number of years for programmed projects to reach TRL 6 Level and intensity of the aeronautical-related R&I (in percentage of turn-over)	Number of programmed projects to have strong market take-up Time taken for new aircraft to be certified (note this will be significantly beyond year 5+) Value of exports generated by the European aeronautical sector (note this will be significantly beyond year 5+) Direct and indirect employment generated by the European aeronautical sector
Societal impact	Number of programmed projects developing technological solutions towards climate neutrality	Level and intensity of the aeronautical-related R&I (in percentage of turn-over) Education and training of students and staff in new technological field	Changes in air quality and well-being (note this will be significantly beyond year 5+)
Incl. Environmental / sustainability impact	Number of programmed projects focusing on large civil aircraft Number of programmed projects focusing on	Number of programmed projects focusing on alternative energies or technologies. Potential and scalability successfully demonstrated and quantified	Changes in CO_2, non-CO_2 emissions and noise generated by the aviation industry in Europe and globally (note this will be significantly beyond year 5+)

	Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
	sustainable aviation fuels integration		

Source: Steer analysis

Appendix A Bibliography

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Appendix B Synopsis report on the stakeholder consultation – Focus on the candidate European Partnership on Clean Aviation

Disclaimer: the views expressed in the contributions received are those of the respondents and cannot under any circumstances be regarded as the official position of the Commission or its services.

B.1 Introduction

Following the European Commission's proposal for Horizon Europe in June 2018,[43] 12 candidates for institutionalised partnerships within 8 partnership areas have been proposed, based on the political agreement with the European Parliament and Council on Horizon Europe reached in April 2019.[44] Whether these proposed institutionalised partnerships will go ahead in this form under the next research and innovation programme is subject to an impact assessment.

In line with the Better Regulation Guidelines,[45] the stakeholders were widely consulted as part of the impact assessment process, including national authorities, the EU research community, industry, EU institutions and bodies, and others. These inputs were collected through different channels:

- A feedback phase on the inception impact assessments of the candidate initiatives in August 2019,[46] gathering 350 replies for all 12 initiatives;
- A structured consultation of Member States performed by the EC services over 2019;
- An online public stakeholder consultation administered by the EC, based on a structured questionnaire, open between September and November 2019, gathering 1635 replies for all 12 initiatives;
- A total of 608 interviews performed as part of the thematic studies by the different study teams between August 2019 and January 2020.

This document is the synopsis report for the initiative "Clean Aviation". It provides an overview of the responses to the different consultation activities. A full analysis of the results is provided in the study Data Report.

[43] https://ec.europa.eu/commission/presscorner/detail/en/IP_18_4041

[44] https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_19_2163

[45] https://ec.europa.eu/info/files/better-regulation-guidelines-stakeholder-consultation_en

[46] The full list of inception impact assessments is available here. They were open for public feedback until 27 August 2019.

B.2 Feedback to the inception impact assessment on candidate initiatives for institutionalised partnerships

Following the publication of the inception impact assessment, a feedback phase of 3 weeks allowed any citizen to provide feedback on the proposed initiatives on the "Have your say" web portal. In total 350 feedback responses were collected for all initiatives.

For the initiative "Clean Aviation", 34 individual feedback responses were collected, mainly from businesses and business associations, academic/research institutions, non-governmental organisations and public authorities.[47] These responses included the following topics:

- Overall support in achieving climate neutrality in aviation;
- Requirement for further collaboration between stakeholders to accomplish the innovation and impact required for achieving the objectives;
- Persistence of problems in absence of policy intervention;
- Support of EU action to address different aspects of the problem;
- The need to explore, mature and demonstrate new technologies, whilst maintaining competition;
- The potential of Horizon Europe to have significant scientific impacts, delivering economic, technological and societal benefits, while ensuring competitiveness in Europe;
- Support of the implementation of an institutionalised partnership to successfully deliver economic and technological impacts; and
- The need to cooperate with other initiatives to enable cutting-edge technologies to be incorporated into the aviation sector.

B.3 Structured consultation of the member states on European partnerships

A structured consultation of Member States through the Shadow Strategic Configuration of the Programme Committee Horizon Europe in May/ June 2019 provided early input into the preparatory work for the candidate initiatives (in line with the Article 4a of the Specific Programme of Horizon Europe). This resulted in 44 possible candidates for European Partnerships identified as part of the first draft Orientations Document towards the Strategic Plan for Horizon Europe (2021-2024), taking into account the areas for possible institutionalised partnerships defined in the Regulation.

The feedback provided by 30 countries (all Member States, Iceland and Norway) has been analysed and summarised in a report, with critical issues being discussed at the Shadow Strategic Programme Committee meetings.

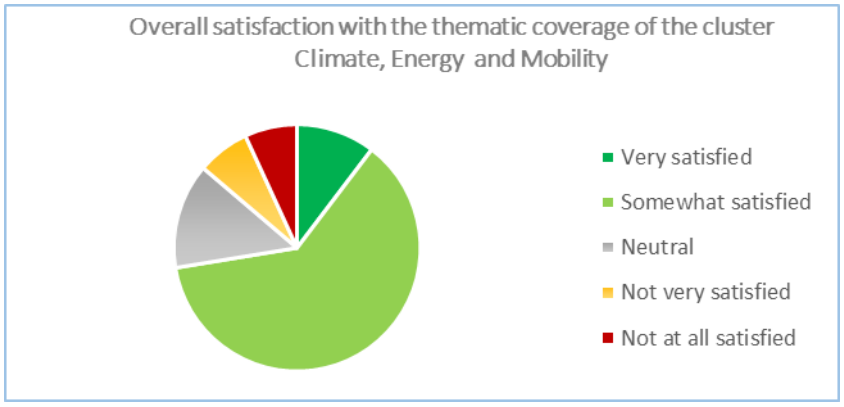
[47] Feedback on inception impact assessment to be found on https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2019-4972457/feedback_en?p_id=5722372

B.3.1 Key messages overall for all candidate Institutionalised Partnerships are the following:

Overall positive feedback on the proposed portfolio, but thematic coverage could be improved

The thematic coverage for the Cluster Climate, Energy and Mobility is perceived as rather satisfying, with 62% being somewhat satisfied and 10% very satisfied, while 7% each are not very satisfied or not satisfied at all.

Figure 12: Satisfaction with the thematic Satisfaction with the thematic coverage of the proposed partnership portfolio for the Climate, Energy and Mobility cluster



Many delegations comment on the **balance of topics and suggest a stronger focus on the environment and climate**, as well as energy topics. Mobility is considered too prominent and should be rationalised further. The area of transport in particular appears to have a disproportionate number of partnerships, which may result in an underinvestment for open calls in this area.

The high number of individual partnerships could jeopardise the ambitious targets to reach the climate neutrality for 2050. Emphasis should be placed on the need to **promote cross-sectorial solutions for decarbonisation**. Cross-sector solutions, or solutions for coupling of different energy vectors will be difficult to implement if each partnership works in silos. Synergies will be difficult to implement since there is a risk that each initiative will defend its own interests. Openness and a clear path to membership for interested parties is essential for the industry partnerships to have true European Added Value.

A majority of countries support additional priorities to be implemented by partnerships, notably the following two:

Partnership on **European Climate Change Science** would the Paris Agreement, in recognition of the need for scientific understanding of climate change as basis to reduce vulnerability and enhance resilience. It would address in a structured and integrated manner key uncertainties regarding Earth system sciences and model development as well as the effectiveness of policy interventions and societal response to climate change. It will address both structural and operational gaps.

Partnership on **Sustainable and Liveable Cities and Communities**, with a holistic approach to make a substantial contribution towards the urban dimension of the SDGs and the Urban Agenda of the EU. I would aim at creating an innovation eco-system for cities to drive urban transitions, create evidence with and for urban stakeholders to achieve urban-related SDGs and position European cities as role models for global sustainable development.

In addition, few delegations propose an additional partnership related to transport, for the waterborne sector, mainly with the argument that this is the only transport mode not covered by a partnership.

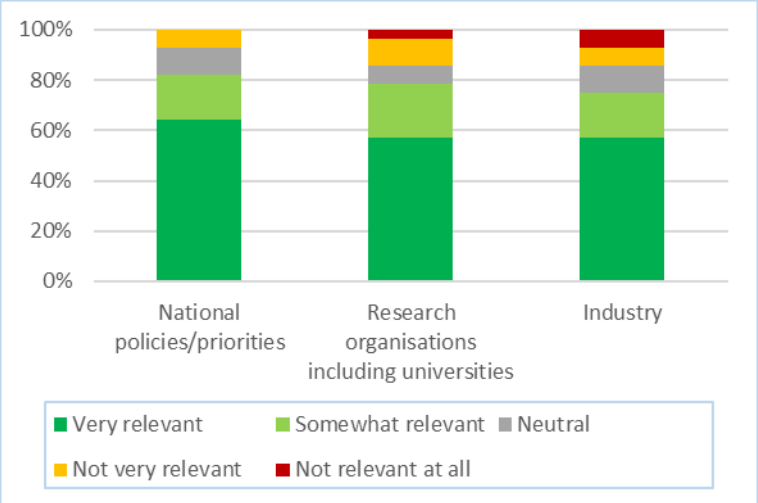
B.3.2 Overall feedback for the initiative "Clean Aviation"

For the initiative "Clean Aviation", the following overall feedback was received from Member States.

Relevance and positioning in a national context

Overall the results of the consultation confirm the relevance of the proposed European Partnership on Clean Aviation, with 78% considering it very or somewhat relevant for their national policies and priorities, and for their research organisations, including universities. 75% respondents found the proposed partnership relevant for their industry.

Figure 13: Relevance of the European Partnership on Clean Aviation in the national context



On the question of existing national/regional R&I strategies, plans and/ or programmes in support of the proposed Partnership on Clean Aviation, 68% (19 out of 28) countries report to have relevant elements in place. National R&I strategies or plans were identified most frequently (54 %, AT, CZ, DE, ES, FR, HR, IT, LV, MT, NL, RO, SE, SL, SK, UK, NO), followed by national economic, sectoral strategy and/or plan with a strong emphasis on research and/or innovation (50 %, AT, BE, ES, FR, HR, IT, LV, NL, RO, SE, SL, SK, UK, NO), regional R&I and/or smart specialisation strategies (50 %, BE, CZ, DE, ES, FR, HR, IT, LV, MT, NL, PT, RO, SE, SL), dedicated R&I funding programmes or instruments (39 %, AT, BE, DE, ES, FR, CR, LV, MT, SE, UK, NO). 36% of countries (CZ, DE, ES, HR, IE, LV, NL, SE, SK, NO, DE) reported other policies/ programmes, such as upcoming sectoral agenda, a national research and innovation agenda, or R&I programmes focusing more broadly on disruptive technologies.

The feedback from delegations on aspects that could be reinforced in the proposal for this partnership that would increase its relevance for national priorities[48] suggest support to the ambition of reducing the environmental footprint of aviation and achieving a carbon neutral aviation, but there seems to be a divergence of views on the scope of the partnership and the pathway in achieving this goal. For instance, some delegations express that the focus should be on the real world introduction of new technologies (i.e. the next generation of commercial aircraft), whilst others support reinforcing attention to aviation research in low technology readiness levels. Although there is no coherent view whether

[48] Comments on scope and content have to be assessed in the context of the overall priority setting to ensure coherence.

this research should take place inside or outside of the proposed Partnership. Other comments suggest broadening the scope by focusing also on short range transport solutions within urban and developing small / urban aircraft solutions, and thereby ensure bigger involvement of smaller suppliers for the air industry, and to strengthen the impact narrative beyond environmental (e.g. by including safety needs, international competitiveness goals, quicker in-service introduction).

The majority of countries (57%) are undecided concerning their interest to participate. At this stage 8 countries (CZ, DE, ES, IE, IT, MT, RO, UK) express interest to join as a partner, and 4 (CY, EE, FR, IS) countries express no interest to participate. Governmental research organisations, research infrastructures, regional R&I and /or smart specialisation strategies and existing national R&I programmes are identified are main potential partners or contributors.

While most are undecided concerning their participation, almost all countries (89%) expressed interest in having access to results produced in the context of the partnership.

Feedback on objectives and impacts

Overall there is a strong agreement (82%) on the use of a partnership approach in addressing challenges related to EU aviation and the development and demonstration of aircraft technologies. There is broad agreement (71%) that the partnership is more effective in achieving the objectives and delivering clear impacts for the EU and its citizens, and to lesser degree that (56%) it would contribute to improving the coherence and synergies within the EU R&I landscape.

Member States indicate good agreement with the proposed objectives at short, medium and long term (75%) and the expected scientific, economic and societal impacts at European level (75%), with the remaining ones remaining neutral. 71% of countries consider the impacts very or somewhat relevant in the national context. There is overall agreement with the envisaged duration of the proposed partnership with 82% of countries finding it adequate. Additional comments made by individual delegations reiterate several points made previously under elements to be reinforced. In addition, individual comments suggest considering the full life-cycle of the aircraft by including the means of production and disposal, as well as to include under objectives innovative flight design, and redesign of the entire Aviation System. In terms of technologies, individual respondents highlighted the importance to cover also aeronautics advance manufacturing technologies and materials, and novel battery technologies. Other comments were related to avoiding duplications with other Partnerships (notably on Integrated Air Traffic Management and Hydrogen), and clarifying objectives (e.g. how the route to CO2 would be achieved).

Views on partners, contributions and implementation

The responses suggest that there is good agreement between countries (57%) on the type and composition of partners. In additional comments, several countries call for opening the proposed partnership to more industries involved in aeronautics, and ensuring broad participation of new and small players. There are some countries expressing support for a model with a core group of partners steering the Partnership, whilst ensuring appropriate involvement of participants from other sectors. Other responses highlighted the need to ensuring an inclusive and transparent governance of the Partnership, and better definition of the involvement of the public sector in the proposal.

The majority of countries (71%) found that there was insufficient information to assess the nature of contributions and level of commitment from the partners, notably on the introduction of financial contributions from industry. Additional comments made by delegations stress the need to strengthen the leverage effect of the partnership, but to limit financial contributions by industry to the administrative/ running costs. In a related manner, some countries emphasise the need to ensure that the financial contributions

would not limit the participation of SMEs and other small partners, including from academia.

The proposed mode of implementation in the form of Article 187 TFEU is supported by 46% of countries, whilst 3 countries disagree. The rest replied that there is insufficient information to make an informed decision. Additional comments suggest considering a co-programmed model for implementing the priority, to merge the proposed Partnership for Integrated Air Traffic Management, and to move away from mode-specific implementation in Mobility. Moreover, several delegations (notably from smaller countries) highlight the need to ensure transparency and openness of the Partnership, including the use of open competitive calls.

B.4 Targeted consultation of stakeholders related to the initiative "Clean Aviation"

In addition to the consultation exercises coordinated by EC services, the external study thematic teams performed targeted consultations with businesses, research organisations and other partners on different aspects of potential European Partnerships.

The feedback obtained as part of this targeted consultation of stakeholders was used in the Impact Assessment study, as described in the approach section below, and was summarised in an Interview Summary Report which was developed and submitted alongside the Impact Assessment study Final Report.

B.4.1 Approach to the targeted consultation

The stakeholder interviews are a primary source of information that support all aspects of the impact assessment, complementing the analyses based on desk research and primary and secondary data. Specifically, it underpins:

- The selection and description of the policy options for the intervention;
- The comparative assessment of options: and
- The assessment of the preferred option in terms of its effectiveness and coherence as well as in relation to the key Criteria for European Partnerships (openness and transparency, additionality and directionality, Member State involvement, and systemic approach and flexibility).

Accordingly, the consultation exercise covered a wide range of organisations, as set out in the following section. In identifying stakeholders, we applied the following criteria:

- The need to discuss the role of a future partnership with key European bodies with a central role in the delivery of EU policy objectives, in particular the European Commission and the CS 2 JU itself;
- The need to engage with stakeholders located in all Member States with an interest in the future direction of aviation-related R&I;
- The need to obtain views from both founding and associate members of the CS 2 JU, including manufacturers and industry who can provide insights into the costs and benefits of a partnership approach to sponsorship and coordination of R&I;
- The importance of understanding key developments in research through dialogue with universities and other research institutions engaged in pre-competitive R&I in the aviation sector;
- The need to engage with organisations who have had little or no involvement in the existing JU but whose role in the delivery of clean aviation and in ensuring that the sector meets European economic, social and environmental targets is important;

- The importance of engaging with pan-European representative organisations who can provide an overview of the perspectives of specific stakeholder groups, including environmental representatives who can bring diverging views from the aeronautics industry;
- The need to obtain data to support an analysis of the costs and benefits of different policy options.

The table below shows the balance of stakeholder organisations across these selection criteria and the rationale for their inclusion in the consultation.

Table 24: Overview of methodology

Stakeholder group	CS2JU members?	Number in selection	Rationale
Key European bodies	Mixed	9	An important perspective on R&I needs during Horizon Europe and beyond
Member State transport authorities	Mixed	5	Can provide views on Member State participation and alignment of R&I policy with national objectives An understanding (for some) of difficulty to access CS2 Programme research
Industry and representatives	Mixed	14	An important perspective on R&I needs An understanding of commercial issues surrounding aviation-sector R&I An understanding of global markets An understanding (for some) of difficulty to access CS2 Programme funding
Research organisations and universities	Mixed	13	Able to provide a perspective on contribution of fundamental research and most effective ways of collaborating with manufacturers and service providers
Airlines and airports representatives	No	3	An important understanding of user requirements influencing the direction of R&I Perspectives on the efficiency and effectiveness of partnerships
Non-aviation technology organisations	Mixed	3	Able to provide a view on potential role of cross-cutting technologies in transport
European environmental organisations	No	3	Able to provide an informed overview of issues faced by the wider society. Able to provide views diverging from industry

The final list of stakeholders was validated by the European Commission. We have interviewed the majority of stakeholders in this list; however, where these have not been interested in contributing to the study or we have not been able to reach them, candidates from a longer list approved by the European Commission have been selected, maintaining the balance between types of organisations and Member States.

The topic guides for the stakeholder interviews have been designed with the intention of guiding the stakeholder interviews. Note that they have not be used as a rigid script, but rather a prompt for interviewers seeking to ensure coverage of relevant issues. As far as possible, the questions have been drafted as open questions to maximise the information provided and avoid unduly constraining the responses.

At the same time, it is important to ensure that the information obtained informs the analysis. Interviewers have therefore sought to cover a range of relevant topics supporting specific elements of the impact assessment, as shown in the table below.

Table 25: Selection criteria

Topics	Issues	Description of policy options	Comparative assessment of policy options	Description of preferred option
Problems and objectives	• Validation of problem • Validation of objectives	✓		✓
Profile of participation	• Profile of participation required • Need for participation of specific players • Need for broader participation • Need for flexibility	✓	✓	✓
Involvement of Member States	• Member States to involve (strength/critical mass/priorities) • Role of Member States	✓		✓
Target groups	• Key sectors to involve • Need for flexibility	✓	✓	✓
Activities	• R&I priorities • Definition and management of programmes • Need for flexibility	✓	✓	✓

Topics	Issues	Description of policy options	Comparative assessment of policy options	Description of preferred option
Collaboration with other partnerships/ initiatives	• Scope/type of informal collaboration • Scope/type of formal collaboration • Synergies relationships between R&I programmes		✓	✓
Finance	• Level of investment required • Importance of long-term funding • Level of commitment required from partners • Level of commitment from Member States • Anticipated costs		✓	✓
Implementation	• Appropriate governance structure • Measures to ensure openness • Measures to ensure flexibility			✓

All 50 interviewees were initially contacted by e-mail as soon as practically possible after their agreement with the European Commission to arrange an interview. Where stakeholders were unresponsive follow-up emails were issued two weeks later. Where stakeholders continued to be unresponsive, we endeavoured to call them to arrange an interview.

Interviews were held either via telephone, or in person where travel arrangements permitted. Interviews were scheduled for one hour and were conducted by three members of the project team, depending on team availability, subject expertise and language if required. Some stakeholders also chose to submit their views in writing to consultation, using the same questionnaire template used to conduct the interviews. Where any additional information or clarification was required from these stakeholders, follow-up calls were arranged.

15 of the 50 originally agreed stakeholders were either unresponsive, unable to contribute or decided that they did not want to contribute towards the study. In their place replacements were selected from the longer list of approved stakeholders.

B.4.2 Overview of respondents to the targeted consultation

The table below describes the number of interviews undertaken by stakeholder category, as well as its proportion of the total.

Table 26: Number of interviews per stakeholder category

Stakeholder category	Number	Share (%)
Key European bodies	7	14%
Member State transport authorities	3	6%
Industry and representatives	19	38%
Research organisations and universities	14	28%
Airlines and airports representatives	3	6%
Non-aviation technology organisations	2	4%
European environmental organisations	2	4%
TOTAL	**50**	**100%**

Representatives from all stakeholder groups were interviewed to ensure that all groups were represented in the impact assessment. The proportion of interviews undertaken with stakeholders from the groups 'Industry and representatives,' and 'Research organisations and universities,' is slightly inflated in comparison to the originally envisaged stakeholder set. This is a consequence of these groups being more willing to engage in the consultation process, when interviews were being arranged from the longer list of stakeholders.

B.4.3 Key results/messages from the targeted consultation

Political and legal context

Emerging Challenges in the field

All stakeholders interviewed were supportive of the proposed objective of achieving climate neutrality by 2050. It was felt that that objective, whilst extremely ambitious, was more encompassing of the effects of aviation and also allowed a more long-term solution to be realised in comparison with those presented under CS2.As well as mitigating the impacts of climate change there was also a consensus that striving towards climate neutrality would support the longevity of the aviation industry in Europe. Many stakeholders noted that the European aviation industry was facing increased competition from Russia and China and thus investing in new technologies could also reinforce Europe's position in the global market place.

Problem definition

What are the problems?

Many interviewed stakeholders highlighted the effect of long development and innovation cycles and high associated costs as a contributing factor to the growing ecological footprint,

and that a transformative change was required to achieve sustainability in the industry, despite the actuals of this being unclear at this stage. There was recognition amongst stakeholders that investments would have to be made in both airframe and propulsion technologies as well as in alternative fuels to achieve the objective at hand. Most stakeholders noted the importance of EU industrial leadership in the field, especially in the face of increasing competition from China and Russia.

What are the problem drivers?

The development of the problem drivers also took the views of stakeholders into account and were fixed as follows:

- Demand for mobility increases faster than the deployment of technological improvements;
- Improving the environmental performance of the aviation industry is complex, lengthy, costly and risky;
- Economic incentives for greener aviation are not strong enough; and
- Ensuring strong competitiveness of the EU aeronautics industry is complex.

There was widespread recognition amongst stakeholders that current levels of traffic growth were not sustainable in the longer term, especially given this growth currently causes a net increase in emissions.

Stakeholders agreed in part that this was due to long and costly development cycles in the industry, especially when compared with non-aviation industries. At the same time there was also recognition that shifting the aviation industry to cleaner fuels is a more complicated and involved process than implementing changes to land-based transport modes. Some parties mentioned the effective duopoly in the commercial aircraft market as a reason for stifled development.

European environmental organisations and some other stakeholder also highlighted that the current state of the market permits this rapid growth and that this could be reduced through the implementation of taxes on fossil fuels. The implementation of taxes and/or market-based measures could have the effect of both reducing air transport demand and increasing the attractiveness of greener technologies as they become more cost effective.

Stakeholders also noted that presence of regulatory barriers in the context of standard and disruptive technology development, although these considerations were felt less strongly than those It was noted by some stakeholders that the lack of global integrated standards undermines the benefits of R&I activities developed at an EU level, thus affecting European competitiveness.

How will the problem(s) evolve?

There was a strong consensus, in the absence of policy intervention, that it would not be possible to achieve the long-term strategy and level of stakeholder participation required to achieve the goal of climate neutrality by 2050. The vast majority of stakeholders recognised that the aviation industry has to be more environmentally friendly if it wants to continue growing in Europe.

At the same time many stakeholders noted that the current regulation in place for CS2 was not always as efficient as required with the majority of stakeholder citing that it was too inflexible and should be reviewed for Horizon Europe. This would enable resources to be allocated more effectively throughout the programme dependent on levels of achievement rather than through pre-determined allocations.

Why should the EU act?

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. Many stakeholders described a lack of coordination in R&I activities at Member State level and national interests considerations rather than a united European approach. Stakeholders participating in the interview programme 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.

Objectives: What is to be achieved?

The vast majority agreed that more focus should be placed on bringing about a transformative change towards sustainability through the development and effective deployment of technology, whilst also making significant contributions towards EU global competitiveness.

There was general support to focus higher proportions of the budget on larger commercial aircraft as resulting developments would have larger impacts compared other airborne modes. The overwhelming majority of stakeholders interviewed supported inclusion of EASA in Clean Aviation, albeit in different roles, to assist in addressing product certification at an earlier stage. Ultimately this should assist in allowing new products to enter the market more quickly.

Likely scientific impacts

Virtually all stakeholders agreed that the objectives would be achieved through the development of airframe, propulsion and fuel technology, all of which would further the advancement of science in materials, aerodynamics, combustion and fuels. During the interview process many research organisations and universities mentioned however that more research results from the partnership should be published.

Likely economic/technological impacts

Most stakeholders regarded the resulting economic and technological impacts from the partnership as being very relevant and were supportive of ensuring increased European industrial leadership as well as the creation of more high-skilled jobs in a low-carbon economy.

Several stakeholders highlighted the importance of encouraging participation from a wide group of stakeholders, including those outside the traditional aviation-market, to assist with the development of innovative technologies. As mentioned previously, there was a general consensus that ESAS should also have oversight of all developments to ensure that the regulation process does not delay the introduction of new technologies.

Likely societal impacts

The vast majority of interviewees maintained the view that safety in the European aviation was of paramount importance, but also explained that developments from new technologies would ensure the longevity and relevance of the European aviation industry, whilst also resulting in reductions of gas and noise emissions, which in turn contribute to improved societal impact.

Comparative assessment of the policy options

Assessment of effectiveness

Scientific impacts

Most of stakeholders interviewed for this study supported the view that the scientific impact under Horizon Europe would be best achieved through and institutionalised partnership. Most stakeholders emphasised the importance of a long-term strategy and greater participation of a wider selection of stakeholders. At the same time some stakeholders were of the opinion that the budget should be focussed on higher TRL projects, 3-6, which would ultimately reduce the scientific impact realised from more innovative technologies. Stakeholders interviews also noted that the ability to have more flexibility with regards to programme composition and funding allocation during the partnership would enable resources to be better focussed on more promising technologies, ultimately improving scientific impact.

Economic/technological impacts

Virtually all interviewees considered that an institutionalised partnership was essential if EU sponsorship of aviation related R&I was to have a transformative economic and technological impact on the sector. In the absence of such a framework it transpired, particularly among many of the larger corporations, that their support for the partnership would be substantially reduced. The reason that was most often quoted by stakeholders for supporting a partnership was financial commitment of the industry in this option.

Societal impacts

The vast majority of stakeholders participating in the interview programme considered an institutionalised partnership to be offer the best range of societal benefits, whilst striving for climate neutrality.

Assessment of Coherence

Internal coherence

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 aviation sector.

External coherence

A significant proportion of the stakeholders' mentioned that links with external organisations, such as regulators or the bodies which define the standards, and the synergies drawn from these relationships, are considered as relevant or very relevant topics which need to be addressed by the type of partnerships which is put forwards and reflected in their legal structure. The ability of each of the options, as described above, to deliver these impacts will be essential to achieve the expected outcomes.

B.5 Open public consultation on the Candidate institutionalised European Partnerships

B.5.1 Approach to the open public consultation

The consultation was open to everyone via the EU Survey online system.[49] The survey contained two main parts and an introductory identification section. The two main parts collected responses on general issues related to European partnerships (in Part 1) and specific responses related to 1 or more of the 12 candidate initiatives (as selected by a participant).

[49] https://ec.europa.eu/eusurvey/runner/ConsultationPartnershipsHorizonEurope

The survey contained open and closed questions. Closed questions were either multiple choice questions or matrix questions that offered a single choice per line, on a Likert-scale. Open questions were asked to clarify individual choices.

The survey was open from 11 September till 12 November 2019. The consultation was available in English, German and French. It was advertised widely through the European Commission's online channels as well as via various stakeholder organisations.

The analysis of the responses was conducted by applying descriptive statistic methods to the answers of the closed questions and text analysis techniques to the analysis of the answers of the open questions. The keyword diagrams in this report have been created by applying the following methodology: First, the open answer questions were translated into English. This was followed by cleaning of answers that did not contain relevant information, such as "NA", "None", "no comment", "not applicable", "nothing specific", "cannot think of any", etc. In a third step, common misspellings were corrected, such as "excellence" instead of "excellence", or "partnership" instead of "partnership". Then, then raw open answers were tokenised (i.e. split into words), tagged into parts of speech (i.e. categorised as a noun, adjective, preposition, etc) and lemmatised (i.e. extraction of the root of each word) with a pre-trained annotation model in the English language. At this point, the second phase of manual data cleaning and correction of the automatic categorisation of words into parts of speech was performed. Finally, the frequency of appearance and co-occurrences of words and phrases were computed across the dataset and the different sub-sets (e.g. partnerships, stakeholder groups). Data visualisations were created based on that output.

