Council of the European Union

Brussels, 24 February 2021
(OR. en)

6446/21
ADD 8

Interinstitutional File:
2021/0048(NLE)

RECH 72
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COVER NOTE

From:	Secretary-General of the European Commission, signed by Ms Martine DEPREZ, Director
date of receipt:	23 February 2021
To:	Mr Jeppe TRANHOLM-MIKKELSEN, Secretary-General of the Council of the European Union
No. Cion doc.:	SWD(2021) 37 final - Part 6/19
Subject:	COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a Council Regulation establishing the Joint Undertakings under Horizon Europe European Partnership for Key Digital Technologies

Delegations will find attached document SWD(2021) 37 final - Part 6/19.

Encl.: SWD(2021) 37 final - Part 6/19

EUROPEAN
COMMISSION

Brussels, 23.2.2021
SWD(2021) 37 final

PART 6/19

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Council Regulation establishing the Joint Undertakings under Horizon Europe

European Partnership for Key Digital Technologies

{COM(2021) 87 final} - {SEC(2021) 100 final} - {SWD(2021) 38 final}

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Glossary

Term or acronym	*Meaning or definition*
AI	Artificial intelligence
ASIC	Application Specific Integrated Circuit
CAGR	Compound annual growth rate
CF	Co-funded partnership
CMOS	Complementary Metal Oxide Semiconductor
CP	Co-programmed partnership
CPS	Cyber-physical system
DAE	Digital Agenda for Europe
DEP	Digital Europe Programme
DSM	Digital Single Market strategy
ECS	Electronic Components and Systems
ECSEL JU	Electronic Components and Systems for European Leadership - Joint Undertaking
EDA	Electronic design automation
ELG	Electronics Leaders Group
EMS	Electronics manufacturing services
EPS	ECSEL Participating States
ETP	European Technology Platform
EP	European Partnerships
ES	Embedded software
FDSOI	Fully depleted silicon on insulator
FPGA	Field-Programmable Gate Array
HEI	Higher education institutions
HPC	High performance computing
IA	Innovation Actions (of ECSEL JU)
IC	Integrated Circuits
ICT	Information and Communication Technologies
IDM	Integrated Device Manufacturer
IoT	Internet of Things
IP A185	Institutionalised Partnership Art 185
IP A187	Institutionalised Partnership Art 187
IPCEI	Important Project of Common European Interest
IS	Intelligent Software
JTI	Joint Technology Initiative
KDT JU	Key Digital Technologies – Joint Undertaking
LIFE	Programme for Environment & Climate Action
MFF	Multi-annual Financial Framework
MS	Member States of the European Union
PS	Platform Software
RIA	Research and Innovation Actions (of ECSEL JU)
R&D	Research and Development
R&I	Research and Innovation

RTO	Research and Technology Organisation
PROs	Private research organizations
PS	Participating States
SDGs	Sustainable Development Goals
SNS	Smart Networks and Systems
SOI	Silicon On Insulator
SoS	Systems of Systems
SRIA	Strategic Research and Innovation Agenda
TRL	Technology Readiness Level

PART 1 - COMMON FOR ALL CANDIDATE INSTITUTIONALISED EUROPEAN PARTNERSHIPS

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

1.1. Focus and objectives of the impact assessment

This impact assessment accompanies the Commission proposal for Institutionalised European Partnerships to be funded under Horizon Europe, the 2021-2027 Framework Programme for EU Research and Innovation (R&I).[1] It sets out to **help decide in a coordinated manner the right form of implementation for specific candidate initiatives** based on a common approach and methodology to individual assessments[2]. It also provides an **horizontal perspective on the portfolio of candidate European Partnerships** to identify further efficiency and coherence gains for more impact.

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

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

The Horizon Europe Regulation defines **eight priority areas,** scoping the domains in which Institutionalised Partnerships could be proposed[4]. Across these priority areas, **13 initiatives** have been identified **as suitable candidate initiatives** for Institutionalised Partnerships because of their objectives and scope. This impact assessment aims to identify whether 12 of these initiatives[5] need to be implemented through this form of implementation and would not deliver equally well with traditional calls of Horizon Europe or other lighter forms of European Partnerships under Horizon Europe. This means assessing whether each of these initiatives meets the necessity test set in the **selection criteria** for European Partnerships in the Horizon Europe Regulation, Annex III.

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

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

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

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

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

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

[6] EU budget commitments to the European Partnership candidates can only be discussed and decided following the political agreement on the overall Multiannual Financial Framework and Horizon Europe budgetary envelopes. The level of EU contribution for individual partnerships should be determined once there are agreed

1.2. The political and legal context

1.2.1. Shift in EU priorities and Horizon Europe framework

European priorities have evolved in the last decades, and reflect the social, economic, and environmental challenges for the EU in the face of global developments. In her Political Guidelines for the new European Commission 2019 – 2024[7], the new Commission President put forward six overarching priorities, which reach well beyond 2024 in scope[8]. Together with the Sustainable Development Goals (SDGs), these priorities will shape future EU policy responses to the challenges Europe faces, and thus also give direction to EU research and innovation.

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

In this context, **at least 35 % of the expenditure from actions under the Horizon Europe Programme will have to contribute to climate action**. Furthermore, a **Strategic Plan** is co-designed with stakeholders to identify **key strategic orientations for R&I support** for 2021-2024 in line with the EU priorities. In the Orientations towards the first Strategic Plan for Horizon Europe, the need to strategically prioritise and "*direct a substantial part of the funds towards the areas where we believe they will matter the most*" is emphasised. The Orientations specify, that actions under Pillar II of Horizon Europe "Global Challenges and European Industrial Competitiveness" will target only selected themes of especially high impact that significantly contribute to delivering on the political priorities of the Union. Most of the candidate European Partnerships fall under this Pillar.

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objectives, and clear commitments from partners. Importantly, there is a ceiling to the partnership budgets in Pillar II of Horizon Europe (the legal proposal specifies that *the majority of the budget in pillar II shall be allocated to actions outside of European Partnerships*).

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

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

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

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

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

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

As analysed in the **interim evaluation of Horizon 2020**[11], a considerable repertoire of partnership initiatives have been introduced over time, with 8 forms of implementation[12] and close to 120 partnership initiatives running under Horizon 2020 - without clear exit strategies and concerns about their degree of coherence, openness and transparency. Even if it is recognised that these initiatives allow setting long-term agendas, structuring R&I cooperation between otherwise dispersed actors, and leveraging additional investments, the evaluation points to the complexity generated by the proliferation of instruments and initiatives, and their insufficient contribution to policies at EU and national level.

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

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

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

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

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

[11] Interim evaluation of Horizon 2020, Commission Staff Working Document, SWD(2017)221 and 222
Interim evaluation of the Joint Undertakings operating under Horizon 2020 (Commission Staff Working Document, SWD(2017) 339); Evaluation of the Participation of the EU in research and development programmes undertaken by several Member States based on Article 185 of the TFEU, Commission Staff Working Document, SWD (2017)340)

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

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

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

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

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

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

[13] Impact assessment of Horizon Europe, Commission Staff Working Document, SWD(2018)307.
[14] Article 8 and Annex III of the Horizon Europe Regulation (common understanding))

1.3. Why should the EU act

1.3.1. Legal basis

Proposals for Institutionalised European Partnerships are based on:

1) Article 185 TFEU which allows the Union to make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes; or
2) Article 187 TFEU according to which the Union may set up joint undertakings or any other structure necessary for the efficient execution of Union research, technological development and demonstration programmes.[15]

1.3.2. Subsidiarity

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

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

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

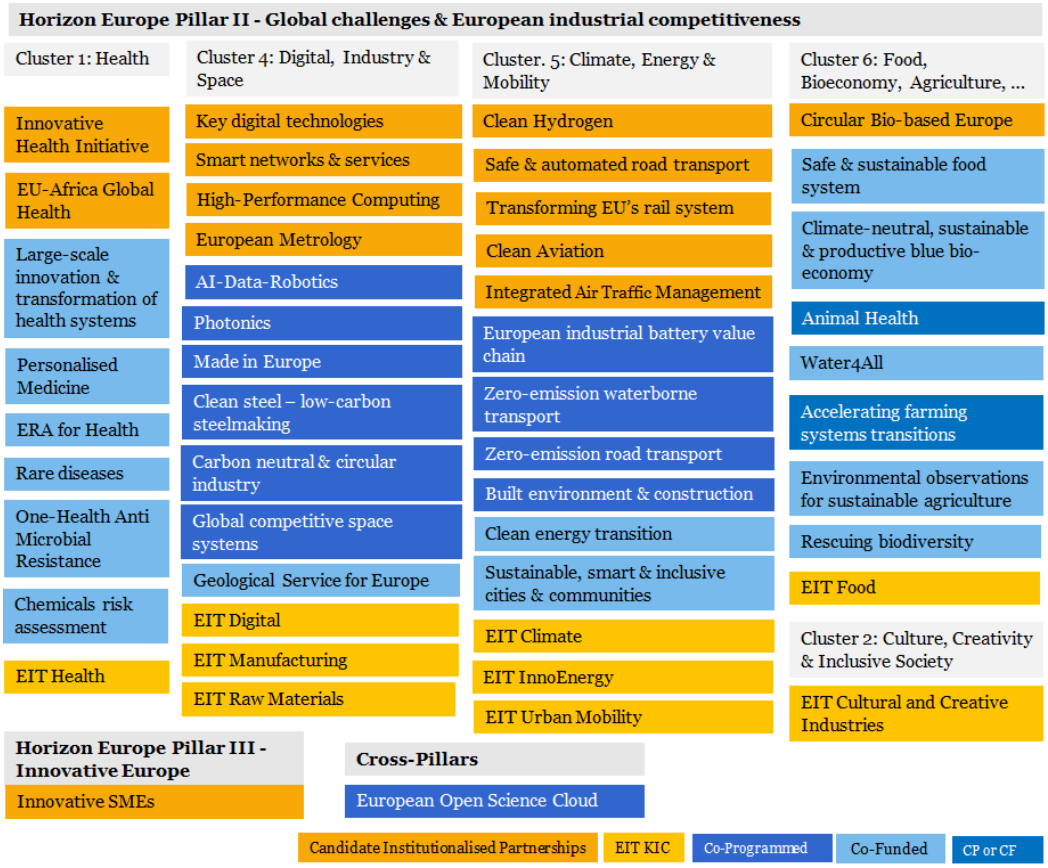
[16] The Interim Evaluation of Horizon 2020 and the impact assessment of Horizon Europe provide qualitative and quantitative evidence on these points. Sections 1 and 2 of each impact assessment on candidate European Partnerships include more detail on the necessity to act at EU level in specific thematic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

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

2.1. Portfolio of candidates for Institutionalised European Partnerships

The new approach for more objective-driven and impactful European Partnerships is reflected in the way candidate Partnerships have been identified. It involved a co-design exercise aiming to better align these initiatives with societal needs and policy priorities, while broadening the range of actors involved. Taking into account the 8 areas for Institutionalised European Partnerships set out in the Horizon Europe Regulation[17], a co-design exercise as part of the Strategic Planning process of Horizon Europe lead to the identification of **49 candidates for Co-funded, Co-programmed or Institutionalised European Partnerships**[18]. Out of these, **13 were identified as suitable candidate Institutionalised Partnerships because of their objectives and scope**[19]. Whilst the Co-Funded and Co-Programmed Partnerships are linked to the comitology procedure (including the adoption of the Strategic Plan and the Horizon Europe Work Programmes), Institutionalised Partnerships require the adoption of legislation and are subject to an impact assessment. The Figure below gives an overview of all candidate European Partnerships according to their primary relevance to Commission priorities for 2019-2024.

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



Source: Technopolis group (2020)

[17] Horizon Europe Regulation (common understanding), Annex Va.

[18] Shadow configuration of Strategic Programme Committee for Horizon Europe. The list of candidate European Partnerships is described in "Orientations towards the Strategic Plan of Horizon Europe" - Annex 7

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

There are only three partnerships for which implementation as an Institutionalised Partnership under Article 185 is an option, i.e. European Metrology, the EU-Africa Global Health partnership, and Innovative SMEs. Ten partnerships are candidates for Institutionalised Partnerships under Article 187. Overall the initiatives can be categorised into '*horizontal*' partnerships and '*vertical*' partnerships.

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

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

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

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

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

2.2.1. Option 0 - Baseline option – Traditional calls

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

Under this option, strategic planning mechanisms in the Framework Programme will allow for a high level of flexibility in the ability of traditional calls to respond to particular needs over time, building upon additional input in co-creation from stakeholders and programme committees involving Member States. The Union contribution to addressing the priority covers the full duration of the initiative, during the lifetime of Horizon Europe. Without a formal EU partnership mechanism, it is less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual commitments and contributions outside their participation in funded projects.

2.2.2. European Partnerships

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

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

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

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

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

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

2.2.2.1. Option 1 - Co-programmed European Partnership

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

2.2.2.2. Option 2 – Co-funded European Partnership

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

2.2.2.3. Option 3 – Institutionalised European Partnership

This type of Partnership is the most complex and high-effort arrangement, and requires meeting additional requirements. Institutionalised European Partnership are **based on a Council Regulation (Article 187 TFEU or a Decision by the European Parliament and Council (Article 185 TFEU)** and are implemented by dedicated structures created for that purpose. These regulatory needs limit the flexibility for a change in the core objectives, partners, and/or commitments as these would require amending legislation. The basic rationale for this type of partnership is the need for a strong integration of R&I agendas in the private and/or public sectors in the EU in order to address a strategic challenge. It is therefore necessary to demonstrate that other forms of implementation would not achieve the objectives or would not generate the necessary expected impacts, and that a long-term perspective and high degree of integration is needed. For both Article 187 and 185 initiatives, contributions from partners can be in the form of financial and in-kind contributions. Eligibility for participation and funding follows by default the rules of Horizon Europe, unless a derogation is introduced in the basic act.

Option 3a - Institutionalised Partnerships based on Article 185 TFEU

Article 185 of the TFEU allows the Union to participate in programmes jointly undertaken by Member States and limits therefore the scope to **public partners** which are Member States and Associated Third Countries. This type of Institutionalised Partnership aims therefore at reaching the greatest possible impact through the integration of national and EU

funding, aligning national strategies in order to optimise the use of public resources and overcome fragmentation of the public research effort. It brings together R&I governance bodies of most if not all EU Member States (legal requirement: at least 40% of Member States) as well as Associated Third Countries that designate a legal entity (Dedicated Implementation Structure) of their choice for the implementation. By default, participation of non-associated Third Countries is not foreseen. Such participation is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement.

Option 3b - Institutionalised Partnerships based on Article 187 TFEU

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

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

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

2.3. Overview of the methodology adopted for the impact assessment

The methodology for each impact assessment is based on the Commission Better Regulation Guidelines[20] to evaluate and compare options with regards to their **efficiency, effectiveness and coherence**. This also integrates **key selection criteria for European Partnerships**.

Box 3 Summary of European Partnerships selection criteria[21]

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

2.3.1. Overview of the methodologies employed

In terms of **methods and evidence used**, the impact assessments draw on an external study covering all candidate Institutionalised European Partnerships in parallel to ensure a high level of coherence and comparability of analysis, in addition to a horizontal analysis.[22] For all initiatives, the understanding of the overall context of the candidate institutionalised

[20] European Commission (2017), Better Regulation Guidelines (SWD (2017) 350)
[21] For a comprehensive overview of the selection criteria for European Partnerships, see Annex 6.
[22] Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Study for the European Commission, DG Research & Innovation

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

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

2.3.2. Method for identifying the preferred option

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

Given the focus of the impact assessment on comparing different forms of implementation, the Better Regulation framework has then been adapted to introduce "**key functionalities needed**" - making the transition between the definition of the objectives and what would be crucial to achieve them *in terms of implementation*. The identification of "key functionalities needed" for each initiative as an additional step in the impact assessment is based on the distinguishing factors between the different options (see Section 2.2.1). In practical terms, each option is assessed on the basis of the degree to which it would allow for the key needed functionalities to be covered, as regards e.g. the type and composition of actors that can be involved ('openness'), the range of activities that can be performed (including additionality and level of integration), the level of directionality and integration of R&I strategies; the possibilities offered for coherence and synergies with other components of Horizon Europe, including other Partnerships (internal coherence), and the coherence with the wider policy environments, including with the relevant regulatory and standardisation framework (external coherence). This approach guides the identification of discarded options while allowing at the same time a structured comparison of the options not only as regards their effectiveness, efficiency and coherence, but also against a set of other key selection criteria for European Partnerships (openness, transparency, directionality)[23].

In line with the Better Regulation Framework, the assessment of the effectiveness, efficiency and coherence of each option is made compared to the baseline. Therefore, for

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

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

On the basis of the evidence collected, the intervention logic of each initiative and the key functionalities needed, the impact assessments first evaluate the **effectiveness** of the various policy options to deliver on their objectives. To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into 'expected impacts' - how success would look like -, differentiating between scientific, economic/ technological, and societal (including environmental) impacts. Each impact assessment considers to which extent the different policy options provides the 'key functionalities needed' to achieve the intended objectives. The effectiveness assessment does not use a compound score but shows how the options would deliver on the different types of expected impacts. This is done to increase transparency and accuracy in the assessment of options[24].

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

To compare the expected costs and benefits of each option (**efficiency**), the thematic impact assessments broadly follow a cost-effectiveness approach[25] to establish to which extent the intended objectives can be achieved for a given cost. A preliminary step in this process is to obtain a measure of the expected costs of the policy options, to be used in the thematic assessments. As the options correspond to different implementation modes, relevant cost categories generally include the costs of setting-up and running an initiative. For instance, set-up costs includes items such as the preparation of a European Partnership proposal and the preparation of an implementation structure. The running costs include the annual work programme preparation costs. Where a Partnership already exists, discontinuation costs and cost-savings are also taken into account[26]. The table below provides an overview of the cost categories used in the impact assessment and a qualitative scoring of their intensity when compared to the baseline option (traditional calls). Providing a monetised value for these average static costs would have been misleading, because of the different features and needs

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

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

[26] Discontinuation costs will bear winding down and social discontinuation costs and vary depending on e.g. the number of full-time-equivalent (FTEs) staff concerned, the type of contract (staff category and duration) and applicable rules on termination (e.g. contracts under Belgian law or other). If buildings are being rented, the cost of rental termination also apply. As rental contracts are normally tied to the expected duration of the current initiatives, these termination costs are likely to be very limited. In parallel, there would also be financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. This is developed further in the individual efficiency assessments.

of each candidate initiative.[27] The table shows the overall administrative, operational and coordination costs of the various options. These costs are then put into context in the impact assessments to reflect the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution (cost-efficiency):

- The costs related to the baseline scenario (traditional calls under Horizon Europe) are pre-dominantly the costs of implementing the respective Union contribution via calls and project, managed by the executive agencies (around 4%, efficiency of 96% for the overall investment).
- For a Co-Programmed partnership the costs of preparation and implementation increase only marginally compared to the baseline (<1%), but lead to an additional R&I investment of at least the same amount than the Union contribution[28] (efficiency of 98% for the overall investment).
- For a Co-Funded partnership the additional R&I investment by Member States accounts for 2, 3 times the Union contribution[29]. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the national programmes, can be estimated at 6% of the Union contribution (efficiency of 98% related to the overall investment).
- For an Article 185 initiative the additional R&I investment by Member States is equal to the Union contribution[30]. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 7% of the Union contribution (efficiency of 96% related to the overall investment).
- For an Article 187 initiative the additional R&I investment by partners is equal to the Union contribution[31]. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 9% of the Union contribution (efficiency of 94% related to the overall investment).

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

Cost items	Baseline: traditional calls	Option 1: Co-programmed	Option 2 Co-funded	Option 3a - Art. 185	Option 3b -Art. 187
Preparation and set-up costs					
Preparation of a partnership proposal (partners and EC)	0	↑↑			
Set-up of a dedicated implementation structure	0			Existing: ↑ New: ↑↑	Existing: ↑↑ New: ↑↑↑
Preparation of the SRIA / roadmap	0	↑↑			
Ex-ante Impact Assessment for partnership	0			↑↑↑	
Preparation of EC proposal and negotiation	0			↑↑↑	
Running costs (Annual cycle of implementation)					
Annual Work Programme preparation	0	↑			

[27] A complete presentation of the methodology developed to assess costs as well as the sources used is described in the external study supporting this impact assessment (Technopolis Group, 2020).
[28] Minimum contributions from partners equal to the Union contribution
[29] Based on the default funding rate for programme co-fund actions of 30%, partners contribute with 70% of the total investment.
[30] Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.
[31] Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.

