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Towards the Implementation of an EU Strategy for Technology Infrastructures

*Insights for the implementation
of the ERA Policy Agenda*

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Executive Summary

Technology Infrastructures (TIs) are essential enablers for Europe to deliver on its ambitions of making successful transitions to a sustainable, digital and resilient industry and society. With rising technological complexity, industry's innovation capacity, productivity and international competitiveness heavily depend on possibilities to develop, test, validate and upscale new technological solutions with new levels of speed. For this, TIs are critical enablers in European RD&I ecosystems. TIs are (physical or virtual) facilities and equipment, such as demonstrators, testbeds, piloting facilities and living labs, capable of building bridges between science and the market. They are mostly created, managed, maintained and upgraded by Research Performing Organisations (mainly Research and Technology Organisations – RTOs, and Technical Universities – TUs), which require dedicated and significant resources and competences. TIs are open to a wide range of public and private users, large and small, collaborating with TI managers to jointly develop and integrate innovative technologies into new products, processes, and services.

Policy Context

The strategic importance of TIs has not sufficiently been recognised as such in European, national and regional policies in Europe, despite a few exceptions. Whereas RIs are quite high in the European RD&I policy agenda, TIs have only been the focus of a limited number of European Commission (EC) policy documents and workshops over the past decade. The [Action Plan to Promote the access of SMEs to KETs technology infrastructures](#) (2015) and the [Staff Working Document on Technology Infrastructures](#) (2019) recognise TIs as essential components of RD&I ecosystems, and crucial to foster the uptake of Europe's research results by the market. TIs have also been recognised as a key element of the new European Research Area (ERA) for R&I. The [EC Communication on a new ERA for Research and Innovation](#) (2020) stresses that *“Industry, and notably SMEs, require access to the right technology infrastructures to quickly develop and test their innovations and successfully enter the market.”* This EC Communication has been endorsed by the [Council Conclusions on the New European Research Area](#) (2020), which call for the development of an EU Strategy for Technology Infrastructures. The strategic importance of TIs in RD&I Ecosystems has also been highlighted in the [EC Proposal for a Council Recommendation on a Pact for Research and Innovation in Europe](#) (2021). This was the basis for the [Council Recommendations on a Pact for R&I in Europe](#) (2021), with a concrete Policy Agenda for the new ERA and a dedicated action plan for TIs over the next three years.

Methodology

In this context, the JRC and EARTO launched a joint project on TIs to gather evidence and highlight the common specificities of TIs across Europe, assess the challenges they face over their whole lifecycle, and identify how their capacity could be further leveraged. The main methodology used to collect input for this project includes a detailed questionnaire sent to TIs managers, and a joint JRC-EARTO dedicated workshop with 49 experts on TIs, among others.

Key policy recommendations

This work provides policy recommendations from TI managers and users, as well as policy makers, to support the implementation of the ERA Policy Agenda towards an integrated European landscape for TIs in the next three years. The main recommendations can be summarised as follows:

- Develop an EU Strategy for Technology Infrastructures using the European Strategy for Research Infrastructures (ESFRI) as a source of inspiration when relevant, and designing dedicated processes adapted to TIs' specificities (e.g. role in the ecosystem, type of users, services provided, etc.).
- Set up an agile governance of TIs at EU level including Member States' experts responsible for TIs and stakeholders (TI managers, and public and private users).
- Develop clear pathways for public support of capital and operating expenditures (CAPEX and OPEX), supporting the long-term sustainability of TIs.
- Combine and complete existing TIs' mappings and use existing EU instruments for roadmapping the future needs for TIs (e.g. European Partnerships, ERA Industrial Technology Roadmaps, Important Projects of Common European Interest (IPCEIs), Industrial Alliances, regional smart specialisation strategies, etc.).
- Put in place investments' prioritisation mechanisms at EU level for European scale TIs and synchronisation of national/regional investment plans for regional-scale TIs.
- Foster pan-European accessibility to TIs by strengthening their use in competitively funded projects, defining standardised principles for access, etc.
- Create thematic networks to better integrate the European landscape of TIs, foster capacity building across regions, and spread expertise to overcome the European innovation divide.

1. Introduction

Evidence shows that Research, Development and Innovation (RD&I) investments and strategic policy coordination are essential for Europe to deliver on its ambitions of making a successful transition to a sustainable, digital and resilient industry and society. Building Europe's strategic autonomy in key areas will be key to meet the needs of EU citizens, while preserving Europe's forefront position in the global innovation race. RD&I will be a game-changer to achieve those ambitions, and deepening the European Research Area (ERA) will be paramount to that aim. As stressed in the EU Industrial Strategy, industry's capacity to co-create, uptake and scale-up technologies into new products, processes and services on the market is essential to boost their productivity and competitiveness. In this context, companies need to strengthen their collaboration with RD&I actors and secure an easy access to state-of-the-art Technology Infrastructures (TIs) in Europe.

Technology Infrastructures are (physical or virtual) facilities and equipment such as demonstrators, testbeds, piloting facilities, living labs. They are used to develop, mature, test, demonstrate and upscale technology to advance through industrial research and experimental development activities from proof of concept to technology validation in relevant environment. They are mostly managed and hosted by research performing organisations, mainly Research and Technology Organisations (RTOs) and Technical Universities (TUs), and they are open to both public and private users (including SMEs) that collaborate to jointly develop and integrate innovative technologies into new products, processes and services. TI managers have the key role to create, operate, maintain, upgrade, and decommission TIs. This is usually very costly and requires a lot of resources and competences including highly skilled technical staff, which most companies cannot afford.

Research Infrastructures (RIs) and TIs are complementary. RIs create new scientific knowledge which is often used by TIs to address the future needs of European Industry. RIs and TIs share some similarities, for instance a diverse landscape, high investment and operational costs required throughout their whole lifecycles. They also have some important differences, including their roles in the RD&I ecosystems, as well as the type of users they address and the services they provide. It is important for policy makers to take their respective specificities into account when designing policies that will enable to leverage their capacities and foster their respective use to their full potential.

1.1 Policy Context

The strategic importance of TIs has not sufficiently been recognised as such in European, national and regional policies in Europe. While RIs are well embedded into the European RD&I policy agenda, TIs have only been the focus of a limited number of European Commission (EC) policy documents and workshops over the past decade.

The European Commission's Joint Research Centre (JRC) has been building key expertise on TIs thanks to the [European Technology Transfer Offices \(TTO\) Circle](#). Together with [RISE](#) and [Teknikföretagen](#), the JRC organised a [workshop on best practices](#) in the opening up of RTOs' TIs to industry for testing, demonstration and co-creation (2017), which is a key stepping stone towards the EU Strategy for TIs. The JRC has also set-up a [programme to open-up its own RIs](#) to a wide range of users from the public and private sectors. Some of the main challenges faced are linked to the management of Intellectual Property Rights (IPR) and the ownership of the data created, as well as financial considerations with regards to the amount to be charged to the users (large and small), and finding the right balance between accessibility and sustainability.

On the side of DG RTD (EC Directorate-General for Research and Innovation), both the [Action Plan to Promote the access of SMEs to KETs Technology Infrastructures](#) (2015) and the [Staff Working Document on Technology Infrastructures](#) (2019) recognise TIs as essential components of RD&I ecosystems, and crucial to foster the uptake of Europe's research results by the market. The four main challenges that have been underlined in the SWD are:

- Visibility: it is not always easy for users to find and access the services and facilities they need.
- Prioritisation: the granularity and actions at the EU, national and regional levels need to be streamlined.
- Accessibility: quick and easy access to TIs is essential for companies of all sizes, but there are some barriers to overcome (access conditions, IPR, cost, etc.).
- Networks: connecting TIs together (as well as to relevant RIs) following a value-chain driven approach is key to share competences and best practices.

The Staff Working Document (SWD) also highlights that a few EU programmes include instruments that can foster TI accessibility across Europe with a bottom-up approach, and these include for instance:

- EU RD&I Framework Programmes' specific calls, e.g. Coordination Support Actions (CSAs) from European Partnerships, specific ICT Innovation for Manufacturing SMEs (I4MS) calls, etc.
- Digital Innovation Hubs of DG CONNECT (EC Directorate-General for Communications Networks, Content)
- European Regional Development Funds of DG REGIO (EC Directorate-General Regional and Urban Policy) and related smart specialisation strategies
- European Institute of Innovation and Technology (EIT) Knowledge and Innovation Communities (KICs)
- New – Digital Europe Programme Test and Experimenting Facilities (TEFs) instrument
- New – Quantum Flagship Framework Partnership Agreements (FPA)
- New – Interreg Interregional Innovation Investments (I3)

More recently, the [EU Industrial Strategy](#) points out to two challenges: (1) strategic autonomy – the EU needs to become more independent in strategic areas for instance from China and the US, and (2) delivering the twin transitions towards green and digital. The role of TIs will be essential to achieve these two objectives, and a strong connection between RD&I and Industrial policy is essential for a coherent European approach to these EU overarching objectives.

TIs have also been recognised a key element of the new European Research Area for R&I. The [EC Communication on a new ERA for Research and Innovation](#) (Sept. 2020) stresses that “*Industry, and notably SMEs, require access to the right technology infrastructures to quickly develop and test their innovations and successfully enter the market. This involves establishing a governance structure for Technology Infrastructures, which will bring together and complete currently existing mappings of available facilities, performing a gap analysis and prioritisation at EU level and elaborating recommendations for common access conditions and engagement models*”. This EC Communication has been endorsed by the [Council Conclusions on the New European Research Area](#) (Dec. 2020), which calls for the development of an EU Strategy for Technology Infrastructures. The strategic importance of TIs in RD&I Ecosystems has also been highlighted in the [EC Proposal for a Council Recommendation on a Pact for Research and Innovation in Europe](#) (July 2021). This was the basis for the [Council Recommendations on a Pact for R&I in Europe](#) (Nov. 2021) which includes a concrete Policy Agenda for the new ERA with dedicated actions towards a more Integrated European landscape for TIs in the next three years.

1.2 Methodology

In this context, the [JRC](#) and the European Association for Research and Technology Organisations ([EARTO](#)) launched a joint project on TIs to gather evidence and highlight the common specificities of TIs across Europe, assess the challenges they face over their whole lifecycle – from inception to decommissioning, and identify how their capacity could be further leveraged. This work was also used to give policy recommendations to support the implementation of the ERA Policy Agenda Action with a concrete work plan to develop an integrated European TI landscape.