The keyword graphs in the following sections have been built based on the relationships between words in the open responses of the survey participants. It features words that appear in the same answer either one after the other or with a maximum distance of two words between them. Each keyword is represented as a node and each co-occurrence of a pair of words is represented as a link. The size of the nodes and the thickness of the links vary according to the number of times that keywords are mentioned and their co-occurrence, respectively. In order to facilitate the visualisation of the network, the keyword graphs have been filtered to show the 50 most common co-occurrences. Although the keywords do not aim to substitute a qualitative analysis, they assist the identification of the most important topics covered in the answers and their most important connections with other topics, for later inspection in the set of raw qualitative answers.

B.5.2 Overview of respondents to the open public consultation

Profile of respondents

In total, 1635 respondents filled in the questionnaire of the open public consultation. Among them, 272 respondents (16.64%) were identified to have responded to the consultation as part of a campaign (coordinated responses). Based on the Better Regulation Guidelines, the groups of respondents where at least 10 respondents provided coordinated answers were labelled as *'campaigns',* segregated and analysed separately and from other responses. In total 11 campaigns were identified. In addition, 162 respondents in the consultation also display similarities in responses but in groups smaller than 10 respondents. Hence, these respondents were not labelled as campaigns and therefore were not analysed separately from the general analysis.

Among the 1635 respondents, 1178 (72.05%) completed the online consultation in English, 141 (8.62%) in German, 89 (5.44%) in French, 58 (3.55%) in Italian and 47 (2.87%) in Spanish, see Figure 14. Respondents that belong to the 11 campaigns follow the same pattern of language distribution, with English being the dominant language of respondents in that group. Table 27 shows that over 50% of respondents come from 4 Western and Southern European countries – Germany, Italy, France and Spain. Overall,

the number of respondents from Eastern and Northern Europe is lower, while among non-EU countries the greater number of respondents come from Switzerland, Norway and Turkey, which are countries associated to the Framework Programme. In the group of respondents labelled as campaigns, most respondents are from Germany (48 respondents or 17.65%), France (39 respondents or 14.34%), Italy (37 respondents or 13.6%), Belgium (23 respondents or 8.46%), the Netherlands (21 respondents or 7.72%) and Spain (17 respondents or 6.25%). Hence, a similar pattern of country of origin is observed in the entire sample of respondents and for the campaigns.

Across all respondents 40.80% indicated to answer to the open public consultation in a public way (non-anonymous) and 20.67% of all respondents indicated their Transparency Register number.

Figure 14: Language of the consultation that selected respondents (N=1635) (non-campaign replies) Aggregation of responses of all candidate initiatives

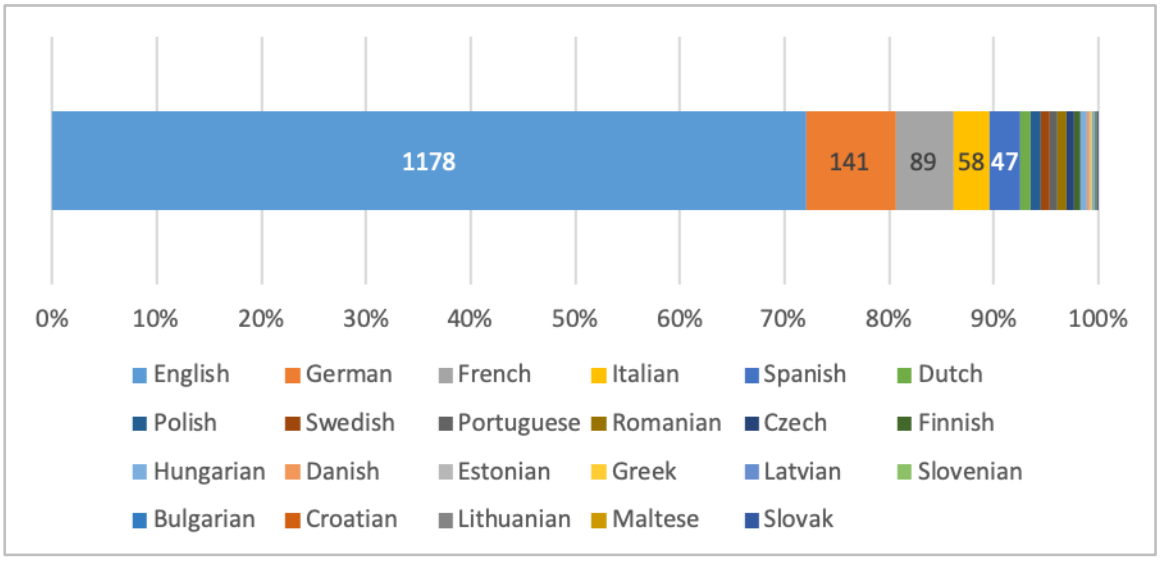


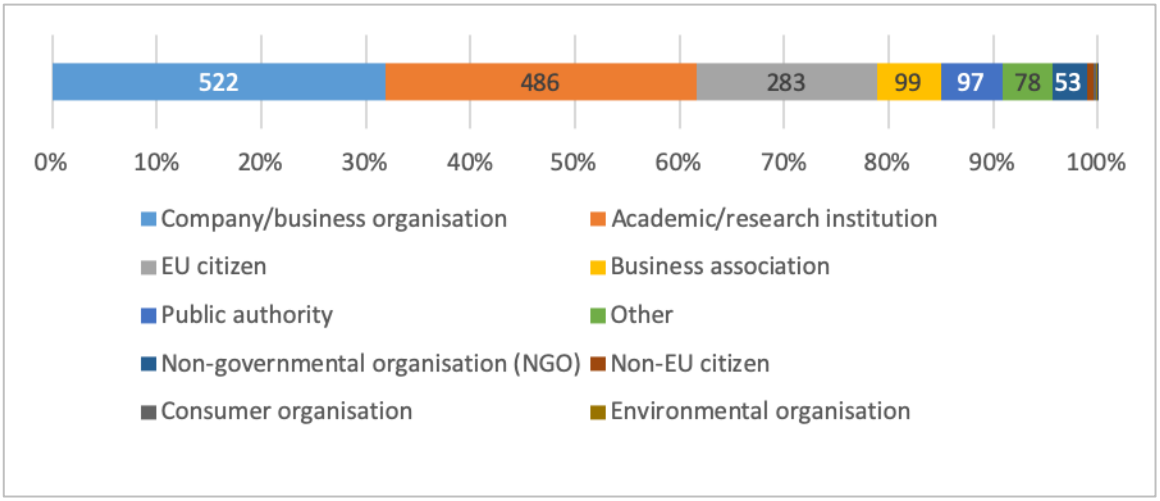
Table 27: Country of origin of respondents (N=1635)

Country	Number of respondents	Percentage of respondents
Germany	254	15.54%
Italy	221	13.52%
France	175	10.70%
Spain	173	10.58%
Belgium	140	8.56%
The Netherlands	86	5.26%
Austria; United Kingdom	61	3.73%
Finland	49	3.00%
Sweden	48	2.94%
Poland	45	2.75%
Portugal	32	1.96%
Switzerland	28	1.71%
Czechia	24	1.47%

Country	Number of respondents	Percentage of respondents
Greece	23	1.41%
Norway; Romania	22	1.35%
Denmark	20	1.22%
Turkey	19	1.16%
Hungary	14	0.86%
Ireland	12	0.73%
United States	11	0.67%
Estonia; Slovakia; Slovenia	10	0.61%
Bulgaria; Latvia	9	0.55%
Bosnia and Herzegovina	7	0.43%
Lithuania	4	0.24%
Canada; Croatia; Israel	3	0.18%
China; Ghana; Iceland; Japan; Luxembourg; Morocco	2	0.12%
Bhutan; Botswana; Cyprus; Iran; Malta; Mexico; Moldova; Mongolia; Palestine; Russia; Serbia; South Africa; Tunisia; Ukraine; Uruguay	1	0.06%

According to Figure 15, the three biggest groups of respondents are companies and business organisations (522 respondents or 31.93%), academic and research institutions (486 respondents or 29.72%) and EU citizens (283 respondents or 17.31%). Business associations, representing multiple businesses, were the fourth largest responding group (99 respondents or 6.05%), no other types of associations were presented amongst the selectable options for respondents. Among the group of respondents that are part of campaigns, most respondents are provided by the same groups of stakeholders, namely companies and business organisations (121 respondents or 44.49%), academic and research institutions (54 respondents or 19.85%) and EU citizens (42 respondents or 15.44%).

Figure 15: Type of respondents (N=1635) (non-campaign replies) Aggregation of responses of all candidate initiatives



Respondents were asked to indicate the organisational size of the companies, organisations and institutions they work for. Based on Table 28, a greater number of respondents work in large companies and business organisations (295 respondents out of 522 or 56.51%) and large academic and research institutions (348 respondents out of 486 or 71.60%). A greater number of respondents that are employed by business associations and NGOs indicated an organisation size of 1 to 9 employees. Among the group of respondents that are marked as campaigns, a greater number of respondents work in large companies and business organisations (82 respondents out of 121 or 67.77%) and academic and research institutions (39 out of 54 respondents or 72.22%).

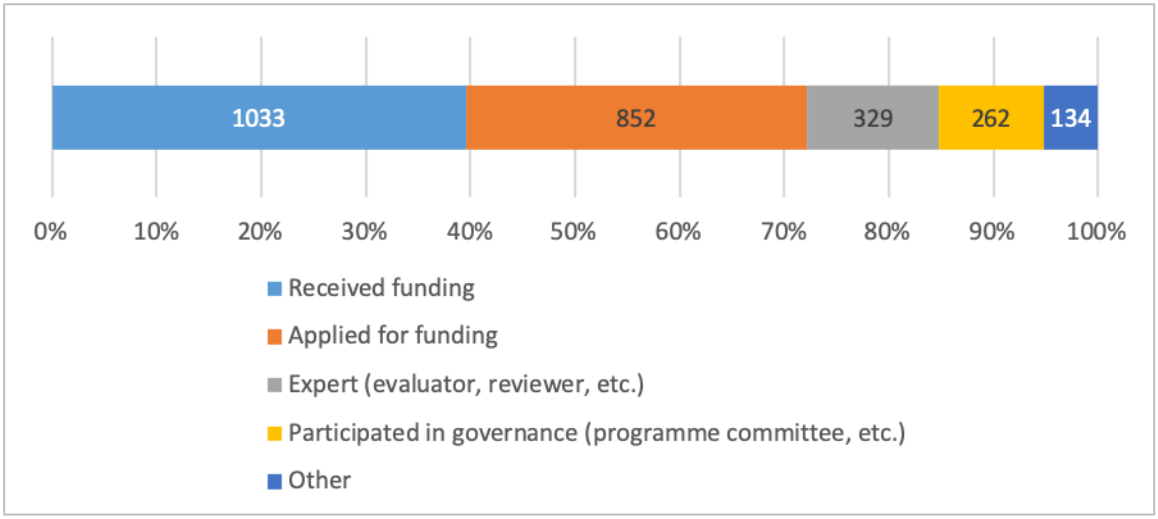
Table 28: Size of organisations that represent consultation respondents (N=1635)

	Organisation size			
Type of respondents' organisations	**Large (250 employees or more)**	**Medium (50 to 249 employees)**	**Small (10 to 49 employees)**	**Micro (1 to 9 employees)**
Company/business organisation	295	66	90	71
Academic/research institution	348	95	31	12
Business association	15	6	34	44
Public authority	58	33	6	0
Non-governmental organisation (NGO)	7	9	11	26
Consumer organisation	1	0	2	1
Environmental organisation	0	0	1	0
Trade union	0	0	1	0
Other	24	16	19	19

Among all consultation respondents, 1303 (79.69%) have been involved in the on-going research and innovation framework programme Horizon 2020 or the preceding Framework Programme 7, while 332 respondents (20.31%) were not. In the group of campaign respondents, the share of those who were involved in these programmes is higher (245 respondents out of 272 or 90.07%) than in the group of non-campaign respondents (1058 out of 1363 or 77.62%). When respondents that participated in the Horizon2020 or in the preceding Framework Programme 7 were asked to indicate in which capacity they were involved in these programmes, the majority stated that they were a beneficiary (1033 respondents or 39.58%) or applicant (852 respondents or 32.64%).

The main stakeholder categories, e.g. companies/business organisation, academic/research institutions, etc., show a similar distribution across the capacities in which they 'have been involved in Horizon 2020 or in the Framework Programme 7' as the overall population of consultation respondents (see distribution in Figure 16). However, a few stakeholder categories have mainly been involved in the capacity of "Received funding" and/or "Applied for funding", this applies to business associations, NGOs and public authorities.

Figure 16: Capacity in which respondents were involved in Horizon 2020 or in the Framework Programme 7 (N=1303)(non-campaign replies) Aggregation of responses of all candidate initiatives, multiple options allowed



Among those who have been involved in the on-going research and innovation framework programme Horizon 2020 or the preceding Framework Programme 7, 1035 respondents (79.43%) are/were involved in a partnership. The share of respondents from campaigns that are/were involved in a partnership is higher than for non-campaign respondents, 89.80% versus 77.03% respectively. The list of partnerships under Horizon 2020 or its predecessor Framework Programme 7 together with the numbers, percentages of participants is presented in Table 29, the table also shows the key stakeholder categories for each partnership.

Most consultation respondents participated in the following partnerships: Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking, Clean Sky 2 Joint Undertaking, European Metrology Programme for Innovation and Research (EMPIR) and in Bio-Based Industries Joint Undertaking. The comparison between the non-campaign and campaign groups of respondents shows that the overall distribution is quite similar. However, there are some differences. For the campaign group almost a half of respondents is/was involved in the Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking, a higher share of campaign respondents is/was participating in Clean Sky 2 Joint Undertaking and in Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking.

Table 29: Partnerships in which consultation respondents participated (N=1035)

Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking	354 (33.33%)	247 (30.31%)	97	9	37	43	41	8	5
Clean Sky 2 Joint Undertaking	195 (18.84%)	145 (17.79%)	57	2	10	27	37	1	7

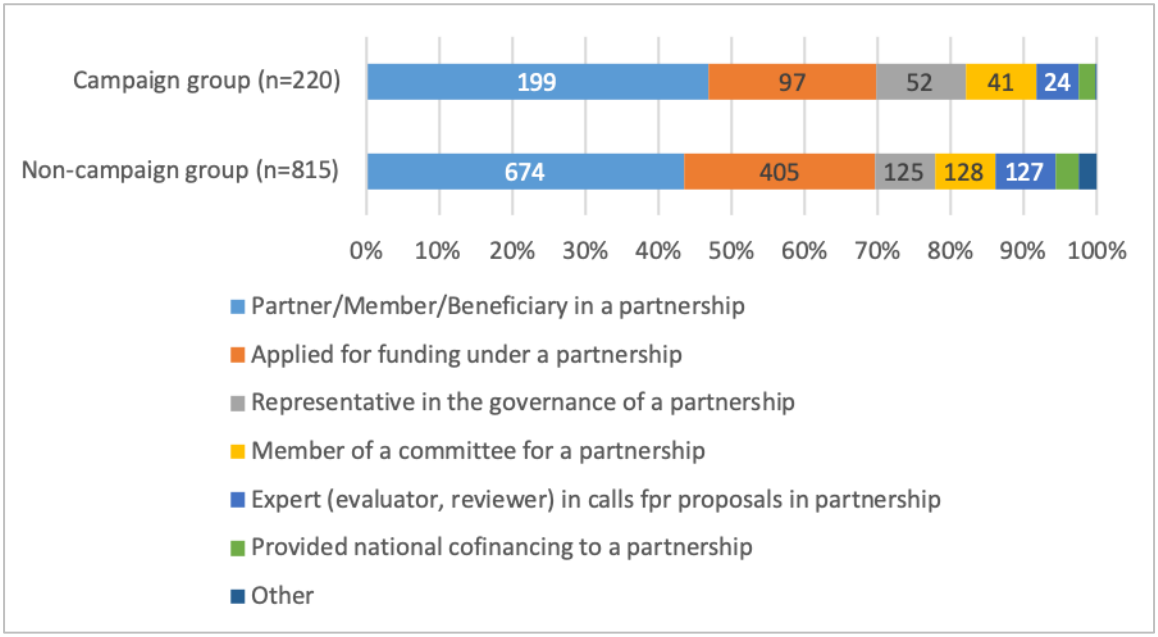
Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
European Metrology Programme for Innovation and Research (EMPIR)	150 (14.49%)	124 (15.21%)	64	0	13	9	14	2	19
Bio-Based Industries Joint Undertaking	142 (13.72%)	122 (14.97%)	39	8	20	27	14	1	6
Shift2Rail Joint Undertaking	124 (11.98%)	101 (12.40%)	31	7	5	31	14	3	7
Electronic Components and Systems for European Leadership (ECSEL) Joint Undertaking	111 (10.72%)	88 (10.80%)	42	2	7	20	12	0	5
Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking	66 (6.38%)	46 (5.64%)	10	3	3	20	3	2	3
5G (5G PPP)	53 (5.12%)	47 (5.77%)	20	1	6	14	5	0	1
Eurostrars-2 (supporting research-performing small and medium-sized enterprises)	44 (4.25%)	40 (4.91%)	17	0	6	1	7	0	6
Innovative Medicines Initiative 2 (IMI2) Joint Undertaking	37 (3.57%)	35 (4.29%)	18	2	3	3	2	4	3
Partnership for Research and Innovation in	28 (2.71%)	26 (3.19%)	15	0	3	1	2	0	2

Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
the Mediterranean Area (PRIMA)									
European and Developing Countries Clinical Trials Partnership	25 (2.42%)	24 (2.94%)	12	0	1	2	3	3	2
Ambient Assisted Living (AAL 2)	22 (2.13%)	21 (2.58%)	11	2	1	1	3	0	3
European High-Performance Computing Joint Undertaking (EuroHPC)	22 (2.13%)	18 (2.21%)	6	0	2	3	5	0	2

When respondents were asked in which role(s) they participate(d) in a partnership(s), over 40% indicated that they act(ed) as partner/member/beneficiary in a partnership (see Figure 17). The second largest group of respondents stated that they applied for funding under a partnership. The roles selected by non-campaign and campaign respondents are similar.

The few respondents that selected "Other" as their role were provided with the opportunity to outline their role. A total of 25 people did provided description. The answers provided were very varied and could not be clustered in sub-groups, a few examples are: former communication and stakeholder relationship officer, chair of steering board, system engineer, grant manager, Joint Programming Initiative (JPI), or a role in advocacy of the partnership.

Figure 17: Role of respondents in a partnership (N=1035) (non-campaign replies) Aggregation of responses of all candidate initiatives



In the open public consultation respondents could provide their views on each of the candidate Institutionalised European Partnerships, and each respondent could select multiple partnerships to provide their views on. The table below presents the number and percentage of respondents for each partnership. It is visible that the majority of respondents (31.37%) provided their views on the Clean Hydrogen candidate partnership. More than 45% of respondents from the campaigns selected this partnership. Around 15% of all respondents provided their views for the candidate partnerships European Metrology, Clean Aviation and Circular bio-based Europe. The share of respondents in the campaign group that chose to provide views on the Clean Aviation candidate partnership is of 20%. The smallest number of respondents provided opinions on the candidate initiative 'EU-Africa research partnership on health security to tackle infectious diseases – Global Health'.

Table 30: Future partnerships for which consultation respondents provide responses (N=1613)

Name of the candidate Institutionalised European partnership	Number and % of respondents from both groups (n=1613)	Number and % of respondents from a non-campaign group (n=1341)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Clean Hydrogen	506 (31.37%)	382 (28.49%)	123	21		55	74	8	13
European Metrology	265 (16.43%)	225 (16.78%)	112	3	21	11	34	3	28
Clean Aviation	246 (15.25%)	191 (14.24%)	57	5	21	34	54	3	8
Circular bio-based Europe: sustainable Innovation for new local value	242 (15%)	215 (16.03%)	63	19	36	35	31	7	13

Name of the candidate Institutionalised European partnership	Number and % of respondents from both groups (n=1613)	Number and % of respondents from a non-campaign group (n=1341)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
from waste and biomass									
Transforming Europe's rail system	184 (11.41%)	151 (11.26%)	29	14	23	39	31	2	7
Key Digital Technologies	182 (11.28%)	162 (12.08%)	55	13	20	22	35	5	7
Innovative SMEs	111 (6.88%)	110 (8.20%)	19	12	39	4	14	4	10
Innovative Health Initiative	110 (6.82%)	108 (8.05%)	35	6	9	12	16	16	5
Smart Networks and Services	109 (6.76%)	107 (7.98%)	34	9	12	17	21	2	6
Safe and Automated Road Transport	108 (6.70%)	102 (7.61%)	25	12	11	19	10	3	9
Integrated Air Traffic Management	93 (5.77%)	66 (4.92%)	8	7	4	24	9	2	7
EU-Africa research partnership on health security to tackle infectious diseases – Global Health	49 (3.04%)	47 (3.50%)	15	2	4	3	12	6	4

Campaigns per candidate Institutionalised European Partnership

As was mentioned above, 11 campaigns were identified, the largest of them includes 57 respondents. The table below presents the campaigns that replied for each candidate partnership. As presented, the candidate Institutionalised Partnership Clean Hydrogen has the highest number of campaigns, namely 5. A few partnerships, such as Innovative SMEs, Smart Networks and Systems, were not targeted by campaigns. Some campaign respondents decided to provide opinions about several partnerships, therefore, campaign #2 and #6 feature in several partnerships.

Table 31: Overview of campaigns across partnerships

Name of the candidate Institutionalised European partnership	Number of a campaign group (total number of respondents in a campaign)	Number of respondents that provided views about a partnership
Clean Hydrogen	Campaign #1 (57 respondents)	57 respondents
	Campaign #2 (41 respondents)	25 respondents
	Campaign #7 (18 respondents)	18 respondents
	Campaign #9 (14 respondents)	13 respondents
	Campaign #11 (10 respondents)	9 respondents
Clean Aviation	Campaign #2 (41 respondents)	17 respondents
	Campaign #6 (19 respondents)	19 respondents
	Campaign #8 (14 respondents)	13 respondents
Integrated Air Traffic Management	Campaign #2 (41 respondents)	10 respondents
	Campaign #6 (19 respondents)	12 respondents
European Metrology	Campaign #3 (36 respondents)	35 respondents
Circular bio-based Europe: sustainable Innovation for new local value from waste and biomass	Campaign #5 (20 respondents)	20 respondents
Transforming Europe's rail system	Campaign #4 (31 respondents)	29 respondents
Key Digital Technologies	Campaign #10 (12 respondents)	12 respondents
Innovative SMEs	-	-
Innovative Health Initiative	-	-
Smart Networks and Services	-	-
Safe and Automated Road Transport	-	-
EU-Africa research partnership on health security to tackle infectious diseases – Global Health	-	-

B.5.3 Responses to the open public consultation at programme level

The following section of the report presents the analysis of responses at programme level, meaning all respondents (excluding campaigns) were included, independent of which candidate European Partnerships respondents selected to provide their views on. The results for responses as part of campaigns are presented separately.

Characteristics of future candidate European Partnerships

Respondents were asked to assess what areas, objectives, aspects need to be in the focus of the future European Partnerships under Horizon Europe and to what extent. According to Figure 18, a great number of respondents consider that a significant contribution by the future European Partnerships is 'fully needed' to achieve climate-related goals, to the development and effective deployment of technology and to EU global competitiveness in specific sectors/domains. Overall, respondents' views reflect that many aspects require attention of the Partnerships. The least attention should be paid to responding towards priorities of national, regional R&D strategies, including smart specialisation strategies, according to respondents.

Overall, only minor differences can be found between the main stakeholder categories. Academic/research institutions value the responsiveness towards EU policy objectives and focus on development and effective deployment of technology a little less than other respondents. Business associations, however, find that the future European Partnerships under Horizon Europe should focus a little bit more on the development and effective deployment of technology than other respondents. Furthermore, business associations, large companies as well as SMEs (companies with less than 250 employees) value role of the future European Partnerships for significant contributions to EU global competitiveness in specific sectors domains a little higher than other respondents. Finally, both NGOs and Public authorities put a little more emphasis on the role of the future European Partnerships for significant contributions to achieving the UN SDGs.

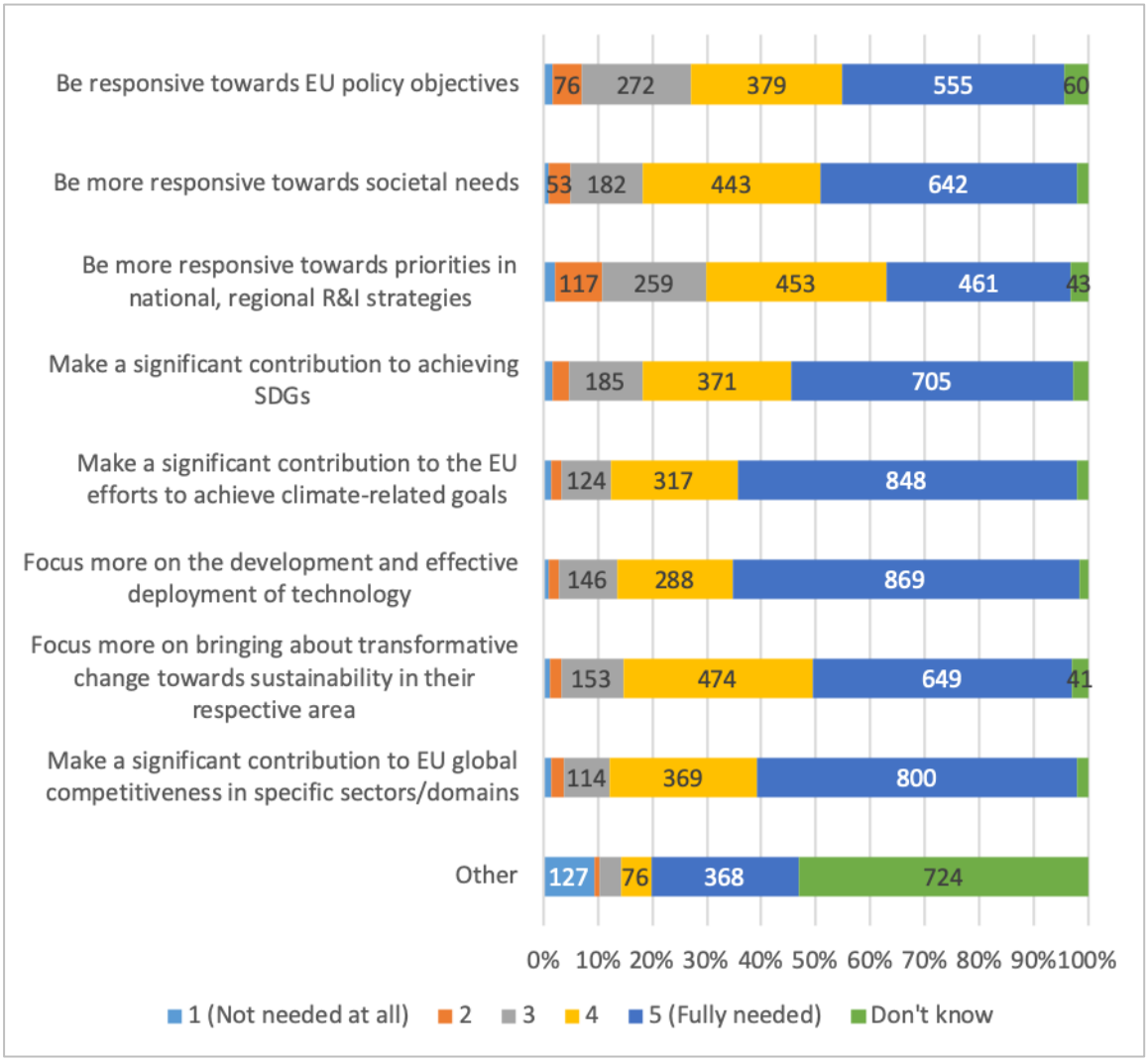
The views of citizens (249, or 18.27%), both EU and non-EU citizens, that participated in the open public consultation do not reflect significant differences with other types of respondents. However, respondents that are/were directly involved in a partnership under Horizon 2020 or its predecessor Framework Programme 7 assign a higher importance of the future European Partnerships to be more responsive towards EU policy objectives and to make a significant contribution to achieving the UN's Sustainable Development Goals.

Among 272 respondents that are classified as **campaigns,** the majority (86.76%) indicated that the future European Partnerships should focus more on the development and effective deployment of technology. Other categories of presented needs that received a high score among many campaign respondents are the need to make a significant contribution to the EU efforts to achieve climate-related goals, Sustainable Development Goals and to EU global competitiveness in specific sectors/domains. The least number of campaign respondents valued the need to be more responsive towards priorities in national, regional R&I strategies (54 respondents gave a score "5 Fully needed", or 19.85%) and to be more responsive towards societal needs (71 respondents gave a score "5 Fully needed", or 26.10%).

