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INRAE's contribution to the EC's consultation on the European strategy on research and technology infrastructures

Executive summary:

Considering the importance of a research-technology-innovation confluence in the design process of innovations, the European Strategy on research (RI) and technology (TI) infrastructures should adopt a global perspective to avoid the binary categorisation RI/TI. Indeed, a better articulation between the activities supported by infrastructures involved in all steps of the research-technological development – industrial development trajectory should be sought. That means that different types of infrastructures are needed to underpin a vibrant research-innovation continuum. The successful articulation of RIs and TIs is thus crucial to reinforce European innovation, ensure EU competitiveness and demonstrate the added-value of a pan-European strategy.

- **Ensuring a continuum from low TRL (RI) to high TRL (TI)**: there is an imperious need to sustain the provision of adequate support for fundamental research and the corresponding infrastructures. The existing RI landscape must be part of the strategy, ensuring that science communities can leverage the most advanced tools and technologies to advance science and provide foundational knowledge. In this regard, pre-industrial demonstrators are ideal support tools for budding SMEs.

- **Long-term funding**: it is essential for Europe to recognise the need for long-term strategic funding for RIs and TIs. The European Union can better rally national-based organisations, encourage pan-European cooperative initiatives, while rationalising the use of funds, in order to maintain the highest level of excellence. Sustainable infrastructures require long-term support linked to rigorous monitoring processes. It is crucial to ensure that Europe possesses sufficient RI and TI capacity, while reducing duplication and inefficient spending.

- **Consistency of the RI-TI landscape** at the national level and at the European level: several infrastructures focused on the same theme areas can coordinate themselves and bring added value in the R&I system while avoiding duplication. That's why coordination mechanisms between them should be considered as well in the rationalisation process of the landscape. The strategy should build on the regular assessments of the national landscape to identify gaps and needs in terms of new European infrastructures.

- **Management of data** generated by RI/TI: European guidelines and good practices to deal with data generated by RI/TI could help to ensure the storage of those data, the quality of data generated, the property of those data, security, etc. The strategy should integrate key technologies such as AI/ML according to open science principles.

- **Efficient communication** on the simplification of the landscape: The Commission needs to be clear on what TIs will develop, how they will complement RIs access and services.

- **Environmental impact** of infrastructures should remain an important topic, given the significant energy and environmental cost of their implementation and operation.

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INRAE supports initiatives that aim to rationalise and improve the research-technology-innovation, especially when these are designed to reinforce links between research and technology activities, accelerating the process of knowledge transfer and the valorisation of research outcomes with socio-economic partners. However, caution is necessary if the proposal is to create another instrument independent from those already existing. In this case, the danger is to create artificial boundaries and increase the overall financial burden.

INRAE considers that the binary categorisation (i.e., RI and TI) of infrastructures insufficiently reflects actual research-technology-innovation needs. Europe needs a consistent, lean framework designed to provide efficient support to a range of different infrastructure types that underpin a vibrant research-innovation continuum. Operating within a framework of scientific excellence, RIs support primary knowledge production. However, **some RIs perform applied research and technological activities**. These more translational RIs are well-connected to industry and support the conversion of knowledge into new concepts and prototypes. Currently these activities are poorly recognised within the ESFRI framework. TIs are focused on technology development, derisking, debottlenecking and industrial innovation. However, **some TIs include research in their activities.** These TIs are likely to be outliers in a binary RI/TI framework. **The successful articulation of research and technology activities is crucial to reinforce European innovation and ensure EU competitiveness**.

As a world trendsetter in the field of infrastructures, Europe has clearly demonstrated the relevance and added value of a pan-European strategy. Compared to national initiatives, European coordinated ones mobilise and focus critical mass on a range of strategic themes, gathering together the skills, know-how, knowledge, tools, data, experimental platforms, etc. within large infrastructures whose value is greater than the sum of its parts. As demonstrated during the Covid pandemic, Europe's large infrastructures are perfectly purposed to provide the EU with a cutting edge when tackling grand challenges, whether these are related to the reinforcement of European industrial competitiveness and/or sovereignty, or to current and future crisis. The creation of a consistent, confluent research-technology-innovation infrastructure landscape is the most efficient way to support Europe's innovation capabilities.

1. Ensuring a continuum from low TRL (RI) to high TRL (TI)

While the development of a clear vision for TIs is useful, there is an imperious **need to sustain the provision of adequate support for fundamental research and the corresponding infrastructures**. Indeed, weakening of Europe's resolve to support research will inevitably lead to the asphyxiation of the European Union's ability to innovate. In this regard, funding efforts to support and - when relevant - enhance the existing RI landscape must be part of the strategy, ensuring that science communities **can leverage cutting-edge tools** and technologies to advance science and provide foundational knowledge. However, a crucial part of any new strategy must also focus on the translation of fundamental knowledge into innovation. This requires new organisations and instruments that are specifically purposed to achieve this, bridging the gap between academic research and industrial innovation and nurturing multidisciplinary innovation ecosystems. One example of how this can be achieved are so-called pre-industrial demonstrators.