In addition to the review of the state of the art for TIs, the methodology used to collect input for this project includes:

- A questionnaire to collect input from TI managers with 18 responses received (September-October 2021).
- A joint JRC-EARTO workshop with nearly 50 experts on TIs (30 September 2021).
- The [EARTO Policy Event 2021](#) which focused on “the new EU Strategy on Technology Infrastructures as key ERA Action to deliver the green & digital transition” (27 October 2021).
- The [CONCORDi conference 2021](#) during which EARTO and the JRC organised a session on Technology Infrastructures (25 November 2021).

1.3 Policy Recommendations

The EC SWD on TIs suggests that “*there is a critical momentum for the EU together with Member States to be more ambitious, exploring with relevant national and regional stakeholders a shared vision and jointly developing a European strategy for technology infrastructures to support industry scale-up and technology diffusion across Europe*”. This recommendation has now been taken up in the frame of the new ERA, with an EC Communication and Council Conclusions including targeted policy actions for TIs.

This joint JRC-EARTO project has resulted in policy recommendations to support the implementation of the ERA Policy Agenda with a concrete action plan to develop an integrated European TIs landscape. These recommendations are structured in the following three parts:

Leveraging the role of TIs in the RD&I ecosystem

- TIs are essential to the well-functioning of efficient European RD&I ecosystems. A **better integration of TIs in policy initiatives** at European, national and regional levels could further leverage their potential. A **Pilot Advisory Board led by a Board Chair** should be established to support the establishment of the European Strategy for TIs and increase its visibility in the public policy landscape.
- TIs are not just physical or virtual infrastructures, they also require interdisciplinary and complex technological competences combined with complementary non-technological expertise, and highly skilled staff to operate them. An **alignment with the European Skills Agenda** would enable to avoid gaps.
- The TI landscape is very diverse. **Combining, completing, and analysing the existing European mappings of TIs** would enable to better understand their specificities, refine and create further typologies of TIs, and improve the design of tailor-made and evidence-based policies and investments.
- RIs and TIs have each their own specificities. The EU Strategy for TIs should **draw inspiration from ESFRI processes and modus operandi when relevant, and design dedicated ones when needed** - e.g. different stakeholders involved, bottom-up and value-chain approach for roadmapping of gaps and needs, different pace to keep up to speed with technology development, etc.
- **RIs and TIs are two important elements of an ecosystem**. There is a whole continuum between RIs and TIs, and they often are complementary: RIs create new scientific knowledge which is often used by TIs to address the future needs of European Industry. To take this ecosystem approach into account, links **between ESFRI and the future EU Strategy for TIs** should be built from the onset.

Ensuring TIs' long-term sustainability

- **TIs managers' foresight capabilities** could be further used by policymakers when designing public policies in various sectors, as their understanding of where the research forefront is going as well as their capability to identify the future needs of industry can be very valuable for prioritising investments.
- **The future users (public & private) of a TI need to be involved** throughout the creation process to ensure its long-term use.
- **A sound business model ensuring the long-term sustainability of a TI** is essential from the onset of a TI's creation process. TIs need to be developed and upgraded at the **same fast pace as the technologies** and the products that are developed and tested. More certainty on public funding cycles would strengthen TIs' capabilities.
- **A strengthened and clearer pathway of grant-based public support for capital investments (CAPEX)** for the creation and upgrade of TIs at European, national, and regional levels would be essential as the current funding landscape is very scattered. These instruments should be adapted to the speed of technology development. Creating synergies for a more structural support to TIs at European, national, and regional levels would be of high added value.
- There is a **lack of public investment plans focusing on the upgrade of existing TIs** at European, national, and regional levels. The support for the **creation of new TIs should be designed in complementarity with the support for the upgrade of existing ones**, taking a balanced approach between the two. Creating a new TI might not always be the best way to fill a gap, and failure to keep existing TIs at the forefront of innovation may result in a suboptimal use of public resources.

Integrating the European Landscape of TIs with a shared strategic vision

- **Taking stock of the public policy initiatives and instruments** that currently exist to support TIs at regional, national, and European levels via a **systematic policy observatory**, would provide opportunities for benchmarking and streamlining investments.
- **Combining and completing the existing repositories and mappings of TIs** at EU level covering both TIs' locations and the services and facilities they offer could be used to (1) enable a better understanding of the TIs' landscape by policymakers and users; (2) foster accessibility to TIs (if coupled with efficient platforms for sharing information and adequate marketing campaigns to increase visibility); and (3) create connections between complementary TIs.
- **Roadmapping of future needs for CAPEX investments in TIs** should be organised (1) with a **sectorial value-chain** and bottom-up approach, (2) with the **involvement of TIs' stakeholders** (managers and users), (3) by **identifying the future needs for TIs in existing roadmaps linked to current EU instruments and actions** - e.g. European Partnerships, ERA Industrial Technology Roadmaps, Industrial Alliances, Important Projects of Common European Interest (IPCEIs), regional smart specialisation strategies, etc.
- Setting up a mechanism to draw from sectorial roadmaps and **prioritise investments in TIs at European level and/or coordinate and synchronise national/regional TIs' roadmaps** in strategic sectors would be valuable to maximise the use of public funds. A pilot could be set-up based on a selected number of strategic sectors, to refine the approach and make this operational.
- **Creating an agile Advisory Board will be necessary to operationalise the investment prioritisation mechanism and the coordination of national/regional TIs' roadmaps.** It should be composed of experts responsible for TIs within national ministries (investors), as well as TIs managers (foresight) and users (long-term use). The Advisory Board should be framed within an overarching governance structure of the EU Strategy for TIs and have a fixed term duration to adapt to the evolution of the RD&I ecosystem.
- The **prioritisation mechanism and synchronisation of national/regional TIs' roadmaps needs to take into account the different types of TIs:** (1) for TIs of European scale and market niche, duplication should be avoided to achieve economies of scale and a broader user-base; whereas (2) for TIs of regional focus, replication at regional level is key to ensure accessibility and avoid gaps to bridge the innovation divide.
- The **pan-European accessibility to TIs should be facilitated** by fostering the use of TIs in competitively funded projects including at EU level, defining standardised principles for access to TIs which could be implemented on a voluntary basis (incl. IPR, Data management, etc.), investing in the digitalisation of TI processes when possible, adopting a one-stop-shop approach in specific value-chains when relevant.
- **Creating thematic networks of TIs with a value-chain approach at EU level** would enable to: better integrate and structure the European landscape for TIs; foster capacity building across regions; spread excellence and expertise to overcome the European innovation divide. Dedicated support and funding for network orchestration activities is needed to explore the full potential of TIs' networks

2. Leveraging the Role of Technology Infrastructures in the RD&I Ecosystem

2.1 The role of TIs in the RD&I Ecosystem

As highlighted in the European Industrial Strategy, RD&I is a key enabler for Europe to deliver on its political ambitions, such as enabling recovery, achieving resilience and strategic autonomy, delivering on the green and digital transitions and the health agenda, as well to fulfil the ERA priorities. This largely depends on Europe's capacity to develop, co-create, uptake and scale-up technologies into new product, process and service solutions on the market.

With rising technological complexity, industry's productivity and international competitiveness heavily depend on possibilities to test, validate and upscale new technological solutions with new levels of speed. For this, TIs are critical enablers in European RD&I ecosystems:

- **TIs play an essential role to facilitate technology transfer** from basic research to the market by enabling system level development, testing and validation ecosystems in close to real world conditions.
- **TIs build bridges across disciplines** to master the increasing technology complexity needed to address societal and industrial challenges.
- **TIs gather all the resources required to speed up technology development, uptake and scale-up**, including experimental platforms, competences and skilled staff, and deliver a wide range of technological and non-technological services (see 2.2.3), especially targeting SMEs.
- **TIs operate with open innovation models, therefore ensuring the connection between a broad range of RD&I actors**, at the heart of RD&I ecosystems. They are mostly run by non-profit research performing organisations such as RTOs, and Technical Universities, and used by those TIs' managers themselves, in collaboration with their public and industrial partners (large and small).
- **TIs fosters and leverages RD&I investments by industry**, most of which would not take place if these companies did not have access to TIs. Such access enables to share, and therefore considerably lower, both the risks and the costs of RD&I investments for industry, while speeding up the implementation of new solutions. These investments are used to cover the operational costs for running TIs within RD&I collaborative projects.

Policy Recommendations:

- TIs are essential to the well-functioning of efficient European RD&I ecosystems. A **better integration of TIs in policy initiatives** at European, national and regional levels could further leverage their potential.
- A **Pilot Advisory Board led by a Board Chair** should be established to support the establishment of the European Strategy for TIs and increase its visibility in the public policy landscape.

2.2 The role of Research Performing Organisations to create, manage and operate TIs

2.2.1 Market failures associated with TI investments

TIs require high and sustainable investments throughout their lifecycle, from the creation phase to several rounds of upgrade to remain state-of-the-art, and then decommissioning. These investments needs and costs levels, as well as the range of resources and skills needed to operate them are too high for the private sector to invest on its own, especially for SMEs. Aid for the construction or upgrade of TIs mainly addresses the market failure stemming from imperfect and asymmetric information or coordination failures:

- **TIs operate in high-risk technological areas where investment needs are very high, and the uncertainty of return on those investments for non-experts is particularly high as well:** information about the prospects for success in TI investments is often asymmetric¹. When investments are needed for a TIs' creation or upgrade, TIs need to be forward looking and adapted to the future needs of large and small industries, which companies are often themselves unaware of at that time. This makes it also difficult to obtain risk premiums for TI investments.
- **TIs' open and transparent users' accessibility policies lowers the incentives for the private sector to co-invest in TIs** as it would "spillover" to other firms². Such policies would indeed demand opening up the TIs to all potential users, including private investors' competitors.

¹ Jaffe, Adam & Newell, Richard & Stavins, Robert. (2005), [A Tale of Two Market Failures: Technology and Environmental Policy](#). Ecological Economics.

² Ibid.