Similarly as for non-campaign respondents, we find only minor differences between the main stakeholder categories amongst campaign respondents. Academic/research institutions indicated that the future European Partnerships need to focus a little less on development and effective deployment of technology than other respondents. On the contrary, large companies find the focus on the development and effective deployment of technology a little more needed than other respondents, as do public authorities. Furthermore, large companies feel responsiveness towards priorities in national, regional R&I strategies is a little less needed than other respondents. Public authorities, however,

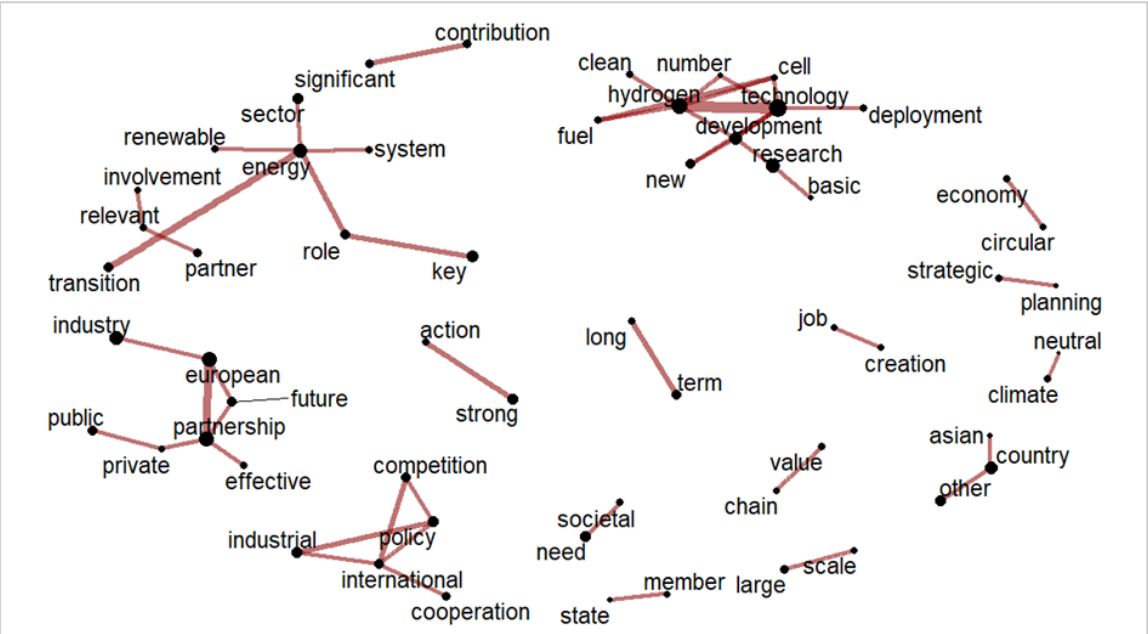
value the responsiveness towards societal needs and priorities in national, regional R&I strategies more than others.

Figure 18: To what extent do you think that the future European Partnerships under Horizon Europe need to (N=1363) (non-campaign replies) Aggregation of responses of all candidate initiatives



The analysis of the open answers provided to explain the "Other" field show that many respondents included the set-up of public-private European partnerships and the link between industrial policy and international competition and cooperation (see Figure 19). This is confirmed through qualitative analysis of answers, many of which mention the importance of collaboration and integration of relevant stakeholders to tackle main societal challenges and to contribute to policy goals. Against this backdrop, fragmentation of funding and research efforts across Europe should be avoided. Additionally, several respondents suggested that faster development and testing of technologies, acceleration of industrial innovation projects, science transfer and market uptake are deemed as priorities. Next to that, many respondents provided answers related to the fields of hydrogen and the energy transition, which corresponds to the high number of respondents that provided answers to the candidate European Partnership specific questions related to these topics.

Figure 19: Assessment of needs, open answers to "Other" field, 50 most common co-occurring keywords (N=734) (non-campaign replies) Aggregation of responses of all candidate initiatives



Many of the respondents that are classified as campaigns took the opportunity of the "Other" field to underline their key messages. The main aspects mentioned were:

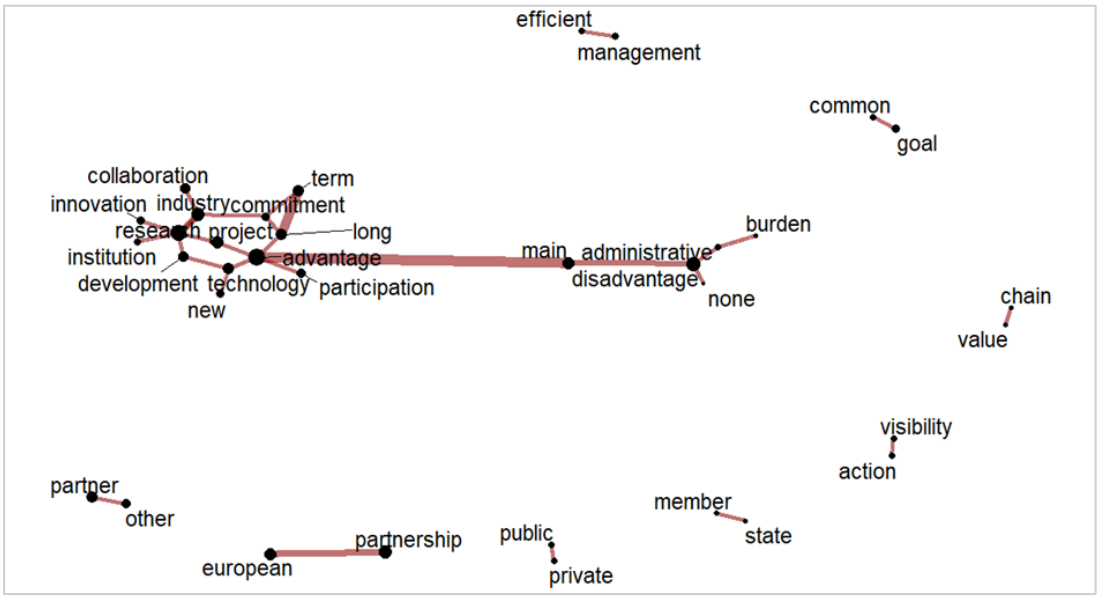
- The global positioning of Europe: outlining the role of global competition (including the role of technology), the importance of autonomy for Europe and the ability of Europe to act as a key player at the global level.
- The balance between policy objectives and private sector interests: Partnerships are regarded as an instrument to secure industry commitments due to the stability required for investments that serve policy goals.
- The importance of the transition between research and innovation (implementing research results in the market).
- The importance of multidisciplinary, and specifically cross-sectoral/cross-partnership collaboration.
- The importance of the long term commitment of a wide range of relevant stakeholders.

Next to that many respondents as part of campaigns stressed the importance of the energy transition, hydrogen and the environment, which corresponds to the high number of respondents that provided answers to the candidate European Partnership specific questions related to these topics.

Main advantages and disadvantages of Institutionalised European Partnerships

In the next question, respondents were asked to outline the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe. This was an open question for which a keyword analysis was used (see the main results in Figure 20). As can be observed, the advantages mentioned focus on the development of technology, overall collaboration between industry and research institutions, and the long-term commitment. Disadvantages mentioned are mainly administrative burdens.

Figure 20: What would you see as main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe? (non-campaign replies) Aggregation of responses of all candidate initiatives, 30 most common co-occurring keywords (N=1551)



When asked about the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe, the following points were mentioned by respondents that are classified as campaigns:

Advantages:

- Long term commitment, stability, and visibility in financial, legal, and strategic terms
- Participation of wide range of relevant stakeholders in an ecosystem (large/small business, academics, researchers, experts, etc.)
- Complementarity with other (policy) initiatives at all levels EU, national, regional
- Efficient and effective coordination and management
- High leverage of (public) funds
- Some innovative field require high levels of international coordination/standardisation (at EU/global level)
- Ability to scale up technology (in terms of TRL) through collaboration
- Networking between members
- Direct communication with EU and national authorities

Disadvantages:

- Slow processes
- System complexity
- Continuous openness to new players should be better supported as new participants often bring in new ideas/technologies that are important for innovation
- Lower funding percentage compared to regular Horizon Europe projects
- Cash contributions
- Administrative burdens

- Potential for IPR constraints

Relevance of EU level efforts to address problems in selected areas of Partnerships

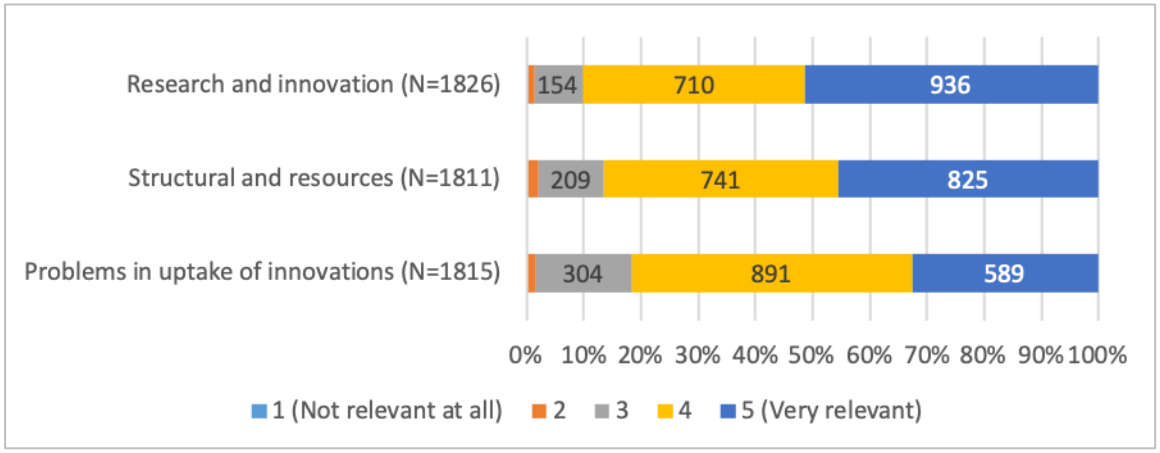
Per candidate European Partnership respondents were asked to rate the relevance of partnership specific problems in three main areas: Research and innovation problems, Structural and resource problems and Problems in the uptake of innovations. To aggregate results the average of the responses on partnership specific problems were calculated.

As presented in Figure 21, research and innovation related problems were rated as most relevant by the respondents across all candidate initiatives, followed by structural and resources problems and problems in the uptake of innovations. Overall, all three areas were deemed (very) relevant across the partnerships, as more than 80% of respondents found these challenges (very) relevant.

Only minor differences were found between the main stakeholder categories of respondents. Research and innovation problems were found slightly more relevant by academic/research institutions, yet slight less relevant by large companies and SMEs. Structural and resource problems were indicated as slightly more relevant by NGOs, but slightly less by academic/research institutions. While both NGOs and public authorities find it slightly more relevant to address problems in uptake of innovation than other respondents.

The views of citizens, both EU and non-EU citizens, are the same as other respondents (no significant differences). Respondents that are/were directly involved in a current/preceding partnership (Horizon 2020 or Framework Programme 7) find, however, the uptake of innovation problems slightly more relevant than other respondents.

Figure 21: To what extent do you think this is relevant for research and innovation efforts at EU level to address the following problems in relation to the candidate partnership in question? (non-campaign replies) Aggregation of responses of all candidate initiatives

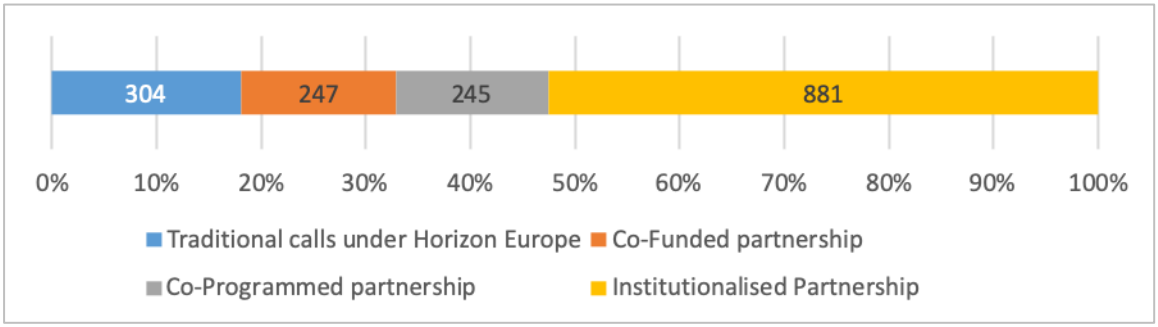


Horizon Europe mode of intervention to address problems

After providing their views on the relevance of problems, respondents were asked to indicate how these challenges could be addressed through Horizon Europe intervention. As shown in Figure 22, just over 50% of all respondents indicated that institutionalised partnerships were the best fitting intervention, however, relatively strong differences between stakeholder categories were found. The intervention of institutionalised partnerships was indicated more by business associations and large companies, but less by academic/research institutions and SMEs. While academic/research institutions valued traditional calls more often, this was not the case for business associations, large companies and public authorities. Public authorities indicated a co-programmed intervention more often than other respondents. Citizens, compared to other respondents,

indicated slightly less often that institutionalised partnerships were the best fitting intervention. Respondents that are/were directly involved in a current/preceding partnership, however, selected the institutionalised partnership intervention in far higher numbers (nearly 70%).

Figure 22: In your view, how should the specific challenges described above be addressed through Horizon Europe intervention? (non-campaign replies) Aggregation of responses of all candidate initiatives



When asked to reflect on their answers, respondents that pointed to the need for using the "institutionalised partnership" intervention mentioned the long-term commitment of collaboration, a common and ambitious R&I strategy as well as the overall collaboration between industry and research institutions. Respondents that referred to possible approaches, sometimes gave examples of good experiences in with other interventions:

- Traditional calls because of their flexibility and integration of a wide range of actors, as long as the evaluation panels do not deviate from the policy premier. This was mentioned by 94 participants, evenly distributed across companies (25 of them), academics (26) and EU citizens (25).
- Co-funded partnership, as a mechanism to ensure that all participants take the effort seriously, while allowing business partnerships to develop. This approach was deemed suitable based on previous experiences with ERANETs. This was raised by 84 participants, 36 of them academic respondents, 18 companies and 16 EU citizens.
- Co-programmed partnerships to tackle the need to promote and engage more intensively with the private sector. This was mentioned by 97 participants, most of them companies (34), followed by academics (22), business associations (15) and EU citizens (11).

Relevance of a set of elements and activities to ensure that the proposed European Partnership would meet its objectives

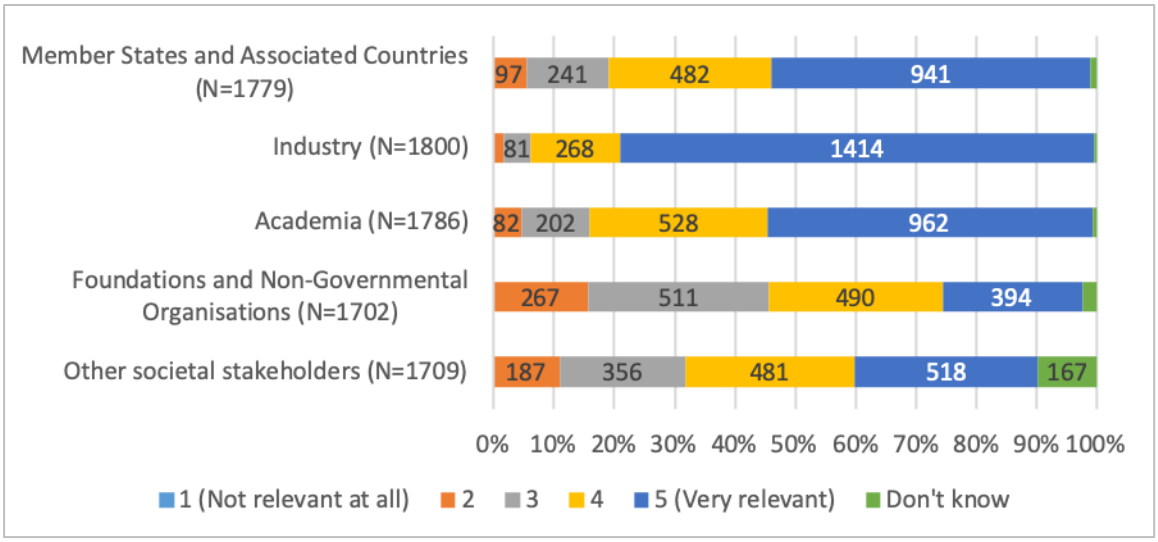
Setting joint long-term agendas

Respondents were asked how relevant it is for the proposed European Partnerships to meet their objectives to have a strong involvement of specific stakeholder groups in setting joint long-term agenda. As presented in Figure 23, collectively all respondents see stakeholders from industry as the most relevant, followed by academia and governments (Member States and Associated Countries). The involvement of foundations and NGOs as well as other societal stakeholders were, however, still found to be (very) relevant by more than 50% of the respondents.

When looking at the differences between the answers of the main stakeholder categories only minor differences could be found. Overall, it could be observed that most respondents indicated the stakeholder group they belong to themselves or that represent them as relevant to involve. Academic/research institutions find it more relevant to involve academia and less relevant to involve industry when compared to other respondents. The other way around large companies, SMEs and business associations find it more relevant to involve industry and less relevant to involve academia, Member States and Associated

Countries and NGOs. The involvement of Member States and Associated Countries was found more relevant by academic/research institutions and public authorities. NGOs also values their own involvement and those of other societal stakeholders more than other respondents. views of citizens also show a slightly higher relevance for foundations and NGOs. This is less so the case for respondents that are/were directly involved in a current/preceding partnership (most predominantly companies and academia).

Figure 23: In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives - Setting joint long-term agenda with strong involvement of: (non-campaign replies) Aggregation of responses of all candidate initiatives

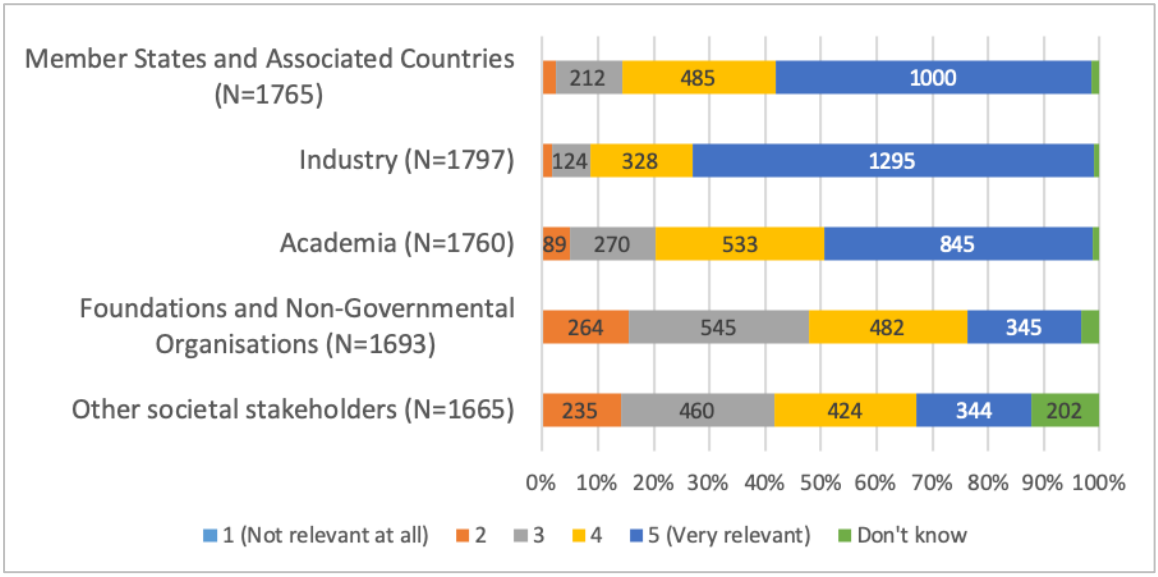


Pooling and leveraging resources through coordination, alignment and integration with stakeholders

Respondents were also asked how relevant it is for the proposed European Partnership to meet its objectives to pool and leverage resources (financial, infrastructure, in-kind expertise, etc.) through coordination, alignment and integration with specific groups of stakeholders. As shown in Figure 24-similarly as for the previous questions-, respondents also see stakeholders from industry as the most relevant, followed by academia and governments (Member States and Associated Countries). The involvement of foundations and NGOs as well as other societal stakeholders are also still found to be (very) relevant for more than 50% of the respondents.

Similarly as described for the question on setting joint long-term agendas, most stakeholder categories valued their own involvement higher than other respondents – although also here differences between stakeholder categories were minor. As such, academic/research institutions see the relevance of academia higher, while large companies, SMEs and business association indicated a lower relevance of academia than other respondents. Similarly, these private sector stakeholders valued the relevance of industry higher than others while valuing the relevance of NGOs and other societal stakeholders less. NGOs value themselves and other societal stakeholders however higher than other respondents, and also public authorities indicated a higher relevance for Member States and Associated Countries then other respondents. Citizens mainly put more emphasis on the role of NGOs and other societal stakeholders then other respondents.

Figure 24: In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Pooling and leveraging resources (financial, infrastructure, in-kind expertise, etc.) through coordination, alignment and integration with: (non-campaign replies) Aggregation of responses of all candidate initiatives

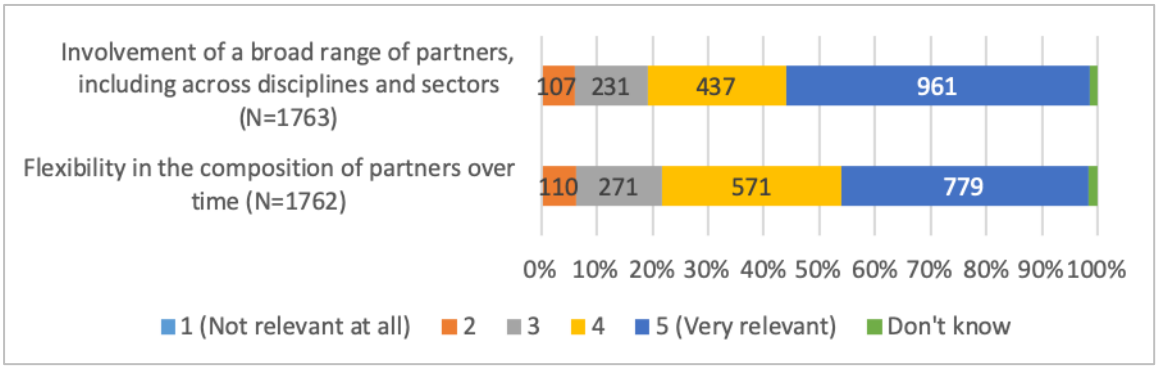


Composition of the partnerships

Regarding the composition of the partnership most respondents indicated that for the proposed European Partnership to meet its objectives the composition of partners needs to be flexible over time and that a broad range of partners, including across disciplines and sectors, should be involved (see Figure 25).

When comparing stakeholder groups only minor differences were found. Academic/research institutions and public authorities found the involvement of a broad range of partners and flexibility in the composition of partners over time slightly more relevant than other respondents, while large companies found both less relevant. SMEs mainly found the flexibility in the composition of partners over time less relevant than other respondents, while no significant differences were found regarding the involvement of a broad range of partners. Citizens provided a similar response to non-citizens. Respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, indicated a slightly lower relevance of the involvement of a broad range of partners and flexibility in the composition of partners over time.

Figure 25: In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Partnership composition (non-campaign replies) Aggregation of responses of all candidate initiatives

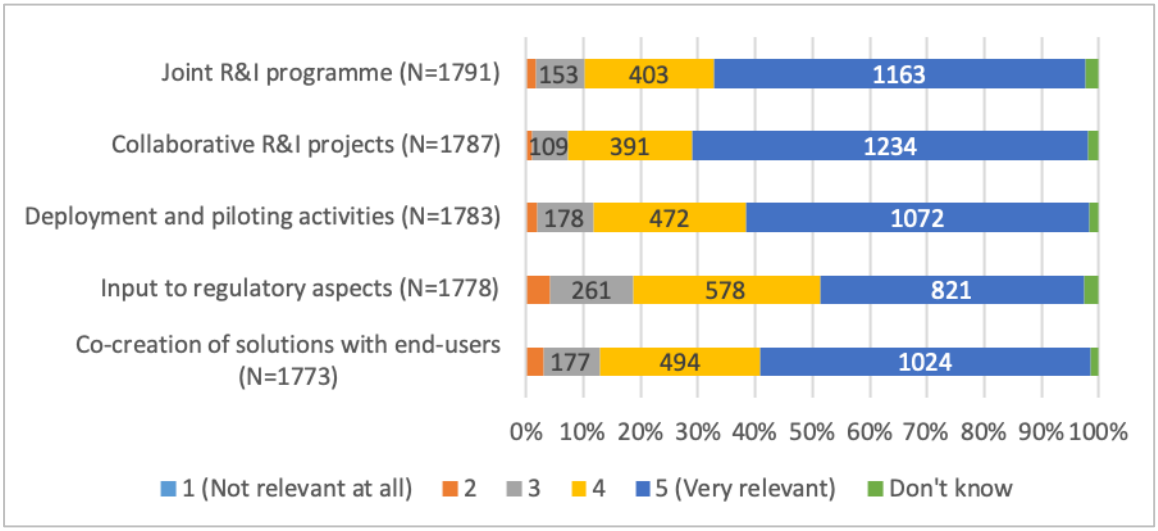


Implementation of activities

Most respondents indicated that implementing activities like a joint R&I programme, collaborative R&I projects, deployment and piloting activities, providing input to regulatory aspects and the co-creation of solutions with end-users are all (very) relevant for the partnerships to be able to meet its objectives (see Figure 26).

Minor differences were found between the main stakeholder categories, the differences found were in line with their profile. As such, academic/research institutions found joint R&I programme & collaborative R&I projects slightly more relevant and deployment and piloting activities, input to regulatory aspects and co-creation with end-users slightly less relevant than other respondents. For SMEs an opposite pattern is shown. Large companies, however, also found collaborative R&I projects slightly more relevant than other respondents, as well as input to regulatory aspects. The views of citizens are similar to non-citizens. Respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, show a slightly higher relevance across all activities shown in Figure 26.

Figure 26: In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Implementing the following activities (non-campaign replies) Aggregation of responses of all candidate initiatives



Relevance of setting up a legal structure (funding body) for the candidate European Partnerships to achieve improvements

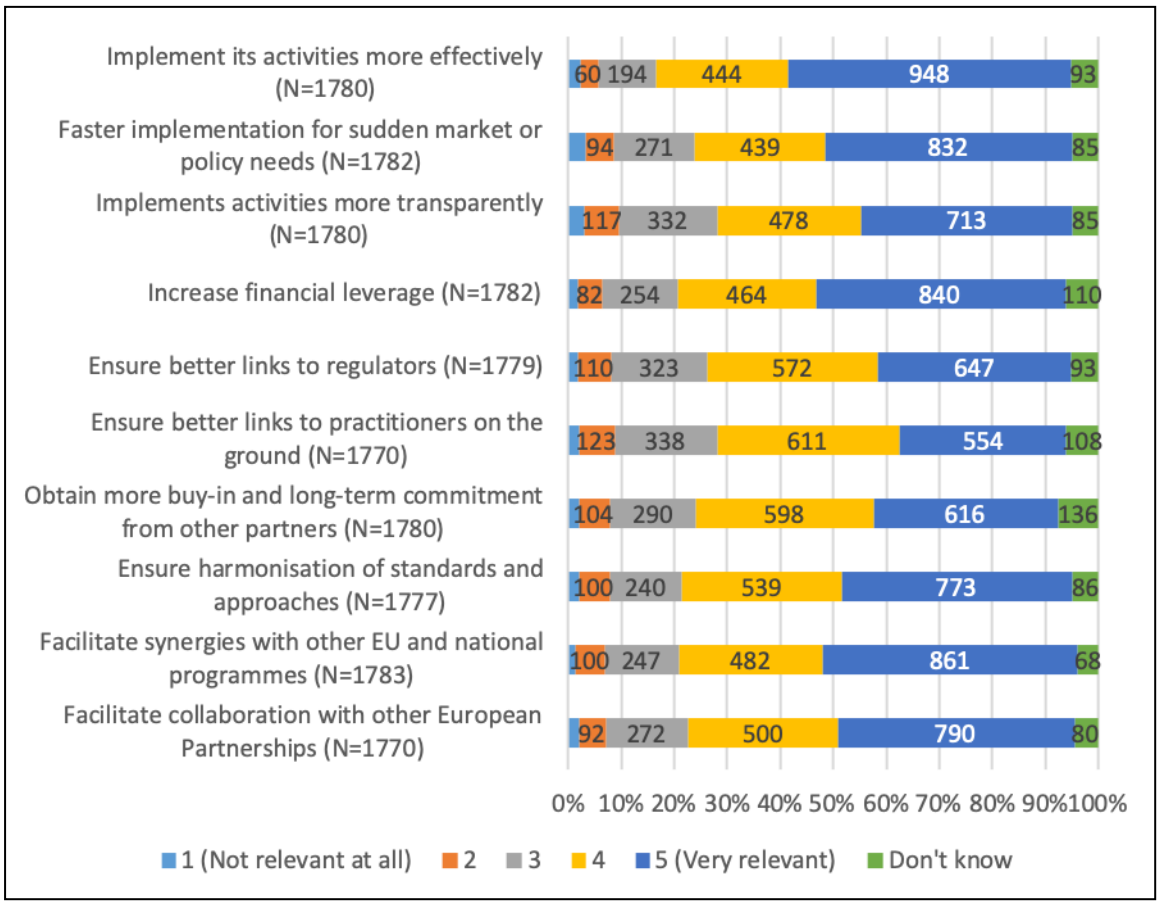
Respondents were then asked to reflect on the relevance of setting up a legal structure (funding body) for achieving a set of improvements, as presented in Figure 27. In general, 70%-80% of respondents find a legal structure (very) relevant for these activities. The legal structure was found most relevant for implementing activities in a more effective way and least relevant for ensuring a better link to practitioners on the ground, however differences are small.