Cost items	Baseline: traditional calls	Option 1: Co-programmed	Option 2 Co-funded	Option 3a - Art. 185	Option 3b -Art. 187
Call and project implementation	0	0 In case of Member States contributions: ↑	↑	↑	↑
Cost to applicants	Comparable, unless there are strong arguments of major differences in oversubscription				
Partners costs not covered by the above	0	↑	0	↑	↑
Additional EC costs (e.g. supervision)	0	↑	↑	↑	↑↑
Winding down costs					
EC	0				↑↑↑
Partners	0	↑	0	↑	↑

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

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

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

As a last step, the alignment of the preferred option with key criteria for the selection of European Partnerships is described, reflecting the outcomes of the '**necessity test'**.[33] The monitoring and evaluation arrangements are concluding the assessment, with an identification of the key indicators to track progress towards the objectives over time.

2.4. Horizontal perspective on candidate Institutionalised European Partnerships

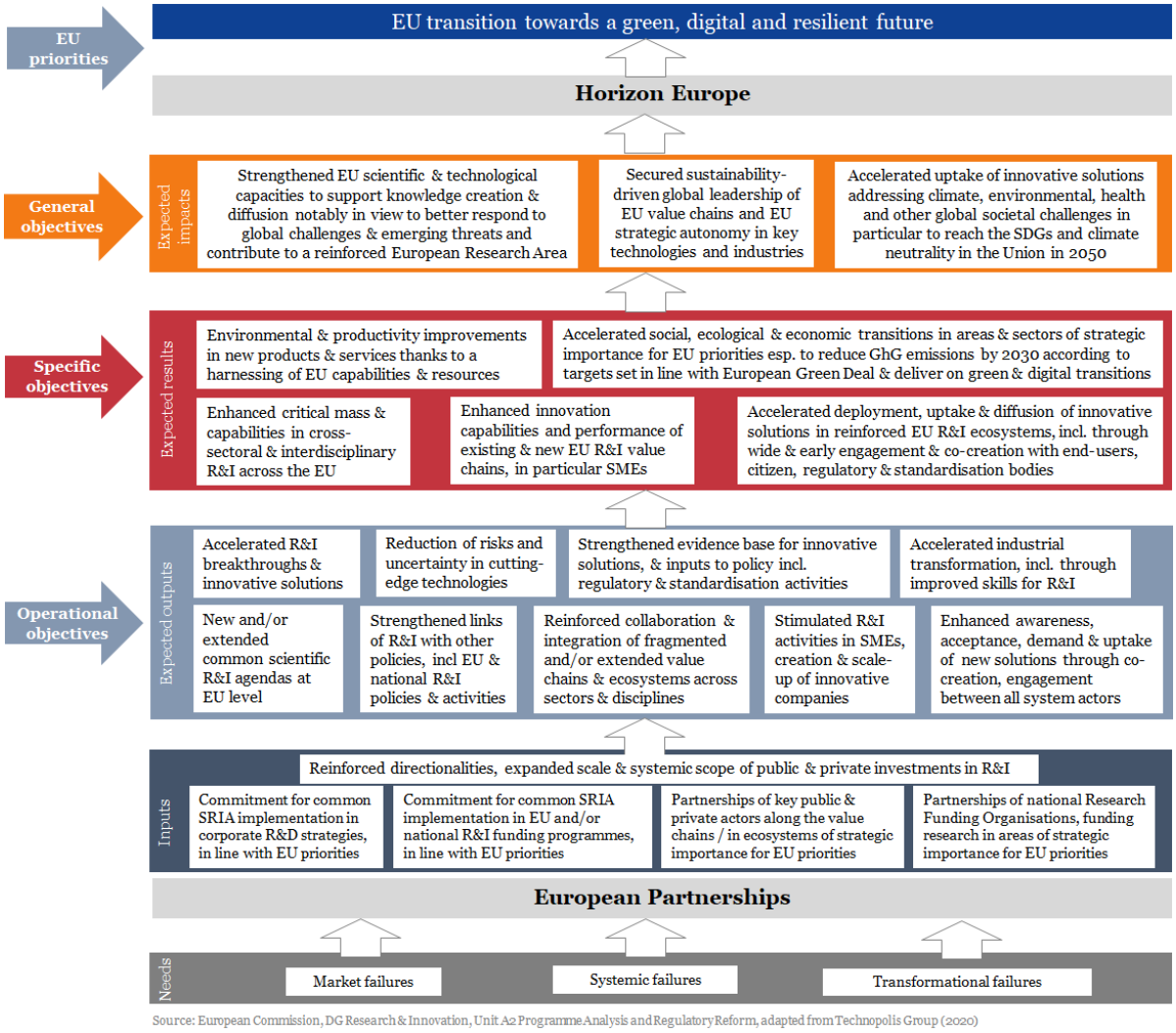
Overall impact orientation, coherence and efficiency needs

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

[32] More details on the methodology can be found in Annex 4.

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

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



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

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

a) Strengthening and integrating EU scientific and technological capacities to support knowledge creation and diffusion notably in view to better respond to global challenges and emerging threats and contribute to a reinforced European Research Area;
b) Securing sustainability-driven global leadership of EU value chains and EU strategic autonomy in key technologies and industries; and
c) Accelerate the uptake of innovative solutions addressing climate, environmental, health and other global societal challenges contributing to Union strategic priorities, in particular to reach the Sustainable Development Goals and climate neutrality in the Union in 2050.

In terms of specific objectives, they jointly aim to:

a) Enhance the critical mass and scientific capabilities in cross-sectoral and interdisciplinary research and innovation across the Union;
b) Accelerate the social, ecological and economic transitions in areas and sectors of strategic importance for Union priorities, in particular to reduce greenhouse gas

emissions by 2030 according to the targets set in line with the European Green Deal, and deliver on the green and digital transition;

c) Enhance the innovation capabilities and performance of existing and new European research and innovation value chains, in particular SMEs;
d) Accelerate the deployment, uptake and diffusion of innovative solutions in reinforced European R&I ecosystems, including through wide and early engagement and co-creation with end-users, citizen and regulatory and standardisation bodies;
e) Deliver environmental and productivity improvements in new products and services thanks to a harnessing of EU capabilities and resources.

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

- **Coherence for impact:** The extent and speed by which the expected results and impacts will be reached, will depend on the scale of the R&I efforts triggered, the profile of the partners involved, the strength of their commitments, and the scope of the R&I activities funded. To be fully effective it comes out clearly that future partnerships need to operate over their whole life cycle in full coherence with their environment, including potential end users, regulators and standardisation bodies. This relates also to the alignment with relevant EU, national or regional policies and synergies with R&I programmes. This needs to be factored in as of the design stage to ensure a wide take-up and/or deployment of the solutions developed, including their interoperability.
- **Collaboration for impact:** Effectiveness could also be improved collectively through enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems. An adequate governance structure appears in particular necessary to ensure cross-fertilisation between all European Partnerships. This applies not only to initiatives where similar R&I topics are covered and/or the same stakeholders involved or targeted, but also to the interconnections needed between the 'thematic' and the 'vertical' Partnerships, as these are expected to develop methodologies and technologies for application in EU priority areas. Already at very early stages of preparing new initiatives**,** Strategic Research and Innovation Agendas and roadmaps need to be aligned, particularly for partnerships that develop enabling technologies that are needed in other Partnerships. The goal should be to achieve greater impacts jointly in light of common challenges.
- **Efficiency for impact:** Potential efficiency gains could also be achieved by joining up the operational functions of Joint Undertakings that do not have a strong context dependency and providing them through a common back-office[34]**.** A number of operational activities of the Joint Undertakings are of a technical or administrative nature (e.g. financial management of contracts), or procured from external service providers (e.g. IT, communication activities, recruitment services, auditing) by each Joint Undertaking separately. If better streamlined this could create a win-win situation for all partners leading to better harmonization, economies of scales, and less complexity in supervision and support by the Commission services.

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

Looking at the coherence of the set of initiatives at the thematic level, the "**digital centric**"

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

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

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

To deliver a deep decarbonisation of highly emitting industrial sectors such as the steel, transport and chemical industries would require the production, distribution and storage of **hydrogen** at scale. The candidate hydrogen initiative would have a central positioning in terms of providing solutions to the challenges for sustainable mobility and energy, but also is expected to operate in synergies with other industry related initiatives. The initiative would interact in particular with initiatives on the zero emission road and water transport, transforming Europe's railway system, clean aviation, batteries, circular industry, clean steel and built environment partnerships. There are many opportunities for collaboration for the delivery and end-use of hydrogen. However, the Clean Hydrogen initiative would be the only partnership focused on addressing hydrogen production technologies.

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

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

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

PART 2 - THE CANDIDATE EUROPEAN PARTNERSHIP ON KEY DIGITAL TECHNOLOGIES

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

Digital technologies are transforming the world at unprecedented speed. They have changed how we communicate, live and work. They have changed our societies and our economies: they contribute to productivity and efficiency as well as to broader socio-economic development. The digital transformation affects all sectors of the economy and it will continue to expand and deepen. It will further determine our capacity to address key societal challenges, from the respect of fundamental rights to our environmental objectives. The digital transformation has been empowered by exponentially growing computing power, through what we call 'key digital technologies'. Key Digital Technologies, in this document, refers to **electronic components and systems** that underpin all digital products and services today. They are viewed as **key** because they are the **basic building blocks** of digital systems.

Electronic components refer to miniaturised physical devices **(**chips) that fulfil precise functions. They are based on semiconductor technology and come in many families (microprocessors, microcontrollers, memory chips, sensors).

Electronic systems[35] refer to sets of interconnected chips that perform more complex functions (various forms of sensing and actuating, process control, navigation etc).

Electronic components and systems include software for enhanced functionality and flexibility.

Electronic components and systems are **the fundamental enablers of innovation** in a number of "vertical" economic sectors such as automotive, manufacturing, healthcare, aerospace and defence, and can be the determinant of first mover advantage for companies active in those sectors. Crucially, they also play a foundational role in shaping how digital transformation unfolds. The Commission has made it a top priority for Europe to lead a digital transformation that goes hand in hand with a green transformation, that delivers to European values such as privacy and trust, security and safety, and that does not threaten citizens' well-being or disrupt critical infrastructures and wider security interests.[36]

Often in need of working in close collaboration with segments of vertical industries, the value chain of electronic components and systems is complex and R&I intensive. It spans a significant number of specialised tasks performed by a variety of companies. Strengthening **the relevant industrial fabric** is crucial to **pursuing the digital transformation in a European way** and will require, amongst others, improving Europe's capabilities in the design and production of the most critical parts of the supply chain, and thereby reducing dependencies on other parts of the globe.

This document focuses on assessing the most effective, efficient and coherent way of implementing an R&I initiative which would focus on joint European research and innovation activities in electronics components and systems under Horizon Europe.

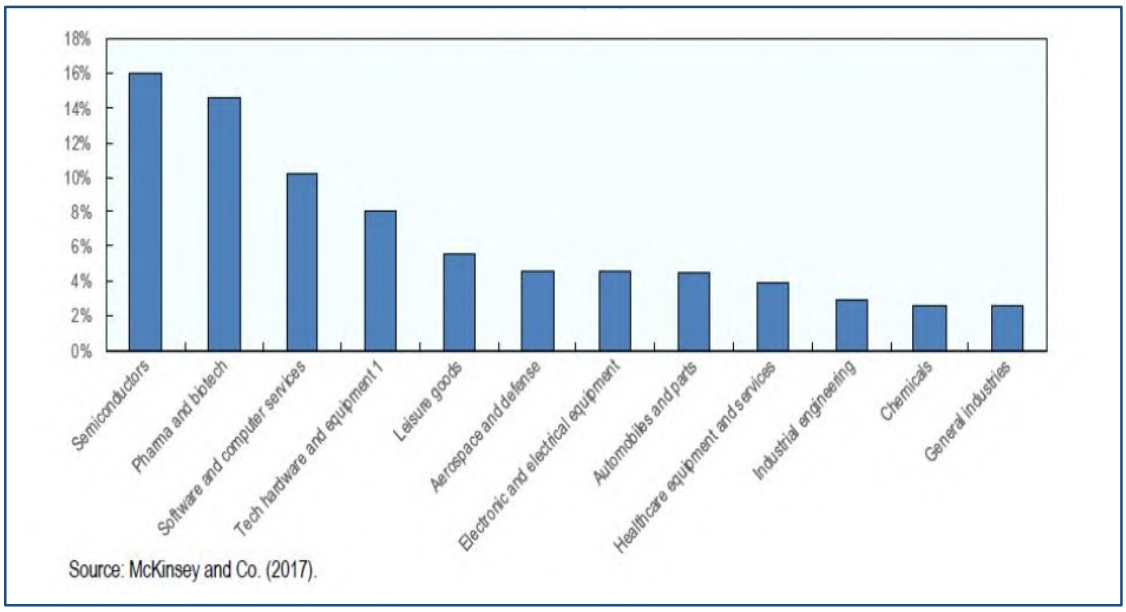
[35] A simple electronic system is the anti-lock brake system (ABS) in a car. ABS combines a sensing component that measures acceleration (accelerometer), a microprocessor that analyses the changes in acceleration over time and a hydraulic valve that acts on the car brakes. Sudden changes in acceleration (e.g. braking sharply in front of a close obstacle) are detected and trigger the system to act intermittently on the brakes, assisting the driver to be in control of the car. Similar systems are used to trigger airbag deployment in case of car collision.

[36] Shaping Europe's Digital Future. COM(2020) 67

1.1. Emerging challenges in the field

The production of electronic components and systems counts among the most R&I-intensive activities (see Fig 6). Over the last 20 years, the annual R&I expenditure as a percent of revenues has been consistently between 15 and 20%.[37,38] They are characterised by rapid technological change fuelled by constant R&I at all stages of the value chain, from the materials, fabrication equipment and design tools, through the processes of chip and system **design** and **manufacturing**, to the **test and packaging** of chips and **assembly into** systems. As components and systems become increasingly complex, the trade-off between the use of hardware and software to meet performance requirements has also become an important R&I challenge.

Figure 6. Research and Development % share of company revenue



This elaborate process translates to a complex and global supply chain and high investment costs with large economies of scale: the cost of designing and developing an advanced chip can be on the order of 1 B€, a leading-edge fab (where fabrication takes place) costs up to 20 B€. No single country or company dominates all of the stages of the value chain.

In recent years, and with the entry of China as an ever more prominent actor in the semiconductor business, global competition has intensified. This is evidenced in part by the growing numbers of **acquisitions** by companies, serving to build up the capacities they need to capture new markets.[39]

Global trade has increasingly been affected by measures serving national or regional policy agendas.[40] The COVID-19 pandemic has further ignited **geopolitical tensions**, stirring up competition between regions and unleashing measures to support local industrial ecosystems

[37] The annual R&I expenditure as a percent of revenues has been consistently between 15 and 20% over the last 20 years: Semiconductor Industry Association - Factbook 2020

[38] Measuring distortions in international markets: The semiconductor value chain. OECD Dec 2019

[39] Industrials Executive Mergers and Acquisitions Report. Kearny. 2019

[40] Illustrative cases include the US-China trade dispute over the licensing of Android operating system to Huawei, the US's prohibition on exports of critical electronic components to Iran, export control of essential semiconductor materials from Japan to South Korea, and more recently, the recent US intervention to block the export of critical EU semiconductor manufacturing equipment to China.

while minimising dependencies on imports.[41] While China is investing 150 B$ in the semiconductor industry over a 10 year period, including for R&I, until 2025, the US has recently[42] announced subsidies of 25 B$ to strengthen domestic production, including R&I into "cutting edge semiconductor" production.

The global **demand for electronic components and systems[43] is being increasingly shaped by digital transformation** as these technologies penetrate more and diverse sectors of the economy. While applications in automotive, manufacturing, healthcare, consumer, aerospace and defence account nowadays for roughly 40% of the semiconductor market, **growth rates are forecast to be higher** than for the computing and communications segments. This translates into a diversity of challenges to be met by electronics components and systems, such as computing speed, low energy consumption, security, real-time constraints and others.

As explained in the European data strategy[44], the **volume of data** produced in the world is growing rapidly, by a factor of five from 2018 to 2025. Processing such data at the speed needed to capture widely its benefits will require an important shift in the way we conceive and produce electronic components and systems. Scaling up the computing performance with today's component technologies will simply make computing one of the biggest energy consuming activities. Future components and systems should therefore exhibit radically **lower energy consumption** to be able to harness the benefits of data growth. Electronic components and systems delivering on energy efficiency will help the digital sector reduce carbon emissions[45] and contribute to the green transformation of the using sectors.

Moreover, safety, security and respect of privacy are fundamental objectives in the development of technologies permeating sectors such as healthcare. During the COVID-19 pandemic, for example, it has become clear that the costs associated with the health service infrastructure can be alleviated by remote medical assistance and personal health-monitoring. Wearable devices will require low-power consumption and **secure electronic components** and systems will be instrumental in ensuring that **privacy is preserved**. **Security, privacy and safety** have therefore become increasingly important challenges in the EU digitised society. Secure hardware and software components will need further development to cater for increasing use of online digital identity, to prevent hacking and manipulation of data, and to ensure GDPR compliance in future networked systems[46]. Computing systems that are increasingly embedded in all types of artefacts will be often operating under real-time constraints[47] and have to be **highly dependable and safe.**

To satisfy these challenges there are two main technological trends, **miniaturisation** and **emerging computing paradigms,** including edge computing.

For decades the industry has been driven forward by Moore's law, according to which capabilities of a chip of a given size double every two years. Using very advanced photolithographic techniques developed and industrialised in Europe, the number of transistors that can be packed into a chip today is on the order of ten billion (see fig. 7).

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[41] Trump and Chip Makers Including Intel Seek Semiconductor Self-Sufficiency WSJ. 11.05.2020

[42] *U.S. Lawmakers Propose $25 Billion to Help Chip Industry*, Bloomberg 10 June 2020

[43] The annual growth rate of the global market is estimated at 5.6% until 2025

[44] COM (2020) 66. A European strategy for data. 19 February 2020

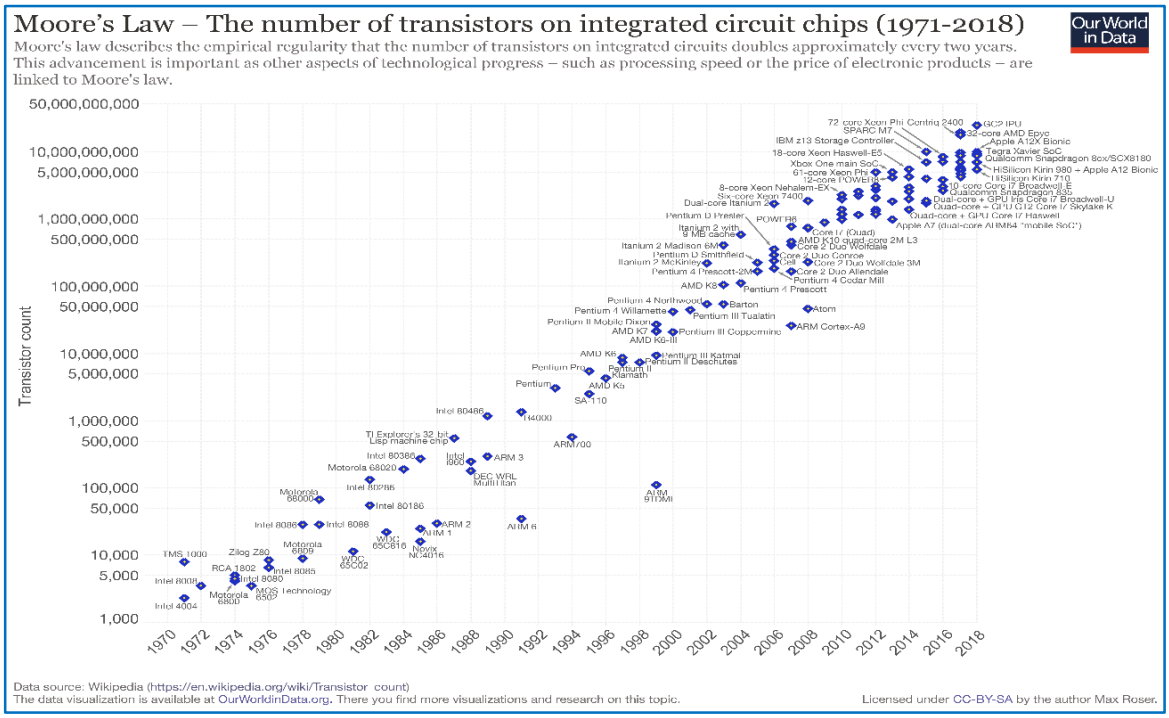
[45] Nowadays the ICT sector is responsible for about 3% of global carbon emissions

[46] HiPEAC. (2019). *HiPEAC Vision 2019*.