- **TIs often operate at the crossroad between several markets, and they can be valuable to quite a wide community:** only part of the TIs' investments would be used to address the private investor's own needs. This would considerably reduce the rewards that private investors would gain from TIs' investments (positive externality of innovation).

Such market failures lead to considerable underinvestment in TIs from the private side, with very few examples of public-private co-investments for the creation of new TIs. Together with the positive externalities for the innovation system and society as a whole, this justifies public support to TIs.

A few exceptions could be found of public-private schemes for the creation of a new TI, especially involving large private users (this would not be feasible for SMEs), but such schemes are far from being the norm and their feasibility heavily depends on the sector and value chain. For instance, for the creation of the [Astazero Testbed](#) in Sweden, even though the TI was fully publicly funded, public and private users committed by contract to use the TI over a period of time, which was used to guarantee a bank loan. These few examples could be further explored and analysed and best practices could be drawn and fostered when possible.

It is slightly easier for the private side (especially large companies) to cover for the operational costs for the use of the TIs in the frame of bilateral/collaborative projects. However, these operational costs are often very high, and some users would also have difficulty in covering those costs, especially SMEs, start-ups, and academia. Support from the public sector to enable the access of those users to TIs is therefore essential (see 3.2).

2.2.2 Role of applied research performing organisations as TI managers

Public investments in TIs are indispensable and enable to ensure that all public and private actors, especially SMEs, have the same possibilities to access TIs. In that context, RTOs and TUs have a key connecting role within RD&I ecosystems, and a long-standing experience in owning and managing TIs while making them accessible to all users. RTOs and TUs, acting as TI managers, work with a not-for-profit approach, they offer technology neutrality, and operate in the pre-competitive phase. They play an intermediary role between basic research organisations and industry, and they bring all stakeholders together from both ends of the TRL scale.

TIs are not just physical or digital infrastructures, they also require complex technological knowhow and expertise to operate them. RTOs and TUs have the highly skilled staff and interdisciplinarity knowhow required, including:

- **Management skills and close connection both to the academic research world and the close-to-market industrial world,** thanks to their open innovation business model, which puts them in an optimal position to align technology development and maturation with concrete market needs. TI managers' close connection to industry indeed provides first-hand information on industry's needs and a long-term market vision, and thus the ability to create, in the long run, innovative concepts of industrial relevance. Business, scientific, project and innovation management skills are essential.
- **Market skills and expertise for horizon scanning and technology foresight and assessment:** this is essential in today's fast-paced markets to make sure that TIs are relevant and state-of-the-art at the time of their creation/upgrade, and that they remain at the cutting edge of technology throughout their lifecycles. These skills include (1) the identification of emerging technologies worth investing in from economic and societal points of view, (2) the knowledge needed to introduce new technologies to the market, (3) the understanding of the measures required to speed-up innovation and achieve policy objectives such as green and digital transitions, health, etc. Such expertise is also used by policy makers at all levels to take knowledge-based decisions for the design of future public policies in all sectors (not only RD&I).
- **Technology skills and trans-disciplinary capabilities with highly skilled and specialised human capital and know-how:** these are at the core of the TI. Trans-disciplinary capabilities are essential to create bridges between the many different disciplines and knowledge necessary to solve complex societal and industrial challenges. TIs require such specialised and highly skilled staff to maximise their potential. TI managers' own researchers use the TI to build and maintain their own knowledge base, but also to develop the TI itself (they are the first users of TIs). They provide the research and development needed for the use of the TI in collaboration with their public and private partners. Combining experts from the two end sides of the TRL spectrum is also a very efficient way to deliver outstanding collaborations with users and other actors of the RD&I ecosystem (incl. academia, RIs, large and small companies, etc.).

A wide range of other complementary skills are also needed to efficiently create and run TIs, including legal skills (IPR, standardisation, etc.), financial skills (incl. securing both public and private sustainable funding streams), entrepreneurship skills, teaching/ advanced training skills, data management skills, etc.

It is actually quite unlikely to find all these skills combined in single persons: TI managers need to have critical mass to be able to have experts that together encompass the required skillsets to manage a TI. This critical mass is very difficult to find within industry. One possibility to acquire these skills is to build partnerships with other PROs to jointly manage and operate the TI. For instance, TIs can be co-owned and jointly operated by RTOs and TUs. This not

only enables to share the financial investments, but also to combine different sets of competences and skills essential for the creation and running of the TI.

2.2.3 Technology and non-technology related services provided to TI users

Thanks to TI managers' strong expertise and skilled staff, the services provided by TIs are tailored and adapted to different groups of target users' group. This specific and personalised support is particularly important for SMEs and can take many forms, including technology-related and non-technology-related services.

TIs offer a wide range of technology-related services, often crossing the boundary between scientific disciplines and technologies to address the complex industrial and societal challenges of today. Depending on the context, a single TI can be used for a wide range of activities:

- **Co-creation, development and maturation of upcoming, completely new “breakthrough” and highly innovative key enabling technologies** with the potential of creating new markets, mostly targeting collaboration with companies with high innovation capacity (large industry but also high-tech SMEs and start-ups), or the creation of new deep-tech start-ups (spin-off incubation).
- **Incremental integration of commercially viable innovations into existing products, processes, and services**, often in different domains, also called “broad roll-out” of technology, mostly targeting SMEs with lower RD&I capacity, supporting them to remain competitive by resolving large profit and loss problems, modernising their production processes, etc.

Such technology services are either provided in collaboration/co-creation with a single public or private partner (large or small), or together with a consortium of several players for example in the frame of competitively funded projects at European, national or regional levels.

TIs connect technologies to non-technological services required for efficient technology uptake and scale-up, especially for SMEs. This includes:

- providing feasibility and regulatory compliance.
- networking and promoting new collaborations amongst large companies and SMEs or start-ups, supporting companies to find the right partners to reach their goals.
- providing market knowledge and business development advice.
- incorporating users' perspectives while looking at solutions bridging commercial interests and societal needs to improve the societal acceptance of innovation (e.g. direct involvement of users within “living labs”).
- providing professional training and coaching to TI users at the front end of industry's technology needs.
- providing legal advice including IPR, standardisation, data management support, etc.
- providing technology roadmapping and technology-watch studies, especially for business and policy makers.

TIs act as a dynamic meeting point for the potential users of a given technology, providing state-of-the-art technology services coupled with a wide range of additional activities essential for the efficient transfer of technology.

Policy Recommendations:

- TIs require interdisciplinary and complex technological competences combined with complementary non-technological expertise and highly skilled staff to operate them. **An alignment between TIs' needs and the European Skills Agenda would enable to avoid skills gaps in the future.**
- **Ensuring the long-term sustainability of TIs is essential for TI managers to attract and retain the highly skilled human capital needed to operate and maintain TIs** (incl. possibility to offer long-term contracts).

2.3 Diversity of the TI Landscape – Towards a typology of TIs

2.3.1 A diverse landscape

As identified in the EC SWD on TIs, the European TI landscape has developed according to historical and local conditions including funding opportunities, technology expertise and market needs, often in alignment with regional smart specialisation strategies. This has led to a wide diversity of TIs cases, sizes, structures, and practices, from small test beds to large living labs, which also reflects the rich diversity of Europe.

The EC SWD highlights the following examples of TIs: “TIs can range from facilities to develop electrolyser stacks to biogas plants, clean-room facilities for chip production to test areas for automate shipping or road traffic safety

solutions, from wind tunnels to testbeds for multi-functional nano-composites, multi-material 3D printing, to thermo-plastics and industrial robotics”.

TIs can be physical or virtual, and sometimes even a combination of both. TIs can be located at a single location, or distributed across various sites within or across countries, generally accessible through a single-entry point. TIs can be focused across several technology domains and markets, and they are most of the time designed to serve multiple sectors with a wide range of possible applications.

2.3.2 A typology of TIs for policy

To better navigate along this diverse landscape of TIs, it may be useful to group TIs according to two different dimensions or typologies:

- **TIs with a national/European dimension:** unique and specialised TIs at national or European level. They are often very expensive to build, maintain and operate. They have a European or international outreach capacity with often a relatively limited number of targeted potential public and private users (niche market, deep-tech companies). These TIs could draw investments at EU level, and prioritisation mechanisms at European level would enable to avoid unnecessary duplication and strengthen accessibility across Europe, thereby growing their users’ base and fostering their sustainability. For those TIs networking and interconnection to create a broader base of services to the industrial users is key.
- **TIs with a local/regional dimension:** strongly linked to the regional dimension and smart specialisation strategy. They are usually small to mid-size facilities, embedded in the local/regional ecosystems, answering to the needs of local/regional users (especially SMEs). There is a need for replication of such TIs across Europe to make sure that they are within reach of all potential users in their regional environment, wherever they are located. For those TIs networking and interconnection to build up competencies and share best practices and expertise is key.

Although these two typologies may lead to oversimplifications in some cases, and many TIs can fall in-between categories, it may prove useful in supporting the design of a European Strategy on TIs.

2.3.3 Geographical unbalances

As stressed in the EC SWD on TIs, “the stocktaking of the EU’s current technology infrastructure landscape shows that there are large regional differences in terms of the availability of TIs’ support, fragmentation, risk of duplication of activities, transnational accessibility difficulties as well as a lack of mechanisms to identify industry needs or missing infrastructure capacity”.

For instance, evidence shows that in some (small) EU countries, TIs are not many, they are often managed within the same sites as RIs, and mostly integrated under the umbrella of RIs in national/regional policies and programmes. In such cases, these infrastructures focus on offering their services to public researchers, rather than to industry (also linked to limited industrial involvement or availability).

This has some consequences, as some studies have analysed the outreach of a TI for SME-users. These studies have found that often there is a cut-off distance for an SME to reach a TI. depending on the sector and context. A short-term solution could be to foster the use of TIs through EU projects to help SMEs access TIs across Europe (see 4.5 below), while a long-term solution could carefully balance investments in TIs to boost innovation capacity and increase networking and collaboration between complementary TIs across Europe. This should be a key target of the new ERA for R&I.