When comparing the main stakeholder categories we found minor differences. Academic/research institutions indicated a slightly lower relevance for transparency, better links to regulators as well as obtaining the buy-in and long-term commitment of other partners. SMEs also indicated a lower relevance regarding obtaining the buy-in and long-term commitment of other partners. 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. NGOs find it slightly more relevant to implement activities faster for sudden market or

policy needs. Public authorities, however, find it slightly less relevant to facilitate collaboration with other European Partnerships than other respondents.

The views of citizens show a slightly lower relevance for a legal structure in relation to implementing activities in an effective way. Quite different results are shown for respondents that are/were directly involved in a current/preceding partnership when compared to respondents not involved in a current/preceding partnership, they indicated a higher relevance across all elements presented in Figure 27.

Figure 27: In your view, how relevant is to set up a specific legal structure (funding body) for the candidate European Partnership to achieve the following? (non-campaign replies) Aggregation of responses of all candidate initiatives



Scope and coverage of the candidate European Partnerships based on their inception impact assessments

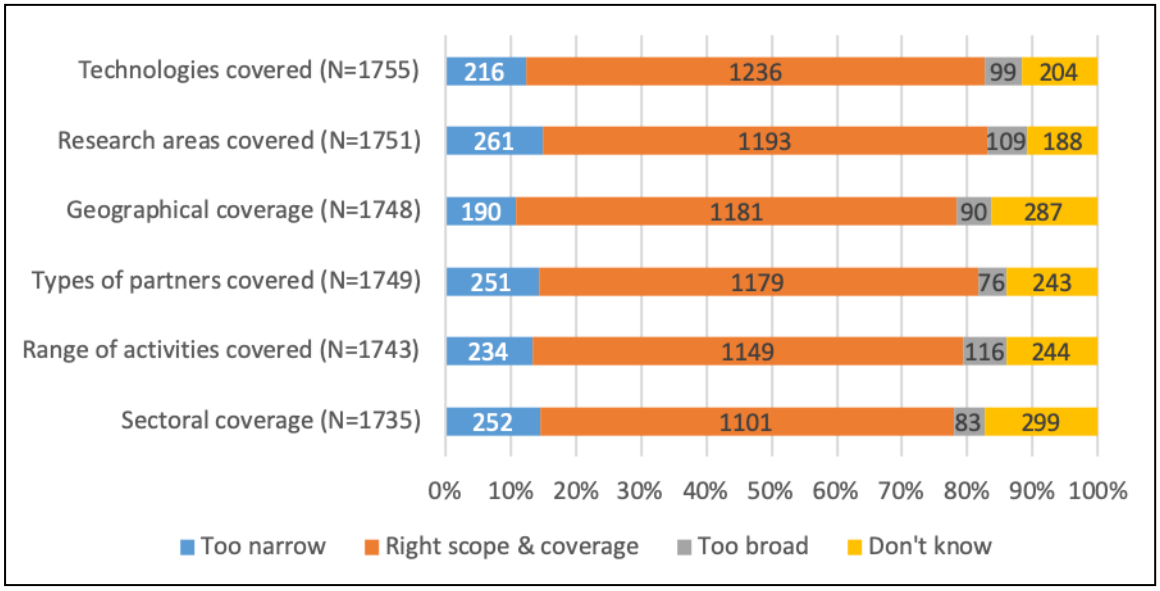
The response regarding the scope and coverage for the partnerships, based on inception impact assessments, shows that the large majority feels like the scope and coverage initially proposed in the inception impact assessments is correct. Figure 28 shows the results. However, about 11% to 15% of the respondents indicated the scope and coverage to be too narrow. About 11%-17% of respondents answered "Don't know". In the open answers respondents mostly reflected on specific aspects of the geographical and sectoral scope and coverage of the specific candidate European Partnerships, no overall lessons could be extracted.

Overall, differences between the main stakeholder categories were found to be minor. Academic/research institutions indicated slightly more often that the research area was "too narrow" then other respondents. SMEs on the other hand indicated slightly more often that the research area and the geographical coverage were "too broad". NGOs and public authorities, however, found the geographical coverage slightly more often "too narrow" when compared to other respondents. Large companies found the range of activities

slightly more often "too broad" and the sectoral focus slightly more often "too narrow" when compared to other respondents.

The views of citizens are the same as for other respondents. Most notably, respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, more often indicated that the candidate institutionalised European Partnership have the "right scope & coverage".

Figure 28:: What is your view on the scope and coverage proposed for this candidate institutionalised European Partnership, based on its inception impact assessment? (non-campaign replies) Aggregation of responses of all candidate initiatives



Scope for rationalisation and alignment of candidate European Partnerships with other initiatives

When asked whether it would be possible to rationalise a specific candidate European Institutionalised Partnership and its activities, and/or to better link with other comparable initiatives, nearly two thirds of respondents answered "Yes" (1000, or 62.15%), while over one third answered "No" (609, or 37.85%). Nearly no differences were found between the main stakeholder categories, only large companies and SMEs indicated slightly more often "Yes" in comparison to other respondents.

The views of citizens are the same as for other respondents. Respondents that are/were directly involved in a current/preceding partnership, indicated "No" more often, the balance is about 50/50 between "Yes" and "No" for this group.

In the open responses respondents often referred to specific similar/comparable and complementary initiatives discussing the link with a specific candidate European Partnership, no overall lessons could be extracted, but more detailed results can be found in the partnership specific result sections.

Relevance of European Partnerships to deliver targeted scientific, economic/technological and societal impacts

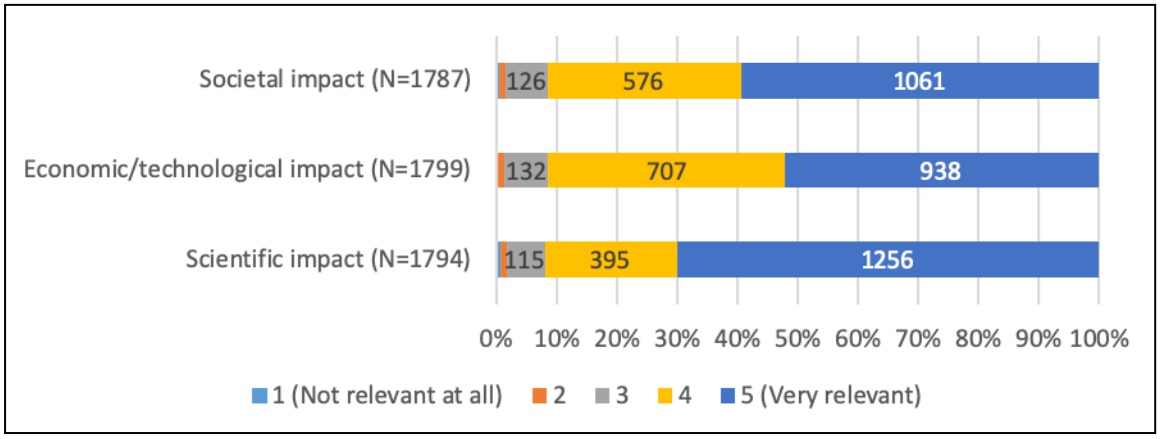
Finally, respondents were asked to rate the relevance of partnership specific impacts in three main areas: Societal impacts, Economic/technological impacts and Scientific impacts. To aggregate results the average of the responses on partnership specific impacts were calculated.

As presented in Figure 29, overall, all three areas were deemed (very) relevant across the candidate partnerships. Scientific impact was indicated as the most relevant impact, more than 90% of respondents indicated that these impacts were (very) relevant.

Only minor difference between stakeholder groups were found. Academic/research institutions found scientific impacts slightly more relevant, while large companies found economic and technological impacts slightly more relevant than other respondents. NGOs found societal impact slightly more relevant, while SMEs found this slightly less important.

Citizens, both EU and non-EU citizens, did not a significantly different view when compared to other respondents. Respondents that are/were directly involved in a current/preceding partnership find all impacts slightly more relevant than other respondents.

Figure 29: In your view, how relevant is it for the candidate European Institutionalised Partnership to deliver on the following impacts? (non-campaign replies) Aggregation of responses of all candidate initiatives



B.6 Responses to the open public consultation for the candidate partnership "Clean Aviation"

B.6.1 Introduction

This section outlines the results of the Open Public Consultation for the candidate European Partnership on Clean Aviation. The section outlines the following:

- Results on general questions, segregated for this candidate European Partnership:
  - Views on the needs of the future European Partnerships under Horizon Europe
  - Views on the advantages and disadvantages of participation in an Institutionalised European Partnership
- Results on specific questions for this candidate European Partnership:
  - Relevance of research and innovation efforts at the EU level to address problems
  - Views on Horizon Europe interventions to address these problems
  - Views on the relevance of elements and activities in: setting a joint long-term agenda; pooling and leveraging resources; partnership composition; implementation of activities.
  - Views on setting up a specific legal structure (funding body)
  - Views on the proposed scope and coverage of this candidate European Partnership
  - Views on the alignment of the European Partnership with other initiatives
  - Relevance of this candidate European Partnership to deliver impacts

B.6.2 Characteristics of respondents

There are 191 respondents who have answered (part of) the consultation for the Clean Aviation Partnership. Of these respondents, 55 (28.80%) were citizens. The largest group of respondents were academic and research institutions (57, 29.84%) closely followed by businesses 55 respondents (28.80). There were 5 respondents from business associations (2.62%). The other respondents were representatives of public authorities (8, 4.19%), non-governmental organisations (3, 1.57%) or other (7, 3.66%). The overwhelming

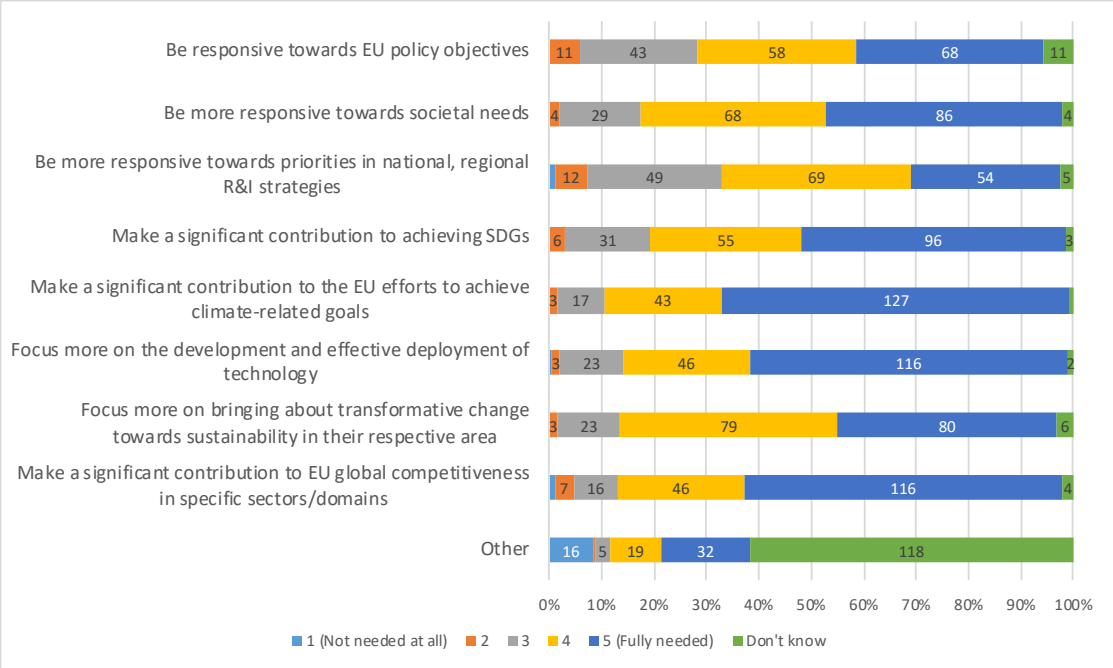
majority, namely 167 (87.43%) respondents, have been involved in the on-going research and innovation framework programme, of which 140 respondents (73.30%) were directly involved in a partnership under Horizon 2020 or its predecessor Framework Programme 7.

B.6.3 Characteristics of future candidate European Partnerships – as viewed by respondents to the Clean Aviation initiative

At the beginning of the consultation, the respondents of this partnership were asked to indicate their views of the needs of the future European Partnerships under Horizon Europe. All 191 respondents answered this questions. Overall, a large part of the respondents indicated that many of these needs were fully needed. The option where most respondents indicated this, was making a significant contribution to the EU efforts to achieve climate-related goals (127, 66.49%), focusing more on the development and effective deployment of technology (116, 60.73%) and making a significant contribution to EU global competitiveness in specific sectors/domains (116, 60.73%). Aside from 'other', the need where the least amount of respondents indicated that improvements were fully needed, being more responsive towards priorities in national and/or regional R&I strategies (54, 28.27%).

No statistical differences were found between the views of citizens and other respondents.

Figure 30: Views of the respondents in regard to the needs of future European Partnerships under Horizon Europe (N=191)

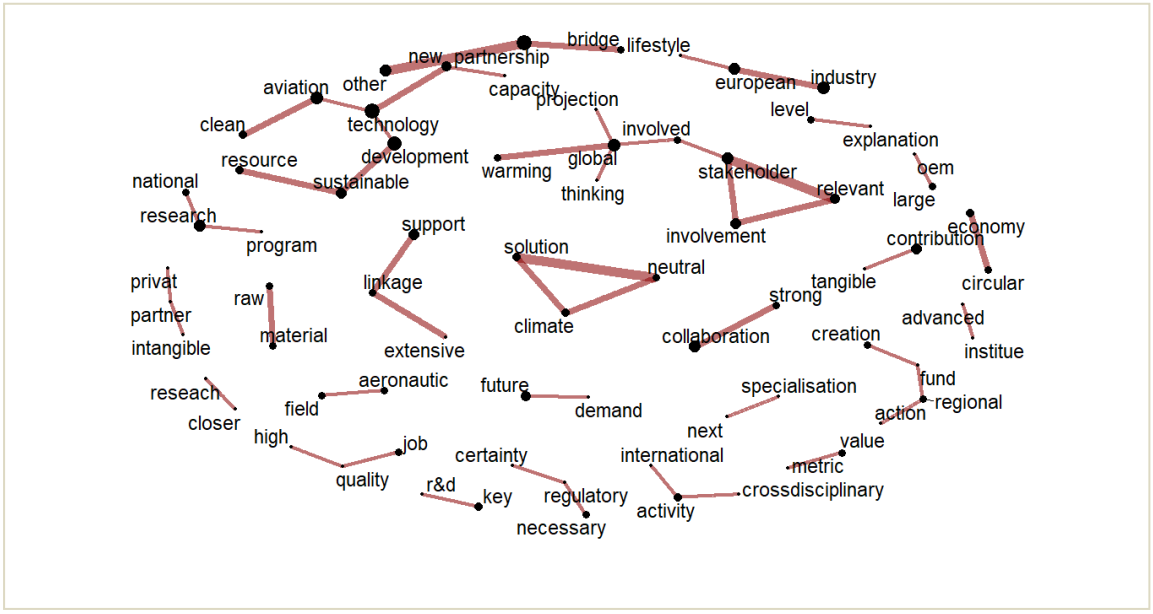


Most business organisations confirmed the importance of meeting societal needs and contributing to both EU-climate related goals and UN Sustainable Development Goals through the effective deployment of new technology whilst also maintaining European competitiveness in the market.

The vast majority also agreed that more focus should be placed on bringing about a transformative change towards sustainability through the development and effective deployment of technology, whilst also making significant contributions towards EU global competitiveness.

The respondents also had the option to indicate other needs. The results of the analysis resulted in the chart shown in Figure 31 showing the co-occurrences of keywords. The results show that respondents have indicated needs around the involvement of relevant stakeholders, climate neutral solutions as well as the development of sustainable technology.

Figure 31: Assessment of open answers of other needs, 50 most common co-occurring keywords (N=74)

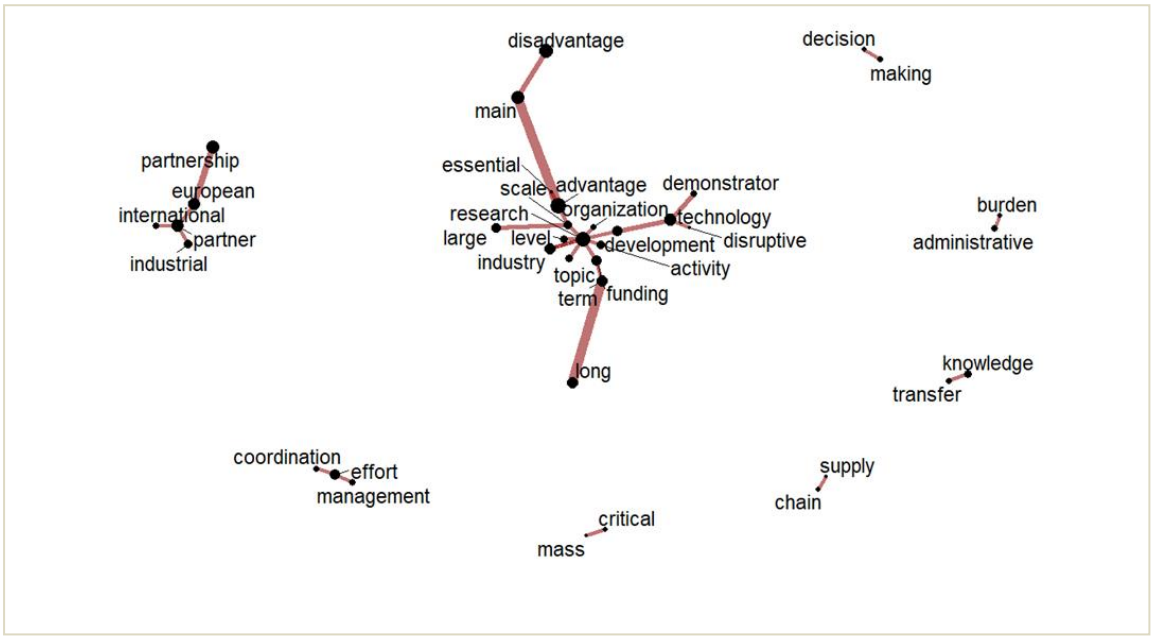


Stakeholders also noted the presence of regulatory barriers in the context of standards and disruptive technology development, although these considerations were felt less strongly than those regarding the innovation cycles. A majority of stakeholders also noted that the lack of global integrated standards undermines the benefits of R&I activities developed at an EU level, thus affecting European competitiveness.

B.6.4 Main advantages and disadvantages of Institutionalised European Partnerships

The respondents were asked what they perceived to be the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe. The keyword analysis used for open questions resulted in the graph shown in Figure 32. This analysis showed the respondents mentioned long term funding, technology development and large-scale research in relation to advantages.

Figure 32: Assessment of open answers with advantages and disadvantages of participation in an Institutionalised European Partnership, 30 most common co-occurring keywords (N=164)

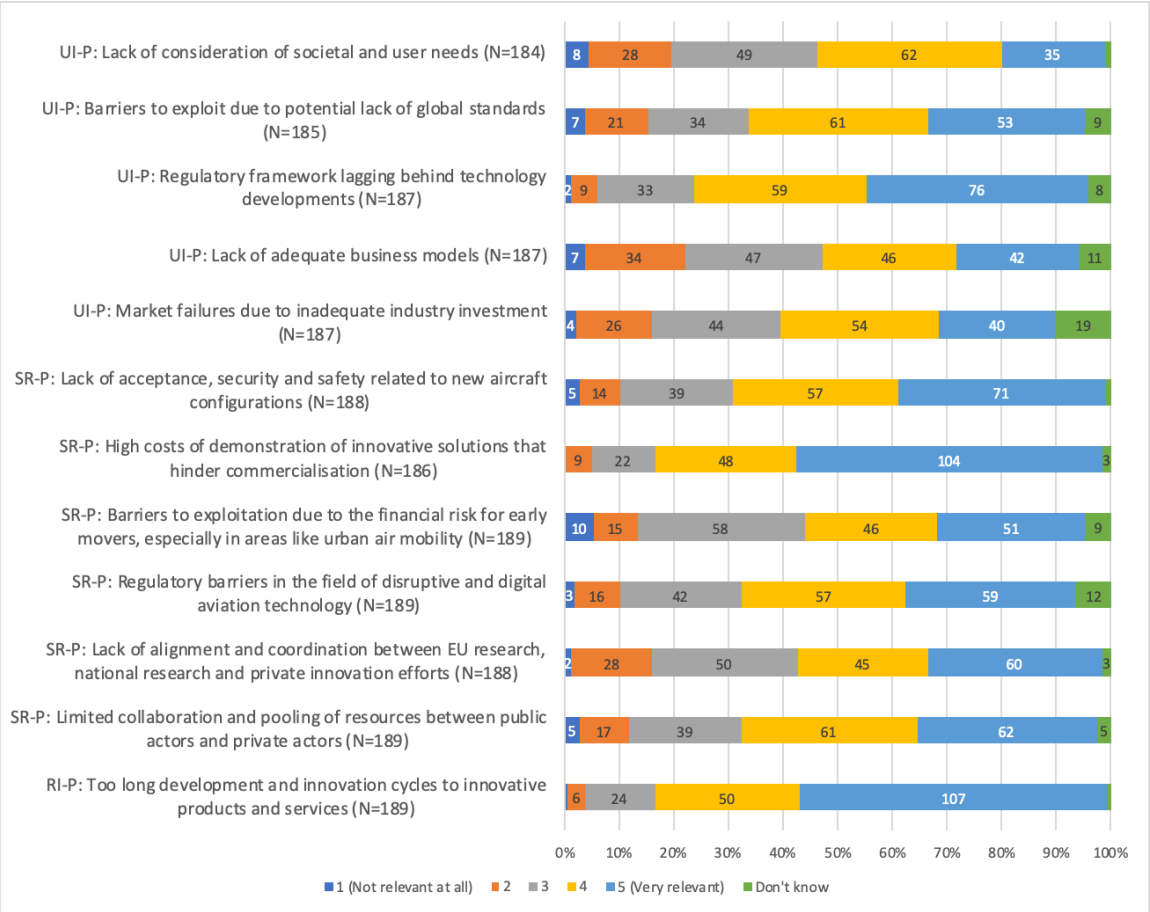


The Open Public Consultation responses pointed towards several factors that would contribute to a more effective delivery of scientific impacts under an institutionalised partnership. For example, a substantial majority of business organisations and associations, academic and research institutions, public authorities and EU citizens considered that the inclusion of a broad range of partners, with flexibility to change the profile of participation over time, was either relevant or very relevant. The responses also supported the view that the initiatives should enable the development of a long-term strategy, underpinned by a roadmap, that mainly draws on inputs from industry and academia, with additional inputs from Member States.

B.6.5 Relevance of EU level efforts to address problems in relation to the Clean Aviation field

In the consultation, respondents were asked to provide their view on the relevancy of research and innovation efforts at EU level to address the following problems in relation to clean aviation, specifically on three types of problems: problems in uptake of clean aviation innovations (UI-P), structural and resource problems (SR-P) and research and innovations problems (RI-P). In Figure 33, the responses to these answers are presented.

Figure 33: Views of respondents on relevance of research and innovation efforts at the EU level to address problems in relation to clean aviation



Most stakeholders strongly agreed that development and innovation cycles are too long and costly. Stakeholders also noted the presence of regulatory barriers in the field of disruptive and digital aviation technology.

A substantial majority of business organisations, business associations, academic and research institutions, public authorities and EU citizens strongly recognise the impact that long development and innovation cycles and high associated costs of demonstration are having on the growing ecological footprint, whilst all parties also recognise that a future partnership must also make significant contributions to EU global competitiveness.

With regard to the uptake in innovation problems, 76 respondents have indicated that the regulatory framework lagging behind technology developments is very relevant (40.64%). The lack of consideration of societal and users needs was considered as less relevant for research and innovation efforts at EU level to address, with only 35 respondents indicating this was very relevant (19.02%)

There are large differences in the responses that the respondents have given with regard to structural and resource problems. 104 respondents have indicated that the need to bring together the Air Traffic Management research community is very relevant (55.91%). While another of the structural problems outlined: market failures due to inadequate industry investment, only received 40 very relevant answers (21.39%).

There was only one research and innovation problem that the respondents were asked to reflect on: the too long development and innovation cycles to innovative products and services. This problem has the most 'very relevant' answers of any of the problems that the respondents were asked to reflect on, namely 107 (56.61%).

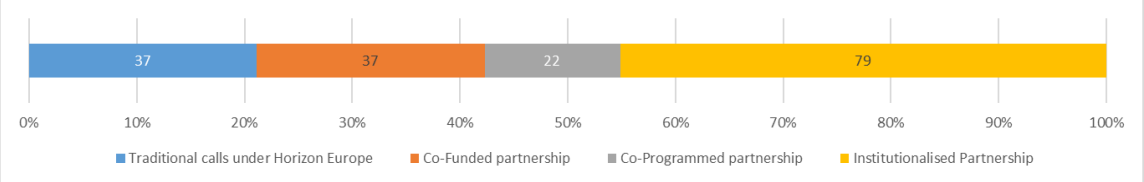
Slight statistical differences were found between the views of citizens and other respondents. Citizens found the structural and resource problem regarding the lack of alignment and coordination between EU research, national research and private innovation efforts more relevant, as well as the uptake in innovation problem concerning market failures and lack of consideration of societal and user needs. Respondents that are/were involved in a current/preceding partnership (Horizon 2020 or Framework Programme 7), found the uptake in innovation problems regarding barriers to exploit due to potential lack of global standards and lack of consideration of societal and user needs less relevant.

B.6.6 Horizon Europe mode of intervention to address problems

After providing their views on the relevance of problems, respondents were asked to indicate how these challenges could be addressed through Horizon Europe intervention. As shown in Figure 34, just over 45% of respondents indicated that institutionalised partnerships were the best fitting intervention.

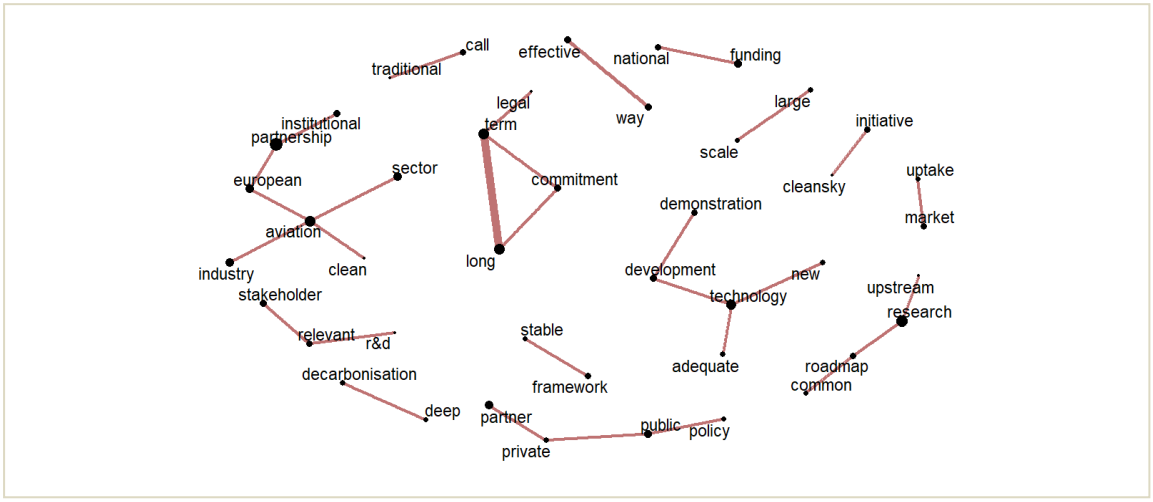
No statistical differences were found between the views of citizens and other respondents.

Figure 34: Assessment of Horizon Europe intervention



The respondents were asked to briefly explain their answers to the question above. People who stated that an institutionalised partnerships was the best fitting answer, mentioned long-term commitment, demonstration and development of new technology, relevant stakeholders and a common research roadmap (Figure 35). Respondents who did not select institutionalised partnership as their preferred intervention (N=87) traditional calls, co-funded partnerships, small companies and industry programme (not pictured).