[47] Real-time systems guarantee a response within a specified time constraint, usually in the order of milliseconds.

While the dimensions of transistors may be squeezed further to 3 and 2 nanometer, Moore's Law is reaching physical (and economic) limits and remains a major R&I challenge. This **progressive miniaturisation** has had the added advantage of increasing computing speed. So-called microprocessors and memory chips resulting from these developments have driven the successive generations of computing and communication devices which account for roughly 60% of the semiconductor component market today.

Figure 7. Technological evolution of semiconductor production technologies (Moore's Law)



As Moore's law reaches its physical limits, **alternative computing paradigms are** beginning to emerge. Today's main contenders are neuromorphic computing (based on neural networks), spintronics and quantum computing – areas where European research organisation are sought after for their know-how. While the first chips have been developed, the full ecosystem of design methodologies and tools, software simulation and fabrication equipment are still in development. Neuromorphic computing, for example, offers great promise for achieving 2-3 orders of magnitude improvements in energy efficiency for data processing tasks and it is particularly suited to power Artificial Intelligence.[48] Further industrialisation of emerging technologies, their integration with sensing and connectivity, will open a window of opportunity. Building out the ecosystem will require new know-how and expertise, new approaches and new collaborations between research and industrial actors.

Finally, many applications in a variety of sectors today make intensive use of data processing and Artificial Intelligence – process automation in manufacturing for example. Given the large volumes of data that can be collected today - thanks inter alia to the variety of sensors that exist - data processing often takes place in remote data centres ('the cloud'). Innovative electronic components such as very low-power microprocessors, accelerators and embedded memory can enable more and more processing to take place close to the user – so-called **edge computing**[49]**.** While cloud and edge computing will likely co-exist, edge

[48] *For a meaningful Artificial Intelligence*. Cédric Villani. 2018 (pp. 51-52)
[49] Emerging compute paradigm whereby processing is done close to the user rather than in remote data centres

computing for AI is on the one hand a huge opportunity for Europe to leverage existing strengths in specific vertical markets. On the other hand, the possibility to avoid transfer of data to the central cloud, improving speed, **energy efficiency, privacy and security**, makes edge computing an attractive proposition from economic, environmental, and fundamental rights perspectives. Electronic components and systems will be important enablers of the transformation.

Stakeholder opinion

In their feedback to the Open Public Consultation to the KDT inception impact assessment, respondents representing industry asked for a broadening of the scope with respect to the ECSEL JU. In particular the need to integrate semiconductor-based photonics, selected software technologies (beyond embedded software) and focus on electronic value chains was highlighted by the industry associations.

A minority of views from industrial representatives expressed concerns with a broader scope. In particular with the fact that an extension of the scope would add complexity to the running of the initiative.

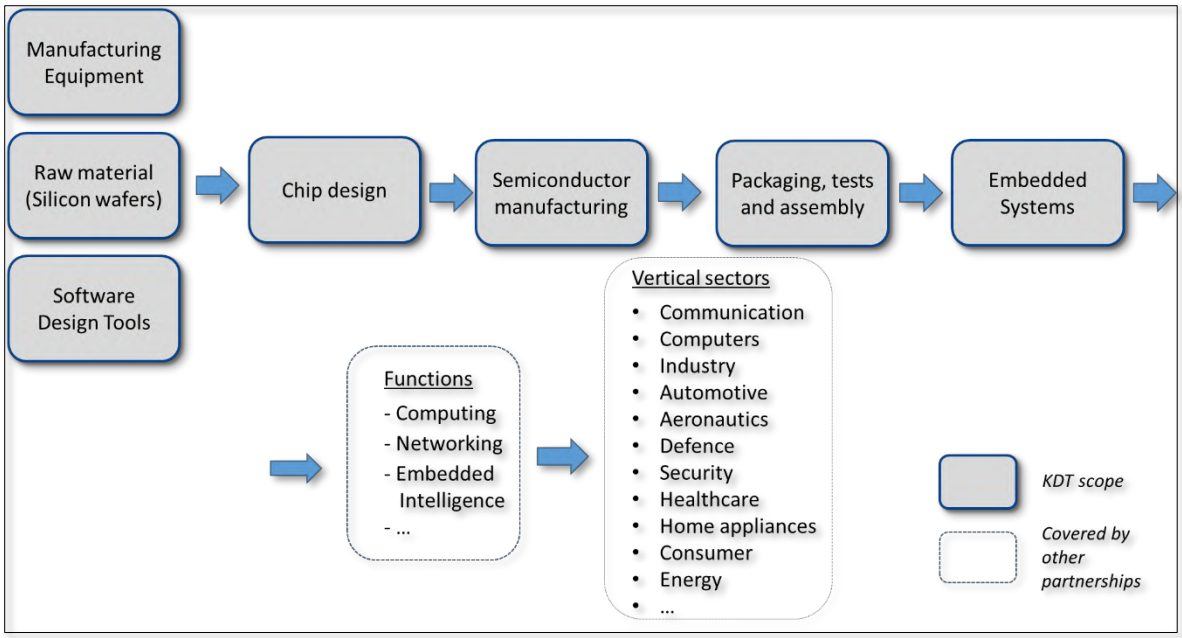
A majority of interviewees[50], including from large companies, industry associations, SMEs, RTOs and universities equally stressed the importance of AI, computer architectures, software engineering and silicon-based photonics for the KDT initiative.

1.2. EU relative position in the field

The electronics value-chain is made up: of i) manufacturing equipment, raw materials, and software-based design tools; ii) chip design and semiconductor manufacturing; iii) packaging, test and assembly; iv) embedded systems. See Figure 8.

[50] Interviews taken place in the context of the study « *Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe - Candidate Institutionalised European Partnership on Key Digital Technologies* ». Technopolis Group. January 2020

Figure 8. The electronics components and systems value-chains



Manufacturing equipment, raw materials, and design tools: Europe accounts for 17% (or 24 B€) of the global market[51]. Europe is the leading provider of advanced photolithography equipment that enables miniaturization of transistors to dimensions of 2 to 3 nanometres. There is significant know-how in Europe's research and technology organisations which have supported development of equipment process technologies. Europe has a vibrant ecosystem of smaller actors, active in equipment such as wafer processing and wafer handling.

Europe also leads in the production of Silicon-on-Insulator (SOI) wafers and process technologies which are increasingly important for communications as well as for applications requiring low power consumption. A process technology based on SOI wafers (FDSOI[52]) was developed in research labs in Europe and transferred to industry.

While Europe has some industrial players in design tools for components, boards and electronic systems it is largely dependent today on US companies for its design needs.

Chip design and Semiconductor manufacturing: EU-headquartered companies accounted for 9% - or 40 B€ - in 2018[53] of this fiercely competitive 456 B€ market, with three European vendors[54] in the top-15 global ranking.[55] Although revenue growth in Europe has been constant over the last decade - at 4.6% - Korean, Taiwanese and Chinese companies are gaining market share. US, Korean and Taiwanese companies, now dominate the top-15.

[51] European Commission. (2019). Study on Emerging technologies in electronic components and systems (ECS) - Opportunities ahead. SMART 2018-0005

[52] Fully-depleted Silicon on Insulator

[53] European Commission. (2019). Study on Emerging technologies in electronic components and systems (ECS) - Opportunities ahead. SMART 2018-0005

[54] STM, NXP and Infineon are ranked at 11, 12 and 13 in the 2018 Semiconductor vendors ranking. Reference: "Measuring distortions in international markets: The semiconductor value chain", *OECD Trade Policy Papers*, No. 234, OECD Publishing, Paris.

[55] A first indication of the 2019 semiconductor market has been published on April 1st, 2020. Two European vendors are in the top-10 (STM, number 8th, and Infineon, number 10th). With currently available information European share of global semiconductor production is estimated at 10%.

In terms of **market segments**, EU companies are strong in automotive, industrial manufacturing, aerospace, defence and security, and healthcare.[56] The European industrial ecosystem in semiconductor components is regaining strengths in manufacturing since 2016 after a long period of stagnation. In particular, important investments made in pilot lines for production, have helped bridge the innovation gap and accelerated the move of innovative technologies from the lab to the fab capitalising on Europe's R&D strengths.

Despite limited industrial presence in **computing and communications** segments, which require large investments in both design and manufacturing[57], European research competencies are strong in these domains in terms of know-how. A number of SMEs – many of which spin-offs from academia – also participate actively in leading-edge research initiatives, such as the European Processor Initiative.[58] Europe hosts the world's best research labs[59] in semiconductor technology with leading[60] capabilities in chips for neuromorphic[61] and in-memory computing, quantum computing and spintronics.

Packaging, test and assembly: Packaging, test and assembly,[62] traditionally labour-intensive activities located to a large extent in South-East Asia (Malaysia, Thailand, Philippines). Packaging may become more strategically important as the phasing out of Moore's Law calls for new approaches to functional integration and miniaturisation of electronic components and systems. Increasing levels in process automation and growing added-value justifies to relocate in Europe some of the advanced packaging activities. Europe has specific strengths in high-end and niche markets, as well as in academia, and there is scope to develop these further.

Embedded systems: refer to electronic systems that perform specific functions within a larger mechanical/electrical system. They are used in applications in specific market segments, such as adaptive cruise control or lane-warning systems in vehicles, process control systems in industrial machinery, diagnostic systems in medical equipment, and autopilot systems in planes. These segments are dynamic and grow faster than computing and communications, where growth has been showing signs of saturation and where competiveness is driven largely by processor and memory performance (presently the dominion of US and Asian players). Europe is a strong player in embedded electronics and software both in research and in its exploitation by industry where it is world leading in the field of real-time systems for safety critical applications in automotive, manufacturing and aeronautics. The Important Project of Common European Interest on microelectronics marked a turning point for Europe. Its approval in December 2018 led to private investments of more than 6B€ in first industrial deployment and related R&I, including the first

[56] European Commission. (2019). Study on the Electronics Ecosystem – Overview, Developments and Europe's Position in the World. Final Report. SMART 2016/0007.
[57] Advanced microprocessors cost between 400 M€ and 3B€ to develop. The construction of advanced fabrication facilities cost on the order of 20B€.
[58] https://www.european-processor-initiative.eu/
[59] Imec in Belgium, CEA-Leti in France, Fraunhofer Institute for Microelectronics in Germany
[60] Self-learning-neuromorphic-chip-that-composes-music, Phys.org, May.2017
[61] Neuromorphic refers to computing approaches making use of electronic circuits that mimic neuro-biological architectures such as those present in nervous systems.
[62] **Packaging** is the process to encapsulate the silicon chip to protect it from the environment. **Testing** assesses the quality and functioning of packaged chips discarding the failures. **Assembly** is the process to mount and interconnect chips onto boards.

greenfield investment in manufacturing in well over a decade. Its main focus was on low-power technology, sensors and power management for electric vehicles.[63]

SUPPORT TO THE FIELD IN THE PREVIOUS FRAMEWORK PROGRAMME – KEY STRENGTHS AND WEAKNESS IDENTIFIED

The proposed **initiative builds on the on-going** (2014-20) **ECSEL Joint Undertaking** based on Art. 187[64], with the participation of the European Commission, ECSEL Participating States (EPS)[65] and industry. It addresses the research and innovation challenges of electronics components and systems.

The overall strategic orientation and operations of the ECSEL JU are the responsibility of the Governing Board (GB). The GB is composed of representatives of the Commission, the Participating States and the private members representing industry, universities and research institutes. Each member appoints its representatives and a lead delegate who holds the voting rights of that member in the GB.

The financial contribution to the ECSEL JU from the Commission, the Participating States and the private partners is set out in the Council Regulation establishing the partnership.

In practice this is implemented on annual basis. Following confirmation of the proposed Commission contribution at the beginning of each year, each EPS announces their commitments. They are then published in the call work programme. Once projects have been evaluated and selected, fine-tuning of the contributions is always feasible (as EPS can decide to augment theirs).

In the period 2014-2018, total contributions from the Commission, EPS and private partners amounts to 822,2, 731,7 and 1795,6 M€[66], respectively. The private partners' contribution takes account of all beneficiaries in projects (both members and non-members of the industrial associations). Approximately, 30% of ECSEL beneficiaries are not members of associations, what gives an idea of the openness of the partnership.

The contribution of industry and research organisations to ECSEL projects is mostly in-kind (e.g. personnel, infrastructure) subject to audit. In the period 2014-18, the ratio of the **audited** in kind contribution of private members to the Commission contribution has been **2.18:1**. The ratio of **EPS** to Commission contributions in the same period is **0.9:1**. [67]

The leveraging of the Commission's contribution by a factor of three has enabled **a critical mass of resources** to be mobilised that is essential for **large-scale** collaborative efforts (on the order of 100 M€) around major industry objectives, such as **pilot lines on new component technology** and **software platforms** and related standardisation efforts. This

[63] In 2018, the Commission gave its approval for an Important Project of Common European Interest (IPCEI) on Microelectronics. Under this IPCEI, DE, FR, IT and the UK jointly support transnational cooperation of 29 companies to maintain and further expand European competencies in the electronics ecosystem. It combines €1.75 billion of national aid with €6.25 billion of private investment addressing innovation and first industrial deployment of technologies developed within European R&D initiatives.

[64] Council Regulation (EU) No 561/2014 establishing the ECSEL Joint Undertaking. 6 May 2014

[65] ECSEL Participating States comprise 25 Member States (Cyprus and Croatia excluded) and four Associated States within the Horizon 2020 programme (Switzerland, Norway, Israel and Turkey).

[66] ECSEL Annual Activity Report 2018.

[67] The Council Regulation establishing the JU, in its recital 21, foresees that all contributions are taken into account when measuring the impact: "In assessing the overall impact of the ECSEL Joint Undertaking, investments from all legal entities other than the Union and the states participating in the ECSEL Joint Undertaking (the 'ECSEL Participating States') contributing to the objectives of the ECSEL Joint Undertaking should be taken into account. Those overall investments are expected to amount to at least EUR 2 340 000 000."

streamlining of priorities and strategies, and synchronisation of funding decisions to mobilise resources, would otherwise not have been possible[68].

What has or is being achieved so far

ECSEL has become instrumental for the European stakeholders and a key pillar of Europe's industrial R&I strategy.[69] Major technological achievements enabled by **large scale** initiatives include:

- *Extreme UV lithography*: development of the world's most advanced process equipment for ultimate miniaturisation of semiconductor components.

- *FDSOI*: Innovative technology for the production of components with reduced energy consumption (a factor of two compared to competing processes) and high performance for radio frequency (RF). It is being rolled-out for Internet of Things applications.

- *Advanced power electronics*: using alternatives to conventional Silicon (e.g. SiGe, GaN). Europe is leading the world in devices for power management and conversion - indispensable for electric vehicles, smart energy grids and industry 4.0.

- *Safety-critical embedded systems*: has become a recognised European strength in applications for which safety is a primary concern such as automotive and avionics.

- *Smart miniaturised systems*: development of a new generation of minimally invasive smart catheters with integrated intelligence.

ECSEL has focused on areas in which the societal impact is particularly strong, such as clean mobility, energy efficient industry and sustainable healthcare.[70] From the perspective of scientific impact, in the period 2014 to 2018, 66% of publications from ECSEL JU participants were in the top 25% ranked journals in their respective fields. When it comes to patents, ECSEL JU has so far a total of 46 patents registered for 400 Million Euro of paid effort as projects continue.

In a growing competitive environment with increasing societal and environmental challenges and a very rapid technological evolution, the intended KDT initiative would build on ECSEL achievements and take them to a higher level, while adapting to the new technological, industrial and geopolitical reality.

Key areas for improvement and unmet challenges – Lessons learnt

The ECSEL interim assessment[71] identifies areas for improvement and put forward specific recommendations:

- to place greater emphasis on a **strategic approach** with a stronger **alignment to EU priorities.** The current partnership was considered as being too bottom-up in its approach, and the Commission and Participating States were encouraged to play a stronger role in priority setting.

- a **broader coverage of electronic value chains** including participation of systems houses[72]. This was in part intended to encourage better working together of the components and systems communities, but also that R&D is well-aligned with industrial needs – whether

[68] European Commission. (2018). *Interim Evaluation of the ECSEL Joint Undertaking (2014-2016) Operating under Horizon 2020*. Final report.
[69] 'Study on the impact of ECSEL funded actions'. Deloitte, Valdani Vicari and Associati. February 2020.
[70] 'Study on the impact of ECSEL funded actions'. Deloitte, Valdani Vicari and Associati. February 2020.
[71] European Commission. (2018). *Interim Evaluation of the ECSEL Joint Undertaking (2014-2016) Operating under Horizon 2020*. Final report.
[72] End user industries with capability to design and produce systems

longer or shorter term - from day1. A slight expansion of the scope to higher layers of software would also help facilitate this.

- to aim at **better harmonisation of national** administrative practices and procedures with a view to **simplification**. This regards practices related to the rules and conditions to participants across Participating States, which can be simplified. The application and reporting processes in particular should not be more complex than they would be for the regular Horizon 2020/Europe calls.

and

- to strive for **further integration of SMEs** and start-ups in the electronics innovation ecosystem. Though participation of SMEs represented up to 30% in terms of numbers, in terms of funding share – currently 17% - there is still scope to play a more active role in the partnership and exploit their full potential.

The proposed initiative in KDT takes account of these lessons learnt in its scope, objectives and implementation. The need of a closer alignment with EU priorities, a broad coverage of value-chains and the better integration of SMEs are part of the intervention logic ('problem drivers') of this initiative and they are addressed in its specific objectives. The harmonisation and simplification of national practices and procedures is to be addressed in the setting and implementation of a potential partnership[73] (currently in discussion with national authorities).

More details are provided in Section 2 (Problems) and Section 4 (Objectives).

1.3. EU policy context beyond 2021

The proposed initiative can be set in the context of a number of recently announced European policies and priorities. These policies would inform the Strategic Research and Innovation Agendas (SRIA) of a future initiative on Key Digital Technologies and be taken into account in work programmes that form the basis for calls for proposals:

Artificial Intelligence: Recent progress in AI has been driven by the ever-increasing processing power of semiconductor chips. The White Paper on Artificial Intelligence[74] acknowledges that advanced low-power processors, a market currently dominated by non-EU players, will be essential for Europe to be creators and not just users of AI. This situation can be turned around by initiatives such as the European Processor Initiative, which develops a low-power processor for supercomputing, and a future initiative on Key Digital Technologies which would address the computational requirements of AI (notably deep learning) and their implications for processor design. The Paper also identifies neuromorphic solutions, where Europe is strong today, as being suited to tasks which deploy AI.

The Data strategy[75]: The aim is to enable the data economy for the coming five years. Processing and storage of data, computing power and cybersecurity are among the essential issues to be tackled, if the EU is to acquire a leading role in the data economy. In this perspective, the EU needs to reduce its technological dependencies on secure, energy-efficient, affordable and high-quality data processing capacities. A future KDT initiative would address the R&D needed to master these capacities.

[73] An on-going EC-Member States dialogue is addressing harmonisation and simplification.
[74] European Commission *White Paper on Artificial Intelligence*, COM(2020)65 final, 19.2.2020
[75] *A European strategy for data, COM(2020) 66 final, 19.2.2020*

Industrial Strategy[76]: The new strategy stresses the need for Europe to pool its strengths to do collectively what no one can do alone. It cites microelectronics as an example of the value of pooling resources to reverse a downward trend. This is in large part due to the current ECSEL JU and an Important Project of Common European Interest (IPCEI) on Microelectronics, and the investments they have triggered in the development and production of electronics components and systems. In the same context the Communication underlines that the EU will continue to support the development of key enabling technologies *i.e.* microelectronics that are strategically important for Europe's industrial future and announces possible follow-up to the first IPCEI on microelectronics. The R&D programme of a future initiative could complement the innovation roadmap of a second IPCEI.

Recovery Plan for Europe[77]: The Commission has proposed a reinforced EU budget to help repair the economic and social damage brought about by the coronavirus pandemic and kick start the recovery. The Commission estimates that investment needs amount to at least 3.5 trillion euros in 2020-2021. Investment in key sectors and technologies is considered crucial. The Communication highlights that strong interdependencies between electronic value chains and other industrial value chains, including digital and automotive, make electronics one of the most important industrial ecosystems in Europe. An annual investment gap of 17B€ has been estimated for semiconductor technologies. Support to Member States and mobilisation of private investment will be crucial to increased investment in key value chains, such as microelectronics, necessary to Europe's future resilience and strategic autonomy in the context of the green and digital transitions. The future initiative will also be instrumental in this sense.