Policy Recommendations:

- **The diversity of the TI landscape needs to be fully taken into account when designing a European Strategy for TIs.** In general, all types of TIs are essential to the well-functioning of efficient European RD&I ecosystems. However, some policy initiatives could leverage TIs’ capabilities differently depending on the specificities of the sectors/industrial value chain they aim to address: there is no one-size-fits-all approach.
- **A more detailed analysis of the TI landscape when combining and completing existing mappings of TIs would be very valuable** to better understand the specificities and possibly refine and create further typologies of TIs which would enable better tailor-made and evidence-based policies and investments.
- **The integration of a structural landscape of TIs at EU level needs to remain deeply rooted into the Policy Agenda of the new ERA,** as the geographical unbalances of the European networks of TIs contribute to the European innovation divide and hamper the innovation capacity of some EU countries.

2.4 Continuity between RIs and TIs

Research Infrastructures (RIs) and TIs are complementary. RIs create new knowledge, which is key for TIs to address the future needs of European Industry. RIs and TIs share some similarities, for instance a diverse landscape, high investment costs throughout their whole lifecycles, etc. But they also have important differences, including their roles in the RD&I ecosystems, but also the type of users they address and the services they provide. It is therefore important for policy makers to thoroughly assess what is their precise role, their geographical reach, and how they complement each other, in order to design the policies that will foster their use to their full potential.

Until now, the distinction between RIs and TIs in RD&I policy has only been operationalised in a few EU countries. The table below is an attempt to summarise the key specificities between RIs and TIs. It is important to note that there is a continuum between RIs and TIs, and that some infrastructures could fall in between these two categories.

| | Research Infrastructures (RIs) | Technology Infrastructures (TIs) |
|---------------------------------------|--|--|
| TRL | Predominantly low TRL | Predominantly intermediary TRL |
| Functionality | Fundamental research: from scientific discovery and education to formulation of technology concept | Technology development: from formulation of technology concept to technology validation in the relevant environment |
| Main Driver | Advancing scientific knowledge | Answering industry needs |
| Host/ Manager | Often independent special purpose organisations, but sometimes also managed by Research Performing Organisations | Mostly hosted and managed by applied research performing organisations (i.e RTOs and Technical Universities) |
| Access/Users | <ul style="list-style-type: none"> - Mostly public users (RPOs), either for individual projects or in collaboration with other RPOs. - Sometimes in collaboration with industry, but not systemically | <ul style="list-style-type: none"> - Internal/individual technology development projects by RPOs (RD&I competence/knowledge building/ TI development) - Projects between TI managers and public and private users (incl. SMEs) mostly in effective collaboration (co-creation model) |
| Type of activities (State Aid) | <ul style="list-style-type: none"> - Mainly collaborative RD&I (non-economic activities). - The economic use of both types of infrastructures remains very limited, as they are mainly used in effective collaboration | |
| Public added value | - Essential to enable RPOs to advance scientific research and strengthen Europe's knowledge base in the public interest. | <ul style="list-style-type: none"> - Enhance TI managers' own knowledge and skills to develop technologies, to be used horizontally in different sectors (spill-overs), strengthening the EU innovation capacity - Enable industry (incl. SMEs) to access skills, knowledge and facilities (collaborating with RPOs) essential to identify and develop the technologies they need but too expensive for them to have in-house, thereby lowering the risk of their RD&I investments |
| Examples | Major scientific equipment, archives and scientific data collections, e-infrastructure and communication networks | Cleanrooms, large test beds, living labs, co-creation labs, pilot lines, technology platforms, etc. |

Source: EARTO (revisited)

Policy Recommendations:

- **RIs and TIs have each their own specificities, which need to be taken into account when designing an EU Strategy for TIs.** Such strategy could draw inspiration from ESFRI processes when relevant, and design dedicated ones when needed.
- **RIs and TIs are two important elements of an ecosystem.** There is a whole continuum between RIs and TIs, and they often are complementary: RIs create new scientific knowledge which is often used by TIs to address the future needs of European Industry. To take this ecosystem approach into account, links between ESFRI and the future EU Strategy for TIs should be built from the onset.

3. Ensuring TIs' Long-term Sustainability over their whole lifecycle

Each process to build a TI is quite unique, as different business sectors or research fields have very different needs. However, they all share some common factors that are essential for the success of a new TI.

3.1 Embedding the TI in the RD&I Ecosystem with a long-term approach

3.1.1 Involving TI users throughout the whole creation/upgrade process

RTOs and TUs, as well as TIs' managers, have the key role to use both their connections to academia and to industry to understand (1) where the research forefront is and where it is going, and (2) what is the state-of-play and future needs of large and small companies. TIs need to be designed based on industry's needs with a long-term approach from the onset: only accounting for the short-term needs of industry or only addressing a policy goal risks in the long run to create strong barriers to the success of a TI. This is also one of the key differences between RIs and TIs, the design of RIs is mostly driven by long-term policy and scientific goals.

3.1.2 Securing support from future users

A market analysis is key to ensure that there will be a growing demand for the services of a TI, supported by the demand of targeted public and private users. From experience, some TI managers have stressed that if the TI's activities are not at least 80% covered by demand at the time of creation, it will not be sustainable in the long run. TIs potential future users (public and private) should be directly involved throughout the TI creation/upgrade process, as this would ensure both the short term and long-term use of the TI. This is especially important to take into account when the TI is created and funded in the frame of time bound publicly funded projects.

Securing users' support can take several forms. In a few specific cases such as the Astazero Testbed in Sweden, public and private users commit by contract to use the TI over a period of time, which can be used to guarantee loans for the creation/upgrade of large infrastructures. A close collaboration and commitment from the users could also make it easier to secure public investments for its creation or rounds of upgrades, such as from regional funds, innovation agencies, etc. However this is far from the norm currently, but it could be further explored and best practices could be exchanged.

3.1.3 Designing a sound business model with a long-term approach

A sound business model ensuring that the TI will be viable after the first investment round is essential from the onset of the TI's creation process. From the day of its creation, the TI's managers need to think about the long-term development of the TI to make sure that it remains relevant and state-of-the-art, as the speed of technology development is extremely high. TIs need to be developed and upgraded at the same pace as the technologies and the products that are developed and tested. TI managers need to build up scenarios with different time horizons for the upgrading of a TI, and they need to start implementing these scenarios from the onset, without waiting for the current technology to be ready for the testing phase. Failing to upgrade a TI on time may result in critically decreasing the demand and interest from users.

A business model that ensures the sustainability and continuity of a TI over its lifecycle contributes to reassure private users that the TI will be relevant for them in the long term and will foster their commitments to use the TI. Continuity and long-term sustainability also demonstrate that the RPO managing the TI is a reliable partner for collaboration in EU research projects, which contributes to make the TI attractive, even across national borders.

However, the uncertainty around public funding cycles makes very difficult to ensure such support from users. TI managers have reported that it is difficult to plan beyond three years ahead in terms of funding. This has consequences for the planning of any upgrades or repurposing needed to keep up with the state-of-the-art.

Policy Recommendations:

- **TIs managers' foresight capabilities could be further used by policy-makers when designing public policies in various sectors**, as their understanding of where the research forefront is going as well as their capability to identify the future needs of industry can be very valuable for prioritising investments.
- **The future users (public and private) of a TI need to be involved throughout the creation process to ensure its long-term use.** These actors should be part of the governance structure of the new EU Strategy on TIs to ensure its success. The existing schemes to secure the long-term commitment of TIs' users should be promoted and further used, for instance, when a TI is created in the frame of a publicly funded project.
- **A sound business model ensuring the long-term sustainability of a TI is essential from the onset of a TI's creation process.** TIs need to be developed and upgraded at the same fast pace as the technologies and products that are developed and tested. More certainty around public funding cycles would strengthen TIs' capabilities.

3.2 Securing the necessary investments from available sources

TIs' investment costs vary considerably from one case to the other. However, the lifecycle of a TI tends to follow a quite typical path, which includes:

- a design phase,
- a planning and construction phase (capital investments),
- an operational phase also including maintenance (operational costs),
- and an upgrade or repurposing phase (capital investments),
- before eventual decommissioning.

The succession between the different phases is not always linear and can be a fluid process with some stages running in parallel or overlapping. In most European countries, the funding landscape that could be used to support investments in TIs is rather scattered, with limited or no structural, recurrent, or dependable public funding.

3.2.1 TIs' planning and construction phase and upgrade rounds

The (very) high initial investments for the creation of a TI are drawn from public sources in the large majority of cases. As explained in 2.2.1, private investments in the creation/upgrade of TIs open to a wide range of users is very rare, due to market failure. Even though there are a few successful cases in specific sectors/value-chains, financing TIs through loans is often not a viable solution: the financial constraints linked to loan-based financing could have a disruptive impact on the business models of such infrastructures, and many public research organisations are not legally allowed to take loans.

The planning and construction phase and the upgrade rounds rely on (very) high and sustainable capital investments (CAPEX) from public sources, while the public investment landscape is quite scattered with many funding gaps:

- **A few public schemes exist in some EU countries to secure initial capital investment for the creation of TIs, but they remain limited** in scale, technology fields and national/regional coverage, often missing a long-term perspective. Well-funded, structural, and recurrent public schemes for the upgrade of TIs are lacking.
- **The number of instruments supporting the joint creation/upgrade of TIs in the cross-regional, pan-European setting are currently very limited.**
- **Funding for the early-stage planning and investigation of new TIs is often not available**, which includes identifying needs to be addressed, building the case, technical design, scoping activities and feasibility studies, defining the governance and financial model, and determining the legal status.

In addition, the time needed to obtain the required investments can have dire consequences on the original TI business plan, especially due to the fast pace of technology development. This is a key challenge, as by the time a TI is operational, which often takes many years for large scale TIs, the public and private demand may differ from original projections. This requires to re-adapt the whole TI business model to avoid that the TI is already outdated once it is finally set-up.

Funding allocation depends on national and EU strategies, for which alignment at EU level on priority areas would be valuable. Examples of EU instruments that would be worth further exploring to support TIs include:

- the new Testing and Experimentation Facilities (TEFs) instrument under the Digital Europe Programme, and especially the Horizontal TEFs, which provide grant-based CAPEX investments to TIs, but only addressing the Artificial Intelligence field. This instrument could be explored as a de-facto pilot for an EU action together with Member States and TI stakeholders across sectors.
- European Regional Development Fund (ERDF), Recovery and Resilience Facility (RRF) and other place-based initiatives such as ERA hubs, European Digital Innovation Hubs (EDIH), Smart Specialisation Platforms (RIS3) could also help to facilitate regional funding streams and interregional exchange between TIs (or actors' engagement/access to European TIs).