Figure 35: Assessment of open answers to explain their choice of an institutionalised partnership in the assessment of the Horizon Europe intervention, 30 most common co-occurring keywords (N=63)



B.6.7 Relevance of a set of elements and activities to ensure that the proposed European Partnership would meet its objectives

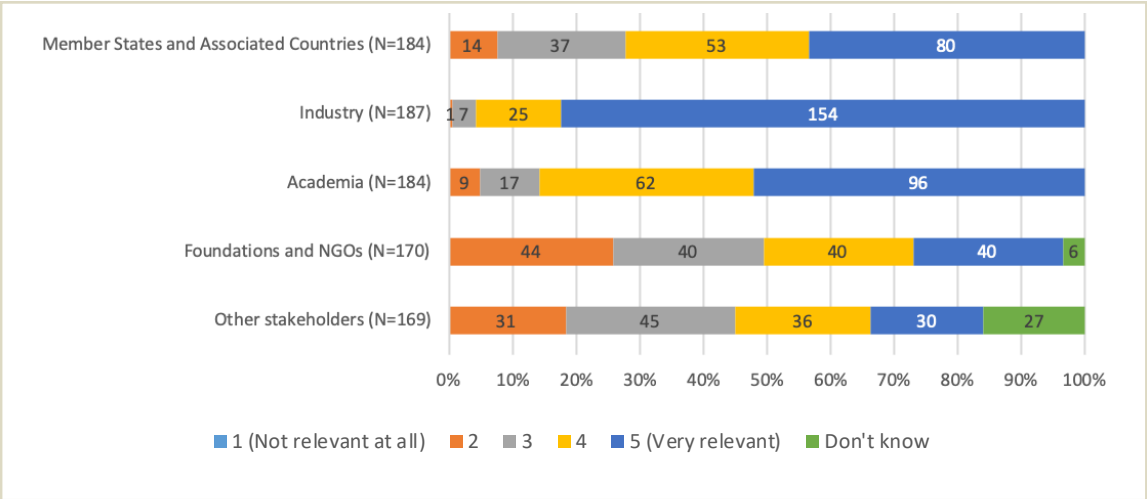
Setting joint long-term agendas

Respondents were asked how relevant the involvement of actors is in setting a joint long-term agenda to ensure that the proposed European Partnership would meet its objectives. The highest amount of respondents indicated that the involvement of Industry is very

relevant (154 respondents or 82.36%). A large part of respondents also indicated that the involvement of Academia (96, 52.17%) and Member States and Associated Countries (80, 43.48%) is very relevant. The opinions were split on Foundations and NGO's and other stakeholders, where there does not seem to be a clear opinion on the relevance of the involvement of these stakeholders.

No statistical differences were found between the views of citizens and other respondents.

Figure 36: Views of respondents on relevance of actors in setting joint long-term agenda



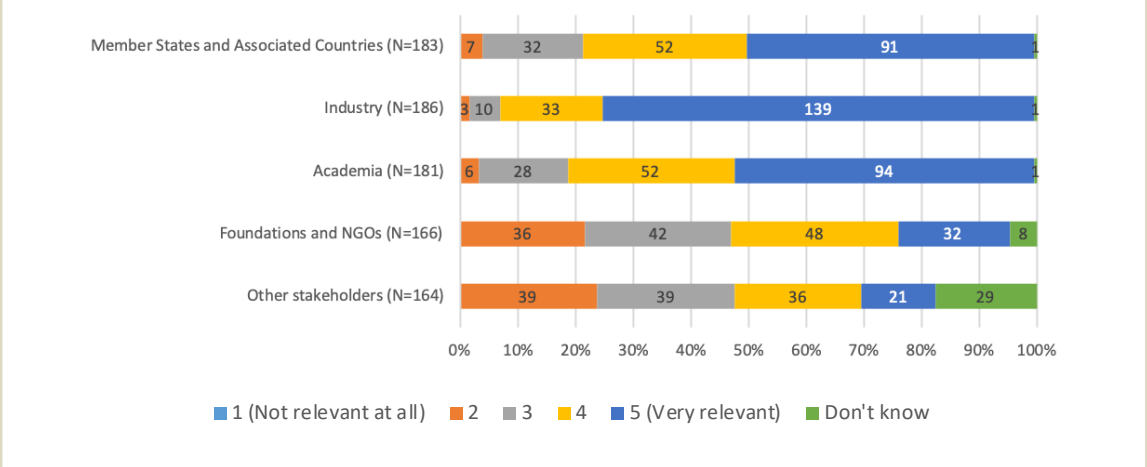
The responses supported the view that the initiatives should enable the development of a long-term strategy, underpinned by a roadmap, that mainly draws on inputs from industry and academia, with additional inputs from Member States.

Relevance of elements and activities in pooling and leveraging resources

With respect to the relevance of actors in pooling and leveraging resources, such as financial, infrastructure, in-kind expertise etc.), to meet Partnership objectives, the patterns are very similar. Most of the respondents (13.9, 74.73%) indicated that industry was very relevant. A large part of respondents also indicated that the involvement of Member States and Associated Countries (96, 52.17%) and Academia (80, 43.48%) is very relevant. Also, similar to the previous question, the Foundations and NGO's and other stakeholders were seen as less relevant and where the opinions of the respondents seems divided. No respondents indicated that any of the categories was Not relevant at all. See Figure 37.

No statistical differences were found between the views of citizens and other respondents.

Figure 37: Views of respondents on relevance of actors for pooling and leveraging resources



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.

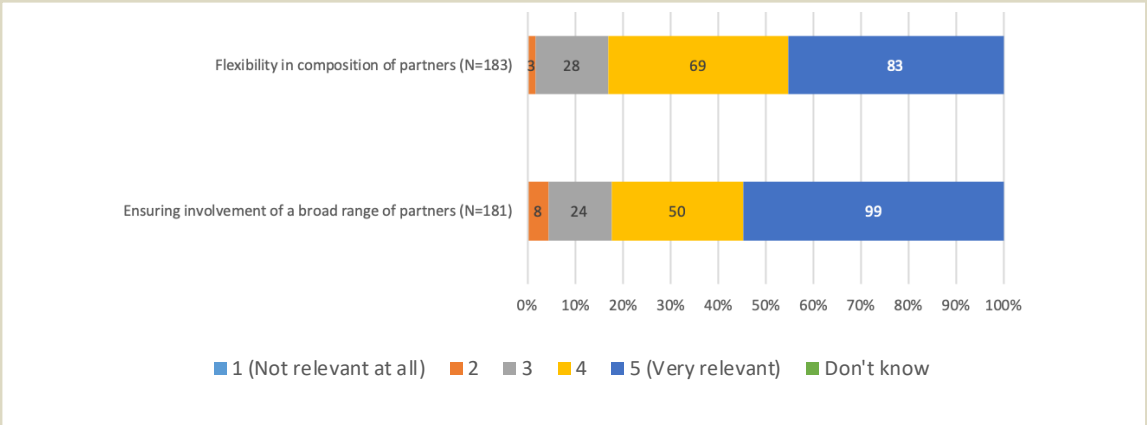
A significant proportion of the stakeholders' responses to the Open Public Consultation show that the links with external organisations such as regulators and the synergies drawn from these relationships, are considered as relevant or very relevant topics which need to be addressed by the types of partnerships which are put forward and reflected in their legal structure.

Relevance of elements and activities for the partnership composition

Respondents were asked about the relevance of Partnership composition, such as flexibility in the composition of partners over time and involvement of a broad range of partners (including across disciplines and sectors), to reach Partnership objectives. As it is visible in Figure 38, ensuring involvement of a broad range of partners has more 'very relevant' answers (99, 54.70%) than the flexibility in the composition of partners (83, 45.36%). Overall 83.06% of respondents have given flexibility either a score of 4 or 5 (very relevant) which is higher than the 82.32% who have given the broad range of partners a score of 4 or 5 (very relevant).

No statistical differences were found between the views of citizens and other respondents.

Figure 38: Views of respondents on relevance of partnership composition elements



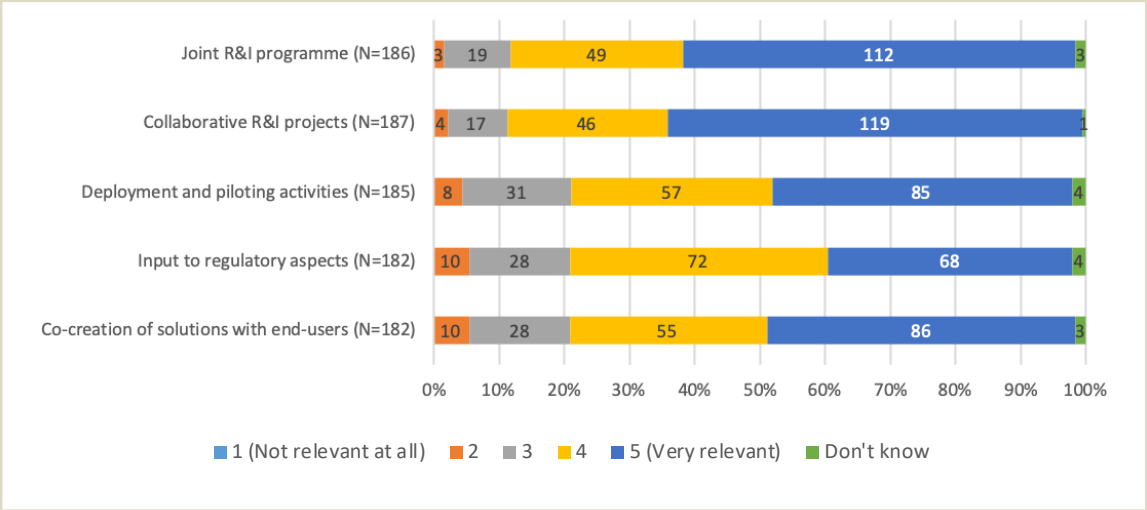
A substantial majority of respondents considered that the inclusion of a broad range of partners, with flexibility to change the composition over time, was either relevant or very relevant.

Relevance of implementation of activities

Respondents were asked to provide opinions on relevance of implementation of several activities for meeting objectives of the Clean Aviation. Among activities were listed – joint R&D programme, collaborative R&D projects, deployment and piloting activities, input to regulatory aspects and co-creation of solutions with end-users. Out of 187 respondents, 119 (63.64%) indicated that collaborative R&I projects are very relevant to ensure that the Partnership would meet its objectives. A Joint R&I programme has also been considered as very relevant by a large number of respondents (112 respondents or 60.22%). Input to regulatory aspects is seen by the least respondents as very relevant, with 37.37% (68) of the responses falling in this category, however 72 respondents (39.56%) have given it a 4 on the relevance scale, which indicates that it is still considered as relevant.

No statistical differences were found between the views of citizens and other respondents.

Figure 39: Views of respondents on relevance of implementation of the following activities



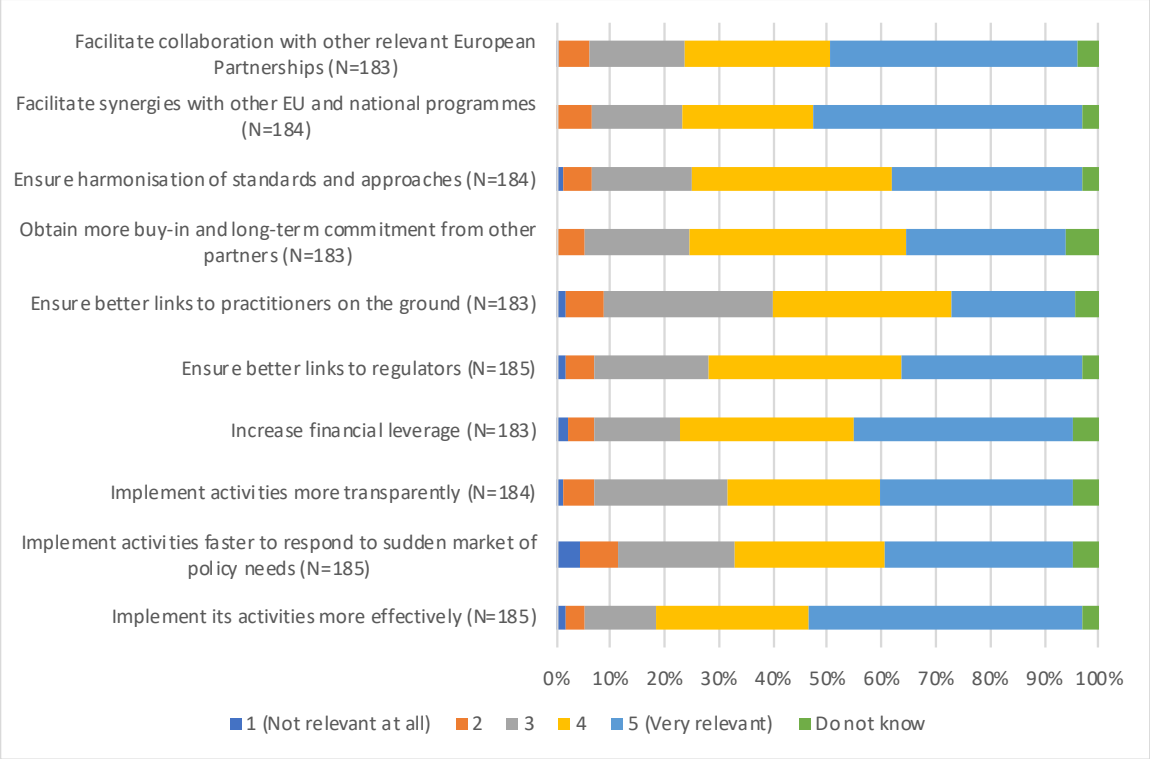
In addition, virtually all stakeholders consulted as part of the Open Public Consultation scored the following impacts with high relevance scores: increased industrial leadership and uptake of new technologies; the acceleration of key technologies through selected demonstrators; as well as the creation of high-skilled jobs in the low-carbon economy.

B.6.8 Relevance of setting up a legal structure (funding body) for the candidate European Partnerships to achieve improvements

Respondents were also asked to assess the relevance of a specific legal structure (funding body) for the candidate European Partnership to achieve several activities. According to Figure 40, the differences across the different categories are not incredibly large. For all but one measure (Implement activities more transparently), over 55% of respondents have selected either 4 or 5 (very relevant) for all the categories. The most respondents indicated that a specific legal structure was 'very relevant' to implement its activities more effectively (93 respondents, 50.27%) and to facilitate synergies with other EU and national programmes (91, 49.46%). The number of respondents that have indicated that they view a measure as 'not relevant at all' is very small across all the measures.

No statistical differences were found between the views of citizens and other respondents for most objectives. Citizens found a legal structure more relevant for the objective related to transparently. Respondents that are/were involved in a current/preceding partnership found the legal structure less relevant for the objective related to regulators.

Figure 40: Views of respondents on relevance of a specific legal structure



The Open Public Consultation responses provided further support for the view that a well-defined legal structure of the kind underpinning an institutional partnership could be expected to increase the economic and technological impacts of the initiative.

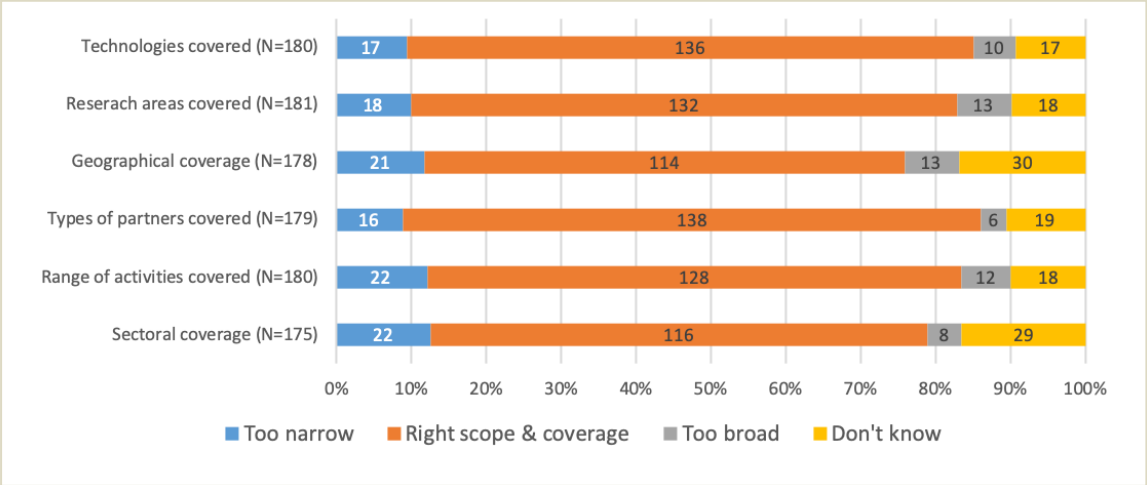
A substantial majority of business organisations of different sizes, business associations, academic institutions, public authorities and EU citizens considered that such a structure was either relevant or very relevant for achieving more effective and faster implementation of the initiative, increased financial leverage, better links to both regulators and practitioners on the ground, harmonised standards, facilitated synergies with EU/National programmes and facilitated collaboration with other partnerships.

B.6.9 Scope and coverage of the candidate European Partnerships based on their inception impact assessments

Respondents were asked to assess the scope and coverage of the Clean Aviation Partnership, based on its inception impact assessment. The clear majority of the respondents have indicated that the partnership has the right scope and coverage across all areas, with over 60% of respondents choosing this option. Respondents are the most positive with regard to the type of partners covered (138, 76.67%), technologies covered (136, 75.56%) and research areas covered (132, 72.93%). Across all areas an average of 10% of the respondents have indicated that the scope is too narrow.

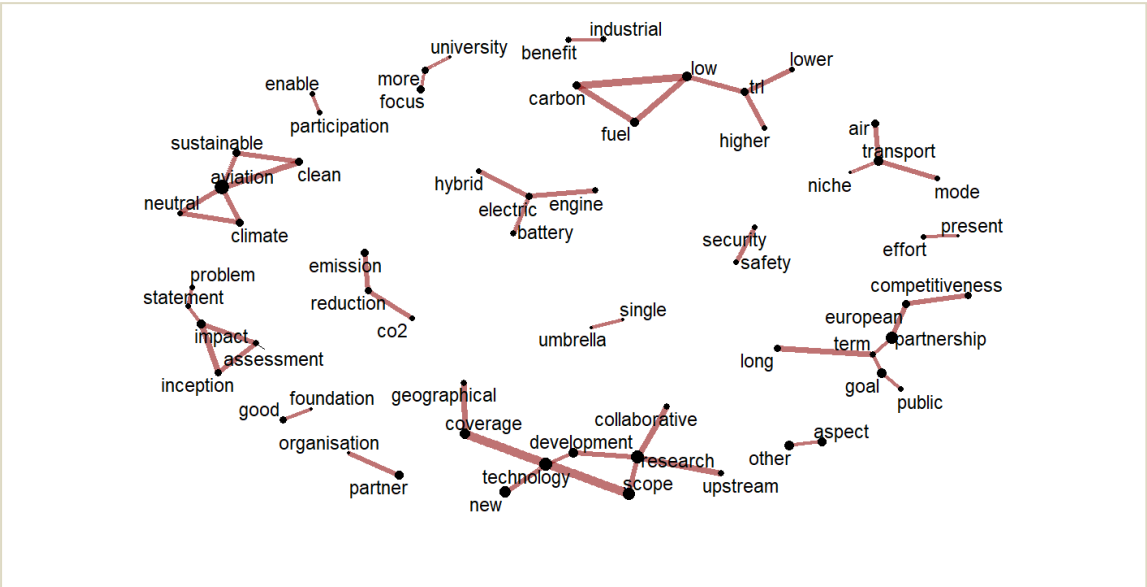
No statistical differences were found between the views of citizens and other respondents.

Figure 41: Views of respondents on the scope and coverage proposed for the Clean Aviation Partnership



Aside from this multiple choice question, the respondents were also asked to provide any comment that they may have on the proposed scope and coverage for this candidate Institutionalised Partnership. The keyword analysis used for open questions resulted in the graph shown in Figure 42. This analysis showed the respondents used this question to talk about low carbon fuel, hybrid electric batteries, impact assessment and the geographical coverage of new technology.

Figure 42: Assessment of open answers with regard to the proposed scope and coverage for this candidate Institutionalised Partnership, 50 most common co-occurring keywords (N=60)



B.6.10 Scope for rationalisation and alignment of candidate European Partnerships with other initiatives

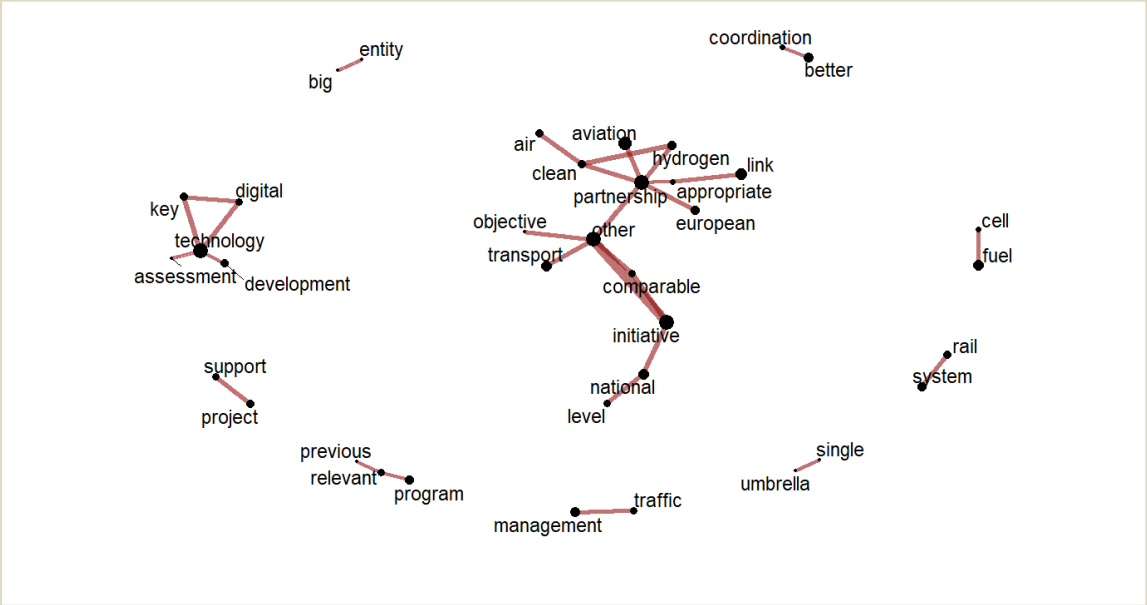
The respondents were also asked if it they thought it would be possible to rationalise the candidate European Institutionalised Partnership and its activities, and/or to better link it with other comparable initiatives. 111 respondents (66.87%) have indicated that they think this is the case.

No statistical differences were found between the views of citizens and other respondents.

The respondents who answered affirmative, where asked which other comparable initiatives it could be linked with. The results of the analysis resulted in the chart shown in Figure 43 showing the co-occurrences of keywords. The results show that respondents

think the initiative could be linked with comparable initiatives at national level, other European partnerships, including clean hydrogen and traffic management.

Figure 43: Assessment of open answers on the question on which other comparable initiatives it could be linked with, 30 most common co-occurring keywords (N=57)

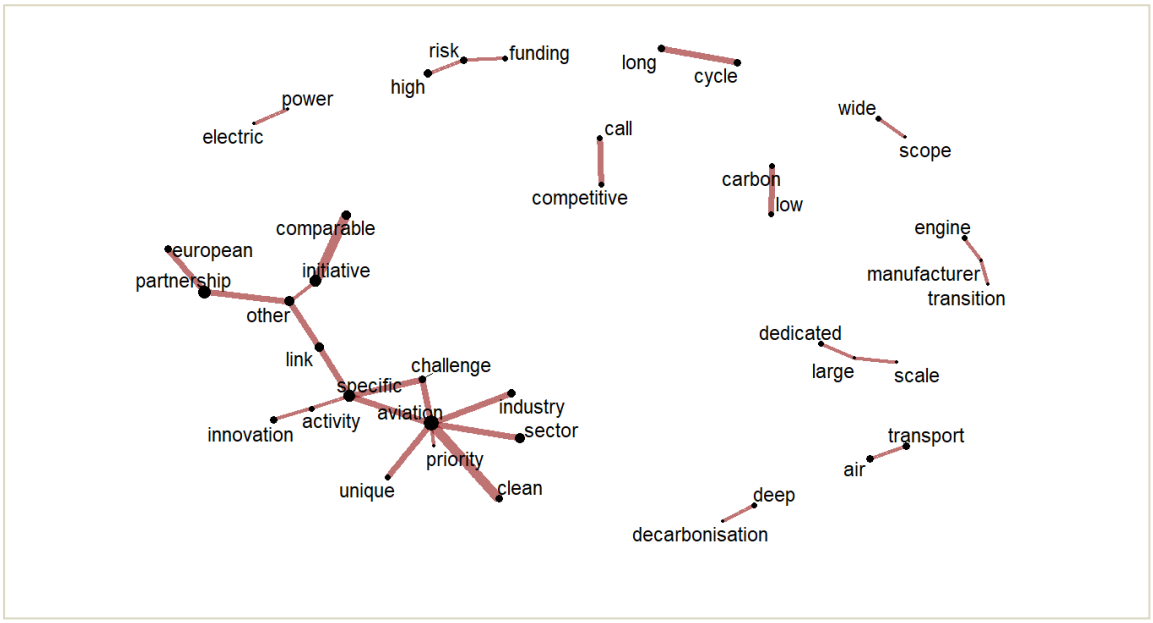


In responding to the Open Public Consultation, a majority of stakeholders stated that the legal structure underpinning an institutionalised partnership was either relevant or very relevant to the facilitation of collaboration with other partnerships under Horizon Europe. Support for this view was particularly strong among business organisations with fewer than 250 people, 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 Clean Aviation and to link it with other initiatives under Horizon Europe.

For the respondents who answered negatively on the previous question, the results of the analysis resulted in the chart shown in Figure 44 showing the co-occurrences of keywords. The results show that respondents mention other comparable initiatives, specific aviation challenges, and competitive calls.

Figure 44: Assessment of open answers on the question why other comparable initiatives are not suitable to be linked, 30 most common co-occurring keywords (N=32)

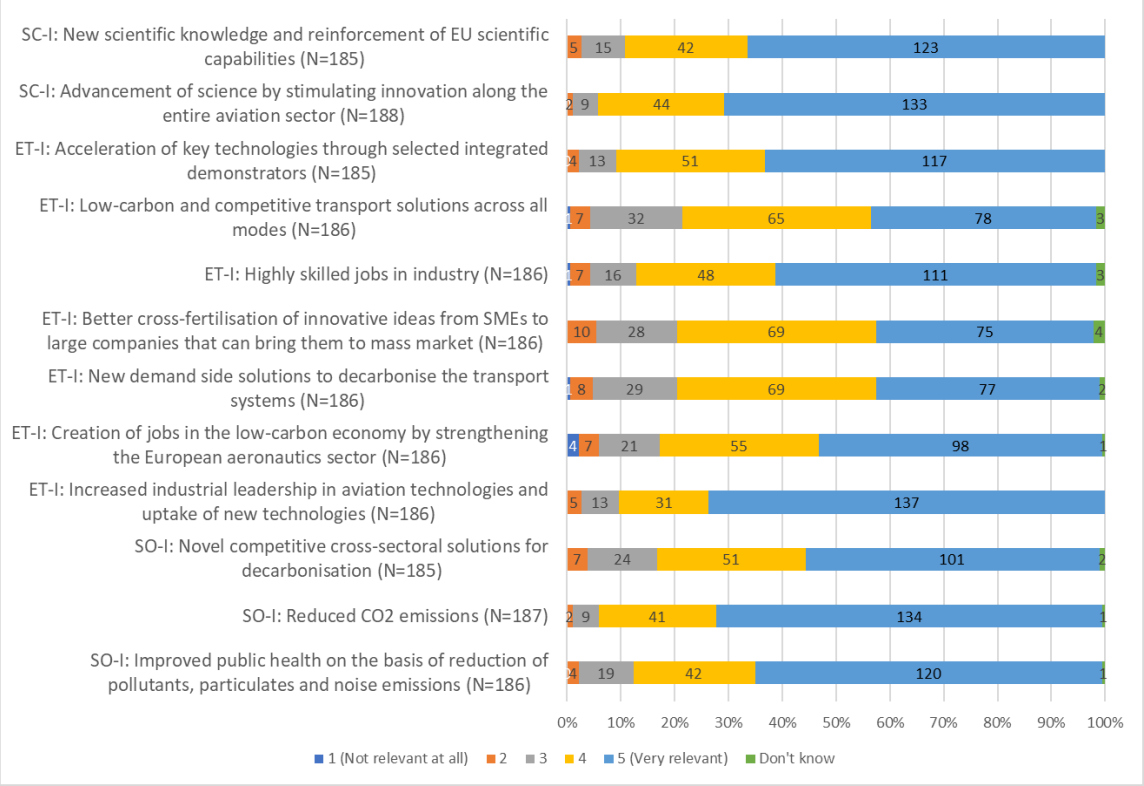


B.6.11 Relevance of European Partnerships to deliver targeted scientific, economic/technological and societal impacts

Respondents were asked to assess the relevance of the candidate European Institutionalised Partnership to deliver on listed impacts. Among societal impacts, a higher number of respondents, namely 134 out of 187 (71.66%), indicated that the Partnership would be 'very relevant' for reducing CO2 emission. Figure 45 shows that among presented economic/technological impact categories, over 60% of respondents suggest that the Partnership would be 'very relevant' for increasing industrial leadership in aviation technologies and in uptake of new technologies, for providing highly skilled jobs in industry, and for acceleration of key technologies through selected integrated demonstrators. The lowest number of respondents, namely 75 and 77 respectively, consider that the Partnership would be 'very relevant' for improving cross-fertilisation of innovative ideas from SMEs to large companies that can bring them to mass market and for providing new demand side solutions to decarbonise the transport systems. The pattern of responses about the scientific impact categories are similar, however, a slightly larger number of respondents consider that the Partnership would be 'very relevant' for advancing science by stimulating innovation along the entire aviation sector.