Green Deal: the Communication[78] points explicitly to the potential of digital technologies to bring efficiencies on the one hand and the need to reduce the environmental footprint on the other, including that of electronics components and systems.[79] A future initiative would need to embrace this two-pronged approach by focussing on the development of low power technologies and their applications.

Research and Innovation: under the proposed **Horizon Europe** programme, Pillar II Cluster "Digital, Industry and Space" aim to make concrete contributions to three overarching EU policies: 'A Europe fit for the Digital Age', 'An economy that works for people', and 'A European Green Deal'. Horizon Europe would cover the earlier stages of research on electronic component and systems technologies with emphasis on high quality scientific outcomes. Mechanisms for interaction between the initiative and Horizon Europe would be put in place such as the setup of technology clusters and the follow up of specific projects ('from lab to fab').

The three candidate Institutionalised Partnerships covering digital technologies, i.e. *Key Digital Technologies, Smart Network and Services* and *EuroHPC,* together with partnerships *Photonics* and *AI, data technologies and robotics*[80], are intended to enable Europe to prepare for the continued massive use of data – much of which is coming from devices and premises at the edge of the network (wearables, autonomous vehicles, factories, hospitals, etc.).

[76] *A New Industrial Strategy for Europe, COM(2020)102 final, 10.3.2020,*
[77] *Identifying Europe's recovery needs*, SWD(2020) 98 final, 27.5.2020
[78] *The European Green Deal*, COM(2019) 640, 19.12.2019
[79] *A new Circular Economy Action Plan,* COM(2020) 98 final. 03.03.2020
[80] 'Photonics' and 'AI, data technologies and robotics' are co-programme candidate partnerships.

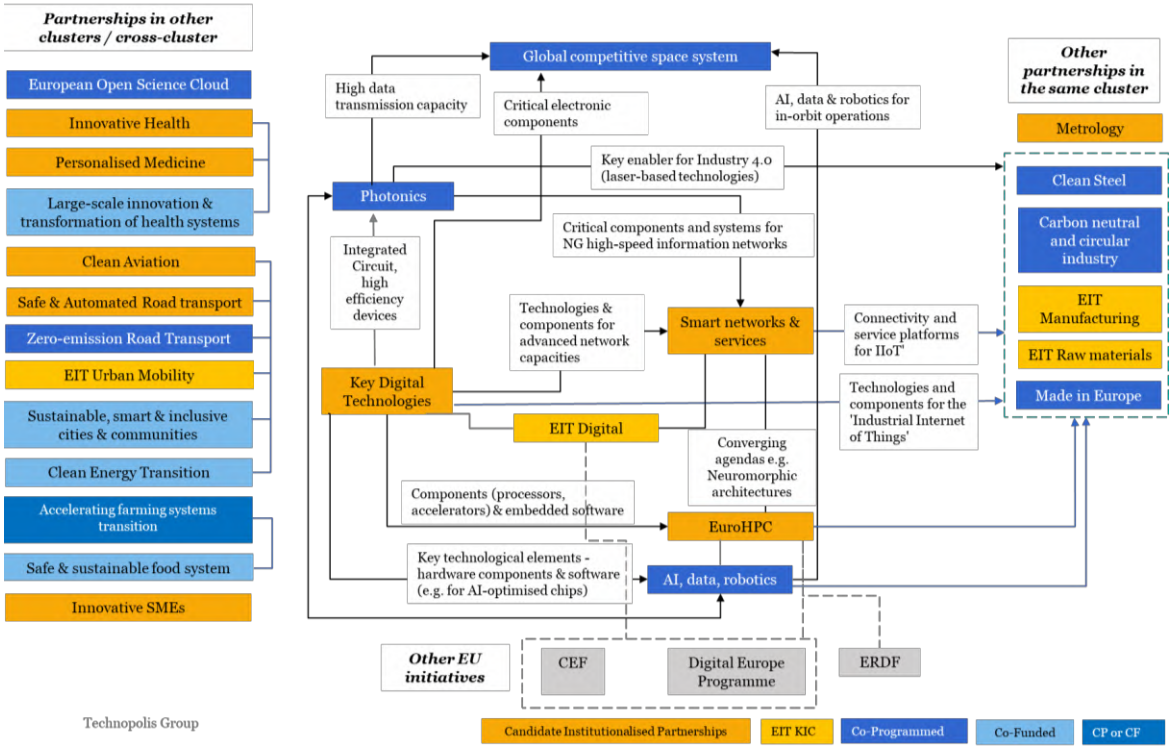
As alluded to in sections 1.1 and 1.2, the proposed **KDT initiative covers advances (design, manufacturing, embedded systems) in the underpinning electronic components and systems technologies** that can provide enhanced performance or additional functionality at the application level. The networking (*Smart Network and Services),* computing *(EuroHPC)* and integrated intelligence *(AI, data technologies and robotics)* functions **build on these advances**. More specifically:

- **Smart Network and Services**: electronic components and systems feed both the network infrastructure (base stations, routers, servers) and the terminals. Network speed, capacity and reliability largely depend on key components (application specific circuits, net processors, radio-frequency devices, smart antennas) that would be expected to be developed by the KDT initiative.
- **EuroHPC**: Supercomputers require high-performance electronic components (processors, accelerators) to be developed by the initiative in KDT.
- **AI, Data and Robotics:** AI systems and robots make use of advanced components (sensors, processors, actuators, embedded memories, power devices) to perform increasingly complex tasks. Data processing is enabled by chips with high computation power which are essential for autonomous, real-time decisions, as requested in robots. Essential components for AI and robotics, such as those mentioned, would be developed in the KDT initiative.
- **Photonics**: Photonics exploits the properties of light and covers a broad range of technologies (such as laser-based 3D printing, optical communications, new types of light sources, multi-sensing, etc.). Photonics include Photonics Integrated Circuits (PICs) which are based on semiconductor technology and, therefore, would be addressed by such an initiative in KDT.

It will thus be important for a future KDT initiative to **build and maintain strategic links** with these partnerships and their stakeholder communities. This is foreseen in the draft Impact Assessment for the candidate European Partnership for Smart Networks and Services (p.32). EuroHPC and ECSEL JUs are currently developing their strategic roadmaps in coordination with each other, and with the involvement of respective Commission and Participating States representatives.

Beyond digital, strategic links with partnerships on mobility, health, manufacturing, space and energy are also envisaged. This is work in progress. Specific targets in this context would be to make use of testbeds (whether vehicles, networks, robots or other) in which components and systems developed in an initiative relating to KDT could be assessed and validated in close-to-real-life scenarios before eventual commercial deployment.

Figure 9: Envisaged European Partnerships in the Digital, Space & industry cluster.

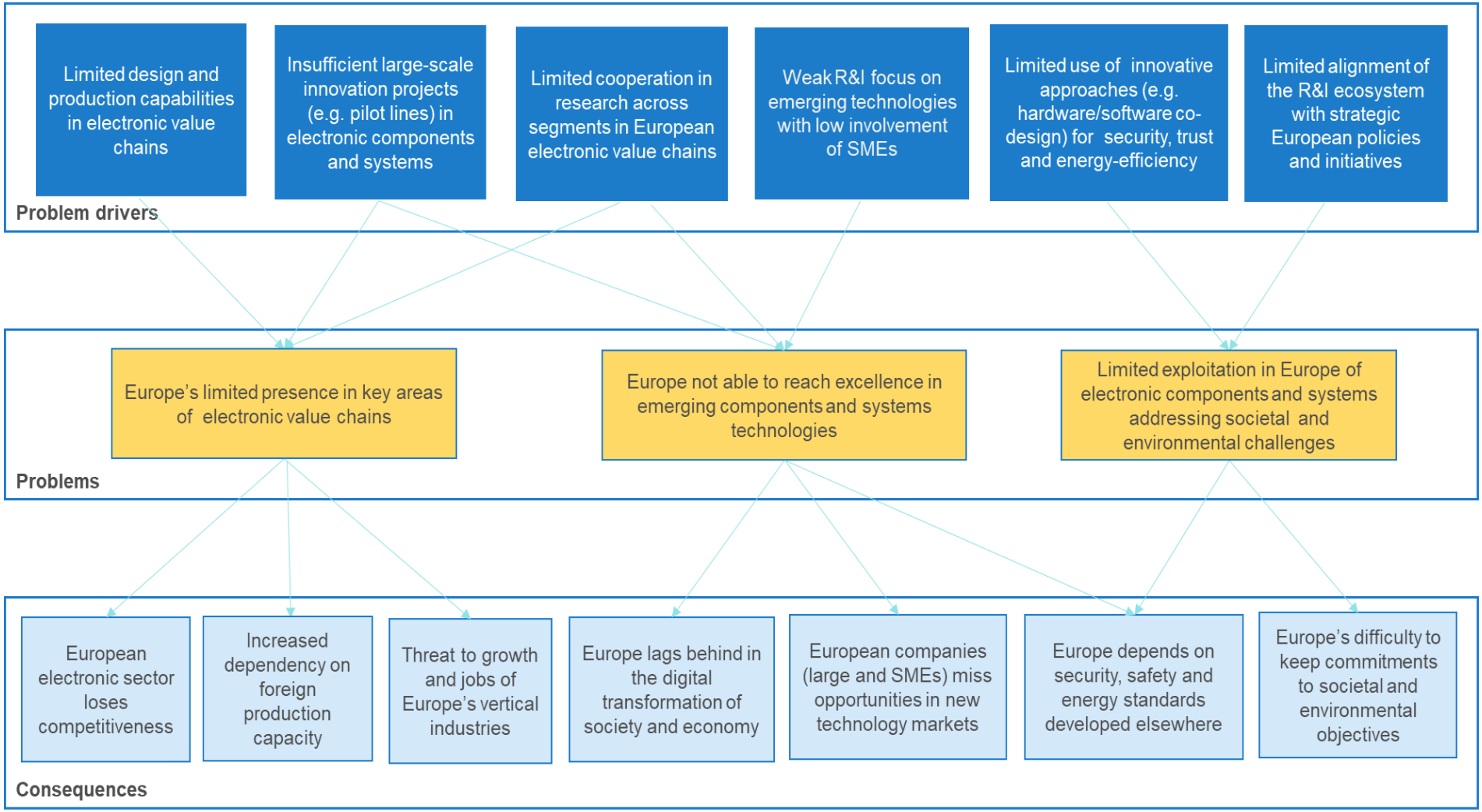


2. PROBLEM DEFINITION

Given the scale of the challenges entailed by the digital transformation, the current scientific, technological and economic positioning of Europe in the field, and the EU policy context, a set of problems have been identified where EU research and innovation in electronic components and systems has a specific role to play.

A problem tree portraying related problems, their drivers and consequences is presented in Figure 10. They are described in detail in the following sections.

Figure 10: Problem tree for the initiative on Key Digital Technologies



2.1. What are the problems?

The predecessor initiative ECSEL was set up to achieve further miniaturisation, higher computing or communication speeds, better energy performance, improved security, safety, reliability, or cost reductions. Despite a considerable number of achievements by ECSEL in these areas, further progress is necessary to stay at the technological forefront and maintain Europe globally competitive in the field of electronics components and systems. Also a number of unmet objectives and shortcomings identified at the interim evaluation of ECSEL need to be addressed.

Main identified problems are:

2.1.1 Europe's limited presence in key areas of electronic value chains

European electronic components and systems suppliers have a strong position in global vertical markets, including automotive, industrial equipment, aerospace, security and healthcare[81]. However, not all stages of development and production take place in the EU. **Manufacturing** of electronic components and systems mostly takes place in **Asia** and circuit **design** is dominated by US and, more recently, by Asian companies. R&I effort would be required to develop the necessary design and manufacturing competences. Additionally Europe has **very limited presence** in high-volume **computing and communications markets,** which currently account for 60% of global components market. Limited presence in key areas affects electronics value chains and undermines EU sovereignty.

The current **COVID-19 crisis** has put additional strain on supply chain resilience and has illustrated the critical importance of **access** to electronic components[82,83] and Europe's ability to develop them.

2.1.2 Europe not able to reach excellence in emerging components and systems technologies

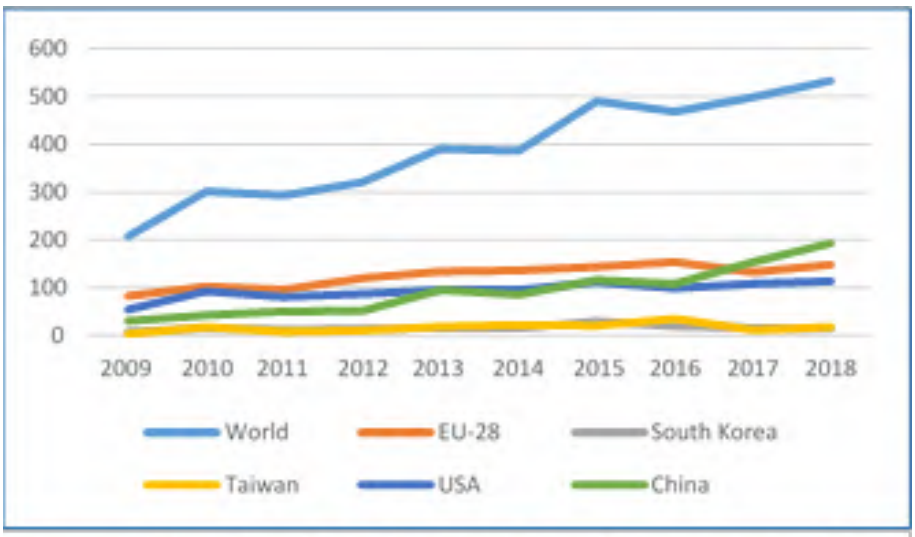
Analysis of the number of research publications in microelectronics in the period 2009-18 (Fig. 11) shows that Europe has been leading, although its leadership has been taken over by China in 2017 and is closely followed by the US. Steep increases in research capacity and R&D investments in these regions are threatening Europe's ability to seize emerging opportunities.

[81] Europe is a leading global supplier of electronic technologies for automotive, industrial equipment, aerospace, defence & security, and healthcare sectors (See 2018 data in Table 1, Annex 6)

[82] The Commission has identified microelectronics as a crucial sector for the EU economy and has addressed its challenges linked to the crisis

[83] EC proposal for a COVID-19 recovery plan.

Figure 11: Production of research publications on microelectronics per country and year — number of publications (2009-2018)



Source: Calculations by Technopolis Group based on Scopus data

Moreover, the uptake of research output by industry in Europe has been slow, mostly because of its fragmentation and smaller footprint when compared with US and China. Finally, European R&D actors, **SMEs and start-ups** are often particularly strong in emerging domains, but can **lack the connection to a broader ecosystem** to develop partnerships, grow their knowledge and eventual customer base, limiting Europe's ability to capitalise on the excellence of the research output.

2.1.3 Limited exploitation in Europe of electronic components and systems addressing societal and environmental challenges

In the development of electronic components and systems, focus has traditionally been on performance and costs. More recently the pressure to extend the autonomy of mobile devices and the increasing attention to environmental impacts have made **reduced energy consumption** a key criteria in technology development. **Safety and security** considerations have also grown in importance following increasing cybersecurity concerns, as well as the societal demand for **trust and privacy** in respect to fundamental rights. However, as end-user companies to date have primarily relied on software-based solutions to achieve higher - but still insufficient - levels of energy efficiency and security, the potential of hardware is as yet unexploited.

Stakeholder opinion

The large majority of stakeholders responding in the **open public consultation** recognised the importance of addressing innovation in electronic components and systems at European level. All stakeholder types expressed the need to make a significant contribution to the global competitiveness of Europe's KDT industries (134 out of 154 respondents, or 87% indicated this as 'relevant' or 'very relevant'). A stronger focus on the development and exploitation of innovative technologies was noted by all consulted stakeholder types (131 out of 150 respondents, or 87%) and notably SMEs.

A minority of stakeholders (mostly industrial representatives) expressed concerns of overlapping of the KDT partnership with the Horizon Europe programme and with related initiatives (e.g. Smart Networks and Services, Connected and Automated Mobility).

2.2. What are the problems drivers?

2.2.1. Limited design and production capabilities in electronic value chains

With every technology generation, the complexity and costs of **design and fabrication** of electronic components increase. Without a coordinated R&I effort to develop key competences in design and production, Europe risks limited presence in these segments, and features gaps in electronics value chains.

Within the electronics value-chain, a growing number of stakeholders ('fabless') focus on chip design and outsources manufacturing to third parties ('foundries'). The most prominent 'fabless' vendors are from the US and Taiwan, with only one European company ranked amongst the world's top ten[84]. Europe lacks a robust **design ecosystem** that can support its own **chip development capabilities.** Such ecosystem would provide incentives for the creation of intellectual property, access to design libraries and EDA[85] tools, and risk-sharing among design houses, Integrated Device Manufacturers (IDMs), research centres and user companies.

The 2019 global market share of semiconductor components that are manufactured in Europe is 9-10%. This, and does not reflect Europe's economic standing and research excellence in the field. In particular, the lack of manufacturing facilities in Europe for advanced digital circuits is a matter of concern as it limits the ability to capture important markets such as data processing and communications. Europe needs, therefore, to strengthen its production capability to bring it in line with its potential for development of digital systems and services, and **avoid disproportionate dependence** on other regions.

2.2.2. Insufficient large-scale innovation projects (e.g. pilot lines) in electronic components and systems

Large-scale projects are essential to the development of technologies from the **early stages of research to maturity**. For example, **pilot lines** of production at high Technology Readiness Levels (TRLs) enable testing of new components and process technology by a large variety of users before industrial deployment. Another example is **large-scale demonstrators** of embedded software and systems, where experimentation by a large set of users in a variety of application environments is essential before commercial exploitation. An R&I setting with EU and national diverging priorities, is not suitable to launch projects of large scale that bring together a broad set of stakeholders to address ambitious objectives.

2.2.3. Limited cooperation in research across segments in European electronic value chains

Intense competition and **fast technological evolution** make the role of electronics value chains ever more important. Keeping pace with this evolution requires intense R&I effort; however, today the various segments of the supply chain (design, manufacturing, packaging, ..) address research in disconnected ways. This makes the role of technology integration arduous and inefficient. The dynamic nature of value chains requires **close collaboration of technology stakeholders across segments,** for example through a common research roadmap.

[84] Dialog (UK) is 10th on the 2Q2019 world ranking of IC design companies. Source: TrendForce. Global Top Ten IC Design Companies for 2Q19. Press release August 29th, 2019

[85] EDA (Electronic Design Automation) are software tools supporting efficient chip design

Stakeholder opinion

According to the **Open Public Consultation**, a majority of stakeholders, especially from SMEs, universities and RTOs, considered that the co-creation of solutions with downstream sectors has high relevance (132 out 151 respondents, or 87% indicated this as 'relevant' or 'very relevant').

Minority views: A few **interviewees**, especially from large companies, highlighted the importance of the transition towards more complex value networks and the fast-evolving nature of digital technologies and the application sectors.

2.2.4. Weak R&I focus on emerging technologies with low involvement of SMEs

To **respond to future challenges and retain its innovation potential**, Europe needs to develop capabilities in emerging technologies that expand its traditional strengths and offer new opportunities. Despite Europe's lead in specific segments today (see section 1.2 EU relative position in the field), its leadership is threatened by massive investments by the US, China and other regions in new areas.[86] Scientific excellence in promising domains is the base for future leadership. Assessment and identification of these domains, based on European capabilities in a global context and their potential for future impact (techno-economic, societal and environmental) is essential.

Emerging technologies open new markets and offer new opportunities to industry, in particular to dynamic **SMEs and start-ups** who can contribute with specific competences and benefit from the value emerging technologies create.

Stakeholder opinion

The need to build technological capabilities in emerging technologies was stressed by several **interviewees** from Member States, large companies, SMEs, business associations, universities and RTOs.

It was frequently mentioned by interviewees that no single European country on its own could take up the competition with the likes of the US and China on emerging technologies.

Some views (mainly from research organisations) in the public consultation suggest to attract more SMEs through a higher involvement of RTOs in the initiative.