3.2.2 The operational phase also entails quite high operational costs (OPEX)

The use of TIs generates operational costs, which can be quite high. Depending on the size and type of TI, their use in projects can generate different types of operational costs, including:

- dedicated support staff,
- utility costs (e.g. electricity, heating, cooling, waste management, etc.),
- base materials and consumables (e.g. chemicals, etc.),
- premises (e.g. rental cost, specialised adaptation of buildings),
- cleaning, security,
- depreciation of the equipment, etc.

TIs also generate maintenance costs, which are sometimes coupled with operational costs. Such operational costs require the use of allocation keys and relevant cost drivers to be properly attributed to projects. The use of cost

allocation mechanisms based on the usual cost accounting practices of the organisation managing the TI are therefore essential.

Depending on the type of contract, operational costs can be covered by a diverse range of sources. In many cases, OPEX is usually covered via public funds in the beginning (competitive grants), and some TIs can become self-sustainable in the long run through acquiring public and private bilateral collaborative projects. Regardless of the size of these project portfolio, not all TIs will become self-sustainable during their lifespan even though they are classified critical for innovation activities: access to public funding to cover OPEX is therefore essential as well.

The uncertainty of funding is one of the main challenges faced by TIs during their operation phase:

- **Operational costs (which include both direct and indirect costs) are rarely covered at their full real value in publicly funded projects**, which means that technology infrastructures' providers need to cover part of these costs themselves.
- **SMEs and academia often cannot afford to cover the high operational costs of TI projects**, and they require support from public funding programmes to be able to do so.
- **Finding the highly skilled staff to operate TIs can be difficult without a long-term perspective** on those operational costs, especially when funding uncertainties allows only fixed-term contracts.

Given the uncertainty of the funding landscape for TIs, many TI managers often need to use their own public funds to cover both operational and maintenance costs, which can contribute to drain the TI managers' own resources, hamper future knowledge development in the RTO, and is by essence limited.

3.2.3 Internal RPO governance structures to decide on TI investments

More often than not, RTOs and TUs do not have a centralised governance structure in place to carry out a gap analysis on TIs' needs, which should be based on a technology scope per value-chain (bottom-up approach). A gap analysis at national level is sometimes carried out by the public body proposing the investment, with RTOs, TUs and Industry involved throughout the process.

A wide range of experts are usually included in the internal TI creation/upgrade proposal and related assessment process, including technical, legal, and financial experts. The final decision regarding the creation/upgrade of a TI and the heavy investments needed is often taken centrally, on a case-by-case basis, at the level of the Investment Board of the organisation setting up the TI. Criteria used to assess the necessity of a new/upgraded TI often include:

- **A sustainable business case and market analysis**, including the identification of business needs in the next years, relevant range of services offered (incl. professional trainings, creation of start-ups, etc.).
- **A technology case**: the TI's plan, including the list of the instruments, equipment's, and tools associated with the new TI, are assessed with regards to the strategic alignment with the RTOs/TUs strategy, competences, skillset, and future research needs.
- **A talent case** which looks into the size of the team associated with TI activities, as well as the profile and competences of team members.

There can also be tensions between establishing new TIs against maintaining and upgrading existing ones. These investment decisions are a critical part of managing a TI portfolio, ensuring the best value for public investments.

Policy Recommendations:

- **A strengthened and clearer pathway of grant-based public support for CAPEX investments for the creation and upgrade of TIs at regional, national and EU levels** would be very valuable in the current context. TIs are often supported by a mix of regional, national and European instruments and their complementarity is sometimes delicate to coordinate. Creating synergies for a more structural support to TIs across Europe would be of high added value in the currently scattered funding landscape.
- **These grant-based public instruments supporting CAPEX investments for TIs need to be designed in an agile way to adapt to the speed needed** for such type of investments, aligned with the speed of technology development. This is also key for Europe to remain competitive at global scale.
- **The support for the creation of new TIs should be designed in complementarity with the support for the upgrade of existing ones, taking a balanced approach between the two.** The existing instruments providing CAPEX investments for the creation of TIs are limited, and those supporting the upgrade of TIs are almost inexistent today at regional, national and EU levels. However, creating a new TI might not always be the best way to fill a gap, and failure to keep existing TIs at the forefront of innovation may result in a suboptimal use of public resources.
- **Public support is essential to enable access to TIs from a wide range of users including SMEs and academia who cannot afford the sometimes high operational costs of TIs.** The use of TIs in publicly funding programmes is key to that effect, but those programmes should better cover the real costs of running those TIs. Voucher systems could also be further used to support SMEs' access to TIs.

4. Integrating the European Landscape of Technology Infrastructures with a shared strategic vision

The EC SWD on TIs suggests that “*there is a critical momentum for the EU together with Member States to be more ambitious, exploring with relevant national and regional stakeholders a shared vision and jointly developing a European strategy for technology infrastructures to support industry scale-up and technology diffusion across Europe*”. This recommendation has now been taken up in the frame of the new European Research Area, with an EC Communication and Council Conclusions including targeted policy actions towards an integrated European landscape for TIs. To ensure the sound implementation of a European Strategy for TIs, the following recommendations were brought up in the frame of this project.

4.1 Creating an observatory of public support schemes for TIs

The starting point of the EU Strategy on TIs should be to take stock of the currently existing public policy initiatives, programmes, instruments, that support TIs at regional, national and European levels. The EC SWD on TIs initiated that important work in 2017, and it would be valuable to have a systematic observatory in place in Europe.

- **This would create opportunities for benchmarking across countries** and at different levels (regional/European), enabling the identification of the most efficient funding schemes for instance.
- **It would also support the identification of funding gaps** in specific areas or countries, and enable to assess if current investments have the right focus and intensity to make sure that we have the capacities in Europe to achieve our ambitions (e.g. strategic autonomy and sustainable transitions).
- **It would enable the identification of clearer pathways of public support for TI managers**, which is key for the long-term sustainability of TIs.
- **It would also contribute to link, align and combine EU and national investment priorities**, organise convergence and complementarity and focus investments on strategic areas, thereby maximising the use of public funding.

This is even more pressing now that the costs and speed needed to establish and maintain TIs is ever growing with the complexity of the problems to be solved and the increased global competition Europe is facing.

Policy Recommendations:

- **Taking stock of the public policy initiatives and instruments that currently exist to support TIs at regional, national and European levels via a systematic observatory** would provide opportunities for benchmarking, identifying gaps, providing a clear pathway of public support, and streamlining investments.

4.2 Mapping of existing TIs

Taking stock of the TIs that already exist and that are essential for the development and deployment of key technologies in strategic areas throughout Europe would help policy makers to have a better understanding of the European TIs’ landscape. To do so, a key recommendation is to start by harmonising and creating bridges between the already existing repositories and mappings at EU level done by DGs GROW, RTD, CNECT, JRC and the EIT, and fill any gaps that might remain.

Such mapping should cover:

- the geographical location and eventual possibility of remote access (digital processes),
- the technology field and accessible facilities and equipment,
- the technology and non-technology-related services on offer, including technical capabilities and specifications, market-readiness levels supported, detailed features, etc.,
- the terms of usage.

To the extent possible, this mapping could also aim to distinguish between the different types of TIs (national/European outreach versus local/regional outreach) as these should be targeted differently by policy makers.

Coupled with an efficient marketing campaign, this mapping of existing TIs could then be further used to foster accessibility to TIs, especially for mid/large users and TIs of European scale (see 4.5). It can also be valuable to create connections between similar and complementary TIs across Europe (see 4.6).

Policy Recommendations:

- **Combining and completing the existing repositories and mappings of TIs at EU level** covering TIs’ geographical locations, services and facilities on offer, as well as the terms of usage, could be used to:
 - enable a better understanding of the TIs’ landscape by policymakers and users,
 - foster accessibility to TIs, if coupled with an efficient marketing campaign to increase visibility
 - create connections between complementary TIs.

4.3 Roadmapping of future needs for TIs to identify gaps and needs for upgrade

Roadmapping and prioritising investments in TIs should draw from the long experience in traditional RIs within the ESFRI context, while making the necessary adaptation to design a process that is tailored to TIs' specificities (see 2.4).

Roadmapping of future needs for CAPEX investments in TIs should be organised with a sectorial value-chain and bottom-up approach, with the involvement of the right stakeholders. This includes:

- TIs' managers (RTOs, TUs) with their technology foresight capabilities and understanding of the future needs of TIs' users in strategic markets,
- and the potential TIs' users (public and private) who should be involved throughout the process as this will be key to ensure the long-term sustainability of TIs.

Such roadmapping should take great care of including both the need of new TIs and the need for upgrade of existing ones to ensure they remain state-of-the-art, as both would require CAPEX investments.

Existing structures and technology roadmapping processes at European level should be used to the extent possible, to avoid creating duplication of efforts:

- **A clear demand to integrate a foresight analysis on the needs for new or upgraded TIs in existing forward-looking technology roadmaps** linked to current EU instruments and actions would be an efficient way to carry out this effort.
- **It would indeed enable the adoption of a value-chain approach and involve the right communities of stakeholders.**
- This could include for instance: each European Partnerships, the new ERA Industrial Technology Roadmaps, but also Industrial Alliances, IPCEIs, RIS3 thematic platforms and Strategic Value Chains, European Technology Platforms, and Interregional Innovation Investments (I3).
- **Links should also be created between these instruments, which could give rise to new synergies of funds.**

Policy Recommendations:

- **Roadmapping of future needs** for CAPEX investments in TIs should be organised:
 - **with a sectorial value-chain and bottom-up approach,**
 - with the **involvement of TIs stakeholders** including TI managers and users,
 - **by requiring the identification of the future needs for TIs in existing roadmaps linked to current EU instruments and actions** - e.g. European Partnerships, ERA Industrial Technology Roadmaps, Industrial Alliances, regional smart specialisation strategies, etc.

4.4 Governance model and prioritisation mechanisms to maximise public resources

These roadmaps of future needs for TIs defined in a sectorial value-chain approach using existing EU mechanisms and instruments should then be connected and reviewed at a central level by a dedicate European Strategic Advisory Board for TIs. Indeed, as it is the case for ESFRI, a mechanism to prioritise investments in TIs at European level in strategic sectors would be very valuable to maximise the use of public funds and deliver on Europe's ambitions to deliver on the green and digital transition and strengthen EU's strategic autonomy and competitiveness.