No statistical differences were found between the views of citizens and other respondents.

Figure 45: Views of respondents on the relevance of the candidate European Institutionalised Partnership to various impacts



Respondents were highly in favour of the potential partnership being used for the advancement of science, to develop new scientific knowledge and capabilities. Impacts that received high relevance scores include increased industrial leadership and uptake of new technologies, the acceleration of key technologies through selected demonstrators and the creation of high-skilled jobs in the low-carbon economy. The reduction in CO_2 emissions and the improvement in public health were also considered as relevant impacts.

B.6.12 Summary of campaigns results for this specific initiative

Three campaigns were identified among respondents that provided answers for the current candidate Partnership. The first campaign includes 17 respondents (campaign #2), the second campaign consists of 19 respondents (campaign #6) and the third campaign consists of 13 respondents (campaign #8).

Table 32: Overview of responses of the first campaign (campaign #2) (N=17)

Question category	Summary of responses
Research and innovation problems	With exception of one respondent, all respondents from that campaign indicated that the research and innovation efforts at the EU level are 'very relevant' to address a listed problem.
Structural and resource problems	With exception of one respondent, all respondents gave a high score (5 'very relevant') for the following categories: "limited collaboration and pooling of resources between public actors and private actors" and "high costs of demonstration of innovative solutions that hinder commercialisation". Other answer categories received lower and more mixed scores.
Problems in uptake of digital innovations	Respondents views are very mixed across all answer categories. On average, each category received a score of 3.

Question category	Summary of responses
Preferred Horizon Europe intervention	Institutionalised Partnership was selected by all respondents. When respondents were asked to explain their choice, all of them used the following quote: *"Regular calls under Horizon Europe would not deliver the coordinated approach needed for aviation decarbonisation goals. A co-programmed partnership would not have the legal status of an Eu body to confer stability, legal certainty and clarity to the partnership. An Institutionalised Partnership has proven effective in ensuring broad participation & financial and legal commitment of all stakeholders, while delivering on ambitious technology Demonstration targets".*
Relevance of actors for setting join long-term agenda	All respondents consider the involvement of industry and academia 'very relevant'. The involvement of Member States and Associated countries, on average, received a score of 4. Other answer categories have a lower score, on average.
Relevance of actors for pooling and leveraging resources	All respondents consider the involvement of industry and academia 'very relevant'. The involvement of Member States and Associated countries, on average, received a score of 4. Other answer categories have a lower score, on average.
Partnership composition	Both categories are considered 'relevant' (score 4), on average. However, respondents gave a higher rating to the category "involvement of a broad range of partners, including across disciplines and sectors".
Implementation of activities	Most respondents gave the highest score to the following activities: "joint R&I programme" and "collaborative R&I projects". Other categories have more mixed views and a lower score, on average.
Relevance of the legal structure	On average, across all categories, respondents indicated that the legal structure would be 'relevant' (score 4). The lowest score (namely, 2.8) was given to the category "ensure better links to practitioners on the ground".
Scope and coverage of the candidate Partnership	Most respondents consider that listed components of the candidate Partnership have right scope and coverage. The greatest number of respondents that indicated that the scope and coverage are too narrow was for the category "technologies covered". Respondents were offered an opportunity to provide comments on the proposed scope and coverage of the Institutionalised Partnership. Several of them included the following quote: *"Complexity of aviation products and the global-based market and regulations do require any EU effort in improving environmental impact is pursued in parallel and coherently with many other technologies allowing faster in-service introduction, affordability, modularity and simple upgrade of aeronautical products to answer to huge investments EU competitors are doing in those areas to challenge the EU leadership in the Sector".*
Rationalisation of the candidate Partnership and linking to other initiatives	Out of 17 respondents, 11 (64.71%) consider that it would be possible to rationalise the candidate Partnership and its activities, and/or to better link it with other comparable initiatives. Respondents were asked to explain their answer. Several of respondents that stated that the Partnership and its activities could be rationalised inserted a following quote: *"Distinct*

Question category	Summary of responses
	partnerships needed as stakeholders and processes are different. Lowering emissions need links and synergies with other partnerships. Despite the aeronautical requirements, several building blocks technologies must be developed in common with other sectors and customized to aviation as of basic performances and potential assessed. Among them battery, materials, digitalization, software, big data, industry 4.0, automation, ATM. PPP-I has the strength and role to set-up such strong links". Almost all respondents that states that it is not possible to rationalise the candidate Partnership and its activities, and/or to better link it with other comparable initiatives inserted the following quote: *"The initiatives have distinctly different technology challenges & objectives; while transport partnerships certainly are aligned with one another, the challenges that would be addressed within rail are distinctly."*
Societal impact	All respondents consider that the candidate Partnership would be 'very relevant' to "reduce CO2 emissions". Other categories received a slightly lower score, but are considered 'relevant' by most respondents.
Economic/technological impact	Most respondents consider that the candidate Partnership would be 'very relevant' or 'relevant' for all suggested impacts.
Scientific impact	Both answer categories are considered 'very relevant' by all respondents.

Table 33: Overview of responses of the first campaign (campaign #6) (N=19)

Question category	Summary of responses
Research and innovation problems	All respondents indicated that the research and innovation efforts at the EU level are 'very relevant' to address a listed problem.
Structural and resource problems	Most respondents gave a high score (5 'very relevant') for the following categories: "limited collaboration and pooling of resources between public actors and private actors" and "high costs of demonstration of innovative solutions that hinder commercialisation". Other answer categories received lower and more mixed scores. The lowest score received the category "regulatory barriers in the field of disruptive and digital aviation technology".
Problems in uptake of digital innovations	The majority of respondents gave a low score (between 2 and 3) across all answer categories.
Preferred Horizon Europe intervention	Institutionalised Partnership was selected by all respondents. When respondents were asked to explain their choice, most of them used the following quote: *"Timescales, risks, interdependencies between technologies, integration challenge at aircraft design level require strong coordination. JU=critical mass & strengthens EU aero-industry ecosystem, global leadership & competitiveness. Stable, long-term commitment & collaboration from the innovation chain gives visibility, overcomes inhibitors to increased investment in disruptive R&I & market failure risks. Roadmap aligned with public policy & synergies with national programs"*.
Relevance of actors for setting join long-term agenda	All respondents consider the involvement of industry is 'very relevant'. The involvement of Member States and Associated

Question category	Summary of responses
	countries, as well as, of academia, on average, received a score of 4. Other answer categories have a lower score, on average.
Relevance of actors for pooling and leveraging resources	Most respondents consider the involvement of industry and academia is 'very relevant'. Other answer categories have a lower score, on average.
Partnership composition	Both categories are considered 'relevant' (score 4), on average.
Implementation of activities	All respondents gave a high score (either 4 or 5) for all activities, with exception of "co-creation of solutions with end users". This category received a lower score (3.16), on average.
Relevance of the legal structure	Almost all respondents considered that the legal structure would be 'very relevant' for implementation of Partnership activities more effectively, for ensuring better links to regulators, for obtaining more buy-in and long-term commitment from other partners, for facilitating synergies with other EU and national programmes and for facilitating collaboration with other relevant European Partnerships. Other answer categories received a lower score, but all of them are considered 'relevant', on average.
Scope and coverage of the candidate Partnership	With exception of one respondent, all listed components of the candidate Partnership are considered to be of right scope and coverage by all respondents. Respondents were offered an opportunity to provide comments on the proposed scope and coverage of the Institutionalised Partnership. Almost all respondents included the following quote: *"The Clean Aviation shall serve the green deal policy objectives and contribute to carbon neutrality. Research areas: the Partnership in itself covers the right research areas, but other issues must be tackled in other partnerships: e.g. batteries for aviation in the Battery partnership. Geographical coverage: excellence shall remain the only criterion for the selection of partners"*.
Rationalisation of the candidate Partnership and linking to other initiatives	Most respondents (17, 89.47%) consider that it would be possible to rationalise the candidate Partnership and its activities, and/or to better link it with other comparable initiatives. Respondents were asked to explain their answer. Those who stated that it would be possible to rationalise the candidate Partnership included the following quote: *"No rationalisation but build bridges with other initiatives. Air transport decarbonisation is too complex for solutions to be developed in CA alone. Upstream cooperation is needed for solutions developed in different sectors to be integrated into aircraft/to ensure new fleets & transport modes can be integrated into ATM. EC should coordinate & support implementation of synergies with ATM, Key Digital Technologies, Batteries, Clean Hydrogen, cybersecurity, AI, 5G, Made in Europe".* Those respondents that considered that it would not be possible to rationalise the candidate Partnership and its activities inserted the following statement: *"A dedicated, strong and stable partnership embracing all relevant research and innovation actors not only from within the aeronautics sector, but where appropriate newcomers with key technologies from other sectors joining in the effort is a condition precedent for success. This partnership must maximize synergies with other*

Question category	Summary of responses
	partnerships such as ECSEL, SESAR and FOF to ensure coordination and increase impact".
Societal impact	All respondents consider that all listed categories are 'very relevant'.
Economic/technological impact	With exception of one answer in one category, all respondents consider that the candidate Partnership would be 'very relevant' for all suggested impacts.
Scientific impact	All respondents consider that all listed categories are 'very relevant'.

Table 34: Overview of responses of the first campaign (campaign #8) (N=13)

Question category	Summary of responses
Research and innovation problems	Respondents have mixed views, however, on average, they consider that the research and innovation efforts at the EU level are 'relevant' (score 4).
Structural and resource problems	Most respondents gave a high score (5 'very relevant') for the following categories: "limited collaboration and pooling of resources between public actors and private actors" and "high costs of demonstration of innovative solutions that hinder commercialisation". Other answer categories received lower and more mixed scores.
Problems in uptake of digital innovations	The majority of respondents gave a low score (between 2 and 3) across all answer categories. A higher score (namely, 3.77) is given to "regulatory framework lagging behind technology developments".
Preferred Horizon Europe intervention	Institutionalised Partnership was selected by all respondents. When respondents were asked to explain their choice, most of them used the following quote: *"iPPP is the most effective way* *-to assure a strong alignment of the research roadmap with public policy & private investment thus strengthening the overall coherence of investments* *-to ensure a strategic commitment on a common roadmap of technology development & demonstration against a sector-wide & overarching challenge such as deep decarbonisation* *-to allow strong program management & monitoring* *-to address long cycles of R&I* *-to ensure adequate assessment of progress & expected impacts"*.
Relevance of actors for setting join long-term agenda	All respondents consider the involvement of industry and academic is 'very relevant'. The involvement of Member States and Associated countries, on average, received a score of 4. Other answer categories have a lower score, on average.
Relevance of actors for pooling and leveraging resources	Most respondents consider the involvement of industry and academia is 'very relevant'. Other answer categories have a lower score, on average.
Partnership composition	All respondents consider that "involvement of a broad range of partners, including across disciplines and sectors" is 'very relevant'. The other category received a lower score (between 4 and 5), on average.

Question category	Summary of responses
Implementation of activities	With exception of two respondents, "joint R&I programme", "collaborative R&I projects" and "input to regulatory aspects" are considered 'very relevant'. Other categories have lower scores, on average.
Relevance of the legal structure	Most respondents considered that the legal structure would be 'very relevant' for implementation of Partnership activities more effectively, for increasing financial leverage, for ensuring better links to regulators, for ensuing harmonisation of standards and approaches, for facilitating synergies with other EU and national programmes and for facilitating collaboration with other relevant European Partnerships. Other answer categories received a lower score, but all of them are considered 'relevant', on average.
Scope and coverage of the candidate Partnership	All respondents that provided answer to this question indicated that the type of partners, range of activities, geographic coverage and scope are right. In other categories, between 2 and 4 respondents indicated that the coverage and scope are too narrow. Respondents were offered an opportunity to provide comments on the proposed scope and coverage of the Institutionalised Partnership. Several of them included the following quote: "Tackle all elements for climate neutral aviation, not only decarbonisation. Balanced approved approach on the budget for both Explore & Mature and Integrate & Demonstrate aspects".
Rationalisation of the candidate Partnership and linking to other initiatives	Most respondents (9, 69.23%) consider that it would not be possible to rationalise the candidate Partnership and its activities, and/or to better link it with other comparable initiatives. Respondents were asked to explain their answer. Regardless of their answer option, all of them inserted a version of the following quote: *"There is no need to rationalize the number of transport partnerships or merge Clean Aviation with other partnerships as the various specificities need to be respected. But links with other partnerships like SESAR, FCH, Batteries, alternative fuels, other parts of the program and other EU, national & regional activities can be improved. While distinct partnerships are needed there should be mechanisms for synergies & cross-fertilization as they share objectives (like lowering emissions)"*.
Societal impact	With exception of two respondents that gave a score of 4 to the category "reduced CO2 emission" other respondents across all categories gave a score of 5 'very relevant'.
Economic/technological impact	All respondents indicated that "increased industrial leadership in aviation technologies and uptake of new technologies" is 'very relevant'. With exception of two respondents, the categories "creation of jobs in the low-carbon economy by strengthening the European aeronautics sector" and "highly skilled jobs in industry" received the highest score from all respondents. Other categories have a lower score, on average.
Scientific impact	The category "advancement of science by stimulating innovative along the entire aviation sector" received a higher score (namely, 4.85) than the other one (4.38).

Appendix C Methodological Annex

C.1 Common impact assessment methodology

The Impact Assessment studies for all 13 candidate institutionalised European Partnerships mobilised a mix of qualitative and quantitative data collection and analysis methods. These methods range from desk research and interviews to the analysis of the responses to the Open Consultation, stakeholder analysis and composition/portfolio analysis, bibliometrics/patent analysis and social network analysis, and a cost-effectiveness analysis.

The first step in the impact assessment studies consisted in the definition of the context and the problems that the candidate partnerships are expected to solve in the medium term or long run. The main data source in this respect was desk research. The Impact Assessment Study Teams went through grey and academic literature to identify the main challenges in the scientific and technologic fields and in the economic sectors relevant for their candidate partnerships. The review of official documentations, especially from the European Commission, additionally helped understand the main EU policy proprieties that the initiatives under assessment could contribute to achieve.

Almost no candidate institutionalised European Partnership is intended to emerge ex nihilo. Partnerships already existed under Horizon 2020 and will precede those proposed by the European Commission. In the assessment of the problems to address, the Impact Assessment Study Teams therefore considered the achievements of these ongoing partnerships, their challenges and the lessons that should be drawn for the future ones. For that purpose, they reviewed carefully the documents in relation to the preceding partnerships, especially their (midterm) evaluations conducted. The bibliography in Appendix A gives a comprehensive overview of the documents and literature reviewed for the present impact assessment study.

Finally, the description of the context of the candidate institutionalised European Partnerships required a good understanding of the corresponding research and innovation systems and their outputs already measured. The European Commission services and, where needed the ongoing Joint Undertakings or implementation bodies of the partnerships under Article 185 of the TFEU, provided data on the projects that they funded and their participants. These data served as basis for descriptive statistic of the numbers of projects and their respective levels of funding, the type of organisations participating (e.g. universities, RTOs, large enterprises, SMEs, public administrations, NGOs, etc.) and how the funding was distributed across them. Special attention was given to the countries (and groups of countries, such as EU, Associated Countries, EU13 or EU15) and to the industrial sectors, where relevant. The sectoral analysis required enriching the eCORDA data received from the European Commission services with sector information extracted from ORBIS. We used the NACE codification up to level 2. These data enabled identified the main and, where possible, emerging actors in the relevant systems, i.e. the organisations, countries and sectors that will need to be involved (further) in the future partnerships.

The horizontal teams also conducted a Social Network Analysis using the same data. It consisted in mapping the collaboration between the participants in the projects funded under the ongoing European partnerships. This analysis revealed which actors – broken down per type of stakeholders or per industrial sector – collaborate the most often together, and those that are therefore the most central to the relevant research and innovation systems.

The data provided by the European Commission finally served a bibliometric analysis aimed at measuring the outputs (patents and scientific publications) of the currently EU-funded research and innovation projects. A complementary analysis of the Scopus data enabled to determine the position and excellence of the European Union on the international scene,

and identify who its main competitors are, and whether the European research and innovation is leading, following or lagging behind.

All together, these statistical analyses will complement the desk research for a comprehensive definition of the context in which the candidate institutionalised European Partnerships are intended to be implemented. The conclusions drawn on their basis will be confronted to the views of experts and stakeholders collected via three means:

- The comments to the inception impact assessments of the individual candidate institutionalised European partnerships received in August 2019
- The open public consultation organised by the European Commission from September to November 2019
- The interviews (up to 50) conducted by each impact assessment study team conducted between August 2019 and January 2020.

For instance, in all three exercises, the respondents were asked to reflect on the main challenges that the candidate institutionalised European Partnerships should address. In the open public consultations, they mainly reacted to proposals from the European Commission like when they were given to opportunity to give feedback to the inception impact assessment.

The views of stakeholders (and experts) were particularly important for determining the basic functionalities that the future partnerships need to demonstrate to achieve their objectives as well as their most anticipated scientific, economic and technological, and societal impacts. The interviews allowed more flexibility to ask the respondents to reflect about the different types of European Partnerships. Furthermore, as a method for targeted consultation, it was used to get insights from the actors that both the Study Teams and the European Commission were deemed the most relevant. For the comparative assessment of impacts, the Study Teams confronted the outcomes of the different stakeholder consultation exercises to each other with a view of increasing the validity of their conclusions, in line with the principles of triangulation. Appendix B includes also the main outcomes of these three stakeholder consultation exercises.

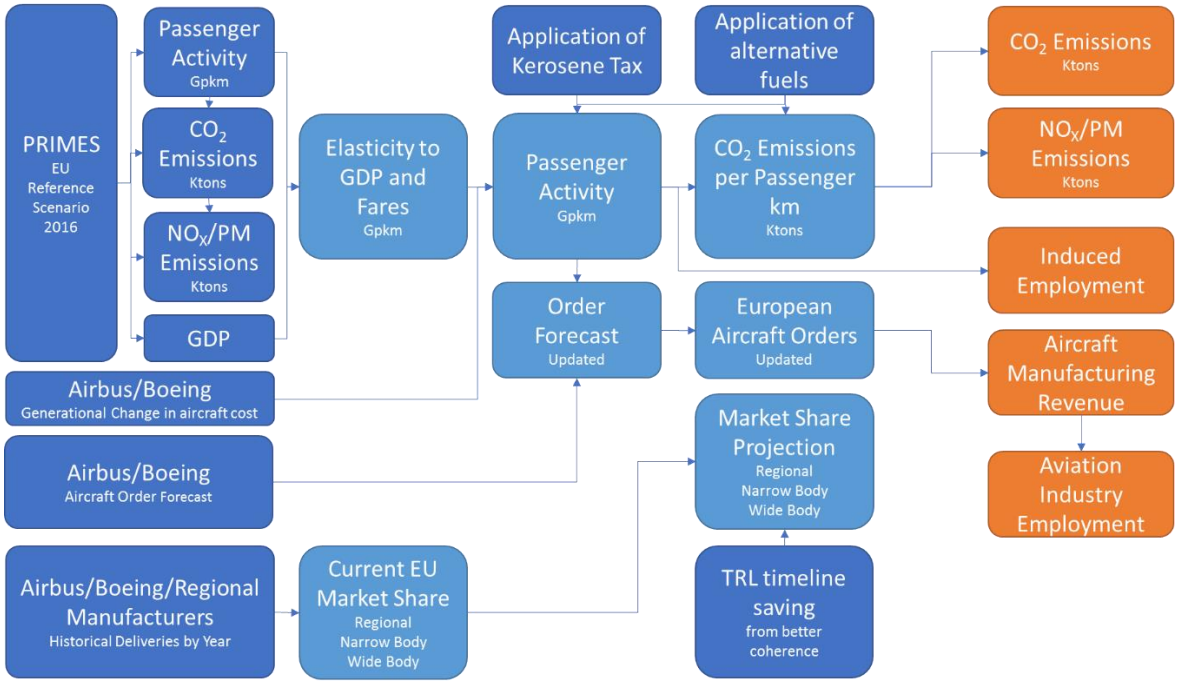
The comparison of different options for European partnerships additionally relied on a cost-effectiveness analysis. When it comes to research and innovation programmes, the identification of costs and benefits should primarily be aimed at identifying the "value for money" of devoting resources from the EU (and Member States) budget to specific initiatives. Based on desk research and consultation with the European Commission services, the horizontal study team produced financial estimates for different types of costs (preparation and setup costs, running costs and winding down costs) and per partnership option. The costs were common to all candidate European Partnerships. The results of the cost model were displayed in a table, where each cost was translated on a scale using "+" in order to ease the comparison between the partnership options.

A scorecard analysis, which allocated each option a score between 1 and 3 against selected variables, was used to highlight those options that stand out as not being dominated by any of the other options in the group: such options are then retained as the preferential ones in the remainder of our analysis. It also allowed for easy visualisation of the pros and cons of alternative options.

C.2 *Overview of the modelling framework developed for the assessment of impacts of the candidate institutionalised partnerships for clean aviation*

A model was constructed to quantify and assess the various impacts on emissions and European competitiveness resulting from the different options outlined in Section 5. The model was constructed in Microsoft excel and draws on the PRIMES forecast obtained from European Commission as well as other industry analysis conducted during the project. An outline of the modelling framework has been included in Figure 46 below. The results obtained from the model have been included in the discussion in Section 6.

Figure 46: Modelling framework



Source: Steer

Note: dark blue = input, light blue = calculation, amber = output

The model uses the following inputs:

- Inputs from the PRIMES Reference Scenario, including activity (passengers, emissions and EU GDP) up to 2050. Elasticities to EU GDP and fares are back-calculated so the effects of higher kerosene taxes can be applied
- Changes in (real) aircraft cost by generation was evaluated by analysing the cost of current and previous generation aircraft. In real term airframe costs have increased, whilst operating costs have decreased.
- Aircraft delivery forecasts by geographical market were obtained from the Airbus Global Market Forecast and Boeing Commercial Market Outlook.
- European market share in the regional, narrow body and wide body market was analysed from manufacturer delivery data by year.
- Impacts on employment were estimated based on the scale of today's market.

The following table provides an indication of matrix of assumptions used.

Table 35: Key assumptions used in the impact assessment

Option	Potential reduction in TRL cycle and	Market take-up of R&I outputs	Alternative Fuels
Traditional open calls	No change	No change due to new technologies[50] European share of Chinese/Russian market reduces to zero by 2050	SAF usages increases by 1% per annum from 2040 for short and long haul flights
Co-programmed partnership	2 years Efficiencies realised from improved cooperation	+11% due to new technologies stimulating demand for new aircraft European share of Chinese/Russian market reduces to ~10% by 2050	SAF usages increases by 1% per annum from 2037 for short and long haul flights
Article 187 partnership	3 years Efficiencies realised from improved cooperation	+18% due to new technologies stimulating demand for new aircraft European share of Chinese/Russian market reduces very slightly	SAF usages increases by 2% per annum from 2032 for short and long haul flights. Battery usage on regional flights increase by 2% per annum from 2040 Hybrid aircraft usage on short haul flights increase by 20% per annum form 2040

Other key assumptions made in the model are the following:

- Taxes are progressively applied to kerosene in Europe, equalising the cost of kerosene and SAF in 2050

The model has been used to calculate the external impacts of efficiency gains on traffic levels, employment and environmental emissions. It can also be used to generate estimates of impact on the economy, measured in terms of Gross Value Added (GVA).

The most important calculations were made as such:

- CO2 emissions are calculated by multiplying the kerosene-powered passenger.km forecast for each scenario with the projected CO2 emissions per passenger. The projected CO2 emissions per passenger.km forecast in the base case is derived from PRIMES reference scenario and assumes that CO2 emissions per passenger.km reduce at an average rate of 1.5% per annum. This projection is in line with that has been stated in the Commission's Inception Impact Assessment and assumes continuous improvements due to current technologies but continued use of kerosene as the source of aviation fuel. Differences in CO2 emissions per passenger are derived from the assumed acceleration of emission per passenger reductions resulting from the various

[50] In the global market, excluding China and Russia

scenarios under Horizon Europe. Changes to the quantity of SAF-powered passenger.km under each scenario also influences overall CO2 as these are assumed to have no net CO2 emissions.

- NOX /PM emissions: ratios of NOX and PM emissions to CO2 emissions is derived from PRIMES reference scenario and applied to the CO2 emission forecasts under each scenario.
- Induced employment is derived by increasing the 2016 European aviation industry employees by either the number of aircraft manufactured in Europe (aeronautical sector employment) or by passenger.km growth (aviation, indirect, induced and tourism).[51]
- Aircraft manufacturing revenue: The aircraft manufacturing revenue is calculated by combining the following drivers:
    - Global market forecasts from Airbus and Boeing (aircraft demand per annum)
    - Average aircraft price (regional, narrow-body, wide-body) based on list prices from Airbus, Boeing and Embraer.
    - Average increase in aircraft cost per annum, based on differences in generational cost between aircraft types (e.g. 787 cost versus 767 cost). Price increases were accelerated under each scenario as more advanced technologies become available to the market more quickly.
    - The European market share of the global commercial aircraft market was assumed by Steer for each scenario.
- Aviation industry employment: see aeronautic sector employment under induced employment

[51] https://aviationbenefits.org/around-the-world/europe

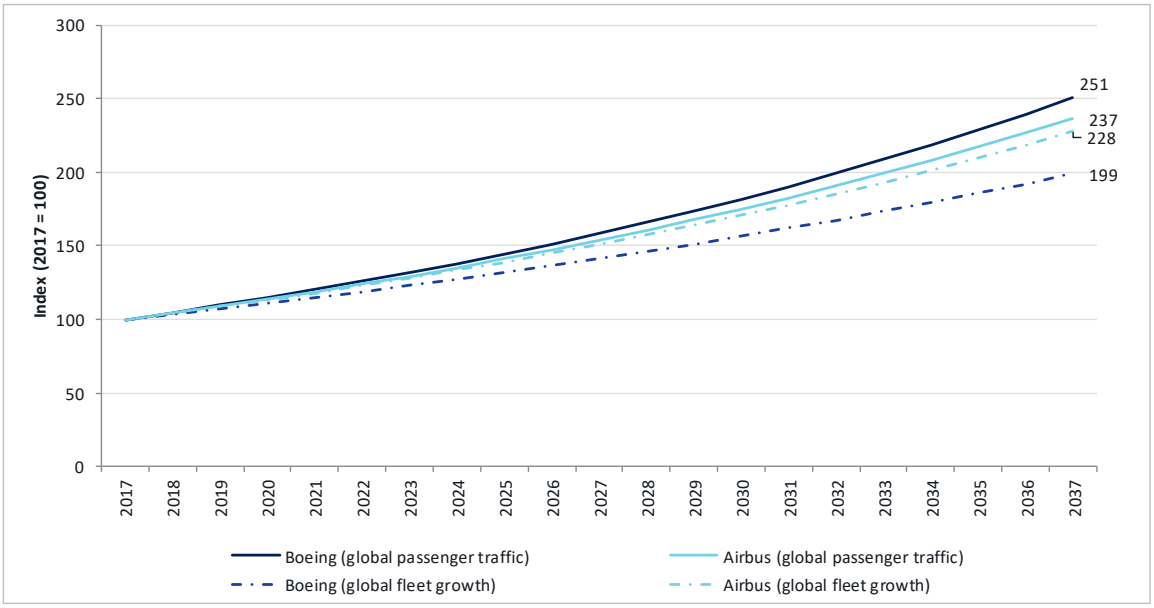
Appendix D Additional information on the emerging challenges in aviation

The civil aviation market has been steadily growing at a significant rate over the last few decades (air passenger numbers doubling every 15 years) as the option of flying becomes more accessible to greater proportions of the world's population. The emergence of low-cost carriers combined with rising levels of disposable income has increased people's propensity to fly. Emerging economies already play a crucial role in air travel, with 30% of emerging country populations taking a flight in 2017. As the middle class develops, it is expected that by 2037 the proportion of emerging country populations that will fly increases to around 85%.

IATA suggests that total air passenger numbers will double over the next two decades, reaching 8.2 billion passengers in 2037. Eurocontrol forecasts that aircraft movements in Europe in 2040 will be 53% more than in 2017 with an average annual growth of 1.9% over the 2017-40 period.

Air passenger and aircraft fleet forecasts from Boeing and Airbus both expect strong growth, as shown in Figure 47. The Boeing Commercial Market Outlook, which is slightly more optimistic than Airbus' Global Market Outlook, expects passenger numbers to increase 2.5 times between 2017 and 2037. Based on the number of expected deliveries for both manufacturers to either increase the fleet or replace part of the existing one, it is expected that the number of aircraft will more than double. Currently the European aerospace industry manufactures 50% of the global civil aviation fleet, which means it has a strong responsibility to address the technological and operational breakthroughs that will lead to climate neutrality.