Pre-industrial demonstrators are public-private open-innovation ecosystems that combine parts of RIs and TIs. They draw upon different knowledge resources, mobilise a variety of research practitioners and are purposed to generate prototypes, derisk concepts, develop processes and deliver innovations

that are ready for further industrial development. In this regard, pre-industrial demonstrators are ideal support tools for budding SMEs.

INRAE coordinates several **pre-industrial demonstrators** focused on agricultural innovation and agro-equipment (Agrotechnopôle de Montoldre[1]), food and health (Ferments du futur[2] and MetaGenoPolis[3]) and biotechnology (Toulouse White Biotechnologies[4]). These public-private consortia bring together public research and companies of all sizes within fit for purpose ecosystems that are able to co-design and co-execute ambitious R&D&I projects targeting different levels of technological maturity. The aim of preindustrial demonstrators is to produce high value intellectual property, nurture scientific start-ups, and industrial spin-offs, both being grounded in the translation of fundamental knowledge into industrially relevant innovation. Pre-industrial demonstrators must champion open innovation and other creative cooperation strategies, creating focal points for technology integration that leverage disruptive, cutting edge developments such as data-driven approaches and artificial intelligence (AI) to tackle major challenges in agriculture, food-health and the bioeconomy.

Finally, it is vital to recognise that the proposed dichotomy between RIs and TIs is frequently challenged by RIs that integrate TI activities to achieve purely technological outputs, for example when developing and testing sensors, software or diverse prototypes.

2. Long-term funding

All research-technology-innovation infrastructures incur major costs for research and innovation actors, requiring not only a robust economic/business model but also a long-term commitment of supporting organisations. For example, when strategically important RIs arising from national initiatives bid for ESFRI status the lead organisation must consent to huge investments (both in-cash and in-kind) during the preparation, implementation and early operational phases (i.e., generally for at least 10 years). When this investment is underpinned by similarly long-term financial aid, it is feasible. However, when funding is inconsistent and short-term, the investment incurs significant risk. For this reason, it is essential for Europe to recognise the need for long-term strategic funding for those instruments that are considered to be vital for its scientific excellence, innovation capacity, competitiveness and economic prosperity. In this manner, the European Union can better rally national-based organisations**, encourage pan-European cooperative initiatives, while rationalising**

[1] The **AgroTechnoPôle platform**, launched in early 2022 and supported by INRAE, is positioned to help meet the Agroecology transition challenge and accelerate the development of new technological solutions to meet the challenges of tomorrow's agriculture. Manufacturers of agricultural robotics support the platform through the RobAgri consortium.

[2] **Ferments du Futur** is a public-private partnership set up to accelerate research and innovation in ferments, fermented foods and biopreservation, thereby promoting safer, healthier and more sustainable food systems.

[3] **MetaGenoPolis** (MGP) is an INRAE unit, expert in gut microbiome research applied to health and nutrition. MGP's expertise in the analysis of the gut microbiome and its implications in health & nutrition has been widely recognized in the international scientific community since 2010.

[4] **TWB** provides a concrete response to companies and entrepreneurs in biotechnology to develop products and processes with biobased raw materials, from laboratory level to pre-industrial pilot level. And also, TWB works with the best public research teams to carry out collaborative research and development projects within an original contractual framework, and provide eco-responsible solutions.

the use of funds. It is crucial to ensure that Europe possesses sufficient RI and TI capacity, while reducing duplication and inefficient spending. To achieve this, it is vital to map the RI and TI landscape at both national and European levels and align strategic roadmaps. To achieve this, it is vital to **map the research-technology-innovation infrastructure landscape** at both national and European levels and align strategic roadmaps. This should involve regular consultation of all relevant stakeholders and focus on strategic economic sectors, such as the agri-food industry, bioeconomy (providing support for biotechnology), environment and health. All these sectors are crucial for Europe's competitiveness and sovereignty.

Infrastructure landscape fragmentation and inefficient support mechanisms are problematic. Current financial support is insufficient to maintain the highest level of excellence. This is particularly obvious with regard to AI integration. Many infrastructures do not have the financial means to fully leverage the opportunities offered by AI. Regarding consistency, financial support is accorded on a short-term (often stop-start) basis. Sustainable infrastructures require long-term support linked to rigorous monitoring processes, like those that are implemented by INRAE to assess its infrastructures.