4.4.1 Designing the Governance Model for TIs

Within ESFRI, the advisory board to the Council of Ministers is used to facilitate the discussion among nations to jointly invest in unique scientific infrastructures. In this capacity, a similar advisory board for the EU Strategy on TIs should be designed, including:

- **the experts responsible for TIs within the relevant ministries or agencies from EU Member-States** – these national representatives would inevitably differ from the ones seating in the ESFRI Advisory Board to better encompass the specificities of TIs, but connections between the two should be fostered.
- **stakeholders from the TI community including managers and users** – they should also be engaged in such prioritisation exercise, including RTOs, TUs, and Industry, as this will be key to ensure alignment and contribute to the success and long-term sustainability of investments in TIs.

Such governance model should be designed in a dynamic and agile manner, to adapt to the speed of technology development. Specific task forces or mirror groups focused on specific technology areas could also be useful for more technical discussions.

4.4.2 Coordinating and Prioritising Investments in TIs

This TIs' Advisory Board should aim to foster dialogue between the EU, Member States, and TIs stakeholders (managers and users). The objective should be to coordinate and align European, national, and regional funding streams for TIs to the extent possible and to enable vertical synergies between EU/national/regional levels.

- **European Priority Roadmap:** Such prioritisation should be first and foremost focused on the most cost-intensive TIs with a national or European dimension and which could attract funding from a number of sources to create multilateral synergies. TIs with unique features, a European/global outreach capacity, and addressing the needs of a rather niche market in Europe would also be an interesting target. For this type of TIs, combining European investments and avoiding duplication makes the most sense (economies of scale), as this would contribute to the success and long-term sustainability of such TIs by ensuring the largest possible users' base in Europe.
- **National and Regional Priority Roadmaps:** In parallel, an EU Strategy for TIs should aim to foster the creation and synchronise national and regional TI planning initiatives. A gap analysis mechanism to feed into national and regional investment roadmaps and ensure that the necessary TIs with regional outreach are indeed accessible in all the relevant regions of Europe would be valuable. For this type of TIs, replication of complementary TIs in a distributed regional TI landscape with similar services are beneficial as they support decentralised and cooperative research, increasing the services available in Europe. This could also foster new types of collaboration schemes across regions in Europe, connecting the frontrunners with the laggards by means of relevant incentives for both, and thereby supporting the bridging of the innovation divide and contributing to complete the ERA.

Connections to ESFRI roadmaps could also be sought to enable continuity between RI and TI investments at EU level, to the extent possible.

Policy Recommendations:

- **A mechanism to draw from sectorial roadmaps and prioritise investments in TIs at European level and/or coordinate national/regional TIs' roadmaps in strategic sectors should be developed** to maximise the use of public funds. A pilot should be set-up based on a selected number of strategic sectors, to refine the approach and make this operational.
- **The creation of an agile Advisory Board will be necessary to operationalise the investment prioritisation mechanism and the coordination of national/regional TIs' roadmaps.** It should be composed of experts responsible for TIs within national ministries (investors), as well as TIs managers (foresight) and users (long-term use). The Advisory Board should be framed within an overarching governance structure of the European Strategy for TIs, and have a fixed term duration to adapt to the evolution of the RD&I ecosystem.
- **The prioritisation mechanism and synchronisation of national/regional TIs' roadmaps needs to take into account the diversity of the TI landscape:**
 - **for TIs of European scale and market niche:** duplication should be avoided to achieve economies of scale and a broader user-base, and
 - **for TIs of regional focus:** replication at regional level is key to ensure accessibility and gaps should be avoided to bridge the innovation divide.

4.5 Facilitating pan-European access to TIs

Access to TIs should be granted on a transparent and non-discriminatory basis and on market terms to multiple users, both public and private, large and small. Access to TIs by third party users is usually regulated through RD&I collaboration projects, including direct bilateral collaborative projects financed by the user, or multi-partners' collaborative projects funded via public research programmes, among others.

Facilitating public and private users' cross-border access to TIs and collaboration between TIs would have many benefits, as it would for instance:

- Contribute to close the innovation divide in Europe by enabling public and private users to access TIs wherever they are located.
- Increase the potential client base and market size for a given TI by providing access to a European-wide range of users.
- Help achieve the necessary utilisation rates to justify the set-up of very large and cost intensive TIs, for which the natural national home market might not be enough.
- Increase the competences of TIs and range of services that they can provide.

In general, when addressing accessibility issues for an infrastructure, it is key to consider who is the target user group, their specificities and needs. Replicating what already exists within ESFRI for RIs does not solve the problem of facilitating transnational access to TIs across Europe, as the users of TIs and their needs can be quite different.

4.5.1 Geographical aspects

The approach towards fostering accessibility should differ between RIs and TIs, especially because for RIs researchers are more open for transnational research, but this is often not the case for TIs.

- For many TIs, the geographical proximity is a key factor for its use by public and private organisations. The facilitation of transnational access for TIs should therefore focus on guiding as much as possible the users towards the most relevant TI, both in terms of services and geography.
- Among TI users, most SMEs with low innovation capacity and limited resources give particular importance to the proximity of facilities, and their innovation investments are heavily based on trust for their local/regional partners, while language and contractual arrangements can be important barriers. Such local trusted partner may be the link to a broader range of European competences and facilities in collaborative networks of TIs.
- Besides, for certain projects which require to develop and test technologies on large pieces of equipment or systems, transportation costs (of both materials and engineering personal) can be high and may not compensate the benefits of accessing a TI beyond a certain distance.
- In addition, some of the potential users of a TI also lack knowledge about the possibilities for accessing TIs, especially across borders. This lack of knowledge has a high search cost.

4.5.2 Strengthening the use of TIs in competitively funded projects, including at EU level

The use of TIs in specific collaborative projects, including in Pillar 2 of Horizon Europe and in particular in partnerships and missions, should be strengthened. This could be done for instance by putting in place dedicated ex-ante criteria and Key Performance Indicators (KPIs) on the use of TIs during projects, as a token of the projects' potential impact.

In addition, to boost SMEs access to a broad portfolio of TIs across borders, learning from previous European (and National) voucher-schemes pilots and creating connection between different TIs should be further improved and used more widely, such as [H2020-I4MS](#) (e.g. [ROBOTT-NET](#)) or Interreg (e.g. [HYPEREGIO B2B](#), [SmartPilots](#)).

In competitively funded collaborative projects, appropriate funding mechanisms should be put in place to cover the use and real operational costs of TIs via the acceptance of unit costs and allocation keys to properly allocate those costs to projects, based on the usual cost accounting practices of the TI managers (see 3.2.1). Failure to properly cover such costs in competitively funded projects could create issues for not-for-profit organisations operating the TIs, as they often lack the funds to cover those costs themselves and may refrain from proposing the use of their TIs in such projects. In addition, invoicing between beneficiaries under the same project consortium is extremely difficult, especially in cases where a TI is co-owned by different organisations. This is something that could be improved, streamlined and investigated further also in view of funding rules.

Besides, the push in current instruments for establishing new legal entities can also create issues and extra administrative burden: the costs/benefits of such approach should be thoroughly assessed.

4.5.3 Enabling remote access to TIs through digital processes

Investing in the digitalisation of TI processes to the extent possible, drawing from what has been put in place during the COVID crisis, would also be a very efficient way to foster transnational accessibility. This could for instance enable a TI and its staff to develop technologies and perform tests on objects while the engineers are remotely connected in real time. This will not be possible for all types of TIs nor for all types of processes, but it should be further explored on an ad hoc basis, and best practices should be exchanged amongst TI managers and users.

4.5.4 One-stop-shop and single-entry point approach

The one-stop-shop platform and the single-entry point concepts have been implemented so far in RIs and open innovation test beds (OITBs) for potential users to identify which infrastructures can best answer their needs, and to facilitate the access for all users to the services provided by the infrastructure. This could be effective for TIs as well if implemented with a value-chain approach. It also needs to be coupled with a strong dissemination campaign with a marketing approach to increase visibility. Such a "one-stop-shop" platform should also from the start include and/or promote digital access to TIs. It would however be less suited to target the smaller and local users of TIs (especially non-tech SMEs). This one-stop-shop approach should not be the only way forward to foster transnational access to TIs.

4.5.5 Standardised Principles for Access

A set of principles for access to TIs could be established and standardised to facilitate the users' requests, especially targeting small organisations like SMEs and start-ups.

- This set of principles or voluntary code for access could for instance draw inspiration from the [European Charter of Access for Research Infrastructures](#) and the EURO PRACTICE models.

- On top of basic terms of access, this code could include other aspects such as IPR rules, licencing, data management and accessibility, the management of sensitive and confidential information, etc.
- However, such framework should remain voluntary, and should be adapted depending on the TIs' business models/sectors/users.

Policy Recommendations:

- **Pan-European accessibility to TIs should be facilitated by fostering the use of TIs in competitively funded projects**, including at EU level (e.g. Horizon Europe Pillar 2), for instance by putting in place dedicated ex-ante criteria and Key Performance Indicators (KPIs) on the use of TIs during projects, as a token of the projects' potential impact. Extending the use of voucher-schemes adapted to the needs of given projects (not one size fits all approach) should be explored to boost SMEs' access to TIs. The costs needed for running TIs during such projects should be covered at their real value, based on the usual cost practices of beneficiaries.
- **The digitalisation of TI processes to enable access to TIs remotely should also be promoted and financially supported**, as it could be a means to foster pan-European access to those TIs.
- **The one-stop-shop platform and the single-entry point concepts** could be effective to a more limited extent for TIs (contrary to RIs). In any case, it needs to be coupled with a strong marketing or dissemination campaign with a business approach to have an impact.
- **A standardised set of principles for access to TIs to harmonise terms and conditions of use** could be put in place on a voluntary basis (incl. IPR, Data management, etc.). Such set of criteria should be defined bottom-up, together with the TI community of stakeholders (TI managers and users).
- **Replicating what already exists within ESFRI for RIs is not a solution to facilitate transnational access to TIs across Europe**, as the users of TIs and their needs can be quite different. For instance, SMEs who are a key target group of users for TIs, are most of the time regionally focused and heavily rely on trust to their local partner. In such cases the facilitation of transnational access for TIs should focus on guiding the users towards the most relevant TI both in terms of services and geography.