Figure 47: Global passenger and fleet forecast from Boeing and Airbus



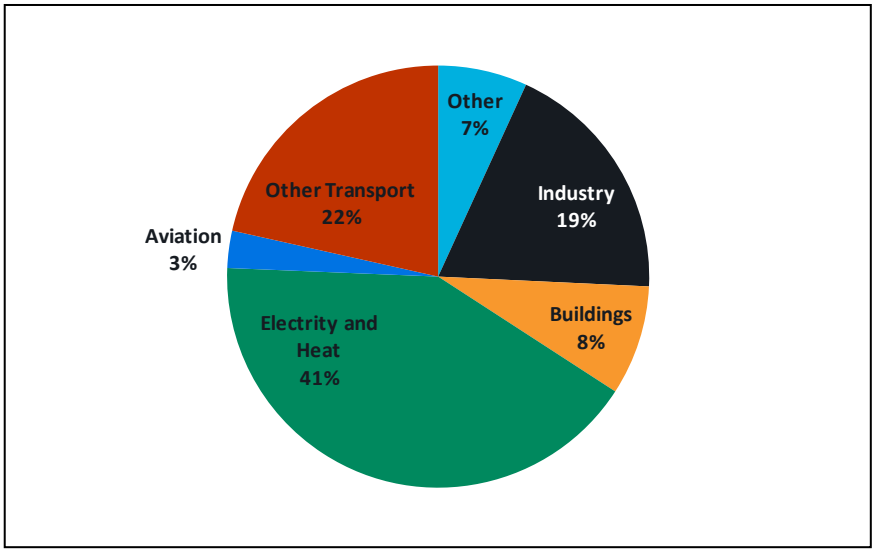
Source: Airbus (2018) & Boeing (2018)

The evolution of the aviation industry will also be impacted by new travel trends (such as Flygskam or "flight shame" leading people to use less pollutant transport modes such as long-distance train travel). The aviation industry was accountable for 13.3% of European transport greenhouse gas emissions in 2016 and was the third largest contributor after road transport (72.1%) and maritime transport (13.6%). Greenhouse gas emissions from railway operation only account for 0.5% of total emissions.

Aviation has significant impacts on the environment: it contributes to climate change primarily through the emission of carbon dioxide (CO_2) and nitrogen oxides (NO_x), but also

through the emission of contrails, sulphur dioxide (SO2), carbon monoxide (CO), hydrocarbons, ultra-fine particulate matter (ufPM) and soot. All are a product of kerosene (fossil fuel) combustion. An additional key environmental issue is the generation of noise, specifically in the vicinity of airports where it impacts the population living close to the airport area as well as under the main flight paths for take offs and landings. Globally, CO_2 emissions from aviation have increased from 88 million to 171 million tonnes, representing an increase of 95%, between 1990 and 2016. The share of EU CO_2 emissions accounted for 20% of global aviation's carbon dioxide emissions in 2015. CO_2 emissions from the aviation sector currently represent around 3% (as displayed in Figure 48) of the total anthropogenic emissions worldwide with its share growing continuously.

Figure 48: Global man-made CO_2 emissions



Source: International Energy Agency (2016)

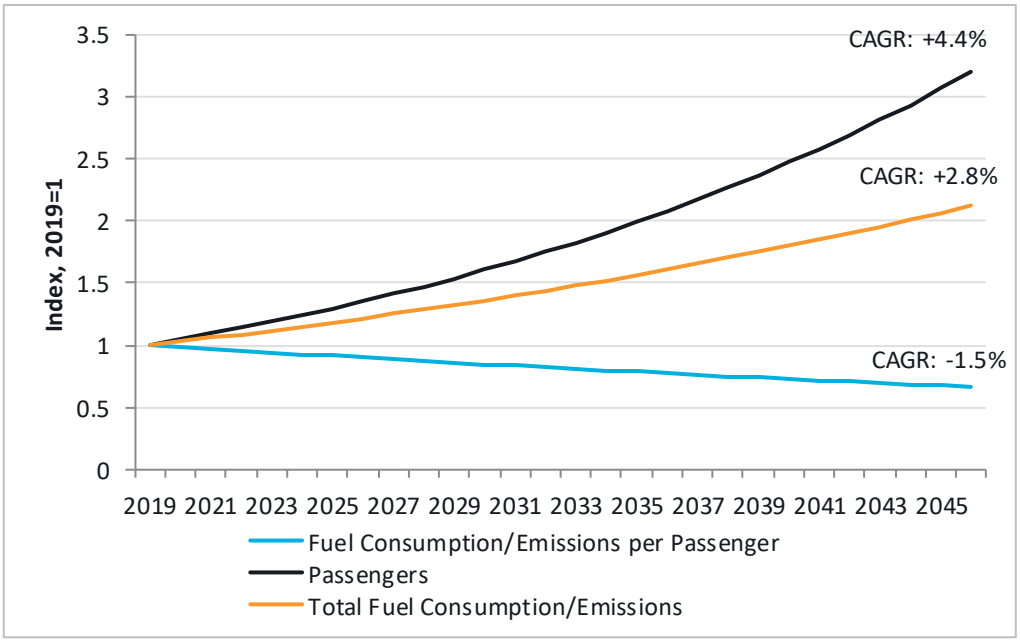
Whilst the figure of 3% is often publicised, the cumulative effect of non- CO_2 impacts more than double aviation's contribution to global warming. Emissions of NO_x contribute to a warming effect from the formation of short-term tropospheric ozone (O_3); the cooling effect from the reduction in ambient methane (CH_4) does not completely counterbalance the warming effect, causing a net increase in radiative forcing. Depending on the atmospheric conditions, linear contrails formed by aircraft can spread into large cirrus-cloud like structures, which can exhibit both warming and cooling effects, although the overall global mean response is considered to be warming.

Over the past decades, the aviation industry has taken various steps towards lowering its environmental footprint and is actively trying to reduce the negative externalities even further. Around €13.4 billion is spent annually on efficiency-related research and development by the civil aerospace industry. Technological improvements have led to substantial historical improvements in fuel efficiency, a move towards more sustainable aviation fuel and reductions in CO_2 emissions, as well as improvements in noise levels. Compared to 50 years ago, an aircraft produces 70% less CO_2 today and is 75% quieter than 30 years ago.

Whilst efficiency improvements are constantly being incorporated into newer generation aircraft, reducing fuel consumption and in turn reducing CO_2, NO_x, ufPM and noise emissions, the increasing popularity of air transport amongst consumers has continued to rise at such a rate that emissions from the air transport industry are continuing to rise year on year. Figure 49 shows the forecasted state of future emissions of CO_2 if the current status-quo of passenger growth and technology improvements are maintained.

Targets to further improve the environmental performance of the sector include for instance fuel efficiency improvement targets set by ICAO, but such incremental technological improvements are expected to only reduce fuel consumption and total CO_2 emissions by 1-1.5% per year. The aviation industry, however, is projected to continue to grow at a much higher rate of 4.4% annually thus also causing CO_2 emissions to increase faster by around 3% each year.

Figure 49: Projection of CO_2 emissions if current status-quo of passenger growth and technology improvements are maintained



Source: European Commission

Due to the complex nature of the aeronautical industry, and the need for stringent safety and security, cycles between aircraft can typically take between 10 and 20 years. The development of each new generation of aircraft is also a very costly exercise: for instance, development costs for the A380 programme were in the range of €15-20 billion, whilst those for the A350 were around €11 billion. Despite their high programme costs, improvements brought to both models were primarily improvements to existing aircraft infrastructure, with efficiency improvements mainly stemming from reducing airframe mass, improving aerodynamic efficiency and the application of the latest generation of turbo-fan engines. All these improvements also allowed for lower airline operational costs, a key driver for airlines' decision to purchase new aircraft.

High-costs and long development cycles combined with financial involvement from the private sector and stringent safety requirements do not foster an environment for step change innovation. Instead, aircraft manufacturers must operate a balancing-act between incorporating efficiencies to new generation aircraft, making these improvements available in a time-frame coherent with average aircraft lifecycle and providing a return on investment.

The movement towards a zero-emissions aviation industry is less straightforward than for other modes of transports. Whilst technologies such as the replacement of combustion engines with electric motors will likely form part of the solution towards delivering cleaner aviation (though not for noise!), delivering an energy source to a non-land based vehicle is far more complex and requires the further development of technologies such as batteries, fuel cells and SAF, whilst maintaining high safety standards and low-mass.

R&D in the aeronautical sector is working on a number of scientific and technological innovations to meet the environmental goals set for the aviation industry. The evolution of

aircraft engines plays a key role in helping to reduce noise and emissions. There are a number of ways to reduce aircraft engine emissions, by reducing fuel consumption through improving the propulsive efficiency of the aircraft engine. With historic engine improvements, substantial reductions in fuel burn have already been achieved with fuel usage falling by 70% since the 1950s and fuel efficiencies continue to be achieved with the improvement of existing and development of new products. This has been mainly due to the improvements in engines along with improvements in materials, structures, aerodynamics and avionics. Additional environmental improvements have been realised from improved air traffic management which has realised reductions in emissions from introducing continuous descent flight paths into airports as well as other means which have improved flight path efficiency. Other environmental KPIs of the Single European Sky (SES) may demand technological improvement and policy changes to achieve the SES goals.

The development of SAF has been identified by the wider aviation industry as a key element in helping to reduce emissions. Over their full lifecycle, SAFs can reduce the carbon footprint by 80% and the first commercial flights using SAFs were already achieved in 2011. Future visions include the adoption of SAFs as a licensing requirement post-2020 and deployments on a commercial scale.

Further scientific and technological research efforts are centred around the improvement of propulsive efficiency. In an aircraft's turbofan where most of the air bypasses the core, thrust is generated with energy from the core driving the fan. This, in turn, increases the propulsive efficiency and as a result improves fuel consumption and reduces noise. Aeronautical R&D is working on lightweight systems that further increase the bypass ratio without significantly increasing the engine's size and weight. Rolls Royce, for instance, aims to improve the fuel efficiency of their engines by 25% by 2025 relative to a Trent 700 engine through UltraFan engines.

Other expected future scientific and technological evolutions in aeronautics will likely include improvements in the engine's thermal efficiency, noise technologies, and minimising the power requirement from non-propulsive systems through embedded electric motors and generators. The disruptive potential of electrification of the aircraft is a key issue for the aeronautical sector. Evolutions in the field of electric technologies have the potential to support the climate neutrality of the aviation industry. Although a fully electric long-haul flight will not be possible to realise in the near to medium term, hybrid electric flights could provide one technical option but with some capacity and range limitations.

Additionally, the design and introduction of urban-air transport vehicles could help reduce land-based traffic congestion in cities. However, risks also exist that advances in partially electrically powered aircraft result in making them a popular alternative to other modes for short trips and thus even further increase the number of people travelling by air. Increased demand for flights on a hybrid aircraft will then increase the levels of noise, NO_x, ufPM and CO_2 emissions including with the introduction of a fully electric aircraft to serve this new demand.

Economic drivers that may have an impact on the future of the global and European aviation industry are the price of oil, integration along the supply chains, and the further integration and application of open data and big data processes to improve technical and operational efficiencies. Furthermore, political developments such as Brexit may have potential long-term effects on the economic cooperation of the different players of the European aeronautics sector, which could result under the most pessimistic scenarios in a change in the value-chain and/or suppliers, increase time and costs linked to border tariffs and customs checks, EASA certification issues on UK-produced parts, etc.

Trade and tariffs wars with the USA, under the arbitration of WTO, have been ongoing for some time, but remain an acute industrial risk negatively affecting market development.

In addition, the public nature of WTO investigations forces Airbus and Boeing to disclose technologies and documents that allow third country competitors to expand their knowledge base.

Appendix E Additional information on the European transport policy

Over the last 20 years, the EU's liberalisation of the internal market for air services and the substantial growth of demand in air transport within the EU and worldwide have resulted in the significant development of the European aviation sector. Aviation is a strong driver of economic growth, jobs, trade and mobility for the European Union. It plays a crucial role in the EU economy and reinforces its global leadership position. All trends indicate a sustained increase in demand from EU citizens for air travel until 2040 and beyond.

The Emissions Trading System (ETS), launched in 2005 before becoming operational in 2012, is the cornerstone of the European Union's policy to tackle climate change. Originally all flights operating within and to/from the EEA were included in the scheme, however the scope of ETS on aviation was provisionally reduced to intra-EU flights until 2016 although this timeframe has since been extended.

In 2015, the European Commission published an "Aviation Strategy for Europe" which set out a number of policy initiatives aimed at fostering a more competitive EU aviation sector and a model for sustainable aviation. In particular, it focused on CO_2 emissions, in view of "the need for urgent and bold action" to combat climate change: verified CO_2 emissions from aviation activities carried out between aerodromes located in the EEA amounted to 67 mega tonnes of CO_2 in 2018, a 25.2% increase since 2013.

The Paris Agreement, a global agreement on the reduction of climate change, negotiated at the 21st Conference of the Parties (COP) in 2015, will enter into force when joined by at least 55 countries which together represent at least 55 percent of global greenhouse gas emissions. The agreement calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. In the adopted version of the Paris Agreement, the parties will also "pursue efforts to" limit the temperature increase to 1.5 °C.

To facilitate the transition away from fossil fuels towards cleaner energy and to deliver on the EU's Paris Agreement, the EU agreed a comprehensive update of its energy policy framework. Based on Commission proposals published in November 2016, the Clean Energy for All Europeans package consists of eight legislative acts. After political agreement by the Council and the European Parliament in 2018 and early 2019, enabling all of the new rules to be in force by mid-2019, EU countries have 1-2 years to transpose the new Directives into national law. On renewables, the EU has set an ambitious, binding target of 32% for renewable energy sources in the EU's energy mix by 2030.

In 2016, ICAO agreed on a resolution for a global market-based measure to address CO_2 emissions from 2021. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) aims to stabilise emissions at 2020 levels by requiring airlines to offset any growth in their emissions after 2020. Airlines will be required to monitor and offset emissions on all international routes and offset excess emissions. All EU countries will join the scheme from inception.

In 2017, the Juncker Commission put forward a set of measures in its "Europe on the move" plan to support decarbonisation, digitalisation and innovation in the transport sector, including a strategic Action Plan for the development and manufacturing of batteries in Europe and a forward-looking strategy on connected and automated mobility.

A key overarching objective of Union transport policy, addressing climate change through a reduction in carbon emissions from transport, is clearly restated in a recent Commission report, 'A Clean Planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy', published in November 2018. The vision describes various pathways "to a net-zero greenhouse gas emissions economy by 2050" based on seven building blocks, including embracing "clean, safe and connected

mobility". While noting that transport is responsible for a quarter of greenhouse gas emissions in the European Union, the Commission argues that a strategy for reducing such emissions cannot rely exclusively on electrification using renewables alone. Rather, it will require action to encourage the development and use of advanced Sustainable Alternative Fuels (SAF), hybridisation and other improvement in aircraft technology, and, by fostering digitalisation and innovation towards greater efficiency. In parallel, the aerospace industry organised through ACARE (the Advisory Council for Aeronautics Research in Europe) updated in 2017 its Strategic Research and Innovation Agenda (SRIA) to guide the future direction of public and private research towards the achievement of the 'Flightpath 2050' Vision, which aims, among others, to reduce CO_2 emissions per passenger kilometre by 75%, NOx by 90% and perceived noise by 65% all relative to the year 2000.

The European Union also supports the United Nation's Sustainable Development Goals, namely SDG 9 on industry, innovation and infrastructure, SDG 11 on sustainable cities and communities, SDG 12 on responsible consumption and production, SDG 13 on climate action, as well as SDG 7 on affordable and clean energy to protect the planet from degradation, so that it can support the needs of the present and future generations. In February 2019, the Commission released a reflection paper towards sustainable Europe setting out ideas.

On 16 July 2019, the President-elect of the European Commission presented her political guidelines, "A Union that strives for more. My agenda for Europe", and six main ambitions for Europe with the first and most important one being a European Green Deal. The European Green Deal aims to make Europe the first climate-neutral continent in the world. It reflects higher ambitions in terms of reduction of emissions: an increase of the 2030 targets from 40% to 50%. A more active role of European Union in international negotiations with other major emitters should aim at a 55% target within the same horizon. The European Green Deal calls for coordinated efforts to reduce the carbon footprint of the transport sector and increase the contribution of the blue economy to decarbonisation.

The attainment of the targets in the European Green Deal implies cutting-edge research and innovation. In addition to the provision of financial support, the European Commission announced measures to stimulate private green and sustainable financing, and ensure that all stakeholders adapt to, and become actors of, the economic transition and system transformation. According to the Mission Letter to the Commissioner-designate for Energy, energy policy should also contribute to the achievement of the European Green Deal Objectives. The President-elect announced that the European Commission will consider whether amendment should be made to legislations on energy efficiency and renewable energy. Other objectives include accelerating the uptake of clean energy implying better interconnectivity and improved energy storage, and on increasing investments in the same area through a dedicated investment plan. The protection of the environment and the related ambition to attain zero-pollution in the European Green Deal are intended to contribute to the improvement of the health conditions of people. Finally, the European Green Deal would include a New Circular Economy Action Plan aimed at a sustainable use of resources in industry, and more stringent rules against single-use plastics.

The Chicago Convention bans parties from imposing taxes on fuel already on board an aircraft when it lands in another country but does not prevent the taxation of the intake of fuel. However, bilateral air service agreements between countries have mutually prohibited the taxation of fuel on flights between the countries in question. According to the Energy Taxation Directive (ETD), aircraft fuel for commercial operations is exempted from taxation, but Member States can tax fuel for domestic aviation since 2003. The ETD also allows for the taxation of fuel on intra-EU flights provided that both Member States have entered into a bilateral agreement. The Netherlands is currently the only Member State that levies taxes on fuel for domestic flights, although the application of this in reality is limited owing to the absence of scheduled domestic flights in the Netherlands. Until now,

there has been a global consensus to exempt aviation kerosene from tax, but the Commission has just launched the process of evaluating the ETD to see if a potential update is necessary. Air passenger taxes are levied in many Member States, whilst the Netherlands is currently reviewing whether to reintroduce a tax in 2021, having previously removed one in 2009.

As environmental pressures from the public and political entities are likely to increase in the future, more regulation and more coordination of policies on emission and noise pollution can be expected. A review of the Industrial Emissions Directive (EC 2010/75) is also planned for 2020. Its scope encompasses all emissions, including those of aviation (NOx, SOx, VOCs, heavy metals and dioxins but not carbon covered under the ETS framework). Other relevant policy initiatives that will be considered include the modernisation of the Noise Directive (EC 2002/49) and the implementation of the Innovation Fund which could provide funding to accelerate promising innovative solutions for aviation: the Fund, endowed with at least 450 million allowances is the successor to the NER 300 programme and could contribute to future partnerships and missions under Horizon Europe in line with the objectives of Directive 2003/87/EC.

With many policy initiatives, a coordinated approach on policy will be necessary to ensure that market-based measures (such as carbon offsets or carbon trading), taxation, alternative energy use, or changes to emissions and noise legislation are considered towards the achievement of the same objectives. Synergies between LIFE, Horizon Europe and the Cohesion Funds are needed.

In addition, the highest standards of safety are required by the European Union, the industry and the passengers so that air transport remains one of the safest transport modes. All policy changes in the sector must occur with no adverse impact on safety, with the industry required to be aligned with DG MOVE's European Aviation Safety Strategy and Programme. A successful EU aviation safety policy is also an important asset of the EU in international relations. EU safety requirements are perceived as state-of-the-art and whilst they enhance global safety levels, contributing to the safety of EU citizens travelling outside the EU, they have a catalytic impact on the competitiveness of the EU aeronautic manufacturing industry. Since its creation, the European Aviation Safety Agency (EASA) has played a key role to ensure a high uniform level of safety protection for EU citizens within the EU and worldwide, to ensure the high uniform level of environmental protection with respect to aeronautical products and to avoid duplication in the regulatory and certification processes among Member States.

The European aeronautical sector is fully integrated with many components crossing national borders several times before final assembly. The supply chain consists of many large, medium and small-sized companies operating just-in-time principles. A no-deal Brexit would be detrimental for the European aeronautical industry's competitiveness on a global scale. Technical discussions on the regulatory environment (including EASA) have been taking place to minimise potential disruptions.

Appendix F Additional information on Clean Sky 2 Joint Undertaking

F.1 Governance

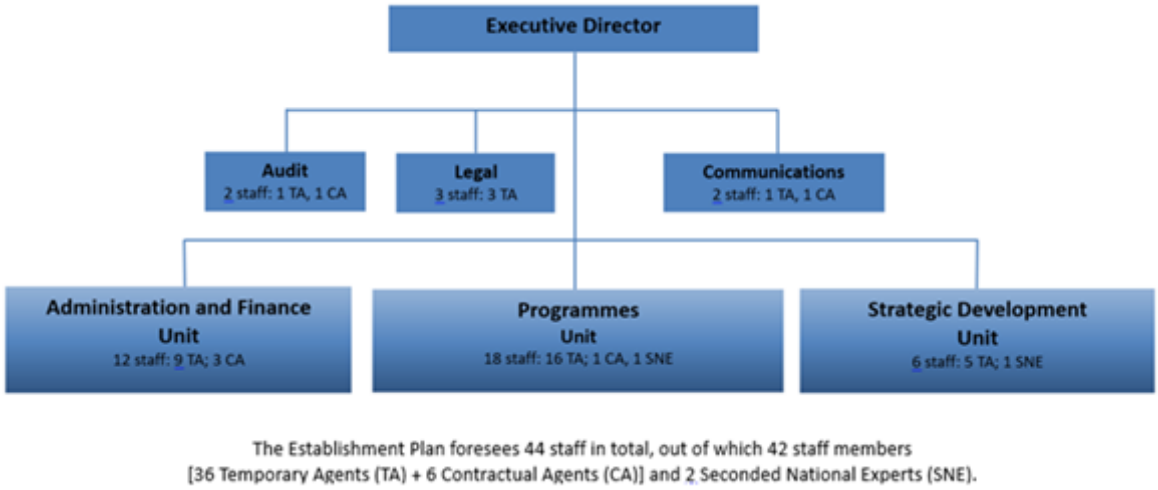
The governance of the CS 2 JU comprises:

- A Governing Board, including representatives of the founding members, core partners and the Commission (with 50% of the voting rights); Observers of the Governing Board include the Chair of the States Representative Group;
- An Executive Director, supported by three Heads of Unit (Strategy and Horizontal Affairs, Programmes and Administration and Finance), responsible for day-to-day management;
- A series of Steering Committees responsible for the technical decisions taken within each Integrated Technology Demonstrators (ITD)/ Innovative Aircraft Demonstration Platforms (IADP) and in the Technology Evaluator as set out below;
- A Scientific Committee providing advice to the Governing Board;
- A States Representative Group (SRG) acting as an advisory body to the Governing Board; and
- Various Working Groups.

F.2 Organisation

The organisational structure of the JU is shown below. It shows the three main units' structure and composition in terms of staffing.

Figure 50: Revised organisational structure of the CS 2 JU



Source: CS 2 JU

F.3 Innovation programme funding

As discussed in section 1.2.2, the R&I activity coordinated by the JU is organised according to a number of ITDs, IADPs, transverse activities and calls. The table below sets out the budget allocation across these expected following adoption of the Annual Work Plan for 2019.

Table 36: CS 2 JU 2019 activities and budget

Activity and 2019 budget	Areas of activity in 2019
IADP 1 – Large Passenger Aircraft **Budget: €99 m**	Scope and test set-up of low-speed test with UHBR test rig defined and associated documentation available, report about outcome of TRL3 for enabling technologies, qualification Test Report for the Dynamically Scaled Flight Demonstrator, CDR for HLFC HTP, Conceptual System & Architecture Design Report of HLFC wing, Report and the model for UHBR Powerplant integration framework, Final report on flow control ground test, Detailed Hybrid Electric Propulsion Aircraft concepts, Intermediate test results of the hybrid electric propulsion system. Multifunctional Fuselage demonstrator shells manufactured (delivery early 2020), Thermoplastic components welding qualification tests completed, results available, Cabin & Cargo platform modules incl. Advanced Micro PSU test specimen available and ready for integration, Delivery and testing of the OBBIGS Environmental Friendly Fire Protection demonstrator, Package (build up process, modules definition, product Mat A, pre-production design), to prepare the simulation results on industrial feasibility of advanced lower centre fuselage concept scheduled in 2020. Flight tests prototypes for Software Defined Radio, DISCO test bench second version, Multimodal Human Machine Interface Prototype for Business Jet cockpit demonstration, REACTOR Standalone technologies operational validation (TRL4), ADVANCE Maintenance solutions demonstration final reports.
IADP 2 – Regional Aircraft **Budget: €6.4 m**	Conventional configuration weight e-balance analysis, aerodynamics and aero-acoustic integration studies - Loop 2 (WP1.1); sub-components representative of outer wing box; verification and Validation (WP2.1); FTB#1 A/C Modifications Technical Dossier - preliminary (WP3.1); Installation layouts and interface control drawing of the Regional Aircraft Cabin major; items of the On-Ground Pax Demonstrator Platform (WP3.2); static & Dynamic Loads assessment on the capabilities of the Load Alleviation System (WP3.5).
IADP 3 – Fast Rotorcraft **Budget: €10 m**	General Requirements & Objectives (GRO) - PDR maturity (WP1); NGCTR Configuration – PDR maturity (WP1); RACER Critical Design Review Minutes of Meeting (WP2); NGCTR input to FRC Mission level Results in support of 1st TE Global assessment (WP4); RACER input to FRC Mission level Results in support of 1st TE Global assessment (WP4)
ITD 1 – Airframes **Budget: €18 m**	Moveable demonstrator CDR; IWTT for the Slat demonstrator; CDR RACER's Wing; winglet Morphing flight components for FTB#2 Step 1; multifunctional Flap flight components for FTB#2 Step 1
ITD 2 – Engines **Budget: €15 m**	Preliminary Design Review report meeting (WP2); preliminary IPPS Test Report following FEPTT (WP3); engine Demo. Critical Design Documentation (WP4); UltraFan® PDR Summary Review (WP5); UltraFan® PDR Summary Review (WP6); Permit-to-Fly documentation (WP7); Final Evaluation report (WP8)

Activity and 2019 budget	Areas of activity in 2019
ITD 3 – Systems **Budget: €15 m**	Enhanced Flight Vision System / Combined Flight Vision System Validation Test Plan (WP1); standardisation plan (WP2); delivery of Spoiler/Aileron electro-mechanical (EMA) for Regional A/C to testing (WP3); detailed design review (DDR) and review results for electro-mechanically actuated (EMA) braking (WP4); electrical network conversion final test description (WP5); Electrical Wing Ice Protection system (EWIPS) TRL5 maturity report (WP6); Seat Demonstrator No.2 – Test Evaluation Results (WP7); update on Demonstrator Topics' Progression (WP100.1); aircraft thermal models for each target platform: combined aircraft models integrating power layers (WP100.3)
Transverse - Technology Evaluator **Budget: €0.5 m**	TE integrated planning new version; mission level report; airport level report; ATS level report
Transverse – Eco-design **Budget: €0.5 m**	Updated Technology List for Eco design activities in SPDs; progress report for the Eco Design Technologies and monitoring; Dissemination and Communication Plan
Transverse – Small air transport **Budget: €0.2 m**	Annual report (WP1); PDR – Integration on P180 from previous GAM (WP3)
Calls for proposals **Budget: €124 m**	Note: The detailed list below of the calls for proposals for 2018 adds up to € 61M. CfP11 (typically published in October) which should detail the calls for proposals for the remaining budget (~€63M) was not published at the time of this report's publication. Large Passenger Aircraft: development of a distributed CFD platform for collaborative design; Innovative Thrust Reverser Actuator System (ITRAS); UHBR Engine Studies for Aircraft Operations and Economics; Advanced solutions for 2030+ UHBR Core Noise reduction; Supporting implementation of 2030+ UHBR low noise fan technology solutions through enhanced modelling capabilities; Advanced Pitch Control Mechanism TRL4 Demonstration; Innovative turbine cavity swirl control systems through Additive Manufacturing; Development of multidisciplinary design tools for rapid concept design for aero engine components; Rear fuselage and empennage shape optimization including anti-icing technologies; Fibre reinforced thermoplastics manufacturing for stiffened. complex. double curved structures; Development of Thermoplastic press forming Tool for Advanced Rear End Closing Frame Prototype and Tooling 4.0 for Assembly and transportation of the Advanced Rear End Prototype; Development and simulation of a forming process for LE HLFC wing outer skins; Development of a manufacturing process and a manufacturing unit for production of a laser treated titanium panel with a 3D printed substructure; Design and manufacturing of multi-functional Ice Protection System power feed/monitoring lines and Shielding/High-lift electrical actuation system for a HLFC Wing demonstrator; Develop and test Power Efficient Actuation