2.2.5. Limited use of innovative approaches (e.g. hardware/software codesign) for security, trust and energy-efficiency

Europe's technological capabilities in secure and trusted components do not always find their way into systems and final products. Similarly for energy-efficient devices. Addressing security and environmental issues is often done at software level in the latest stages of development with suboptimal results. Solutions addressing hardware-software co-design early in product development provide more efficient results but they require the adoption of innovative technologies and methodologies by the users.

As electronic components and systems are embedded in most of the smart products and services we use today, ensuring a supply of **trusted, secure, energy-efficient and reliable components** addressing specific environmental and societal requirements is of paramount importance for Europe.

[86] The 'Made in China 2025' initiative plans $150 billion in semiconductors investments by 2025. The US Networking and Information Technology Research & Development (NITRD) has made $4 billion available, for high capability computing systems, data management and software design.

Stakeholder opinion

At the **open public consultation** stakeholders put forward that the KDT initiative is highly relevant for securing access to trusted electronics components and systems (127 out of 154 respondents, or 82%, indicated this as 'relevant' or 'very relevant'). This view was especially supported by industry associations, universities, RTOs, Member States and large companies, while it was shared to a lesser extent by SMEs.

A minority of stakeholders (mostly from industry) stressed the importance of security and indicated that the initiative should place a higher emphasis on technologies for security.

2.2.6. Limited alignment of the electronic R&I ecosystem with strategic European policies and initiatives

The ECSEL Interim assessment[87] recommends **a more strategic approach** of the partnership in the development of electronic components and systems, and a closer link to the digital transformation of the EU economy. Limited alignment to policies reduces the strategic impact of an R&I initiative and it is a source of inefficiencies. The support to the societal and environmental objectives of the Union would need to be embedded in the agenda of the future initiative. To this end the **Commission** and the **Participating States** would need to **play a strong role in setting** and monitoring progress towards **strategic objectives**.

2.3. How will the problems evolve?

If action is not taken the problems identified will persist and risks will materialise. Europe will head to a situation from which it will very difficult or not possible to recover.

Without action addressing the risks and problems, it is anticipated that Europe

- will **lose scientific leadership** in terms of R&I in electronic components and systems technologies in which it excels today.
- can **lose competitiveness** by weakening its ability to develop electronic components and systems technologies in which it is strong today(semiconductor equipment and materials, low energy consumption microelectronics, power components, embedded software).
- will put at **risk its leadership in critical industries** and services (automotive, avionics, industrial, machinery, healthcare, security). Performance requirements (whether energy consumption, security, reliability or cost) that determine their position in the market - might not be met. The losses in those sectors will be progressively important as they become increasingly digitised.
- will **miss out on opportunities** that new technologies (e.g. Artificial Intelligence, new forms of computing) may create for the sector of electronic components and systems. It will be increasingly difficult to enter new markets and grow with them.
- will be **dependent on other regions** (US, Asia) for key technologies, with limited choice and exposed to unilateral trade decisions on technology access and conditions.
- will **not be able to shape the digital future according to its values** (privacy, security, ethics). Electronic components and systems coming from abroad do not commonly meet the EU high standards for privacy and transparency.

[87] European Commission. (2018). Interim Evaluation of the ECSEL Joint Undertaking (2014-2016) Operating under Horizon 2020. Final report

- will **not be able to fully implement key policies**, such as environmental, data and industrial strategies. Digitisation and technological innovation are integral elements of policies, lack of access to advanced digital technologies within the EU will be a major drawback for their implementation.

Over time, with market consolidation and technological maturity these effects would intensify. Their combination can lead to a situation where **Europe is irrelevant as a digital technology driver and becomes a mere technology consumer.**

The development of the necessary technological capabilities requires investments of industry in production capacity for electronics components and systems in Europe within the next 5 to 10 years to provide a solid base for European companies to effectively respond to the challenges ahead. Investments in production capacity in Europe is not in the scope of a KDT initiative that focuses on R&I. However, support to R&D and innovation activities, such as piloting and validation of technologies, are important elements for industries as they federate and lower risks of private investments. The recent IPCEI in microelectronics, addressing innovation and first industrial deployment of technologies developed in European R&D initiatives, ECSEL in particular, is a good example of R&I actions leading to private investments.

Stakeholder opinion

The fast-evolving nature of key emerging digital technologies, including their influence on industries and technological areas, were stressed by **interviewees** from industry associations, large companies and SMEs.

The need for a policy action, and the implications of 'no action' for critical industries, was underlined by all interviewed stakeholder types.

3. WHY SHOULD THE EU ACT?

3.1. Subsidiarity: Necessity of EU action

Electronics value chains are vast and complex, expanding across regions and industrial sectors. Rapid technological progress, increasing investments by growth of large vertically-integrated companies in the US and Asia[88] in developing their own chips[89], and the massive investments by these competing regions in know-how and production capacity, demand a rapid and coordinated response of the EU to maintain and further improve its competitive position in electronics components and systems, and related industries.

Moreover the impact of geopolitical tensions on the global industrial and technology landscapes with no end yet in sight, calls for an enhanced effort by the EU in close partnership with the Member States, industrial and research actors to agree a coherent strategic agenda with an appropriate level of ambition.

In order to be able to **shape the digital future according to European values** (privacy, security, ethics, respect for the environment), closer collaboration with Member States is needed to agree an appropriate framework at European level including standards and

[88] Tesla, Google, Huawei, Samsung, Baidu, etc.

[89] tesla-new-self-driving-chip-is-here-and-this-is-your-best-look-yet, The Verge, Apr. 2019; google-rattles-tech-world-new-ai-chip, wired, May 2017; samsung-to-make-baidus-new-ai-chips, ZDNet, Dec. 2019

certification schemes for electronic components and systems that will ensure those values can be adhered to.

Electronic components and systems also are increasingly important for Europe's vertical industries in their digital transition. The reinforcing of industrial ecosystems and value chains that provide for the research and innovation needs of those industries will necessarily **involve a variety of actors from across the Union**.

The experience of the ECSEL JU confirms that a sustained and coordinated effort under a common structure can lead to positive achievements.

3.2. Subsidiarity: Added value of EU action

Evolution in technology and innovation affects the way stakeholders interact in value chains. A fast-changing environment requires coordinated initiatives that bring together suppliers and users addressing hardware and software technologies, aligning European, national and industry efforts.

Companies alone or single countries cannot meet the scale and the intensity of investments by major competing regions (US, China, South Korea, Taiwan and Japan). Only a European mobilisation and coordination of investments could ensure the necessary critical mass.

Similarly Europe has many strengths at different parts of the electronics value chain which are scattered across different Member States. Consolidation would reinforce those strengths and thereby Europe's global position. Coordinated actions at EU level would stimulate the creation of ecosystems in which SMEs and start-ups can progress and grow faster.

Stakeholder opinion

The results of the **Member States consultation** on Horizon Europe Partnerships[90] confirm strongly the overall relevance of the proposed initiative in Key Digital Technologies (KDT). 96% of Member States consider electronic components and systems relevant for their national policies and priorities, as well as for their industry, research organisations and universities.

All **interviewed** stakeholder groups noted the need for alignment and policy coordination on research agendas; interviewees from industry commented that the level of investment by the US and China in electronic components and systems technologies cannot be matched by any individual European country and, as a result, coordination and critical mass at EU level are required.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives of the initiative

Three general objectives corresponding to the main problems discussed in Section 2.1 are identified:

1. *Reinforce Europe's **technology sovereignty** in electronic components and systems to support future **needs of vertical industries** and the economy at large*

   Ensuring that Europe stays at the technological forefront in advanced electronic components and systems would contribute to strong strategic value chains. Gaps in the

[90] European Partnerships under Horizon Europe: results of the structured consultation of Member States. Shadow Configuration of the Strategic Programme Committee. 27 June 2019

value chain can become problematic in the presence of global crises, as dependence on technologies developed in other regions can deprive user industries of first mover advantage and limit their capacity to innovate. This is of particular importance in the transition of industry to digital and it will be increasingly critical as digital technologies become more pervasive across sectors. European strengths in specific segments of electronic components and systems (e.g. equipment and materials, low-power semiconductors, power electronics, embedded software) have a positive impact on the sectors they serve. European concerted action is required to develop leading-edge technologies, to accelerate their uptake and reinforce EU industries where they are strong.

A reinforced EU sovereignty should materialised in doubling the value of the design and production of electronic components and systems in Europe by 2030, in line with the weight of the EU in products and services.

2. *Establish EU **scientific excellence** and **innovation leadership** in emerging components and systems technologies*

Further miniaturisation towards physical limits, the rapid penetration of artificial intelligence, the emergence of edge computing and of alternative computing paradigms (such as neuromorphic, quantum computing) open new opportunities for electronics components and systems and their applications. A solid scientific base in emerging areas can enable Europe to seize such opportunities. An **early involvement of industry stakeholders** in specific promising areas in the research cycle will speed time-to-market, boost leadership and innovation, and maximise social and economic impacts. Moreover it will facilitate a more prominent role by Europe in standards setting, allowing European needs to be reflected. **SMEs and start-ups** who, in Europe, are generally strong in emerging technologies, can benefit from and help give shape to new ecosystems, supported by simplified administrative procedures.

As a target for an initiative on KDT, SMEs should represent at least one third of the total number of participants while at least 20% of public funding should go to SMEs.

3. *Ensure that components and systems technologies **address Europe's societal and environmental challenges***

Public and private sectors need to pool resources to address EU societal and environmental challenges and objectives to build know-how and capacity in **areas that are currently missing or not sufficiently developed**. Specific components and systems technologies to which Europe needs to step up in these areas would be identified and addressed in the initiative together with standards setting.

Technologies considered essential for Europe will be tailored to **reflect European values in their application**. In particular technologies that provide the right levels of trust and privacy, as well as those contributing to the EU environmental objectives.

The initiative would align with the EU policy on energy efficiency. The target is to reduce energy consumption 32.5% by 2030. This target would be revised upwards by the Commission in 2023.[91]

[91] Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency

Each of the three general objectives of the KDT initiative contributes to the objectives of Horizon Europe to deliver respectively techno-economic, scientific and societal impact from the Union's investments in research and innovation. They would strengthen the scientific and technological base of the Union and foster its industrial competitiveness at global level.

4.2. Specific objectives of the initiative

To better achieve the general objectives, six specific objectives are defined. These specific objectives respond to each of the problem drivers discussed in Section 2.2.

a. *Establish **design and production capabilities** in Europe for strategic application areas*

   Strengthen and extend current European design and manufacturing capabilities in specific areas (such as power electronics, digital devices, etc.) to critical domains such as communication, computing and intelligent systems. Establishing new capabilities in Europe requires long-term planning and a firm commitment of public and private stakeholders. Interaction with relevant digital partnerships (SNS and EuroHPC for example) and initiatives addressing applications (such as healthcare and automotive) will be necessary to ensure coherence of action along the respective value chains. While R&I for production will involve mainly large semiconductor companies and research labs, the design activities will attract mostly SMEs and start-ups.

b. *Launch large-scale projects supporting the fast transfer of technologies from the lab to the fab*

   This specific objective would support large scale projects, such as pilot lines of production and real scale demonstrators that bring together technology suppliers and users. These actions mobilise a high volume of resources and require the combination of public (European and national) and private resources under a common scheme. Large-scale projects bring specific value to the implementation of a long-term strategic planning. These projects should be open to SMEs - in addition to large companies and research organisations - providing unique opportunities for small companies and start-ups to get access to such facilities.

c. *Build a dynamic EU-wide ecosystem based on digital value-chains with simplified access to newcomers*

   Establish an ecosystem that facilitates interaction between stakeholders and makes cooperation within and across value chains more efficient. The ecosystem will serve semiconductor and software producers, large and small, RTOs and academia, as well as technology users (systems manufacturers, service providers) to set common agendas and technology roadmaps and establish relations that go beyond research cooperation.

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

d. Strengthen EU scientific excellence and exploit the potential of SMEs and start-ups in emerging technologies

Strengthen current capabilities and develop new knowledge and technological competence in emerging areas such as novel computing paradigms, and support emerging trends and opportunities such as edge AI. This objective would require the mobilisation of new stakeholders, mainly SMEs and start-ups active in emerging technological areas. To stimulate their participation, efforts to simplify the administrative requirements linked to participation – with respect to those of the current partnership - will be important.

e. Enhance component technologies that guarantee security, trust and energy-efficiency for critical infrastructures and sectors in Europe

Reinforce electronic components and systems technologies to guarantee the supply (design and production capacity) of secure, trusted and low energy components. Drive standards setting and support their integration into critical infrastructures (energy, data, transport,…) and systems, ensuring that they respond to future needs.

f. Ensure alignment of the new initiative with European policy priorities

Establish coherence between the Strategic R&I Agenda of the initiative and EU policies so that electronics components and systems technologies contribute efficiently. This objective would require a long-term roadmap that complements R&D with security certification[92] and standardisation actions. The alignment of projects and the initiative as a whole with EU policies would be monitored and reported regularly.

Stakeholder opinion

The **open public consultation** showed a broad consensus about KDT making a significant contribution to global competitiveness of key European industries (112 out of 162 respondents, or 69% indicated this as 'very relevant'). Establishing the link between KDT and application sectors was perceived as fully needed by four out of five respondents from business associations, large companies, SMEs, universities, RTOs and public authorities. Promote leadership in emerging technologies and secure technological sovereignty and globally competitive presence in key digital technologies were equally stressed as important by all **interviewed** stakeholder groups.

A majority of stakeholders to the **open public consultation** indicated the need to 'focus more on bringing about transformative change towards sustainability' (67 respondents indicated this as 'needed', and 63 respondents as 'fully needed', with a combined 67%) and to make a 'significant contribution to the EU efforts to achieve climate-related goals' (respectively 64 and 61 respondents indicated this as 'needed' or 'fully needed', combined 64%).

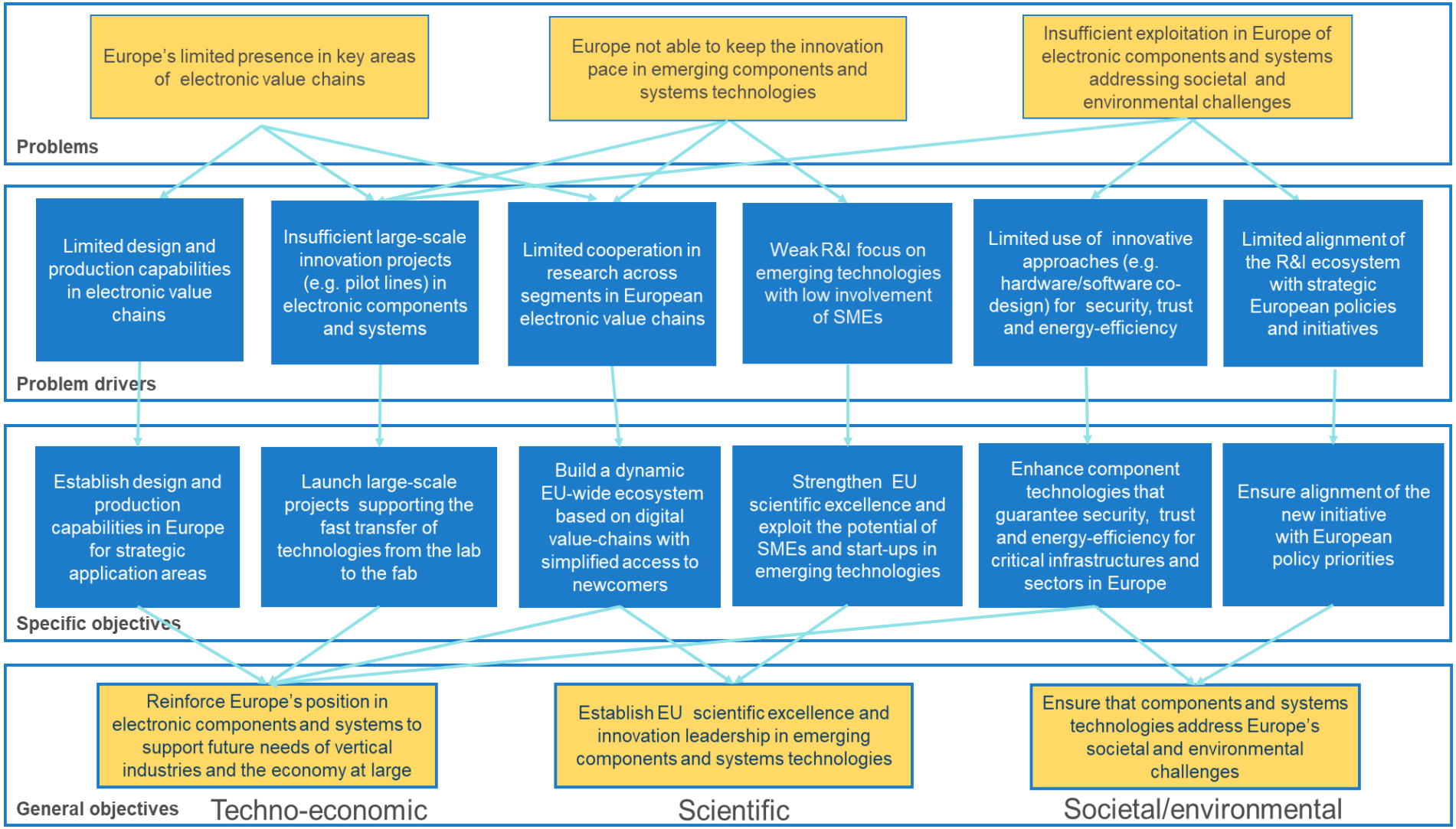
A minority of stakeholders (13 respondents or 8%), mainly academia and citizens, indicated that the KDT initiative was moderately needed or not needed for EU global competitiveness.

[92] The KDT activities on security and trust would have a direct impact on the EU's ability to attain its political goals in this area and specifically in the following initiative: Development of cybersecurity certification schemes developed under the European Cybersecurity Certification Framework that was established by the Cybersecurity Act (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.151.01.0015.01.ENG&toc=OJ:L:2019:151:TOC). In particular, the first scheme being prepared under the Framework is based on the so-called "Common Criteria" (standards that have been applied with great success in the EU to the certification of smart cards, integrated circuits, hardware security modules and other similar technologies).

4.3. Intervention logic for the initiative

The relationship between the general and specific objectives of the potential initiative on Key Digital Technologies is shown in Figure 12.

Figure 12: Intervention logic for an initiative on Key Digital Technologies



How would success look like?

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

Scientific impacts

- Europe reinforces its **scientific** capabilities in emerging fields of electronic components and systems, maintaining **excellence** in publications and attracting best talents.
- Improved cross-border and cross-sector **scientific cooperation** that strengthen the exchange of knowledge across the ecosystem

The following specific objectives would contribute to these impacts:

- Strengthen scientific excellence in emerging technologies would contribute to extend Europe's leadership (see ranking of research publications in Figures 1-4 in Annex 6) to new research areas.
- Build a dynamic EU-wide ecosystem with an extensive network of national research organisations and universities spread across Europe facilitates cross-disciplinary and cross-sector dissemination and application of scientific results.

Stakeholder opinion

A majority of stakeholders from business associations, universities, large companies and SMEs identified in the **open public consultation** scientific impact as most relevant for the KDT initiative. More than half of public authorities and more than three-quarters of universities and RTOs consulted found it 'very relevant'.
Regarding minority views, two respondents (a business association and an academic organisation) indicated scientific impact as 'not relevant'.

Economic/technological impacts

- European electronics components and systems industry strengthens its **technological leadership** and its **global competitive position,** creating jobs and aligning its design and production capabilities with the EU's needs and economic weight.
- Strengthen **digital transformation** in vertical sectors through electronic components and systems technologies developed in Europe
- Create a dynamic **ecosystem of innovation** in electronic components and systems with higher and more active involvement of SMEs

The following specific objectives would contribute to these impacts:

- Establish design and production capabilities in Europe for strategic application areas
- Launch large-scale projects supporting the fast transfer of technologies from the lab to industrial settings.
- Build a dynamic EU-wide ecosystem with the involvement of users will help accelerate the market readiness of emerging technologies and facilitate the integration of SMEs.

Stakeholder opinion

According to the **open public consultation**, 'a more innovative, sustainable and competitive electronics and systems industries' was deemed as the most important impact by stakeholders (95 out of 154 respondents, or 62% indicated this as 'very relevant'); an overall majority of universities, RTOs, companies, business associations and public authorities found it relevant or highly relevant.

To facilitate economic impact through the 'development and exploitation of innovative technology paradigms' was also considered to be highly relevant (80 out 150 respondents, or 53%), although to a slightly lower extent.
A minority view, two respondents (a business association and an academic/research organisation) indicated economic/technological impact as 'not relevant'. In particular for the options 'a more innovative, sustainable and competitive electronics and systems industries' and the 'development and exploitation of innovative technology paradigms'.