4.6 Building integrated TIs' networks in Europe based on a strategic value chain approach

Creating thematic networks of TIs with a value-chain approach at EU level would enable to:

- **better integrate and structure the European landscape for TIs**: TIs are often built at the intersection between several technology sectors, and a TI manager can have a very good visibility into the core segment technology of the TI (incl. other related or complementary TIs, etc.), but lack knowledge in other aspects of the TI's related technology focus. Being part of joint platforms on a strategic value-chain approach would be very valuable for TI managers to have a better visibility into the capabilities existing at EU level in this particular area,
- **support pan-European access** to TIs (see 4.5),
- **foster knowledge transfer and capacity building across regions** linked to smart specialisation strategies, thereby spreading excellence and expertise in order to overcome the European innovation divide.

The creation of structural networks of TIs will not normally happen unless they are stimulated. A few ad-hoc network collaborations of TIs do exist today at European level, either based on strong relations between TI managers (RTOs, TUs) or strong industry users' demand and often an EU funding of some kind (CSAs, I4MS, DIH, IPCEI, etc.). Some initiatives have been taken in certain areas to build innovation ecosystems with TIs at their centre (e.g. [EuroBioimaging](#), [Ascent+](#), [NFFA-Europe](#), [EUroNanoLab](#)). Feedback from those experiences should be used to strengthen cross-border collaborations. For instance, TI managers involved in those initiatives mentioned that dedicated support and funding for network orchestration activities is needed to explore the full potential of TIs' networks.

Instruments that could be further used to create such structured networks of TIs include:

- **The I4MS scheme**, offering an efficient framework for the creation and operationalisation of a network of TIs in specific technology fields.
- **Incorporating TIs in the network of Digital Innovation Hubs (DIHs)** could also be a good way forward and an option to further explore. This would also facilitate collaboration between TI managers and users and foster the inclusion of citizen participation, since DIHs follow a specific ecosystem approach. Such schemes, so far exclusively used in the digital sector, would need to be expanded to the non-digital ones.
- **Other interesting examples to draw inspiration and best practices include EIT KICs' initiatives**, which are also key enablers of TIs' networking projects.

- **The new Digital Europe Programme's calls to provide grant-based co-investments from EU and Member-States for the upgrade of Testing and Experimentation Facilities (TEFs)**, which has been designed from the onset with a network approach, since the project proposal has to be submitted by a consortium of infrastructures from different member states. The results of such approach (especially the horizontal TEFs) should be further looked into, and possibly replicated in other sectors beyond AI, with the objective of creating long-lasting connections between the consortium partners beyond the project's lifecycle.
- **The new Interreg Component 5 for Interregional Innovation Investments** should also include a focus on creating cross-border TIs as well as TIs' networks. This would help address the innovation divide across regions in Europe. Pilot projects should be launched with this target.
- **The new FET flagship calls to establish and develop demonstration and pilot facilities capabilities via framework partnership agreements (FPAs)** to implement a jointly developed roadmap is an example of new schemes that could create long-lasting collaboration models between TIs in a given sector.

In addition, creating connections between RIs and related TIs' networks would enable to incentivise sequential RI and TI service provision. This can be done based on an analysis of complementarities and of their potential contribution to the creation of new value chains, matching the potential applications of RI scientific fields to the TI technology fields. A way to implement these incentives can be via the development of connected services between TIs and with RIs, at the proposal stage. The common barriers that these structural networks of TIs usually face should be identified and addressed, with the objective to generate trust and potentially avoid conflicting scenarios.

Policy Recommendations:

- **Creating thematic networks of TIs with a value-chain approach at EU level** would enable to better integrate the European landscape of TIs, support pan-European access to TIs, and foster knowledge transfer and capacity building across regions, while contributing to overcome the European innovation divide.
- **Dedicated support and funding for network orchestration activities is needed to explore the full potential of TIs' networks.** The creation of structural networks of TIs will not normally happen unless they are stimulated.
- **Instruments that could be further used to create such structured networks of TIs include at EU level:** the I4MS or other types of voucher-system, DIHs, EIT KICs, TEFs, FET Quantum FPAs, Interreg Component 5 (RIS3), etc.
- **Creating connections between RIs and related TIs' network** would also be of added value.

5. Concluding Remarks

The present report provides recommendations drawn from TI managers and users as well as policy makers to support the implementation of the ERA Action plan towards an integrated European landscape for TIs in the next three years, which can be summarised as follows:

- Develop an EU Strategy for TIs using ESFRI as a source of inspiration when relevant, and designing dedicated processes adapted to TIs' specificities (e.g. role in the ecosystem, type of users, services provided, etc.).
- Set up an agile governance of TIs at EU level including Member States' experts responsible for TIs and stakeholders (TI managers, and public and private users).
- Develop clear pathways for public support of capital and operating expenditures (CAPEX and OPEX), supporting the long-term sustainability of TIs.
- Combine and complete existing TIs' mappings and use existing EU instruments for roadmapping the future needs for TIs (e.g. European Partnerships, ERA Industrial Technology Roadmaps, Important Projects of Common European Interest (IPCEIs), Industrial Alliances, regional smart specialisation strategies, etc.).
- Put in place investments' prioritisation mechanisms at EU level for European scale TIs and synchronisation of national/regional investment plans for regional-scale TIs.
- Foster pan-European accessibility to TIs by strengthening their use in competitively funded projects, defining standardised principles for access, etc.
- Create thematic networks to better integrate the European landscape of TIs, foster capacity building across regions, and spread expertise to overcome the European innovation divide.

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Annexes

Annex 1 – Table of Acronyms

| | |
|------------|---|
| CAPEX | Capital Expenditures |
| CSA | Coordination Support Actions |
| DG CONNECT | EC Directorate-General for Communications Networks, Content |
| DG GROW | EC Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| DG REGIO | EC Directorate-General Regional and Urban Policy |
| DG RTD | EC Directorate-General for Research and Innovation |
| DIH | Digital Innovation Hub |
| EARTO | European Association of Research and Technology Organisations |
| EC | European Commission |
| EIT | European Institute of Innovation and Technology |
| ERA | European Research Area |
| ERDF | European Regional Development Fund |
| ESFRI | European Strategy for Research Infrastructures |
| EU | European Union |
| I4MS | ICT Innovation for Manufacturing SMEs |
| ICT | Information and Communication Technology |
| IPCEI | Important Project of Common European Interest |
| JRC | Joint Research Center |
| KET | Key Enabling Technology |
| KIC | Knowledge and Innovation Community |
| OPEX | Operational Expenditures |
| RI | Research Infrastructure |
| RIS3 | Smart Specialisation Strategy |
| RPO | Research Performing Organisation |
| RRF | Recovery and Resilience Facility |
| RTO | Research and Technology Organisation |
| SME | Small and Medium size Enterprise |
| SWD | Staff Working Document |
| TEF | Testing and Experimentation Facility |
| TI | Technology Infrastructure |
| TRL | Technology Readiness Level |
| TTO | Technology Transfer Offices |
| TU | Technical University |

Annex 2 – JRC-EARTO Workshop on TIs - 30 September 2021 - Agenda

| JRC-EARTO Workshop on Technology Infrastructures – 30 September 2021 | |
|--|---|
| 11.00-11.20 | <p>Introduction</p> <ul style="list-style-type: none"> ■ Welcome by the moderator Fabio Taucer, Deputy Head of Unit Scientific Development, JRC ■ Introduction by Giancarlo Caratti, Active Senior, JRC ■ Opening Speech by Apostolia Karamali, Head of Unit R&I Actors & Research Careers, DG RTD |
| 11.20-11.50 | <p>Session A - Role of TIs in the RD&I Ecosystem and EU Strategy</p> <ol style="list-style-type: none"> 1. <i>What is the role of TIs in the RD&I Ecosystem?</i> 2. <i>What is the role of Public Research Organisations to create, manage and operate TIs?</i> 3. <i>How should the mapping and prioritisation of investments in TIs be concretely organised to maximise resources at EU level?</i> 4. <i>What type of governance model would be relevant for a European Strategy on TIs?</i> <p>Trigger speeches by:</p> <ul style="list-style-type: none"> ■ Verena Fennemann, Head of EU Office, Fraunhofer ■ Bertrand Bouchet, Director EU Affairs, CEA <p>Followed by open discussion with workshop participants</p> |
| 11.50-12.20 | <p>Session B - Ensuring TIs' Long-term Sustainability over their whole lifecycle</p> <ol style="list-style-type: none"> 1. <i>What is the usual process to create a new TI?</i> 2. <i>What are the different types of funding streams that you typically require to sustainably finance a TI in the long run?</i> 3. <i>What are the major challenges that you face for the creation and to ensure the long-term sustainability of TI(s)?</i> 4. <i>What policy recommendations would you have to overcome such challenges?</i> <p>Trigger speeches by:</p> <ul style="list-style-type: none"> ■ Monica Ringvik, CTO, RISE ■ Lula Rosso, European Affairs Manager, VTT <p>Followed by open discussion with workshop participants</p> |
| 12.20-12.50 | <p>Session C - TIs' Operational Phase: Ensuring (transnational) Access</p> <ol style="list-style-type: none"> 1. <i>What types of technology and non-technology related services are offered to TI users? What types of skills are required to deliver those services?</i> 2. <i>From your perspective, are TIs currently used to their full potential?</i> 3. <i>What is needed to facilitate (transnational) access to TIs across Europe (incl. SMEs)?</i> 4. <i>What can be done to create better connections between TIs and between TIs and RIs?</i> 5. <i>How is the exploitation of the TI-related results currently facilitated to ensure an efficient technology transfer to the market?</i> <p>Trigger speeches by:</p> <ul style="list-style-type: none"> ■ Ricardo Migueis, Head of Brussels' Office, INESC TEC ■ Esther Hurtós, R&I Policy and Funding Programmes, EURECAT <p>Followed by open discussion with workshop participants</p> |
| 12.50-13.00 | <p>Closing remarks by Muriel Attané, Secretary General, EARTO</p> |