Activity and 2019 budget	Areas of activity in 2019
	Concepts for Separation Flow Control at large aerodynamic areas requiring very low actuation energy; Loop Heat Pipe development for severe environment; Development of innovative welding systems for structural joints of Thermoplastic matrix based Composites; Development of short fibre reinforced thermoplastic airframe clips and brackets using factory waste; Innovative miniaturized sensing device for large wave length spectrum reception capability as a tool for quality control and aircraft maintenance. Regional aircraft: theoretical and experimental evaluations of strain field modification induced by flaws in loaded composite structures; Innovative Noise Generation System for testing of Regional Cabin Interior Noise reduction; SHMS and Dynamic fields sensors development. Fast rotorcraft: innovative kinematic analysis to incorporate multiple functions within a movable surface; Smart Active Inceptors System development for Tilt Rotor application; Multipurpose bench for Tiltrotor equipment functional test; Engine exhaust wake flow regulator for Tilt Rotor. Air frames: low speed handling quality and innovative engine integration of a new configuration aircraft; Development of a methodology (test. measurement. analysis) to characterize the behaviour of composite structures under dynamic loading; Verification of advanced simplified HLFC concept with variable porosity; Development of a methodology to optimize a wing composite panel with respect to tyre damage certification requirement; Coupon and element testing and manufacturing of test article for morphing technologies; Increasing the efficiency of pulsed jet actuators for flow separation control; Application of graphene based materials in aeronautical structures for de-icing. lightning strike protection. fire barrier and water absorption prevention purposes; Development of FEM fastener parametric/adaptable sizing tool including EMC impact. and manufacturing and EMC/LSP testing of demonstrators (SAT); Innovative flight data measurements to support the aerodynamic analysis of a compound helicopter demonstrator; Active Flow control on Tilt Rotor lifting surfaces; Innovative approaches for interior Noise Control for Next Generation Civil Tilt Rotor; Innovative weight measurement system for Tilt Rotor application; Modular platform development for Tilt Rotor final assembly; Development of a multifunctional system for complex aerostructures assembly. assisted by neural network software; Development of equipment for composite recycling process of uncured material; End of Life (EoL) for biomaterials; Disassembly and recycling of innovative structures made of different Al-Li alloys; Scrapping of carbon reinforced thermoplastic materials. Engines: low NOx / Low soot injection system design for spinning combustion technology; Revalorisation of Recycled Carbon Fibres and CFRP preparation through Eco design (ECO). Systems: enhanced digital georeferenced data models for cockpit use; Innovative processing for flight practices improvement; New Efficient production methods for 94 GHz (W-band) waveguide antennas; Low-profile/drag electronically steerable antennas for In-Flight Connectivity; VOC filtration device for Inserting System; Innovative high flow rate constant pressure valve for inert gas discharge from pressurized vessels; Grey Water Container with Reduced Biofilm Growth; Automatic Haptic System Test Bench for Active Inceptors; Innovative DC/DC converter for HVDC power sources hybridization; Toward a Digital Twin ECS and thermal management architecture models : Improvement of MODELICA libraries and usage of Deep Learning technics; Vapor Cycle System - Heat Exchanger performance 3D modelisation with different new low GWP refrigerants; Electro-Mechanical

Activity and 2019 budget	Areas of activity in 2019
	Landing Gear system integration for Small Aircraft (SAT); Power Semiconductor Device module using Silicon Carbide devices for a relatively high-frequency. circa 100kW aircraft motor drive applications. Thematic topics: Ultra-High Aspect ratio wings; Experimental and numerical noise assessment of distributed propulsion configurations; Disruptive Active Flow Control for aircraft engine applications; Non-intrusive. seedless measurement system: design. development. and testing.
Administrative expenditures	
Total budget: €5.2 m	Staff expenditure
Total budget: €4.2 m	Infrastructure expenditure (rents, etc)
Revenues	
Budget share: €290 m	European Union
Budget share: €4.7 m	Industry
Carry-over from previous year: €9.9 m	Adjustments

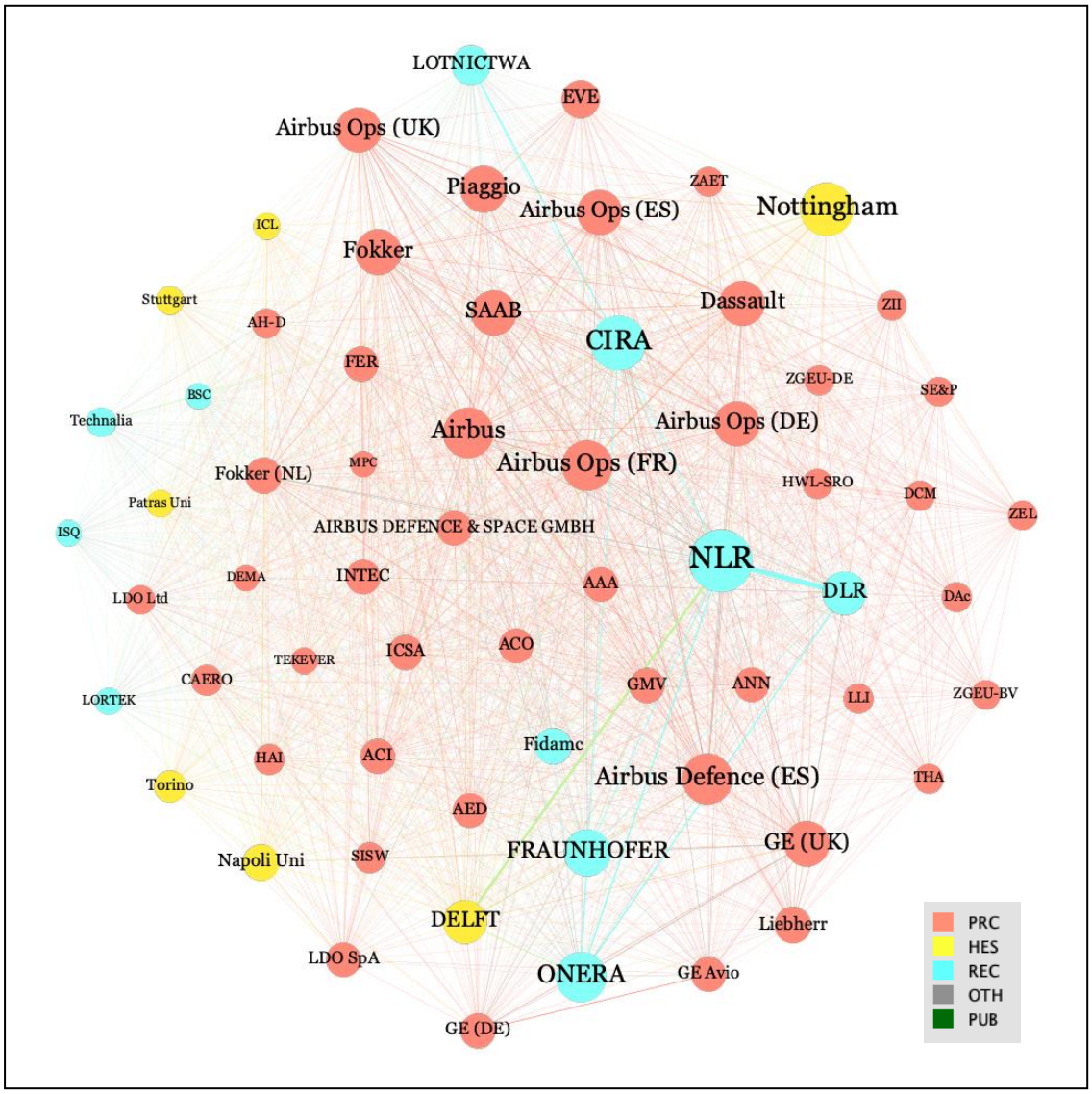
Source: CS 2 JU

F.4 Stakeholder analysis

Up to 40% of CS 2 available funding is allocated to its 16 leaders (and their affiliates), and up to 30% to core partners, leaving only 30% of the funding to be distributed through calls for proposals and calls for tenders for which industry, SMEs, research organisations and academia are all eligible.

A key objective for the CS 2 JU defined in Council Regulation 558/2014 is active promotion of the participation and close involvement of all relevant stakeholders from the full aviation value chain and from outside the traditional aviation industry in aeronautics-related R&I. shows the results of an analysis of the participation rates of organisations involved in CS 2 JU projects, based on a preliminary mapping of the network, presented in the form of a network diagram illustrating the level of participation of individual organisations (represented by the size of the circles) and the strength of the connections between them. Note that this mapping of the partnership network is based on an identification of the participants in the partnership projects, derived from CORDA.

Figure 51: Participation of organisations in CS 2 by NACE industry sector

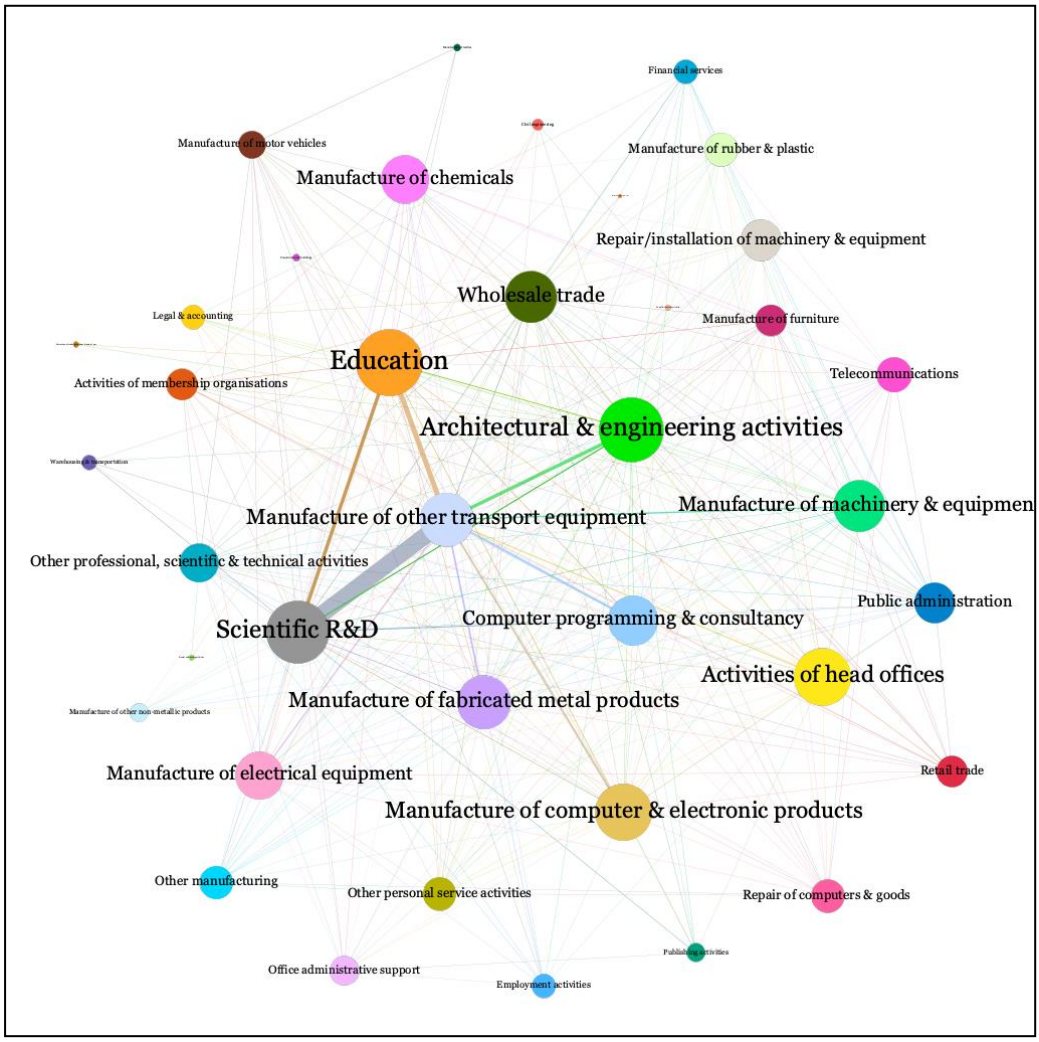


Source: Technopolis analysis based on analysis of Corda and NACE codes[52]

Figure 52 shows the same results but based on organisation type. Note that the analysis is based on an examination of NACE codes and the allocation of organisations to sectors is not fully representative in every case.

[52] PRC: Private companies, HES: Higher educational facilities, REC: Research centres, OTH: Other PUB: Public, non-profit organisations

Figure 52: Participation of organisation type in CS 2 by NACE industry sector



Source: Technopolis analysis based on analysis of CORDA and NACE codes

The results lead to a number of conclusions concerning participation in CS 2:

- The majority of funding went to private companies (PRC), specifically equipment manufacturers. On SMEs participation, information from stakeholders differs with ASD stating that 420 SMEs participated (with a SMEs Call for Partners funding share of 34% (of the 30% of funding reserved for Calls) with the SME average size of topics at €600k), and European Aerospace Cluster Partnership (EACP) noting that the current small allocation of funding to SMEs stifles innovation and that more funding should be allocated to foster innovation. Note that the 70% of budget that was pre-allocated to Leaders and Core partners included very few SMEs.
- The JU has involved participation from organisations throughout the value chain, including aircraft manufactures, engine manufactures and avionic manufacturers, as well as research and educational institutions: ASD[53] indicates 373 research centres, 350 universities were involved in addition to 334 bigger industrial organisations.

[53] ASD, 2019

- The weightings of the participating organisations imply a relatively even spread in participation among the organisations, however it should be noted that if the constituent parts of Airbus were to be grouped into one entity it would clearly dominate.
- Educational and scientific and research institutions are well represented although, participation is concentrated on a relatively limited number of organisations with NLR, Onera, CIRA, DLR, and Fraunhofer (FHG) being the dominating research institutions and the University of Nottingham and Technische Universiteit Delft being the dominating education institutions.

F.5 Previous evaluation of the JU

An interim evaluation report[54] on CS 2 JU, published in 2017, notes that the scope of activity identified is still considered relevant. It observed that the scope of CS 2 was expanded compared to that of CS 1 and also highlighted that recent political developments (such as the Paris 2015 Agreement) underscore even further the need to do everything possible to accelerate the development and introduction of environmentally friendly products and services.

The mid-term evaluation and stakeholder discussions held for this study highlighted a number of issues, include the following observations:

Governance:

- Technology evaluator: its limited scope (i.e. only technology and only inside Clean Sky) does not appear idea. It is also dependent on the goodwill of the CS 2 SPDs to provide it with input and information. The fact that the technology evaluator is within Clean Sky 2 may also raise questions regarding its objectivity in assessing technological achievements.
- The Scientific Committee could have more focus on the technological challenges than on Clean Sky internal management;
- States Representative Groups (SRGs): there is a need for stronger interaction between Governing Boards and advisory bodies (States' Representatives Groups and Scientific Committees). Efficient collaboration between these bodies is of critical importance to the purposeful functioning and successful outcome of the JUs. A concern expressed related to the low impact of the advisory bodies on the Governing Boards' strategic decisions. For example, the SRG did not seem to have fulfilled its full potential in ensuring a close relationship with the Member States in order to influence the Clean Sky programme or to develop synergies with national research strategies.
- The Commission needs to stimulate the States Representative Groups (SRGs) to contribute to maximising the leverage effect of research programme synchronisation. The statutory SRG is not actively contributing to Clean Sky coordination with aeronautics research funded by the Member States.

Openness:

A more integrative programmatic approach to managing work would be more effective and that there should be greater transparency regarding accomplishments and funding. In particular it highlighted:

- Easier and more proactive disclosure of the parties and their funding;

[54] Interim Evaluation of the Clean Sky 2 Joint Undertaking (2014-2016) operating under Horizon 2020, Experts Group Report

- The economic impact of the programme should be better promoted, even if this may take years to be realised;
- As a scientific programme, some questioned whether CS 2 should not have been able to contribute to more research publications.

Research:

- Call topics should be less prescriptive and funds should be allocated to create opportunities in areas that CS 2 does currently not operate;
- The evaluation suggested to optimise 'complementarity and synergy' with the demonstrator projects while nurturing the bottom-up inspired 'innovation pipeline'.

Technical:

Relationships between research activity and the demonstrator objectives in the broad framework should be clearer. Alternative views of research are needed to create visibility in the intended application of each technology development, whilst alternative views of accomplishments are needed to provide an overview of technology maturity (Increased Insight).

Management and communication:

Current administrative processes are not always suitable and add much complexity and rigidity to the management process. The following points were identified:

- Options aim at reducing administrative workload (including grant administration) should be considered.
- Concerns were raised regarding the suitability of the Delegation Agreement;
- Greater use should be made of subcontracting in high TRL projects;

CS 2 currently operates with a top-down structure. A mechanism could be in place to foster more bottom-up working.

Appendix G Additional information on the problem definition

G.1 Taxonomy of failures requiring policy intervention

In defining the problem described in Section 2 of the main report, we have considered failures identified through the application of a standard taxonomy developed by Technopolis. A generic description of the failures appears in Table 37 and the findings from its application to aeronautical-related R&I are shown in Table 38.

Table 37: Standard taxonomy of failures

Market failures	
Market power	Inadequate market structures due to the degree of competition and barriers to entry such as strongly concentrated / closed industry sectors or markets
Externalities	Low return on investments due to difficulties, for innovators, appropriating the outcomes of their investments and limiting undesired spill over to the benefit of competitors. Those externalities often cause low (private) investments, especially for uncertain and risky R&D activities.
Information asymmetry	Actors within a particular market (or system) have uneven access to information. Some may lack the information they need to develop and exploit their innovative products/services.
Systemic failures	
Capability	Factors related to the individuals' and organisations' absence or shortage of the necessary capabilities to acquire and absorb new knowledge, to adapt to new and changing circumstances, to grasp (technological) opportunities, and to switch from old to new (technological) trajectories. At a systemic level, it relates to 'sufficient scale' or 'critical mass'
Network	Interactions between a set of actors are too dense to allow for novel insights or inspirations to emerge. Strong dependence on few partners may lead to lock-in phenomena. *Weak network failure:* Too limited exchange and collaboration between organisations and individuals, which limit co-creation and co-development of new products and services,
Institutional	Norms and rules (regulatory framework) hinder innovation; social norms and values, and culture hinder innovation
Infrastructural	Lack of the physical (R&D facilities, ICT infrastructure, transport etc.) and knowledge (knowledge, skills, database etc.) infrastructures needed to enable and stimulate innovation activities.

Transformational failures	
Directionality	Lack of shared vision regarding the goal and direction of the required system transformation process. No coordination between the actors involved in system transformation. Absence of targeted funding for R&I activities and infrastructures, which would define collectively accepted trajectories of development.
Demand articulation	A deficit in anticipating and learning about user needs and constraints. Insufficient use of public demand to orient and leverage wider demand and influence innovation activities. Lack of mechanisms to articulate the demand from various groups of actors.
Policy coordination	Missing or weak coherence between the activities of national, regional, sectoral and technological institutions: lack of coordination between innovation and sectoral policies; lack of coordination between ministries and implementing agencies; no alignment between public and private organisations; mismatches in the timing of policy intervention
Reflexivity	Insufficient ability to monitor progress of (transformative) policy interventions towards the achievement of their objectives, to develop adaptation strategies, to anticipate changes (e.g. by developing strategies with open options taking into consideration uncertainty), and to involve a wide range of actors in the governance process. Absence of opportunities for experimenting policy instruments.

Source: Technopolis Group (2018), Modified from Weber & Rohracher (2012)

Table 38: Failures in aeronautical-related R&I

Market failures	
Externalities	The benefits of aeronautics-related R&I are distributed broadly and do not necessarily correlate with the investment that individual organisations need to make. Two key benefits, namely a reduction in greenhouse gas emissions from transport and reduction of noise around airports, has the characteristics of a classic externality.
Information asymmetry	Uncertainty, significant capital requirements and short-time horizon of private investors lead to undersupply of funding for aviation R&I. This has been recognised by Member States which have offered various mechanisms (loan, guarantees, etc) to support the R&I activities of the aviation industry.
Market power	Increased aviation industry consolidation in Europe and in the world (equipment manufacturers and airlines) tightens the competitive landscape between suppliers.
Systemic failures	

Capability	The European aviation industry has demonstrated over the last 50 years that it is highly capable of developing leading products. However, whilst the industry has managed to be one of the two parts of a duopoly, it remains increasingly challenged by competitors around the world. In addition, as the leader in its field, it is paramount that the industry consolidates its market shares by being the first to develop new and safe technologies.
Network	The industry network, encompassing manufacturers and their supply chain, ground equipment manufacturers, operators, airports, service providers, research and educational institutions, is particularly well established compared to some other industrial sectors. However, there is a risk that SMEs or Eastern European and Mediterranean Member States participants may find it difficult to join it, as project participation in the CS 2 JU is concentrated among a relatively limited number of players reflecting the composition of leaders and core partners.
Institutional	While CS 2 JU provides an institutional framework for addressing the second problem driver identified, as already noted, there are aspects of the design and implementation of the JU that appear to have limited effectiveness. In particular, certain aspects of its governance arrangements such as the role of the States Representative Groups. The lack of involvement of EASA in Clean Sky may have an impact on the "time to market" which benefits from an early assessment of potential safety risks and other issues related to certification of new products and technologies.
Infrastructural	Similarly, elements of CS 2 JU procedural infrastructure are constraining the R&I effort, as previously described. There is arguably a need for greater flexibility and for reduction in the administrative burden. There are also some communication improvements that could be made.
Transformational failures	
Policy coordination	There is a possible risk of a lack of multi-level policy coordination (e.g., regional/national/European). The horizontal coordination between research, technology and innovation policies is good in the European aviation sector, but it may require some coordination with sectoral policies as there is stronger public appetite for these.
Market failures	
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	recognised by Member States which have offered various mechanisms (loan, guarantees, etc) to support the R&I activities of the aviation industry.
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Systemic failures	
Capability	The European aviation industry has demonstrated over the last 50 years that it is highly capable of developing leading products. However, whilst the industry has managed to be one of the two parts of a duopoly, it remains increasingly challenged by competitors around the world. In addition, as the leader in its field, it is paramount that the industry consolidates its market shares by being the first to develop new and safe technologies.
Network	The industry network, encompassing manufacturers and their supply chain, ground equipment manufacturers, operators, airports, service providers, research and educational institutions, is particularly well established compared to some other industrial sectors. However, there is a risk that SMEs or EU-13 participants may find it difficult to join it, as project participation in the CS 2 JU is concentrated among a relatively limited number of players reflecting the composition of leaders and core partners.
Institutional	While CS 2 JU provides an institutional framework for addressing the second problem driver identified, as already noted, there are aspects of the design and implementation of the JU that appear to have limited effectiveness. In particular, certain aspects of its governance arrangements such as the role of the States Representative Groups. The lack of involvement of EASA in Clean Sky may have an impact on the "time to market" which benefits from an early assessment of potential safety risks and other issues related to certification of new products and technologies.
Infrastructural	Similarly, elements of CS 2 JU procedural infrastructure are constraining the R&I effort, as previously described. There is arguably a need for greater flexibility and for reduction in the administrative burden. There are also some communication improvements that could be made.
Transformational failures	
Policy coordination	There is a possible risk of a lack of multi-level policy coordination (e.g., regional/national/European). The horizontal coordination between research, technology and innovation policies is good in the European aviation sector, but it may require some coordination with sectoral policies as there is stronger public appetite for these.

Appendix H Additional information related to the policy options descriptions

H.1 Degree of coverage of the different functionalities by policy option

Table 39: Type and composition of actors (including openness and roles)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? *Any legal entity* in a consortiu**m** can apply to Horizon Europe calls in ad hoc combinations Calls are open to participation from across Europe and the world (not all entities from third countries are eligible for funding)	***What is possible?*** Partners can include *any national funding body or governmental research organisation*, Possible to include also *other type of actors*, including foundations.	***What is possible?*** Partners can include *MS and Associated Countries*.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, regions, foundations. By default open to AC/ 3rd countries, but subject to policy considerations. Can cover a *large and changing community.* HE rules apply by default to calls included in the FP Work Programme, so any legal entity can apply to these.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, foundations. By default open to legal entities from AC/ 3rd countries, but subject to policy considerations. In case of countries participating non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements HE rules apply by default, so any legal entity can apply to partnership calls.
What is limited? Systematic/ structured engagement with public authorities, MS, regulators, standard making bodies, foundations and NGOs.	***What is limited?*** Requires substantial national R&I programmes (competitive or institutional) in the field. Usually only legal entities from countries that are part of the consortia can apply to calls launched by the	***What is limited?*** Non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements. Needs good geographical coverage – participation of at least 40% of Member States is required	***What is limited?*** If MS launch calls under their responsibility, usually only legal entities from countries that are part of the consortia can apply to these, under national rules	***What is limited?*** Requires a *rather stable set of partners* (e.g. if a sector has small number of key companies). Basic act can foresee exceptions for participation in calls / eligibility for funding.

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
	partnership, under national rules.	Requires substantial national R&I programmes (competitive or institutional) in the field. While by default the FP rules apply for eligibility for funding/participation, in practice (subject to derogation) often only legal entities from countries that are Participating States can apply to calls launched by the partnership, under national rules.		
What is not possible? To have a joint programme of R&I activities between the EU and committed partners that is implemented based on a common vision.	***What is not possible?*** To have industry/ private sector as partners.	***What is not possible?*** To have industry/ private sector as partners.		

Table 40: Type and range of activities (including flexibility and level of integration)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Horizon Europe standard actions that allow *broad range of individual activities* from R&I to TRL 7 or sometimes higher. Calls for proposals published in the Work Programmes of Horizon Europe (adopted via comitology).	***What is possible?*** Activities may range from R&I, pilot, deployment actions to training and mobility, dissemination and exploitation, but according to national programmes and rules. Decision and implementation by "beneficiaries" (partners in the co-fund grant agreement) e.g. through institutional funding programmes, or by "third parties" receiving financial support, following calls for proposals launched by the consortium.	***What is possible?*** Horizon Europe standard actions that allow a broad range of coordinated activities from R&I to uptake. In case of implementation based on national rules (subject to derogation) Activities according to national programmes and rules. Allows integrating national funding and Union funding into the joint funding of projects	***What is possible?*** *Horizon Europe standard actions* that allow a broad range of coordinated activities from R&I to uptake. The association representing private partners allows to continuously build further on the results of previous projects, including activities related to regulations and standardisation and developing synergies with other funds Union contribution is implemented via calls for proposals published in the Work Programmes of Horizon Europe based on the input from partners (adopted via comitology). Open and flexible form that is simple and easy to manage.	***What is possible?*** *HE standard actions* that allow to build a portfolio with broad range of activities from research to market uptake. The back-office allows dedicated staff to implement integrated portfolio of projects, allowing to build a "system" (e.g. *hydrogen*) via pipeline of support to accelerate and scale up the take-up of results of the partnership, including those related to regulations and standardisation and developing synergies with other funds. E.g. setting up biorefinery plants and promoting their replication by additional investments from MS/ private sector. Procuring/purchasing jointly used equipment (e.g. HPC) Allows integrating national funding and Union funding into the joint funding of projects
What is limited?	***What is limited?*** Scale and scope of the programme the resulting funded R&I actions and depend on the participating programmes, typically		***What is limited?*** Limited control over precise call definition, resulting projects and outcomes, as they are implemented by EC agencies.	***What is limited?*** Limited flexibility because objectives, range of activities and partners are defined in the Regulation, and negotiated in the Council (EP).

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
	smaller in scale than FP projects			
What is not possible? To design and implement in a systemic approach a portfolio of actions. To leverage additional activities and investments beyond the direct scope of the funded actions				

Table 41:Directionality

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Strategic Plan (as implementing act), annual work programmes (via comitology). Possible also to base call topics on existing or to be developed SRIA/roadmap	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Annual work programme drafted by partners, approved by EC Objectives and commitments are set in the Grant Agreement.	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the legal base. Annual work programme drafted by partners, approved by EC Commitments include obligation for financial contributions (e.g. to administrative costs, from national R&I programmes).	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the contractual arrangement. Input to FP annual work programme drafted by partners, finalised by EC (comitology) Commitments are political/best effort, but usually fulfilled	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the legal base. Annual work programme drafted by partners, approved by EC (veto-right in governance) Commitments include obligation for financial contributions (e.g. to administrative costs, from national R&I programmes).
What is limited? No continuity in support of priorities beyond the coverage of the strategic plan (4 years) and budget (2 years Annual work programme).				
What is not possible? Coordinated implementation and funding linked to the concrete objectives/ roadmap, since part of overall project portfolio managed by agency				

Table 42: Coherence (internal and external)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Coherence between different parts of the Annual Work programme of the FP ensured by EC	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with national/regional programmes and activities	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with national/regional programmes and activities Synergies with other programmes	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC If MS participate: Synergies with national/regional programmes and activities Synergies with industrial strategies	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with other programmes or industrial strategies If MS participate: Synergies with national/regional programmes and activities
What is limited? Synergies with other programmes or industrial strategies	***What is limited?*** Synergies with other programmes or industrial strategies	***What is limited?*** Synergies with industrial strategies	***What is limited?*** Synergies with other programmes	
What is not possible? Synergies with national/regional programmes and activities				

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