Societal impacts

- European applications and services provide high levels of **privacy and security** through the use of European components and systems
- Implementation of **EU policies** (green and digital transition, technology sovereignty) takes place according to **European values and ambitions**

Specific objectives contributing to societal impacts:

- Enhanced component technologies that guarantee security and trust for critical European infrastructures and sectors.
- Alignment of the initiative with European policy priorities would favour the development of digital technologies that meet European standards.

Environmental impacts

- Electronic component and systems industries and vertical industries progressively **reduce their negative environmental impact**

Specific objectives with expected contribution to the environmental impacts are:

- Enhance technologies that guarantee energy-efficiency including the design and manufacturing of low consumption components,
- Alignment with the EU policy priorities and in particular with the European Green Deal and the Circular Economy Action Plan

Expected impacts on fundamental rights

Research and innovation on secure and trusted components, systems, software and related applications will contribute to the protection of sensitive personal information[93]. This will have an impact on the fundamental right to privacy, essential to human autonomy and protection, serving as the foundation upon which other human rights are built.

This impact is linked to the specific objectives on access to secure and trusted components and alignment to EU policy priorities.

Stakeholder opinion

According to the **open public consultation,** delivering 'enabled safety and security' was among the most important impacts for stakeholders (94 out of 153 respondents, or 61% indicated this as 'very relevant'). It was followed by the need to ensure the 'provision of trusted electronics components and systems to the public and businesses' (86 respondents out of 154 respondents, 56%). On the other hand, 'contribution to more functional, efficient, economical and accessible electronics systems' was by a smaller number of respondents indicated as 'very relevant' (70 out of 152 respondents or 46%).

[93] Charter of Fundamental Rights of the European Union (2012/C 326/02). Article 8. Protection of personal data.

With efforts maintained over time, all impacts are expected to be materialised within the time framework of the new initiative.

4.4. What is needed to achieve the objectives – Key functionalities needed

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

4.4.1. Type and composition of the actors to be involved

Collaboration among stakeholders of the ecosystem, representing all segments of the value chains, is essential for the development of new technologies and the fast market uptake of innovation. The scope of the candidate initiative in terms of technology coverage would need to be broader than ECSEL JU, and the need for integrating relevant stakeholders would be even more relevant. **Openness and flexibility** to integrate players from emerging and/or adjacent technologies and to encourage SMEs participation is also vital.

The involvement and commitment of the following actors is necessary to achieve the intended objectives:

- **Industrial technology suppliers**. Industrial actors from the various segments of the value-chain: Manufacturing equipment and material suppliers, design centres, integrated device manufacturers, software developers. They are the core partners in the initiative and play a central role in its implementation.
- **Industrial users (vertical industries).** They set the system and service requirements, assess technological choices and play an active role in their validation and demonstration.
- **SMEs and start-ups.** In relation to both previous categories, they would contribute with specific know-how and expertise, and benefit in multiple ways from the involvement in the initiative. Based on the interim evaluation of ECSEL, a lesson to be learned is in terms of the need to enable an increased participation of SMEs, including from the financial point of view, to help achieve both scientific and economic impacts.
- **Research and academic organisations.** They range from world-class RTOs, to national research organisations and universities. Their cooperation with industry to develop innovative solutions is an essential element for the success of the initiative.
- **Participating States**. Member and Associated States would provide guidance on setting the priorities, ensure the coherence of national and EU programmes and strategies, and stimulate the involvement of relevant national partners. Their financial contribution[94] allows to raise significantly the ambitions of the initiative.
- **European Commission.** Together with Participating States, the Commission ensures that public societal and environmental priorities are fully considered, integrates the

[94] From ongoing discussions with Member States it is expected that they will collectively match the EU contribution to the partnership (as it is currently with ECSEL)

initiative in the context of the EU Framework Programme and supervises the proper setup and running of the candidate initiative in the form of a partnership.

Finally, a high level of participation and balance of sectors, technologies and type of partners, should be achieved - improving current ECSEL levels[95]- to guarantee an open initiative and prevent unjustified concentration on specific technologies or sectors to the benefit of a reduced set of organisations.

4.4.2. Type and range of activities needed

This section concerns the types of activities that the initiative is intended to encourage, so as to respond effectively to the challenges and problems described in Chapter 2.

To deliver in its objectives, the initiative would need to support activities ranging from the formulation of the technology concept (Technology Readiness Level[96], TRL2) to the completion and qualification of systems (TRL8). The type of activities include:

- Collaborative R&I actions that foster academia-industry, industry-industry and cross-sectoral collaborations.
- Innovation actions to accelerate the maturity of new technology generations for their rapid integration in vertical industries.
- Large-scale projects, such as pilot lines for validation and demonstration of technologies in close to real-life environments.
- Technology platforms where suppliers and users can assess and optimise new technological approaches.
- Research actions addressing the design and manufacturing challenges of critical cross-cutting technologies, such as smart networking and high-performance computing.
- Research and Innovation actions for developments in emerging technological areas.
- Coordination and support actions for the production of common research agendas, mobilisation of stakeholders (e.g. SMEs) and their integration in the ecosystem; coordination with relevant European and national initiatives; and contribution to standardisation activities.
- Coordinated activities between Participating States, Commission, and private members to address security and energy-efficiency aspects in technology and application roadmaps. They would include certification and standardisation activities.
- Coordination with other European initiatives (e.g. IPCEI, European Processor Initiative) for complementary investments on design and production capacities of secure and trusted components.

[95] The total number of different entities participating in ECSEL in the period 2014-19 is 2681. ECSEL Annual Activity Report 2019. Pending publication.

[96] Technology Readiness Level (TRL) gives an indication of the maturity of a technology in a scale from TRL1 (basic principles observed) to TRL9 (competitive manufacturing)

4.4.3. Priority setting system and level of directionality required

It has been argued in the problem analysis in section 2.1 and the analysis of drivers in section 2.2 that for Europe to compete with China and US especially in emerging technologies, significant investments and resources need to be mobilised. To meet the objective of technological sovereignty and address the problem of Europe's dependence on critical technologies, making sure that Europe has access to technology that respects its values, a broad agreement on a roadmap of activities is necessary. The high ambitions for technological sovereignty and economic leadership imply the development of a shared **European vision** implemented through a **unified research agenda** with strategic objectives reflecting EU priorities and supported by a critical mass of resources (financial, infrastructure and human resources) from the members of the initiative. Thus, the highest possible leverage of resources from industry and Member States under the shared vision is critical to be able to tackle the objectives and deliver on impacts.

The strategic vision should be implemented by the stakeholders along the value chain through the preparation of a common Strategic Research and Innovation Agenda (SRIA). Under the existing partnership ECSEL this has been an open exercise that has involved hundreds of representatives from research, industry and administrations. The priorities of technologies and application sectors in the SRIA has been the result of a broad consensus of participants. The SRIA is in a first instance produced by the private partners and submitted for comments and inputs to the partnership members (EC, Participating States) and approved by the Governing Board.

Responding to shortcomings identified in the interim evaluation of the ECSEL partnership, the Commission and the Participating States in the future initiative would need to steer the agenda towards strategic objectives that are aligned with the policy priorities of the Union. This multi-stakeholder process will aim at producing a balanced agenda that takes account of industry priorities, research challenges and EU and national policies, and making it difficult for a small set of partners to wield undue influence. The monitoring of the initiative would need to ensure that this balance is maintained. An updated SRIA would need to be produced annually, following a broader consultation, which is open and involves a larger amount of stakeholders than nowadays, including innovative smaller companies, to ensure that the scope and priorities of the initiative align as necessary with fast-changing developments.

The sectors and technologies identified in this report are presented as examples based on current context and trends.

The interim evaluation of ECSEL JU recognises the significance of coordination, common vision and research agendas.[97] The experience from ECSEL JU shows that the leverage effect could reach a ratio of 1:3, meaning that for every Euro of EU funding, Participating States and industry could contribute 3 Euros. The ECSEL experience with ratios of 1€ from EU, 0,9€ from Participating States and 2,18€ from private members in the period 2014-18 is encouraging.[98]

Recent declarations from industry associations[99] and from national authorities[100] confirm their intention to continue the current tri-partite scheme with the same relative contributions

[97] European Commission. (2018). *Interim Evaluation of the ECSEL Joint Undertaking (2014-2016) Operating under Horizon 2020*. Final report.
[98] ECSEL Annual Activity Report 2018.
[99] Declaration of the ECSEL Industry Associations
[100] Declarations from Member States

(1€ from EU, 1€ from participating states, 2€ from private members[101]). Commitments from the initiative's members would need to be reflected in the future Council Regulation. The implementation details are still pending internal discussion.

The KDT initiative, object of this impact assessment, would aim at a more challenging set of objectives and with a broader impact than the current ECSEL JU. At the time of writing this impact assessment the level of financial support to the KDT initiative is uncertain. Despite the fact that the three members of the initiative (European Commission, Participating States and Industry) consider KDT as an area with far-reaching impact on the EU economy and society, the COVID-19 crisis may limit available resources. In case of a reduced budget, a decision by its members (via a shadow governing board) on the prioritisation of objectives and rationalisation of activities would be necessary to ensure that its ambitions can be realistically achieved.

Given the importance of establishing robust electronics value chains, the consolidation of an ecosystem would be a priority for coordination, especially at the early stages of the candidate initiative.

The above conclusions are also supported by the interviews with the ECSEL JU industry associations and downstream stakeholders. The consensual view is that coordination of research agendas among EU, Member States and industry allows a more effective R&I response in a fast-moving market and with a higher level of impact.

4.4.4. Coherence needed with the external environment

Alignment with strategic EU policies and initiatives is a major recommendation from the ECSEL Interim evaluation and one of the problem drivers for the intervention logic of the future initiative. "The European Green Deal", "A Europe fit for the digital age" and "An economy that works for people", but also the most recent "Recovery Package"[102], are major EU priorities to which the initiative should provide valuable contributions. Access to secure and energy-efficient components for strategic European infrastructure and sectors and ensuring technological sovereignty would be objectives of the candidate initiative closely related to the objectives of these EU initiatives.

Participation of Member States would facilitate alignment with national programmes and strategies, reducing overlap and fragmentation of efforts, and importantly, ensuring critical mass and synergies can be built.

As indicated earlier, the enabling character of electronic components and systems argues in favour of coordination with other partnerships and initiatives in digital sector (see section 1.3). The 'digital cluster' of partnerships is expected to coordinate with Member States and industry for a comprehensive EU digital strategy. Coordination is also expected with partnerships addressing other verticals such as space (Global competitive space system) and manufacturing (Made in Europe) sectors as well as health (IMI), mobility and energy.

Synergies with the Digital Europe Programme (DEP)[103] would need to be exploited with testing facilities, skills development and capacity building activities in specific digital domains. Similar synergies would need to be explored with Connecting Europe Facilities

[101] These relative contributions are based in ECSEL experience. Matching of public funding by the private members takes account of contributions from all project beneficiaries (members and non-members of industrial associations)

[102] Europe's moment: Repair and Prepare for the Next Generation. COM(2020) 456

[103] DEP (Digital Europe Programme) has been proposed by Commission as part of the EU long-term budget 2021-27. https://ec.europa.eu/digital-single-market/en/news/digital-europe-programme-proposed-eu92-billion-funding-2021-2027

(CEF)[104] that supports investments in European infrastructure networks for transport, energy and digital.

The achievement of EU technological sovereignty would need to be facilitated by the coordination of the KDT initiative with a future IPCEI on digital technologies. There are indications[105] that efforts could be made towards combined national and private investments for first industrial deployment, building the required capacity for production in Europe of advanced components for edge-computing.

Finally, the interim evaluation of ECSEL JU stressed the importance and potential for coordination with local, regional, national and European initiatives.[106] Coordination with regional clusters such as Silicon Europe, Silicon Saxony (Dresden), Minalogic (Grenoble), and DSP Valley (Leuven-Eindhoven) could contribute to the mobilisation of stakeholders, especially SMEs, and their integration in the ecosystem.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

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

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

The baseline scenario used in this impact assessment is a situation without a Partnership and only traditional calls of Horizon Europe. Given that there is a predecessor Partnership as well as other funding sources in the area, these will continue generating effects even if there is no new Partnership. In particular it is expected that these already existing initiatives will still create effects in the area of digital technologies. This is taken into account in the effectiveness assessment.

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

The baseline (Option 0) for the functioning of this research and innovation initiative in the field of electronic components and systems is to make use of mainstream channels of Horizon Europe. The related priorities would be implemented through traditional calls under the Framework Programme. Table 1 presents the key characteristics of the baseline.

Table 1: Key characteristics of the baseline situation – *Traditional calls*

	Implications of option
Enabling appropriate profile of	• Consortia of public and/or private actors in ad hoc combinations are eligible. Specific actions can be for a single actor (mono-beneficiary).

[104] CEF (Connecting Europe Facilities) has been proposed by the Commission as part of the EU Multi-financial Framework 2021-27. https://ec.europa.eu/commission/presscorner/detail/en/IP_18_4029

[105] Electronics Leaders Group. (2018). *Boosting Electronics Value Chains in Europe: A report to Commissioner Gabriel*.

[106] European Commission. (2018). Interim Evaluation of the ECSEL Joint Undertaking (2014-2016) Operating under Horizon 2020. Final report.

participation (*actors involved*)	• Calls are open for participation of entities from Member and Associated States. Organisation from third countries can participate under specific conditions. Partners from industrialised countries are not eligible for funding. • Systematic and structured engagement of Member States limited to the participation in the programme committees.
Supporting implementation of R&I agenda (*activities)*	• Supported activities include Horizon Europe standard actions that allow a broad range of individual actions covering the whole spectrum of activities that are required for the digital technologies achieving the objectives of the KDT initiatives (TRL2 to TRL8). • Combination of activities into a portfolio of actions for achieving a common objective is not possible. • Leverage of additional activities or investments beyond the direct scope of the funded actions is not possible.
Ensuring alignment with R&I agenda (*directionality*)	• The strategic programming through the programme committees of Horizon Europe involving a wide range of stakeholders (who are not necessarily aware of, relevant to, or interested in the objectives of the KDT initiative) implies a lower level of directionality and a lower weight of industry's voice in shaping the priorities compared to other options. • There is possibility to develop an SRIA or roadmaps. However, without a formal EU partnership mechanism, it is less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual financial commitments beyond the single project participation. • The strategic planning mechanisms of Horizon allow for a high level of flexibility and responsiveness to changing needs. • Coordination with national or regional initiatives difficult to achieve in practice. • Coordinated implementation and funding linked to concrete objectives and roadmap is not possible as the funded projects are part of much broader project portfolio managed by an agency or EC services. • Support of priorities cannot continue over the four years of the strategic plan and budget and therefore it is less likely that the funding will be used for supporting long term objectives. • The coherence of funded activities in the area of electronic components and systems with other parties of the Annual Work programme is ensured by the EC. • Coordination and exploitation of synergies with other programmes beyond the FP and industrial strategies is limited as it requires more structured approaches which are not available in Horizon Europe.
Securing leveraging effects (*additionality*)	• Member States do not contribute to the budget. Thus, the resources that could be mobilised are sensibly lower compared with other options. • Substantial industry contribution, mostly in-kind (e.g. researchers, labs), of 50% of the total cost of the initiative, will not be possible.
Key differences compared to the current situation	• Moving from the current ECSEL JU to Horizon Europe calls (baseline option) would entail the dismantling of the JU with the following consequences: - The development and implementation of a common vision with the partners in the area and the achievement of objectives would not be possible to the same extent - A stable structure encompassing Participating States, the industry associations and the EC for R&I cooperation would disappear - Large scale R&I actions (pilots, platforms) could not be implemented in a coordinated way - The initiative would be fully financed by the EU. Participating States and Industry would not be able to contribute at programme level (but at project level) - The overall budget of the initiative, including contributions by industry and Member

	States, would likely be substantially reduced

5.2. Description of the policy options

5.2.1. Option 1 - Co-programmed European Partnership

This form of European Partnership is based upon a *Memorandum of Understanding* or a *Contractual Arrangement* signed by the European Commission and industrial associations representing the private partners. The formal commitments from partners are not legally binding and subject to "best efforts". Table 2 presents the key characteristics of the option.

Table 2: Key characteristics of Option 1- Co-programmed European Partnership

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• Suitable for the participation of a large community of stakeholders able to contribute to the definition and implementation of the Strategic R&I agenda. • Private members (industry, RTOs) represented by associations that provide limited administrative support. • The calls are included in the FP Work programme. Horizon Europe rules for participation apply.
Supporting implementation of R&I agenda (*activities)*	• 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). • R&I activities follow 2-year Work programmes, with risk of discontinuity of actions and limited long-term financial stability to pursuit the partnership objectives • Implementation of actions and administration by Commission services or relevant executive agency. • A broad range of coordinated activities from low TRL to demonstration are possible under the standard actions of Horizon Europe. • The associations representing private partners allow some level of coordination, including activities related to regulation and standardisation and developing synergies with other initiatives.
Ensuring alignment with R&I agenda (*directionality*)	• The strategic R&I agenda/roadmap is agreed between partners and EC. • The objectives and commitments are set in the contractual arrangement. • The input to FP work programme is drafted with the inputs from partners and finalised by EC (comitology). • The commitments are political/best effort. • Coherence among partnerships and with different parts of the Work programme of Horizon Europe can be ensured by partners and EC, however exploitation of synergies with other programmes is limited. • Coordination with national or regional initiatives difficult to achieve in practice. • Coordinated implementation and funding linked to concrete objectives and roadmap is not possible as the funded projects are part of much broader project portfolio managed by an agency or EC services. • Synergies with industrial strategies is ensured through the industrial partners. • Synergies with national and regional programmes and activities can be explored.
Securing leveraging effects (*additionality*)	• Leveraging target defined and agreed from the onset but agreement to commit resources from the involved stakeholders remains "best efforts" • Under this type of partnership in-kind contribution of industry is possible and it would be included in the Contractual Agreement. • Member States: This option allows only for light coordination of efforts with R&I in the field at the national level but no financial contribution to the budget of the initiative

Key differences compared to the current situation	• Moving from the current ECSEL JU to Co-Programme partnership (Option 1) would entail the dismantling of the JU with the following consequences: - The implementation of a common vision and achievement of objectives would be less efficient and take longer - A stable structure encompassing Participating States, the industry associations and the EC for R&I cooperation would disappear - Large scale integrated R&I actions (pilots, platforms) could not be implemented - Important contributions (financial) from Participating States and industry would not materialise and the EU would have to bear a higher share of the cost. - The overall budget of the initiative, including contribution by industry, Member States, would likely be substantially reduced - Substantial discontinuation cost, with a 4-year winding down period for the current JU (see rationale at 6.2 Efficiency)

5.2.2. Option 2 – Co-funded European Partnership

See table with key characteristics of Option 2 in Annex 6 (Impact Assessment, Part 2)

5.2.3. Option 3 – Institutionalised European Partnership

a) Institutionalised Partnerships under Art. 185 TFEU

See table with key characteristics of Option 3a in Annex 6 (Impact Assessment, Part 2)

b) Institutionalised European Partnership under Art 187 TFEU

An Art 187 TFEU partnership is based on a Council Regulation and implemented by dedicated structures created for that purpose. It can be implemented only where other parts of the Horizon Europe programme, including other forms of European Partnerships would not achieve the objectives or would not generate the necessary expected impacts, and if justified by a long-term perspective and high degree of integration.