| |
|--|
| <p>JRC-EARTO Questionnaire on Technology Infrastructures - 23 September-13 October 2021</p> |
| <p>Target group: TIs managers and operators - mainly RTOs, Technical Universities, (sometimes companies when public-private co-funding schemes).</p> |
| <p>Deadline: please send your input to the JRC (fabio.taucer@ec.europa.eu) and EARTO (viscido@earto.eu) by 13 October 2021.</p> |
| <p>Name of Organisation: Country: Name of Contact: Email: Job title:</p> |
| <p>Part A. Role in the RD&I Ecosystem and EU Strategy</p> <ol style="list-style-type: none"> 1. What is the role of TIs in the RD&I Ecosystem? What is the role of TIs to support regional/national/EU governments to reach their policy ambitions such as achieving the sustainable transition to a green and digital economy and society, the Health agenda, RRF plans, support the achievement of the new ERA, improving the connection between the EU RD&I policy and the Industrial Strategy, ensuring the EU technology sovereignty, etc. 2. What is the role of Public Research Organisations such as RTOs and Technical Universities to create, manage and operate TIs? How is the private sector involved? 3. Is there a (dedicated) national (or regional) strategy and/or funding stream(s) for TIs in your country? Are there roadmaps highlighting potential gaps and assessing future needs for TIs? If so, could you please provide details on the governance structure for such strategy, and further insights on how these roadmaps are created and what could be used to develop the EU strategy on TIs? 4. How should the mapping and prioritisation of investments in TIs be concretely organised to maximise resources at EU level, organise convergence and complementarity, and avoid duplication to the extent possible (at least for very unique and cost-intensive TIs)? What type of actors should be involved? Could existing structures/programmes such as European Partnerships, ERA Technology Roadmaps, Industrial Alliances, IPCEI, etc. be used for such mapping and prioritisation exercise, and if so, how concretely? 5. What type of governance model do you think would be relevant for a European Strategy on TIs? How to foster dialogue between Member States to coordinate specific/dedicated national/regional funding streams for TIs to the extent possible and to enable vertical synergies between EU/national/regional levels? How could this support the bridging of the innovation divide and contribute to complete the ERA? How can the EU Strategy on TIs complement the ESFRI strategy on RIs? |
| <p>Part B. Long-term Sustainability over the whole lifecycle</p> <ol style="list-style-type: none"> 6. What is the usual process to create a new TI from your organisation’s perspective? What type of funding streams are required for the creation of a TI? Does your organisation have a dedicated governance structure in place to provide a <u>gap analysis</u> and decide on heavy investments in new TIs? If so, how is it set-up and who is involved? 7. What are the different types of funding streams that you typically require to sustainably finance a TI in the long run (for CAPEX and OPEX)? Are there internal/regional/national (policy) mechanisms in place to ensure the <u>long-term sustainability</u> of TIs? What types of models of joint financing of TIs do you typically use (e.g. RTO-University co-management)? Do you have good examples of public-private models of joint financing of new TIs (and related business models) and for what type of industrial sectors could such models be fostered (large VS small industrial users, concentration of large companies, etc.)? How is access to third parties organised and financed? What type(s) of decommissioning policy are used? 8. What are the major challenges that you face for the creation and to ensure the long-term sustainability of TI(s) – e.g. long-term planning of public funding support (incl. upgrade and maintenance investments), regulatory barriers, speed issue for the creation/upgrade of TIs, competition with non-EU TIs, training and keeping skilled TI dedicated staff, participation in competitive funding projects, etc.? 9. What policy recommendations would you have to overcome such above-mentioned challenges? What types of funding schemes/policy initiatives/programmes/instruments would be needed to support TIs over their |

whole lifecycle? What type of funding schemes for TIs could be envisaged at EU level, and for what type of TIs, ensuring synergies with national/regional funding schemes as well?

Part C. Operational Phase: Ensuring (transnational) Access

- 10. What types of technology and non-technology related services are offered to TI users? What types of skills are required to run those TIs and deliver those services?**
- 11. From your perspective, are TIs currently used to their full potential, including in publicly funded projects (regional/national/EU level), and in bilateral projects with public and private partners? If not, what are the barriers and how can the use of TIs be further strengthened?**
- 12. What is needed in practice to facilitate (transnational) access to TIs from a wide range of users across Europe (incl. SMEs), thereby making them more sustainable? Would the creation of a one-stop-shop platform be useful for potential users to identify which TIs can answer best their needs, and if so, how should it be set-up? Would the development of a “European Voluntary Code” to harmonise access conditions be useful, and if so, what should it focus on and how should it be set up? Could the Charter of Access be considered as a model for such Voluntary Code? How can collaboration between different types of TI users be further facilitated (e.g. start-ups and SMEs, large companies, RTOs, universities, etc.)? How can citizens’ perspective be further integrated in practice into TI processes?**
- 13. Are the TIs managed by your organisation well interconnected with other relevant TIs (and RIs) across Europe? If so how? Are there good examples of existing regional/national/EU scheme(s) that enable the creation of structural networks of TIs in specific technology fields (clustering effect) that could be further replicated (incl. EU funded schemes such as H2020 I4MS or INTERREG)? How else could these networks be operationalised? What would be the added values of better interconnecting TIs in a more formalised network for each specific technology field across Europe?**
- 14. In general, what are the types of operational costs that need to be covered during the operational phase of a TI’s lifecycle? How are such costs currently supported in different types of (publicly and privately funded) projects?**
- 15. How is the exploitation of the TI-related results currently facilitated to ensure an efficient technology transfer to the market? What would be needed to strengthen such technology transfer activities, including in terms of policy? What is the role of IPR in that process, and how can sound IP management be further strengthened in TI-related projects? Are the TI-related projects using standardisation as a means for a more efficient market uptake of RD&I, if yes how and if not why?**
- 16. What type of monitoring mechanism(s) do you have in place to provide data on TIs to assess accessibility, performance, ability to deliver on policy priorities, etc.? What type of input/output/impact-based indicators could be monitored in the frame of the ERA scoreboard for TIs?**
- 17. Anything else to add?**

Annex – examples of TIs

Names and focus of the major TIs managed by your organisation (please limit to the max 5 most relevant ones)

– include website link when available:

- **Name of TIs (& URL):**
- **Technology field:**
- **Relevant size-related indicators** e.g. turnover, number of dedicated staff, average number of projects yearly, etc.
- **Is the TI linked to regional/national/EU mapping/programme/label (e.g. DIH, RIS3, ATI, etc.)?** – if yes please provide info (mapping name & URL)

Annex 4 – EARTO Policy Event 2021 - 27 October 2021 – Agenda

| EARTO Policy Event 2021 – 27 October 2021 | |
|--|--|
| Towards the new EU Strategy on Technology Infrastructures as key ERA Action to deliver the green & digital transitions | |
| 10.00-10.05 | Welcome – Muriel Attané , Secretary General, EARTO |
| 10.05-10.20 | In conversation with Antti Vasara , EARTO President and CEO, VTT, Finland |
| 10.20-10.35 | Keynote Speech – Guy Van den Eede , Acting Director, Health, Consumers and Reference Materials (Geel), DG JRC, European Commission |
| 10.35-11.10 | <p>Panel 1 – How the new EU Strategy on Technology Infrastructures should support the EU Industrial Alliances, the EU RD&I Partnerships and the new ERA Industrial Technology Roadmaps?</p> <ul style="list-style-type: none"> • Ulla Engelmann, Acting Director of Networks & Governance, DG GROW, European Commission • Petri Lehmus, Vice President of R&D, Neste Corporation, Finland • Mathias Rauch, Director of Research Programme, Fraunhofer, Germany <p>Reaction by Antti Vasara, EARTO President and CEO, VTT, Finland Moderation by Muriel Attané, Secretary General, EARTO</p> |
| 11.10-11.45 | <p>Panel 2 – Towards the new EU Strategy on Technology Infrastructures – How can Europe support further developments to deliver the green & digital transitions?</p> <ul style="list-style-type: none"> • Martina De Sole, Director, ENoLL • Theo Föllings, Director Business Development at Oost NL-Development Agency East Netherlands and Vanguard Initiative • Jean-Philippe Bourgoin, Deputy Executive Director, CEA Tech, France <p>Reaction by Antti Vasara, EARTO President and CEO, VTT, Finland Moderation by Muriel Attané, Secretary General, EARTO</p> |
| 11.45-12.00 | In conversation with Apostolia Karamali , Head of Unit, R&I Actors and Research Careers, DG Research & Innovation, European Commission (<i>Reaction of the European Commission on the panels' discussions</i>) |

Annex 5 – EARTO-JRC Session on TIs at the CONCORDi Conference 2021 – 25 November 2021 – Agenda

| CONCORDi Conference 2021 - EARTO-JRC Session – 25 November 2021 | |
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| EARTO-JRC Session 1 - Technology Infrastructures: Key enablers for the transition to a sustainable and digital industry | |
| 10.10-10.12 | Introduction – Muriel Attané, Secretary General, EARTO |
| 10.12-10.15 | Video on the role of Technology Infrastructures for Europe’s Prosperity & Sustainable Future , featuring Thomas Kallstenius, CEO, LIST; João Claro, CEO, INESC TEC; Xavier Lopez, CEO, EURECAT; William Scanlon, CEO, Tyndall |
| 10.15-10.30 | Keynote – Towards an integrated European technology infrastructure landscape by Anna Panagopoulou, Director “ERA and Innovation”, Research and Innovation Directorate, General, European Commission |
| 10.30-10.45 | Presentation of JRC Policy Brief on Technology Infrastructures by Fabio Taucer, Deputy Head of Unit Scientific Development, JRC, European Commission |
| 10.45-11.25 | <p>Presentations of Technology Infrastructures’ Case Studies</p> <ul style="list-style-type: none"> • Monica Ringvik, CTO, RISE • Pierre Vadrine, Head of Accelerators, Cryogenics and Magnetism Department, CEA • Anne Van den Bosch, Director Public R&D Policies and Programs, Imec • Dmitri Petrovykh, Corporate Expert, INL • Andrzej Taube, Area Leader at Institute of Microelectronics and Photonics, Łukasiewicz Research Network • Esther Hurtós, R&I Policy and Funding Programmes, EURECAT <p>Panel discussion and Q&A</p> |

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