Private sector should be involved in the funding of infrastructures. RIs are catalysts for public-private collaboration and, in some cases, provide the means to perform translational research, ensuring the efficient transfer of new knowledge and emerging methods to the commercial sphere. In this regard, RIs that focus on translational (applied) research must be better recognised and supported within the RI landscape.

3. Consistency of the RI-TI landscape at the national level and at the European level

Maintaining the consistency of the rich European RI and TI landscape should be a goal in itself. The ESFRI roadmap clarifies the existing infrastructures but also identifies the gaps that are to be bridged. It can be from a thematic perspective, from a TRL perspective, the kind of services provided to end-users, etc.

Sometimes several infrastructures may deal with the same thematics, which is not an issue as they can coordinate themselves and bring added value in the R&I system while avoiding duplication. That's why **coordination mechanisms between them should be considered as well in the rationalisation process of the landscape**.

Moreover, the regular assessments of the national landscapes are useful and the EU should build on those analysis to clarify the gaps and the kind of infrastructures to be developed at the EU level, being sure all the communities are included in the landscape. This should be considered in a TI strategy elaborated in close relation with the RI strategy.

To ensure the EU's competitiveness in the face of major competitors, the infrastructure landscape needs to be structured to meet major challenges. By ensuring that RIs and TIs are well coordinated, the EU will be in a position to be more competitive, accelerate innovation and stimulate its innovation potential.

4. Management of data generated by RI/TI

RI/TI are key producers of data. The challenge that can be addressed is how to ensure the storage of those data, to ensure the quality of data generated, the property of those data, security, etc. and European guidelines and good practices to deal with data generated by RI/TI could help.
If RI/TI need money for the everyday functioning, they also need funding to store the data and to be able to have long series of data. Dedicated resources are very much needed in particular when it comes to climate change or addressing other environmental issues.
Building on the developments of the EOSC federation, the strategy for European research and technology infrastructures should ensure that the integration of technologies such as AI and Machine Learning is based on the principles of open science. We need to engage with industry in order to provide data that are FAIR by design.

5. **Efficient communication on the simplification of the landscape**

Creating a community of end-users around an infrastructure is key to its operation. It's a question of communicating, training, and also capturing the infrastructure's development needs to better serve the community. The process should be seen as a win-win strategy since it is beneficial not only for end-users (e.g., having access to cutting-edge infrastructures) but also for the operators and managers of infrastructure (e.g., being stimulated - and paid for - for continuously updating equipment and improving services).
Therefore, the definitions used by the Commission mention for both RIs and TIs the role they play in developing key technologies, leaving the distinction between TIs and RIs unclear. The risk is by simplifying the landscape to make it even more difficult to understand, leading to confusion, redundancy, and, possibly lead to double-funding. The Commission needs to be clear on what TIs will develop, how they will complement RIs access and services.

6. **Environmental impact of infrastructures should be considered and kept to a minimum**

Finally, in line with the new ESFRI requirements and the growing importance of this theme, the strategy must continue to consider the environmental impact of Infrastructures. Energy consumption of RIs and TIs, the environmental impact of building and operating them, their carbon footprint and level of sustainability are matter of concern, including within scientific communities themselves. Priority should be given when possible to smart and sober techniques.

7. **RIs and TIs in the field of agriculture, food and the environment at INRAE**

To carry out its research as close as possible to the reality of farmers and other local stakeholders, INRAE relies on a network of 75 experimental units (EU) and facilities (IE) spread throughout mainland France and Guadeloupe. These sites provide an ideal opportunity for scientists to test, refine and validate innovative solutions. Many EUs and IEs co-design the corresponding experiments with industry and local players (farmers, local authorities, technical and training institutes, cooperatives, the agri-food sector, etc.), taking account of their issues and expertise.
By focusing on every link in the chain, from plant varieties that are more resistant to pests to the implementation of innovative agricultural production systems, INRAE's teams of scientists and technicians are testing new approaches and designing breakthrough systems. They focus on studying the economic, social and environmental performance of the options explored. Sustainable practices,

farm incomes, organising and reducing the drudgery of work, outlets in processing industries, improving the food autonomy of livestock farms and animal welfare are all components of the Institute's work, some of which is part of local food projects.

In addition, INRAE is coordinating several national RIs in its speciality areas, such as agricultural experimentation in the broadest sense, plant phenotyping, metabolomics, forestry, bioresources, biotechnologies or food sciences. INRAE also lends its support to generic RIs or those run jointly by several institutions in the areas of genomics, bioinformatics, experimental ecology, biodiversity, terrestrial and ecosystem observation, data and remote sensing. Some of these RIs are already part of ESFRI infrastructures in the field of environment (ICOS), life sciences (EIRENE, ELIXIR, EMPHASIS, MIRRI), biotechnology (IBISBA, coordinated by INRAE) or projected RIs (e.g., eLTER).