Table 3: Key characteristics of Option 3: Institutionalised Partnership under Art 187 TFEU

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• This option is suitable for the participation of all types of partners contributing to the definition and the delivery of the SRIA • The upfront commitments and long-term planning of this option are attractive to a large set of participants. • The involvement of Participating States contributes to the mobilisation and participation of national actors. • In response to emerging challenges and evolving priorities, the SRIA can be defined to attract new relevant partners. • Horizon Europe rules apply by default, so any legal entity can apply to partnership calls. • In addition to Participating States, companies and research organisations from other countries can participate but subject to policy considerations. • Non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements. Basic act can foresee exceptions for participation in calls / eligibility for funding.
Supporting implementation	• The standard actions of Horizon Europe that allow to build a portfolio with a broad range of research, innovation and demonstration activities.

of R&I agenda (*activities)*	• The dedicated administrative structure of the JU can efficiently implement, monitor and report results of an integrated portfolio of projects. • The option allows the combination of national and Union funding for the joint financial support of activities. It enables the achievement of critical mass of investments in a common agenda across the EU. • Communication and dissemination activities can be supported by the partnership structure.
Ensuring alignment with R&I agenda (*directionality*)	• The Strategic R&I Agenda setting the objectives and priorities of the partnership is agreed between Participating States, the industry associations and the EC. • The annual work programme is adopted by the Governing Board of the partnership. • The voting majority of EU and national members in the partnerships facilitates the alignment of the partnership with public policy priorities. • The objectives and commitments are set in the legal base. Changes require modification of the Regulation and approval by the Council.
Securing leveraging effects (*additionality*)	• Commitments include the obligation for financial and in-kind contributions of partnership members, including contributions to the administrative costs. Commitments would be legally established in the basic act. • For the KDT JU where a tripartite model is envisaged, contribution of industry to the operational running of the partnership is expected to be 50% of the aggregated partnership budget. Contribution of Participating States is expected to maintain the current ECSEL level and match the EU contribution (25% of the aggregated budget)
Key differences compared to the current situation	• The JU structure of ECSEL would be taken over by the KDT partnership • Modifications will be introduced in administrative procedures and practices to ensure that operations are lean and as efficient as possible

5.3. Options discarded at an early stage

The Co-Funded partnership and the Institutionalised Partnership created under Article 185 of the TFEU are not considered relevant for the impact assessment of the initiative on Key Digital Technologies.

Based on the objectives of the KDT initiative, the direct beneficiary is the industry. Therefore, the objectives can be only achieved if industry plays a pivotal role in the setting of the agenda, implementation and mobilisation of resources. This precondition is not satisfied by Co-Funded or Art 185 partnerships:

- The Co-Funded partnership allows only public partners at its core and the industry cannot make formal commitments or contributions to it, nor to participate in the setting of the research agenda.
- The participation in Art 185 TFEU is limited to Member States.

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

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

6.1. Effectiveness

To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into 'expected impacts' - how success would look like -, differentiating between scientific, economic/ technological, and societal (including environmental) impacts. This section considers to which extent the different policy options would allow delivering these expected impacts – confronting what is needed (functionalities) with what each form of implementation can provide in practice. The assessments in this section set the basis for the comprehensive comparative assessment of all retained options against all dimensions in Section 6.4, based on a scoring system[107].

Scientific Impacts

- *Europe reinforces its **scientific capabilities** in emerging fields of electronic components and systems, maintaining **excellence** in publications and attracting best talents.*
- *Improved cross-border and cross-sector **scientific cooperation** that strengthen the exchange of knowledge across the ecosystem*

Scientific impacts would be generated by collaborative actions of **interdisciplinary research** teams. The active **involvement of industry** is necessary, as well as a good degree of **coordination** and a significant **volume of resources**, to ensure that scientific advances are supported through the innovation cycle and eventually transferred to industrial environments. These elements are part of a strategic approach characterised by directionality towards common objectives, alignment of individual projects, and participation of industrial partners.

Baseline: Horizon Europe traditional calls

Option 0 with traditional calls under the Framework Programme can effectively attract **high-quality research** teams particularly in emerging and less established technologies. This option allows to define a technology roadmap, however, it is **less attractive to industry, including to SMEs and start-ups, due to the difficulty of long-term planning** to align research activities with industrial priorities. This option therefore does not ensure the participation of all necessary actors as a partnership would.

The uncertainty of industry involvement and the absence of financial contribution from Participating States makes this option **unlikely to mobilise a critical volume of resources**. Furthermore, the use of open calls, with limited coordination, to address research priorities is likely to involve a considerable **degree of inefficiency** due to the risk of different projects addressing similar issues.

Finally, Horizon Europe traditional calls are **well suited to address cross-sector research** by multi-disciplinary teams. This option, however, **would not mobilise important stakeholders** (large companies and SMEs) to support scientific cooperation towards common objectives. As a consequence, this option would have a **limited contribution** to a dynamic **ecosystem**.

Option 1: Co-Programmed European Partnership

Option 1 can address research challenges as a part of a **strategic agenda that aligns with industrial objectives**. It can attract the participation of **academia and research**

[107] A more in depth and detailed analysis of each policy option is provided in the "Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe – Candidate Institutionalised European Partnership on Key Digital Technologies". Technopolis Group (2020)

stakeholders to address scientific challenges in emerging fields, and provide a **good level of coordination** to support industrial commitments.

In this option industry associations can mobilise a **broad range of stakeholders**, including SMEs, and ensure a **good coverage** of the value chains, including research organisations and technology users. Also, they can contribute more systematically in the building of a **collaborative multidisciplinary ecosystem**, facilitating the exchange of knowledge across sectors. However, the lack of participation of Participating States in this option **limits both directionality and the volume of resources** necessary to implement large-scale actions supporting the transfer of scientific outcomes to industrial settings, limiting the involvement of user industries.

Therefore, the potential of the option to generate the expected scientific impacts is good (+) compared to the baseline.

Option 3: Institutionalised European Partnership under Article 187 TFEU

Option 3 can attract and engage in research activities the different types of stakeholders, in a **strategic agenda that aligns research effort with industrial and policy priorities**. The participation of the industry is expected to be high as this option provides the **highest possible commitment and a coordinated long-term strategic planning**. The launching of open calls, as in the other options, provides opportunities to **attract new participants** with the necessary competences to address emerging challenges. Further harmonisation and simplification of administrative procedure will also facilitate participation. Therefore, it is considered that the potential of this option to **attract the necessary mix of stakeholders** to research activities is high.

The tripartite model of this option with the **involvement of Participating States** would attract national research organisations and ensure the highest level of coordination with **national research** programmes. On the assumption that the Commission financial contribution would be similar to other options, the tripartite model of this option would **mobilise a substantially higher volume of resources** by combining Commission, national and private contributions, as proven in the existing ECSEL JU. It enables the design and implementation of a common agenda across the EU with the necessary resources to build a dynamic European ecosystem for electronic components and systems.

The existence of a **central coordination** mechanism which can proactively mobilise different types of stakeholders, including national research organisations, can provide the highest possible coverage of value chains. The central coordination of this option also offers the flexibility and enables the implementation of follow-up activities to disseminate **knowledge across sectors and stakeholders** (e.g. SMEs) sustaining and **reinforcing the ecosystem**.

Therefore, the potential of the option to generate the expected scientific impacts is high (++) compared to the baseline.

Table 4: Overview of the options' effectiveness compared to the baseline - Scientific impacts

Impacts	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Europe reinforces its scientific capabilities in emerging fields of electronic components and systems maintaining leadership excellence in publications and attracting best talents.	0	+	++
Improved cross-border and cross-sector cooperation that strengthen the exchange of knowledge across the ecosystem	0	+	++

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

Economic/Technological impacts

- *European electronics components and systems industry strengthens its **technological leadership** and its **global competitive position** aligning its design and production capabilities with the EU's needs and its economic weight.*
- *Strengthen **digital transformation** in vertical sectors through electronic components and systems technologies developed in Europe*
- *Create a dynamic **ecosystem of innovation** in electronic components and systems with higher and more active involvement of SMEs*

Achievement of the expected impacts requires the ability to support technology development from the initial phases of R&D until technology maturity. This implies the combined use of **research actions and large-scale pilots at the appropriate points in time**.

It will require a strategic approach endorsed by private and public sector actors and their commitment to **mobilise a critical mass of resources** over the longer term. It will necessarily imply achieving **a coherent alignment between industrial priorities and public sector policies**.

Moreover it requires **moving rapidly from low to higher TRLs** and achieving a high level of integration, with the involvement of users in the early phases of the technology development. SMEs and start-ups should be involved as providers of new ideas for innovations.

Baseline: Horizon Europe traditional calls

Under the **baseline option** the development of a **strategic research and innovation agenda with the participation of the industry is possible,** but **the degree of alignment with industry priorities over time is likely to be limited.**

The absence of any steering and any financial contribution from the Member States limits the potential of this option to establish coherence with national policies and the possibility to mobilise the required volume of resources that would be needed in particular for large-scale pilots.

Horizon Europe calls do not have the mechanism to support successive phases of technological development nor the creation of industrial consortia to accelerate technologies maturity from low to higher TRLs.

Traditional calls in Horizon Europe can attract the participation of SMEs but with considerable risk of discontinuity of effort. The **low level of coordination** offered would not support the creation of an ecosystem where SMEs and start-ups can interact with relevant stakeholders beyond research cooperation.

Option 1: Co-Programmed European Partnership

Under Option 1, the **industry associations could provide coordination** to their members and mobilise the necessary mix of stakeholders.

Option 1 offers the possibility of aligning the partnership with the strategies of industry and the development of an agenda of activities.

However the **industrial commitment may be limited** to 'best effort' which may affect a long-term planning necessary to support technologies along the full R&I cycle from low to higher TRLs.

The interest of industry and their participation in projects contributing to the digital transformation would **stimulate industrial investments**. However, absent national public support, this Option is **unlikely to mobilise the necessary public and private resources** to support large-scale pilot and demonstration projects required for the validation of technologies in specific sectors.

The **industry associations can mobilise stakeholders** and ensure the **participation of relevant organisations** from across the value chain, including SMEs, and is open to newcomers according to emerging needs. The **industry associations will facilitate and steer appropriate collaboration among their members**.

Although the Option offers higher coordination compared to the baseline, the building of the ecosystem that stimulates the involvement of SMEs requires flexibility and feedback mechanisms: flexibility to design and implement calls according to the needs, feedback loops that facilitate learning and adaptation of the activities to fit the changing needs best. These possibilities are only partially covered due to the **absence of a central coordination and management system.**

Therefore, the potential of the Option to generate the expected impact compared to the baseline is high (++) for 'Strengthen digital transformation in vertical sectors through electronic components and systems technologies developed in Europe' and it is good (+) for the rest.

Option 3: Institutionalised European Partnership under Article 187 TFEU

The Institutionalised Partnership Art 187 is subject to a legal framework set out in a Council Regulation. As the other options do, it provides the opportunity to any organisation to participate through open calls. Therefore, in terms of the **participation of the necessary mix of partners**, the potential is high.

Option 3 offers the ability to generate integrated portfolios of projects through activities supporting **technology acceleration, scale-up and validation** and allows the pooling of private and public resources and the implementation of **large-scale projects** bringing together technology suppliers and users.

Option 3 offers the **highest directionality** among the various options. The partnership is built around a common European strategic research and innovation agenda agreed among the Commission, the Participating States and the industry represented by industry associations, and implemented through work programmes that can be updated annually.

The legal basis offers a stable framework for long-term planning and financial commitments compared to other Options and facilitates the alignment of the partnership with EU, national and industrial priorities.

The central coordination of this option offers the **flexibility to design specific activities to adapt to emerging areas and to attract and integrate SMEs** It also provides the highest possible directionality and leverage and the ability to design and implement a portfolio of activities that can support the building of the ecosystem that can attract and sustain SMEs and start-ups. **Further harmonisation of procedures across Participating States and simplification of administrative procedures** (currently in place in ECSEL) will further contribute to the increased participation of SMEs.

Therefore, the overall potential of the option to generate the expected impact is high (++).

Table 5: Overview of the options' effectiveness compared to the baseline - Economic/technological impacts

	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
European electronic components and systems industry strengthens its technological leadership and its global competitive position aligning its design and production capabilities with the EU's needs and its economic weight	0	+	++
Strengthen digital transformation in vertical sectors through electronic components and systems technologies developed in Europe	0	++	++
Create a dynamic ecosystem of innovation in electronic components and systems with higher and more active involvement of SMEs	0	+	++

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

Societal and environmental impacts

- *European systems and services providing high levels of **privacy and security** through the use of European digital technologies*
- *Implementation of **EU policies** (digital transition, technology sovereignty) according to the **European values and ambitions***
- *Electronic components and systems industries and vertical industries progressively **reduce their negative environmental impact***

Baseline: Horizon Europe traditional calls

Under Horizon Europe, the prioritisation by the Commission and the Member States (through the Programme Committee and the work programmes) is likely to place **high emphasis on societal and environmental impacts**. This emphasis would be accentuated as the European Commission has declared Horizon Europe a key instrument to achieve the Green Deal objectives[108].

High-quality research results are, therefore, expected regarding the optimisation of security and privacy as well as the environmental characteristics of electronic components and systems. However, the generation of the expected impacts depends on the final uptake of relevant digital technologies by the vertical industries. **Horizon Europe** would be **effective in the generation of the research results** through stand-alone projects and early prototyping, but it would be **less effective in facilitating industrial uptake at later stages of technology maturity.** The scale and scope of research impacts would therefore be limited.

Due to the **lack of a critical mass of resources** and the **limited alignment with industry priorities**, it is unlikely that this Option would achieve the intended mitigation of environmental impacts (which requires industry wide adoption of technologies).

Similarly, **lack of coordination** across low and high TRL stages would limit the alignment of the area with EU societal and environmental policies.

Option 1: Co-Programmed European Partnership

Under the Co-Programmed partnership, more emphasis will be given to later stages of the research process compared to traditional calls in Horizon Europe. This option can **balance**

[108] 'Mobilising Research and fostering innovation'. The European Green Deal. COM(2019) 640. 11 December 2019

social/environmentally-driven research and activities supporting the use of research results in sectors and services of interest.

The environmental impacts of the initiative is related to its potential to **reduce the energy consumption** of the applications by making use of greener components and systems technologies.

Further to commercial interests, industry will take into account environmental impacts as the workprogramme is established by the Commission. Therefore, the improvement of energy efficiency and the development of **environmentally friendly technologies** is expected to be a high priority.

In Option 1 the **coordination necessary to align** industry with other EU policies and commit to their implementation might be limited.

The overall potential of the Option to generate societal and environmental impacts is expected to be high (++) compared to the baseline with the exception of impact 'Implementation of EU policies (green and digital transition, technology sovereignty) according to the European values and ambitions' which is expected to be good (+) compared to the baseline. See table 6.

Option 3: Institutionalised European Partnership under Article 187 TFEU

An institutionalised Art. 187 partnership with a **long-term strategy** agreed between public and private members can ensure that **societal and environmental** aspects are addressed in the later stages of R&D and in the preparation for industrialisation.

Joint **public-private priorities** of societal relevance include the development of technologies supporting **security, safety and trust,** ensuring their availability in the digital transition of systems and services.

The **portfolio approach** of this option would support a balanced coverage of **citizen-centred technological solutions** together with others that focus on performance, sustainability, etc.

Public-private priorities of societal relevance also include skills and education policies. There is a clear shortage of engineering and ICT skills in microelectronics that needs to be addressed. Increased collaboration between academia and industry can facilitate on-the-job learning; research ministries can facilitate support programs for Masters, PhDs, and internships in these areas.

A **tripartite model** with the participation of Member States would bring to an institutionalised partnership national experiences, **expanding and diversifying the scope** of societal challenges addressed and approaches taken.

In addition to commercial interests, **the strong coordination and central management** of this option and the key role of the Commission and the Participating States would enable closer alignment to EU policies, including by establishing coordination with relevant partnerships and, improving on the current experience in ECSEL, by steering the SRIA towards those policy objectives.

As shown in the existing ECSEL JU, the **high volume of public and private resources** that this option can mobilise will help the development of technologies and their integration in a broad number of sectors and applications.

Therefore, the overall potential of the Option to generate both societal and environmental impacts related to security and alignment with EU policies is expected to be high (++) compared to the baseline.

Summary

Table 6 below lists the scores assigned for each of the policy options to reach the various impacts. Scores are based on the assessments above, as well as on the views expressed by the different stakeholders.

Table 6: Overview of the options' effectiveness compared to the baseline - Societal impacts

	Option 0: Horizon Europe calls	**Option 1: Co-programmed**	**Option 3: Institutionalised Art 187**
European systems and services providing high levels of privacy and security through the use of European digital technologies	**0**	++	++
Implementation of EU policies (green and digital transition, technology sovereignty) according to the European values and ambitions	**0**	+	++
Electronic components and systems industries and vertical industries progressively reduce their negative environmental impact	**0**	++	++

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

Assessment of directionality and additionality

As argued in the problems and drivers sections for both the European electronic ecosystem and the vertical industries that depend on these technologies for their competitiveness, the main challenge is Europe's ability to retain leadership and address technological sovereignty while facing severe competition from other regions, in particular China and US. The KDT initiative is expected to play a pivotal role in tackling the challenge by strengthening technological leadership of Europe in electronic components and systems, ensuring the supply of secure and energy-efficient components and systems for critical infrastructures and sectors, and ensuring the coordination and integration of R&I efforts by companies, national research communities and ecosystems that connect their long-term investment to the European and global value chains and networks. The development of a shared European vision, set together with the Commission and the Participating States, with a coordinated research agenda and a central management system aligned with EU, national and industry priorities and strategies is necessary for exploiting synergies. Also the commitment of the initiative members to enable the pooling of resources and the leverage effects is necessary to support the activities that would generate the expected impacts. Thus, the option that offers the highest level of directionality and additionality will maximise the economic and technological impacts of the initiative.

6.2. Efficiency

In order to compare the policy options consistently in terms of their efficiency, a standard cost model was developed for the external study supporting the impact assessment for the set of candidate Institutionalised Partnerships. The model and the underlying assumptions and analyses are set out in the Common Part of this impact assessment, Section 2.3.2 and in the Methodology Annex 4. A dedicated Annex 3 also provides more information on who is affected and how by this specific initiative in line with the Better Regulation framework. The scores related to the costs set out in this context allow for a "value for money" analysis (cost-effectiveness) in the final scorecard analysis in Section 6.4.

In addition, for this specific initiative under the baseline scenario of traditional calls, there would be winding down and social discontinuation costs for the existing implementation

structure of the current Article 187 initiative ECSEL. The JU statutes[109] foresee a 4-year winding down period to manage projects launched in the last phase of the JU and running beyond 31st December 2020.[110]

There would be also 'intangible costs' associated to the JU discontinuity. It will be difficult to justify a lower intensity of EU support in R&I to the components and systems industry at a moment in which access in Europe to key digital technologies is becoming critical and when other regions (China, US, Korea) are receiving substantial public support that goes beyond R&I.

Discontinuity of the ECSEL JU will represent administrative savings of €5.53 million/year (of which 50% contribution by the EC), with the exception of the 2021-24 period as indicated above. It is estimated that the overall longer term cost savings from using traditional calls (or a co-programme model) instead of an existing Article 187 initiative would considerably exceed the costs incurred for winding down operations. This overall situation is set as the starting point for the comparison of options. The score of this baseline scenario (traditional Horizon Europe calls) is set to 0 to be used as a reference point.

On this basis, the scores for the costs of the different options range from a value of 0, in case an option does not entail any additional costs compared to the baseline, to a score of (-) when an option introduces limited additional costs when compared to the baseline and a score of (-)(-) when substantial additional costs are expected in comparison with the baseline. In case the scores are lower than for the baseline scenario, (+) and (+)(+) are used.

The intensity of additional costs for specific items for the various options as compared to the baseline, i.e. Option 0 (Horizon Europe calls) is presented in Figure 4 in the overview of the methodology (Section 2.3. in the common part of this report).

It is considered therefore that there is a clear gradation in the **overall costs** of the policy options, this is reflected in the scores assigned to baseline (0), co-programme (0) and Article 187 (-)(-) scenarios. The cost differentials, however, are less marked when one takes into account the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution. From this perspective, there are only one or two percentage points that split the most cost-efficient policy options – the baseline (traditional calls) and the Co-Programmed policy options – and the least cost-efficient – the Institutionalised Partnership option. Indeed, in terms of cost-efficiency, the Co-Programmed Partnership (Option 1) is 2 percentage points more efficient than the baseline; and an Article 187 Partnership is 2 percentage points less cost-efficient than the baseline. A score of (+) is therefore assigned for **cost-efficiency** to the Co-Programmed options and a score of (-) for the Institutionalised Partnership policy option[111].

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, above.

When assessing efficiency, the financial contribution of Member States to the candidate KDT JU as well as the industrial commitment need to be taken into account. Based on the existing JU experience[112] and on-going consultation with Member States and Industry Associations, it is intended (see sub-section 4.4.3) that the envisaged initiative in KDT

[109] Council Regulation (EU) No 561/2014 of 6 May 2014 establishing the ECSEL Joint Undertaking

[110] The administrative cost planned for the management of ECSEL legacy in the period 2021-24 is €10.4 million, to be equally shared by EC and industry members.

[111] The baseline (traditional calls) is scored 0, as explained above.

[112] ECSEL leverage ratios in the period 2014-18: 1€ from EU, 0,9€ from participating states and 2,18€ from private members. ECSEL Annual Activity Report 2018

would generate a leverage effect of 1:3, enabling a critical volume of resources to support actions at the right scale to generate the foreseen impacts.

Table 7 summarises the cost scores.

Table 7: Matrix on 'overall costs' and 'cost-efficiency'

	Baseline: Horizon Europe calls	**Option 1: Co-programmed**	**Option 3: Institutionalised Art 187**
Overall cost	0	0	(-)(-)
Cost-efficiency	0	(+)	(-)

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

6.3. Coherence

6.3.1. Internal coherence

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

Option 0: Horizon Europe calls (baseline)

Under this option, coherence between activities in the area of electronic components and systems with activities under Cluster 4 of the Horizon Europe and the other initiatives presented are ensured by the Commission. However, exploitation of synergies between the KDT and other initiatives, such as exchange of knowledge and experience at the level of projects and stakeholders, is limited as it requires an extra layer of coordination beyond the Programme Committees.

Option 1: Co-Programmed

Under the Co-Programmed option, the exploitation of synergies can go beyond the possibilities offered by the baseline option. The Commission can ensure coordination at the level of the research agendas, while the industry associations can proactively bring together projects and stakeholders from various initiatives to work together on common problems or exploit together common challenges.

Therefore, the potential of the Option to generate the expected impact is good (+) compared to the baseline

Option 3: Institutionalised Art 187

The Institutionalised Art 187 partnership can provide the highest level of coordination, as in addition to the role of the Commission, the Participating States and the industry associations there is a central coordination mechanism which can increase the effectiveness of the effort. Since the central management of the partnership (i.e. the Governing Board, with representation of all members) decides on the actions, calls and funding allocation, the KDT partnership could set together with other initiatives joint activities of common interest.

Therefore, the potential of the Option to generate the expected impact is high (++) compared to the baseline

6.3.2. *External coherence*

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

Option 0: Horizon Europe calls (baseline)

In section 4.4.4 several opportunities for collaboration and development of synergies with initiatives and programmes beyond Horizon Europe have been identified. Under this option, some coordination with other European Commission activities is possible at the level of priorities. However, coordination at the level of implementation is somewhat limited or even not feasible.

Collaboration with national or regional initiatives such as national programmes for the support of KDT or a close coordination with regional clusters is difficult to achieve under this option.

Option 1: Co-Programmed European Partnership

Under this option, limited synergies can be established with other Union programmes and industrial strategies. For example, 35% of the budget of Horizon Europe will be supporting the Green Deal.

Therefore, the potential of the Option to generate the expected impact is good (+) compared to the baseline

Option 3: Institutionalised European Partnership under Article 187

The central coordination of this option provides the best scenario for exploitation of synergies with initiatives outside the framework programme, including international programmes. The participation of Member States provides the opportunity for coordination with national programmes and regional clusters. The close interaction in this option between Member States and private partners can support the coordination of national and industry efforts to set up a new IPCEI contributing to EU technological sovereignty, as announced in the Industrial strategy[113].

Beyond Horizon Europe, the Digital Europe Programme (DEP) is of particular interest to the KDT initiative. The central management and the up-front member commitments of an institutionalised partnership would facilitate the planning and coordination of the R&I activities of the envisaged partnership and the capacity building, technology deployment and skills development activities foreseen in the Digital Europe Programme.

Therefore, the potential of the Option to generate the expected impact is high (++) compared to the baseline

Based on the above analysis, table 8 summarise the scores assigned to the various options on internal and external coherence.

Summary

Table 8: Overview of the options' potential for ensuring and maximizing coherence

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

[113] EU Industrial Strategy. A new Industrial Strategy for a green and digital Europe. 10 March 2020. https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en

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

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

6.4. Tabular comparison of options and identification of preferred option

Table 9 below, lists the scores assigned for each of the policy options, based on the assessments above, and taking into account the views expressed by the different stakeholders.

Table 9: Scorecard of the policy options for all criteria

	Criteria	Baseline: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Effectiveness	**Scientific impacts**			
	Europe reinforces its scientific capabilities in emerging fields of electronic components and systems	0	+	++
	Improved cross-border & cross-sector scientific cooperation that strengthen the exchange of knowledge across the ecosystem	0	+	++
	Economic/technological impacts			
	European electronic components and systems industry strengthens its technological leadership and its global competitive position	0	+	++
	Strengthen digital transformation in vertical sectors through electronic components and systems technologies developed in Europe	0	++	++
	Create a dynamic ecosystem of innovation in electronic components and systems with higher and more active involvement of SMEs	0	+	++
	Societal impacts			
	European systems and services providing high levels of privacy and security through the use of European digital technologies	0	++	++
	Implementation of EU policies according to the European values and ambitions	0	+	++
	Electronic components and systems industries and vertical industries progressively reduce their negative environmental impact	0	++	++
Coherence	**Internal coherence**	0	+	++
	External coherence	0	+	++
Efficiency	**Overall cost**	0	0	(-)(-)
	Cost-efficiency	0	(+)	(-)

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

According to the scorecard in Table 9 the baseline option (Option 0) performs less well against the criteria of effectiveness and coherence compared to Options 1 (Co-Programme) and Option 3 (Institutionalised Art. 187). The higher score of Option 0 in the criterion of overall cost does not weight up against its low scores in all the other dimensions.

When compared with Option 1, Option 3 received the highest scores in effectiveness for most criteria on scientific and economic/technological impacts (in one economic/technological impact at the same level as Option 1). On the criteria for societal/environmental impacts Options 1 and Option 3 have the same scores in two impacts and Option 3 higher in one impact. We can conclude that Option 3 maximises the benefits compared to the other two options.

Option 3 received the lowest score in terms of cost-efficiency. However, the difference with the other two options is not significant (one to two percentage points) and it is largely compensated with the clear benefits in all other criteria.

Weights can be associated to the different criteria to reflect their relative importance in the objectives of the initiative. For this initiative a very important success factor is its impact on the vertical industries. This suggests that higher weights be given to societal/environmental and economic/technological impacts.

On societal and economic/technological impacts, Option 3 scores at the same level or higher than Option 1 and significantly better that Option 0. A higher weight for this impact, therefore, will not change the conclusion that Option 3 offers the highest benefits.

Compared to the other options, Option 3 would:

- Provide a more appropriate structure than the other options to implement a common vision and to achieve the objectives more efficiently (in terms of time and resources).
- Generate overall higher level of all impacts.
- Provide higher levels on internal and external coherence.
- Support integrated large-scale actions (pilots, platforms) with involvement of a large variety of users.
- Stronger involvement of technology users will generate spillover effects on the vertical "user" industries.
- Support a tri-partite model (EU, Participating States and Industry) with financial contributions from the EU and Participating States, mobilising a volume of resources not possible with Horizon Europe calls or a co-programmed partnership.
- Provide greater effectiveness through higher leverage and structuring effects in the ecosystem, creating a critical mass of financial and human resources, attracting more SMEs.
- Improve coherence beyond Horizon Europe and a co-programmed partnership through better coordination with European, national or regional initiatives at the level of priorities and implementation, as well at the level of individual projects or stakeholders.

When considering Option 3 (Institutionalised partnership based on Art. 187) in a bi-partite approach with **European Commission and Industry as members** (i.e. excluding Member States), it is concluded that the **following benefits will be severely limited or fully disappear**:

- ✓ The volume of R&I resources (public funding and industry contribution) supporting the initiative would be reduced to 50%. This would substantially limit the ambitions of the KDT initiative, and in particular the industrial actors, in a scenario of increasing competition from other regions.

- ✓ The integration of European and national priorities in electronic components and systems under a unified strategy at EU level will not be fully implementable.
- ✓ The coherence of the initiative at the European (Horizon Europe and beyond) and national levels would diminish in scope and efficiency.
- ✓ The needs of users will not be taken into account
- ✓ Enhancing technology sovereignty which requires a critical mass of efforts at both demand and supply sides will no longer be realistic as a goal.
- ✓ The coexistence of EU and national initiatives in the area will create fragmentation of actions and stakeholders, and will weaken the ecosystem of electronics components and systems technologies which is critical to maintain a strong industrial base in Europe.
- ✓ The contribution of the initiative to EU political priorities, notably to 'A Europe fit for the Digital Age' and to the 'European Green Deal', would be lowered if Member States are not actively involved in the initiative.

The above assessment concludes that Option 3, **Institutionalised Partnership based on TFEU Article 187** in a tri-partite configuration with European Commission, Participating States and Industry is the preferred option, showing **higher levels of impacts and coherence** than the other options that largely compensate the lower cost-efficiency of the Option.

The Institutionalised Partnership Art 187 is subject to a legal framework set out in a Council Regulation, which defines the objectives and the resources contributed by partners in relation to the proportion of EU funding. The partnership is steered by a governing board with representation of all partners, i.e. the private sector, represented by industry associations, representatives of all Participating States and the Commission. The operation is managed by a central structure supporting, among other things, the development of a long-term strategy and the specification of annual work programmes delivered through projects through open calls.

As it was unanimously agreed by stakeholders interviewed, Option 3 can ensure the highest possible commitment of industry and Member States around a strategic agenda. At the same time, the alignment with the EU policy is ensured by the participation of the Commission in the management of the partnership. The calls are designed by the management of the partnership according to the work programme with the highest possible alignment with the industry's strategy. The central coordination of the selection of the projects will result in a stronger and more coherent research portfolio. Therefore, the potential to achieve the required directionality is high.

Based on the assessment in chapter 6, we conclude that Institutionalised Partnership based on Article 187 TFEU is the preferred option for the KDT initiative.

This option

- ensures that the electronic components and systems industry, including all segments of the European ecosystem, is taking a leading role and it is fully engaged in the implementation of the initiative.
- ensures the highest possible coordination of research agendas (including national ones) and mobilisation of resources that are necessary for the creation of the critical mass that is necessary for achieving the ambitious initiative objectives.
- provides the highest level of commitments from public and private members
- provides a stable structure and simplified administrative procedures to sustain a long-term planning that attracts major stakeholders as well as SMEs

- offers the highest possible coordination and coherence with other initiatives of Horizon Europe, as well as external initiatives.
- favours the alignment of the initiative with the EU priorities through the involvement of European and national authorities

Finally the preferred option provides flexibility in the definition and implementation of priorities through the annual revision of the strategic agenda and the efficient decision process through a central management. This makes the Institutionalised Partnership based on Article 187 TFEU best suited for the KDT initiative to respond to future technological changes and to new political priorities.

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

What continues	What is different
• A focus on electronics components and systems • An industry-driven R&I programme • High-quality science and research actions • A tri-partite (EC, Participating States, Industry) model • A governance model with a Public Authorities Board (EC and PS) and a Governing Board (EC, PS and Industry) • The Joint Undertaking support office • The combination of EU and national financing (50/50) • The industrial commitment to match public funding	• A broader coverage of electronic value-chains, involving technology supply- and user-sides • A more effective participation of SMEs and start-ups • A more active involvement of users in early phases of research • A more strategic approach to R&I actions following a set of priorities established by industry, Commission and Participating States • A closer alignment to European political priorities such as environment, societal and digital transformation objectives • Increased flexibility in addressing technology change • A stronger focus on emerging technologies • A closer follow-up of project impacts • A stronger interaction with relevant partnerships • A larger set of Participating States* • A simplified set of rules and participation criteria for the Participating States* * *Currently in discussion with Member States*

7. THE PREFERRED OPTION – HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

7.1. The preferred option

In Table 10, below, the alignment of the preferred option of Institutionalised European Partnership under Article 187 TFEU with the selection criteria for European Partnerships defined in Annex III of the Horizon Europe Regulation is depicted. Seeing that the design process of the candidate Institutionalised Partnerships is not yet concluded and several of the

related topics are still under discussion, the criteria of additionality/directionality and long-term commitment are covered in terms of *expectations* rather than ex-ante demonstration.

Table 10: Alignment with the selection criteria for European Partnerships

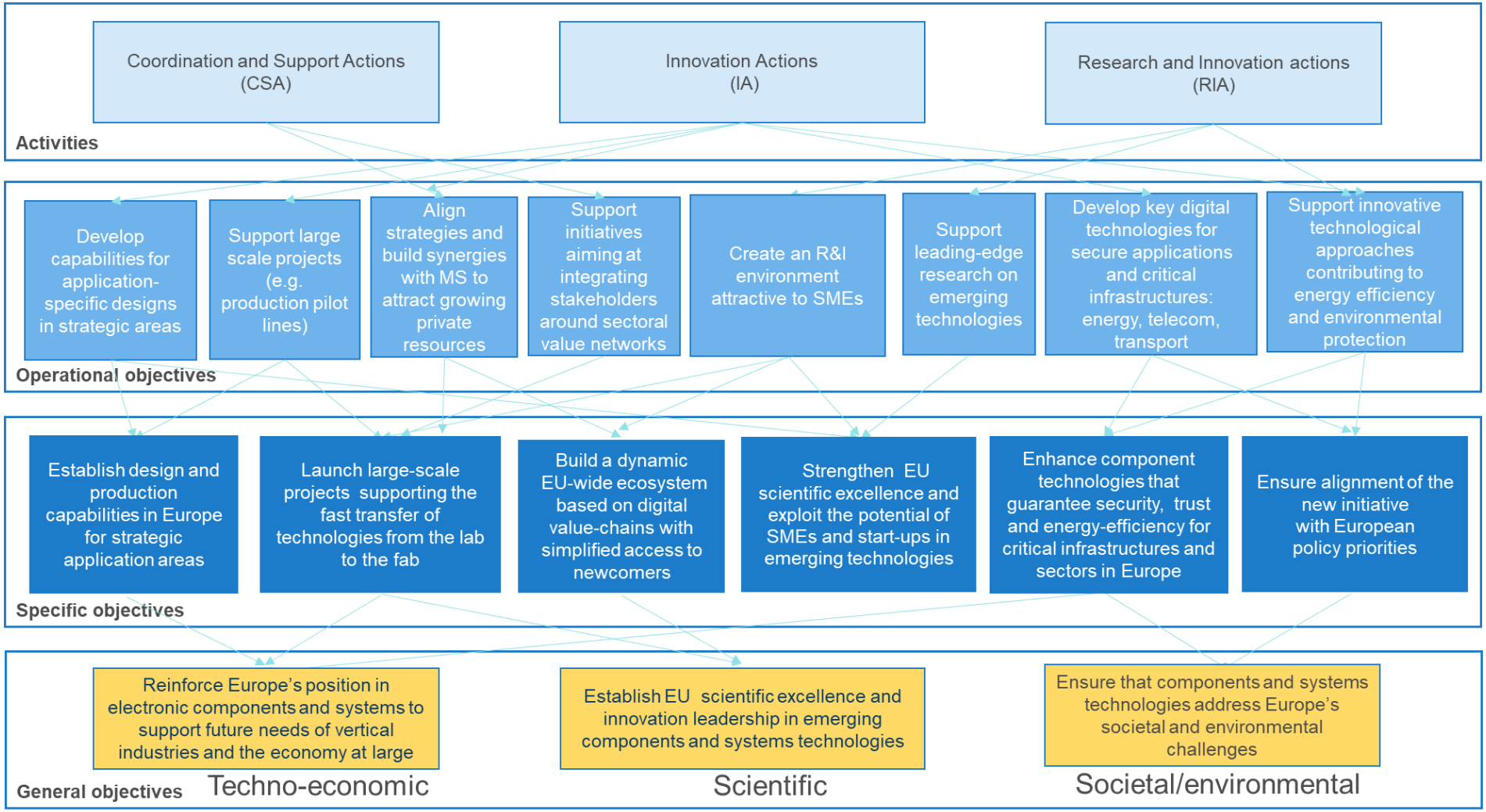
Criterion	Alignment of the preferred option
Higher level of effectiveness	According to the assessment in chapter 6, an Article 187 TFEU partnership will be more effective in increasing the competitive position of the electronic components and systems and the downstream industries, establish the European leadership in emerging technologies and securing the technological sovereignty of Europe
Coherence and synergies	Article 187 TFEU partnership provides the necessary conditions for coordination and creating synergies with other internal or external initiatives and also for developing the electronic ecosystem. The participation of the EC in the governance structure of the partnership ensures the alignment of the objectives with the Horizon Europe objectives and the EU priorities, while the central management structure can effectively coordinate with other partnerships and European initiatives.
Transparency and openness	The management framework and the tripartite character of the partnership ensure transparency and openness in terms of participation.
Additionality and directionality	The partnership would be able to assemble contributions from the EU, Participating States and private members in a tripartite model. This would create the critical mass of resources necessary to address the ambitious objectives of the partnership. The partnership would also be able to develop a coherent, long-term European strategy for the development of the electronic ecosystem and its technological capabilities. The ambition is to establish leadership in emerging technologies, secure the sovereignty of Europe in electronic components and systems and further strengthen its competitive position in strategic sectors that rely on electronic components and systems.
Long-term commitment	The partnership would encourage long-term commitment of financial and in-kind resources from Participating States and private members. Based on the experience of ECSEL and on-going consultations the partnership is expected to ensure a financial contribution from Participating States up to 25% and a contribution from the private sector at least equal to 50% of the aggregated European Partnership budget.

7.2. Objectives and corresponding monitoring indicators

Operational objectives

The Figure 13 identifies a broad range of activities and operational objectives that can be implemented under Horizon Europe. This reflects the definition of European Partnerships in the Horizon Europe Regulation as initiatives for which the Union and its partners "commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake."

Figure 13: Operational objectives of the initiative



Monitoring indicators

In addition to Key Impact Pathways indicators set centrally in the Regulation of Horizon Europe, a number of short, medium and long-term monitoring indicators have been identified to measure progress of the partnership towards its objectives. See Table 11.

Table 11: Monitoring indicators in addition to the Horizon Europe key impact pathway indicators

Objectives	Impacts	Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
Establish EU scientific excellence and innovation leadership in emerging components and systems technologies	**Scientific impact** – Europe reinforces its scientific capabilities in emerging fields of electronic components and systems	Number of projects with one or more publications Number of peer reviewed publications produced by the partnership	Share of publications produced by the partnership in journals within the upper 25% based on Field-weighted Citation index	Number and share of peer reviewed publications from the partnership projects that are core contribution to the scientific field
	Scientific impact – Improved cross-border and cross-sector cooperation that strengthen the exchange of knowledge across the ecosystem	Number of peer reviewed publications with co-authoring from industry and academia (Universities, research organisations)	Field-weighted citation index of peer reviewed publication with co-authoring from industry and academia	Number and share of peer reviewed publications from projects that are core contributions to scientific field with co-authoring from industry and academia
Reinforce Europe's position in electronic components and systems to support future needs of vertical industries and the economy at large	**Technological / economic impact** – Strengthen digital transformation in vertical sectors through electronic components and systems technologies developed in Europe	Number of IPs, new products or services digitised with European technologies	Number/Share of supported companies successfully launched new digitised products and services	World market share of Europe in the supported segments due to the initiative
	Technological / economic impact - European electronics components and systems industry strengthened its technological leadership and its global competitive position	Contribution of the initiative to the various market segments of electronic components and systems	Global market share of Europe in the various market segments of electronic components and systems	Evolution of world market share of Europe in electronic components and systems segments due to the initiative
	Technological / economic impact – Create a dynamic ecosystem of innovation in electronic components and systems with higher and more active involvement of SMEs	Number of SMEs involved in research and innovation actions in the initiative and associated funding	Participation (number of partners) and percentage of funding to SMEs in the initiative	Market share differential of SMEs through their participation in the KDT initiative
Ensure that components and systems technologies address Europe's societal and environmental challenges	**Societal impact –** European systems and services providing high levels of privacy and security through the use of European digital technologies	Number of technologies (chips, components, systems, applications) with high levels of security and privacy developed in selected projects	Number of technologies in the value chains (chips, components, systems, applications) with reduced consumption of energy developed by supported projects and reached the market	Market share of new products with enhanced security and privacy
	Societal impact – Implementation of EU policies (digital transition, technological sovereignty) according to the European values and ambitions	Number of projects with a direct link to the EU policy objectives	Number of project outcomes making a specific and measurable contribution to EU policies	Share of products and services specifically developed to align with EU priorities and policies
	Environmental impact – Vertical industries progressively reduce their negative environmental impact	Number of projects with reduction in energy consumption Number of projects addressing improvement of the environmental characteristics of technologies.	Maximum level of energy efficiency achieved in projects Number of applications and services adopting technologies with improved environmental performance	Overall energy efficiency gain due to projects results Share of vertical industries with highly reduced environmental impact through the use of European electronic components and systems supported in projects

7.3. Evaluation framework

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